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:NKG DATE:07/21/11

CHECKED BY:JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.1 Unveg	1.1 Veg		1.2 Unveg	1.2 Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	12.00	12.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	3.35	5.53		4.00	6.70
CHANNEL SIDE SLOPES (H:V)	2	2		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.33	0.50		0.33	0.50
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	4:1		6:1	1:1
A (AREA IN SQ. FT.)	.89	1.50		.97	1.73
R (HYDRAULIC RADIUS)	0.25	0.35		0.24	0.34
S (BED SLOPE, FT/FT)*	0.1000	0.1000		0.0521	0.0521
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0400	0.0840		0.0550	0.124
V (AT FLOW DEPTH d, CFS)	4.72	2.79		2.37	1.33
Q (AT FLOW DEPTH d, CFS)	4.2	4.2		2.30	2.30
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0384	0.1341		0.0724	0.2948
$.7S_c$	0.0268	0.0938		0.0506	0.0471
$1.3S_c$	0.0499	0.1743		0.0941	0.0875
STABLE FLOW? (Y/N)	Y	Y		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		1.17	-
FREEBOARD BASED ON STABLE FLOW FT	1.16	0.62		-	0.72
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	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.37	0.72		1.08	0.64
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.0	8.0		1.55	4.20

* 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		1.4 Unveg	1.4 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	16.50	16.50		10.00	10.00
CHANNEL TOP WIDTH (FT)@ d	12.50	12.62		4.49	6.13
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		1.0	1.0
d (FLOW DEPTH IN FT)	1.58	2.13		0.58	0.83
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	1:1		2:1	1:1
A (AREA IN SQ. FT.)	12.18	19.96		1.57	2.89
R (HYDRAULIC RADIUS)	0.94	1.21		0.34	0.46
S (BED SLOPE, FT/FT)*	0.0049	0.0049		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0310	0.0590		0.053	0.121
V (AT FLOW DEPTH d, CFS)	3.26	1.99		1.91	1.04
Q (AT FLOW DEPTH d, CFS)	39.7	39.7		3.0	3.0
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0149	0.0536		0.0610	0.285
$.7S_c$	0.0104	0.0375		0.0427	.1995
$1.3S_c$	0.0193	0.0696		.0793	0.3705
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.67	.065		0.92	0.64
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.25	2.25		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	0.48	0.65		0.73	1.07
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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	1.5 Unveg	1.5 Veg		1.6 Unveg	1.6 Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	8.00	8.00		10.00	10.00
CHANNEL TOP WIDTH (FT)@ d	4.97	5.88		5.69	6.74
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)	0.74	0.97		0.91	1.18
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		2:1	2:1
A (AREA IN SQ. FT.)	2.59	3.79		1.33	5.17
R (HYDRAULIC RADIUS)	0.49	0.60		3.50	0.71
S (BED SLOPE, FT/FT)*	0.0451	0.0451		0.0133	0.0133
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0350	0.0600		0.0460	0.0770
V (AT FLOW DEPTH d, CFS)	5.53	3.77		2.60	1.76
Q (AT FLOW DEPTH d, CFS)	14.3	14.3		9.10	9.10
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0243	0.0669		0.0398	0.1048
$.7S_c$	0.0170	0.0468		0.0278	0.0733
$1.3S_c$	0.0315	0.0869		0.0517	0.1362
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.76	0.53		1.08	0.81
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
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)	V/S	V/S		V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	2.09	2.72		0.77	0.99
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	8.00		1.55	4.20

* 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	1.7 Unveg	1.7 Veg		1.8 Unveg	1.8 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	16.00	16.00		18.75	18.75
CHANNEL TOP WIDTH (FT)@ d	11.56	12.75		13.32	15.44
CHANNEL SIDE SLOPES (H:V)	3	3		2,3	2,3
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		5.0	5.0
d (FLOW DEPTH IN FT)	0.48	0.77		1.44	2.08
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	4:1		3:1	2:1
A (AREA IN SQ. FT.)	2.12	4.05		12.39	21.26
R (HYDRAULIC RADIUS)	0.35	0.52		0.97	1.31
S (BED SLOPE, FT/FT)*	0.0111	0.0111		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.055	0.136		0.0220	0.0460
V (AT FLOW DEPTH d, CFS)	1.42	0.74		6.67	3.89
Q (AT FLOW DEPTH d, CFS)	3.0	3.0		82.70	82.70
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0713	0.3684		0.0125	0.0296
$.7S_c$	0.0499	0.2578		0.0087	0.0207
$1.3S_c$	0.0926	0.4789		0.0162	0.0384
STABLE FLOW? (Y/N)	Y	Y		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		1.09	-
FREEBOARD BASED ON STABLE FLOW FT	0.74	.54		-	0.66
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.0	1.0		2.75	2.75
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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.33	0.53		0.90	1.30
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.00	8.00

* 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	1.9 Unveg	1.9 Veg		1.10 Unveg	1.10 Veg
PROTECTIVE LINING **	SC250	SC250		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	19.00	19.00		8.00	8.00
CHANNEL TOP WIDTH (FT)@ d	9.35	11.13		4.25	4.91
CHANNEL SIDE SLOPES (H:V)	3,6	3,6		2	2
CHANNEL BOTTOM WIDTH (FT)	1.0	1.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.82	1.13		0.51	0.72
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1:1	1:1		4:1	3:1
A (AREA IN SQ. FT.)	3.87	6.82		1.53	2.47
R (HYDRAULIC RADIUS)	0.45	0.60		0.36	0.47
S (BED SLOPE, FT/FT)*	0.0270	0.0270		0.0477	0.0477
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0340	0.0720		0.0400	0.0780
V (AT FLOW DEPTH d, CFS)	4.24	2.40		4.11	2.55
Q (AT FLOW DEPTH d, CFS)	16.4	16.4		6.3	6.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0379	0.0915		0.0482	0.1212
$.7S_c$	0.0265	0.0640		0.0337	0.0848
$1.3S_c$	0.0492	0.1189		0.0626	0.1575
STABLE FLOW? (Y/N)	N	Y		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	1.07	-		0.94	-
FREEBOARD BASED ON STABLE FLOW FT	-	0.87		-	0.77
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		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	9.5	15.0		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.39	1.90		1.51	2.14
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.0	8.0		3.0	8.0

* 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	1.11 Unveg	1.11 Veg		1.12 Unveg	1.12 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		8.50	8.50
CHANNEL TOP WIDTH (FT)@ d	5.03	7.13		4.20	5.25
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.5	2.5
d (FLOW DEPTH IN FT)	0.46	0.75		0.28	0.45
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	3:1		9:1	6:1
A (AREA IN SQ. FT.)	1.56	3.20		0.94	1.74
R (HYDRAULIC RADIUS)	0.32	0.47		0.22	0.33
S (BED SLOPE, FT/FT)*	0.0127	0.0127		0.1000	0.1000
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.055	0.148		0.040	0.0970
V (AT FLOW DEPTH d, CFS)	1.41	0.69		4.27	2.30
Q (AT FLOW DEPTH d, CFS)	2.2	2.2		4.0	4.0
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0650	0.0650		0.0394	0.2041
$.7S_c$	0.0455	0.0455		0.0275	0.1428
$1.3S_c$	0.0845	0.0845		0.0512	0.2653
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.99	0.64		0.72	0.54
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.50	1.50		1.0	1.0
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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.36	0.60		1.75	2.82
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.0	8.00

* Slopes may not be averaged.
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*** Minimum Freeboard,F, is 0.5 ft.
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CHANNEL OR CHANNEL SECTION	1.13 Unveg	1.13 Veg		1.14 Unveg	1.14 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	10.00	10.00		8.00	8.00
CHANNEL TOP WIDTH (FT)@ d	3.20	6.33		3.68	4.83
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)	0.71	1.03		0.36	0.61
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		6:1	3:1
A (AREA IN SQ. FT.)	2.42	4.16		0.99	1.97
R (HYDRAULIC RADIUS)	0.47	0.63		0.27	0.42
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0500	0.106		0.0550	0.144
V (AT FLOW DEPTH d, CFS)	1.78	1.03		1.61	0.81
Q (AT FLOW DEPTH d, CFS)	4.3	4.3		1.6	1.6
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0025	0.2031		0.0687	0.4160
$.7S_c$	0.0017	0.1421		0.0480	0.2912
$1.3S_c$	0.0032	0.2640		0.0893	0.5408
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.70	0.92		1.80	0.79
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		1.5	1.5
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	0.64		0.45	0.76
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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	1.15 Unveg	1.15 Veg		1.16 Unveg	1.16 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	8.25	9.92		5.17	6.04
CHANNEL SIDE SLOPES (H:V)	3	3		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.88	1.15		0.79	1.00
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	3:1		3:1	2:1
A (AREA IN SQ. FT.)	4.94	7.43		2.84	4.03
R (HYDRAULIC RADIUS)	0.58	0.72		0.51	0.62
S (BED SLOPE, FT/FT)*	0.0112	0.0112		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0460	0.0810		0.0480	0.0780
V (AT FLOW DEPTH d, CFS)	2.35	1.56		2.78	1.96
Q (AT FLOW DEPTH d, CFS)	11.6	11.6		7.9	7.9
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0383	0.1104		0.0449	0.1119
$.7S_c$	0.0268	0.0772		0.0314	0.0783
$1.3S_c$	0.0497	0.1435		0.0583	0.1454
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.13	0.85		1.21	0.99
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	0.61	0.80		0.99	1.25
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.17 Unveg	1.17 Veg		1.18 Unveg	1.18 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		17.00	17.00
CHANNEL TOP WIDTH (FT)@ d	4.84	6.18		7.21	9.55
CHANNEL SIDE SLOPES (H:V)	2	2		3,4	3,4
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.44	0.70		0.59	0.90
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	7:1	4:1		5:1	3:1
A (AREA IN SQ. FT.)	1.70	3.10		3.02	5.51
R (HYDRAULIC RADIUS)	0.34	0.50		0.41	0.58
S (BED SLOPE, FT/FT)*	0.0133	0.0133		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.0550		0.0530	0.121
V (AT FLOW DEPTH d, CFS)	1.53	0.84		1.56	0.85
Q (AT FLOW DEPTH d, CFS)	2.6	2.6		4.7	4.7
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0649	0.3124		0.0561	0.2599
$.7S_c$	0.0454	0.2186		0.0392	0.1819
$1.3S_c$	0.0843	0.4061		0.0729	0.3378
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.04	0.71		1.40	1.06
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		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	0.58		0.37	0.56
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.19 Unveg	1.19 Veg		1.20 Unveg	1.20 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	19.25	19.25		31.00	31.00
CHANNEL TOP WIDTH (FT)@ d	6.31	8.54		9.13	11.11
CHANNEL SIDE SLOPES (H:V)	3, 3.5	3, 3.5		3	3
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		5.0	5.0
d (FLOW DEPTH IN FT)	0.48	0.78		0.66	0.94
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	4:1		10:1	7:1
A (AREA IN SQ. FT.)	2.17	4.31		4.60	7.35
R (HYDRAULIC RADIUS)	0.35	0.52		0.50	0.67
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0091	0.0091
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.1430		0.0510	0.100
V (AT FLOW DEPTH d, CFS)	1.34	0.67		1.74	1.09
Q (AT FLOW DEPTH d, CFS)	2.9	2.9		8.0	8.0
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0630	0.3722		0.0561	0.2215
$.7S_c$	0.0441	0.2605		0.3927	0.1550
$1.3S_c$	0.0819	0.4838		0.0729	0.2879
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.99	1.65		2.81	2.48
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.5	2.5		3.5	3.5
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	0.30	0.49		0.37	0.53
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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.

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.21 Unveg	1.21 Veg		1.22 Unveg	1.22 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	7.5	7.00		26.00	26.00
CHANNEL TOP WIDTH (FT)@ d	3.63	4.54		8.47	10.69
CHANNEL SIDE SLOPES (H:V)	2	2		3	3
CHANNEL BOTTOM WIDTH (FT)	1.5	1.5		5.0	5.0
d (FLOW DEPTH IN FT)	0.51	0.74		0.56	0.85
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		9:1	6:1
A (AREA IN SQ. FT.)	1.28	2.19		3.78	6.43
R (HYDRAULIC RADIUS)	0.34	0.46		0.44	0.62
S (BED SLOPE, FT/FT)*	0.0235	0.0235		0.0091	0.0091
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.114		0.0540	0.1140
V (AT FLOW DEPTH d, CFS)	2.02	1.18		1.53	0.90
Q (AT FLOW DEPTH d, CFS)	2.60	2.60		5.80	5.80
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0667	0.2629		0.0588	0.2973
$.7S_c$	0.0466	0.1840		0.0411	0.2081
$1.3S_c$	0.0867	0.3417		0.0764	0.3864
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.97	0.74		2.92	2.55
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		3.50	3.50
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	0.75	1.08		0.32	0.48
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.23 Unveg	1.23 Veg		1.24 Unveg	1.24 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	3.97	5.13		5.15	6.02
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)	0.45	0.69		0.79	1.00
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	3:1		3:1	2:1
A (AREA IN SQ. FT.)	1.32	2.34		2.82	4.00
R (HYDRAULIC RADIUS)	0.33	0.46		0.51	0.62
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.122		0.0480	0.0790
V (AT FLOW DEPTH d, CFS)	1.82	1.02		2.77	1.95
Q (AT FLOW DEPTH d, CFS)	2.40	2.40		7.8	7.8
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0662	0.2914		0.0450	0.1120
$.7S_c$	0.0463	0.2039		0.0315	0.0784
$1.3S_c$	0.0860	0.3788		0.0585	0.1456
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.01	0.72		0.71	0.50
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		1.5	1.5
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	0.57	0.86		0.98	1.25
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.25 Unveg	1.25 Veg		1.26 Unveg	1.26 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	10.50	10.50		10.00	10.00
CHANNEL TOP WIDTH (FT)@ d	5.28	6.50		6.14	7.40
CHANNEL SIDE SLOPES (H:V)	2, 5.5	2, 5.5		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.30	0.46		1.03	1.35
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	10:1	7:1		2:1	1:1
A (AREA IN SQ. FT.)	1.23	2.17		4.18	6.32
R (HYDRAULIC RADIUS)	0.23	0.33		0.63	0.79
S (BED SLOPE, FT/FT)*	0.0571	0.0571		0.0101	0.0101
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.1230		0.0430	0.0750
V (AT FLOW DEPTH d, CFS)	2.43	1.38		2.56	1.69
Q (AT FLOW DEPTH d, CFS)	3.0	3.0		10.7	10.7
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0725	0.3231		0.0338	0.0962
$.7S_c$	0.0507	0.2261		0.0236	0.0673
$1.3S_c$	0.0942	0.4200		0.0439	0.1250
STABLE FLOW? (Y/N)	N	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	0.70	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	-	0.53		0.97	0.65
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.0	1.0		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	1.07	1.64		0.65	0.85
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.27 Unveg	1.27 Veg		1.28 Unveg	1.28 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	10.50	10.50		8.00	8.00
CHANNEL TOP WIDTH (FT)@ d	6.07	8.86		6.33	8.02
CHANNEL SIDE SLOPES (H:V)	2, 5.5	2, 5.5		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.41	0.77		1.08	1.50
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	7:1	4:1		2:1	1:1
A (AREA IN SQ. FT.)	1.84	4.51		4.47	7.49
R (HYDRAULIC RADIUS)	0.30	0.50		0.66	0.86
S (BED SLOPE, FT/FT)*	0.0571	0.0571		0.0059	0.0059
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.1910		0.0420	0.084
V (AT FLOW DEPTH d, CFS)	2.88	1.17		2.06	1.23
Q (AT FLOW DEPTH d, CFS)	5.3	5.3		9.2	9.2
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0669	0.6798		0.0319	0.1174
$.7S_c$	0.0468	0.4758		0.0223	0.0821
$1.3S_c$	0.0869	0.8837		0.0414	0.1526
STABLE FLOW? (Y/N)	N	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	1.09	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	-	0.72		1.17	0.74
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
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)	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	1.45	2.73		0.40	0.55
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	1.29 Unveg	1.29 Veg		1.30 Unveg	1.30 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	3.38	4.25		3.38	4.47
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)	0.33	0.51		0.31	0.52
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	4:1		6:1	4:1
A (AREA IN SQ. FT.)	0.89	1.52		0.82	1.56
R (HYDRAULIC RADIUS)	0.25	0.36		0.24	0.36
S (BED SLOPE, FT/FT)*	0.0476	0.0476		0.0343	0.0343
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.1180		0.0550	0.1370
V (AT FLOW DEPTH d, CFS)	2.37	1.38		1.94	1.03
Q (AT FLOW DEPTH d, CFS)	2.1	2.1		1.6	1.6
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0721	0.2950		0.0721	0.3890
$.7S_c$	0.5047	0.2065		0.0504	0.2723
$1.3S_c$	0.0937	0.3835		0.0937	0.5057
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.15	0.94		1.15	0.88
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	0.99	1.50		0.67	1.10
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

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	10.00	10.00		14.00	14.00
CHANNEL TOP WIDTH (FT)@ d	5.84	7.25		7.76	9.63
CHANNEL SIDE SLOPES (H:V)	2	2		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.95	1.31		0.95	1.27
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	2:1		2:1	2:1
A (AREA IN SQ. FT.)	3.72	6.03		4.64	7.36
R (HYDRAULIC RADIUS)	0.59	0.77		0.58	0.73
S (BED SLOPE, FT/FT)*	0.0080	0.0080		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0450	0.0860		0.0450	0.0830
V (AT FLOW DEPTH d, CFS)	2.10	1.29		2.31	1.45
Q (AT FLOW DEPTH d, CFS)	7.8	7.8		10.7	10.7
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0377	0.1274		0.0368	0.1158
$.7S_c$	0.0263	0.0891		0.0257	0.0810
$1.3S_c$	0.0490	0.1656		0.0478	0.1505
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.04	0.69		1.04	0.73
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	0.48	0.65		0.60	0.79
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	2.3 Unveg	2.3 Veg		2.4 Unveg	2.4 Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	15.50	15.50		14.00	14.00
CHANNEL TOP WIDTH (FT)@ d	10.67	14.48		6.58	9.39
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	1.44	2.08		0.74	1.16
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	1:1		3:1	2:1
A (AREA IN SQ. FT.)	9.10	17.20		3.13	6.40
R (HYDRAULIC RADIUS)	0.82	1.13		0.47	0.68
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0050	0.0050
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0220	0.0510		0.0500	0.1300
V (AT FLOW DEPTH d, CFS)	5.96	3.15		1.28	0.62
Q (AT FLOW DEPTH d, CFS)	54.20	54.20		4.00	4.00
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0079	0.0380		0.0482	0.2867
$.7S_c$	0.0055	0.0266		0.0337	0.2006
$1.3S_c$	0.0102	0.0494		0.0626	0.3727
STABLE FLOW? (Y/N)	N	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	1.31	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	-	0.67		1.24	0.77
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.75	2.75		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	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.90	1.30		0.23	0.36
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.0	8.0		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	2.5 Unveg	2.5 Veg		2.6 Unveg	2.6 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	8.00	8.00		15.50	15.50
CHANNEL TOP WIDTH (FT)@ d	4.87	5.75		9.17	12.30
CHANNEL SIDE SLOPES (H:V)	2	2		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.71	0.93		1.19	1.71
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		2:1	1:1
A (AREA IN SQ. FT.)	2.44	3.59		6.61	12.18
R (HYDRAULIC RADIUS)	0.47	0.58		0.70	0.95
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0500	0.0850		0.0270	0.0610
V (AT FLOW DEPTH d, CFS)	2.54	1.73		4.37	2.37
Q (AT FLOW DEPTH d, CFS)	6.2	6.2		28.9	28.9
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0500	0.1353		0.0125	0.0575
$.7S_c$	0.0350	0.0947		0.0087	0.0402
$1.3S_c$	0.0650	0.1758		0.0162	0.0747
STABLE FLOW? (Y/N)	Y	Y		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		1.05	-
FREEBOARD BASED ON STABLE FLOW FT	0.78	0.56		-	0.53
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		2.25	2.25
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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.89	1.16		0.74	1.07
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.0	8.0

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	2.7 Unveg	2.7 Veg			
PROTECTIVE LINING **	S75	Grass			
CHANNEL TOP WIDTH (FT)@ D	14.00	14.00			
CHANNEL TOP WIDTH (FT)@ d	5.85	8.42			
CHANNEL SIDE SLOPES (H:V)	3	3			
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0			
d (FLOW DEPTH IN FT)	0.61	0.93			
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1			
A (AREA IN SQ. FT.)	2.34	4.44			
R (HYDRAULIC RADIUS)	0.40	0.56			
S (BED SLOPE, FT/FT)*	0.0100	0.0100			
VEGETATIVE LINING RETARDANCE	-	C			
n (MANNING'S COEFFICIENT)**	0.0520	0.125			
V (AT FLOW DEPTH d, CFS)	1.54	0.81			
Q (AT FLOW DEPTH d, CFS)	3.6	3.6			
Q_r (REQUIRED CAPACITY) CFS	-	-			
S_c (CRITICAL SLOPE)	0.0611	0.3862			
$.7S_c$	0.0427	0.2703			
$1.3S_c$	0.0794	0.5020			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-			
FREEBOARD BASED ON STABLE FLOW FT	1.36	0.93			
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	0.58			
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20			

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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.1 Unveg	3.1 Veg		3.2 Unveg	3.2 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	8.00	8.00		17.00	17.00
CHANNEL TOP WIDTH (FT)@ d	4.90	5.66		10.17	13.84
CHANNEL SIDE SLOPES (H:V)	2	2		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.72	0.91		1.37	1.97
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		1:1	1:1
A (AREA IN SQ. FT.)	2.48	3.47		8.34	15.56
R (HYDRAULIC RADIUS)	0.47	0.57		0.78	1.08
S (BED SLOPE, FT/FT)*	0.0250	0.0250		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0500	0.0790		0.0230	0.0540
V (AT FLOW DEPTH d, CFS)	2.86	2.05		5.43	2.91
Q (AT FLOW DEPTH d, CFS)	7.1	7.0		45.3	45.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0498	0.1176		0.0087	0.0433
$.7S_c$	0.0348	0.0823		0.0060	0.0303
$1.3S_c$	0.0647	0.1528		0.0113	0.0562
STABLE FLOW? (Y/N)	Y	Y		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		1.14	-
FREEBOARD BASED ON STABLE FLOW FT	0.77	0.59		-	0.53
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		2.5	2.5
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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.12	1.42		0.85	1.23
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.00	8.00

* 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.

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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.3 Unveg	3.3 Veg		3.4 Unveg	3.4 Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	32.00	32.00		8.00	8.00
CHANNEL TOP WIDTH (FT)@ d	9.48	12.65		4.99	5.76
CHANNEL SIDE SLOPES (H:V)	3	3		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	1.24	1.78		0.75	0.93
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	1:1		3:1	2:1
A (AREA IN SQ. FT.)	7.08	13.06		2.61	3.60
R (HYDRAULIC RADIUS)	0.72	0.99		0.49	0.58
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0250	0.0250
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0260	0.0580		0.0490	0.0770
V (AT FLOW DEPTH d, CFS)	4.64	2.52		2.95	2.14
Q (AT FLOW DEPTH d, CFS)	32.90	32.90		7.7	7.7
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0114	0.0515		0.0475	0.1110
$.7S_c$	0.0079	0.0360		0.0332	0.0777
$1.3S_c$	0.0148	0.0669		0.0617	0.1443
STABLE FLOW? (Y/N)	N	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	3.75	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	-	3.22		0.75	0.56
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	5.0	5.0		1.5	1.5
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	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.77	1.11		1.17	1.45
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	8.00		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.5 Unveg	3.5 Veg		3.6 Unveg	3.6 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	10.00	10.00		26.00	26.00
CHANNEL TOP WIDTH (FT)@ d	5.98	7.40		7.17	8.66
CHANNEL SIDE SLOPES (H:V)	2	2		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.99	1.35		0.86	1.11
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	1:1		2:1	2:1
A (AREA IN SQ. FT.)	3.94	6.32		3.94	5.88
R (HYDRAULIC RADIUS)	0.61	0.79		0.53	0.65
S (BED SLOPE, FT/FT)*	0.0080	0.0080		0.0400	0.0400
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0440	0.0830		0.0330	0.0570
V (AT FLOW DEPTH d, CFS)	2.18	1.36		5.89	3.94
Q (AT FLOW DEPTH d, CFS)	8.6	8.6		23.2	23.2
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0357	0.1179		0.0204	0.0567
$.7S_c$	0.0249	0.0825		0.0142	0.0396
$1.3S_c$	0.0464	0.1532		0.0265	0.0737
STABLE FLOW? (Y/N)	Y	Y		Y	N
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	2.89
FREEBOARD BASED ON STABLE FLOW FT	1.00	0.65		3.14	-
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.0	2.0		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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.49	0.67		2.15	2.76
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.00	8.00

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

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	23.00	23.00		23.00	23.00
CHANNEL TOP WIDTH (FT)@ d	5.30	6.49		4.20	4.99
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)	0.56	0.82		0.29	0.45
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	5:1	4:1		10:1	7:1
A (AREA IN SQ. FT.)	2.33	3.82		1.06	1.77
R (HYDRAULIC RADIUS)	0.42	0.57		0.24	0.35
S (BED SLOPE, FT/FT)*	0.0133	0.0133		0.0500	0.0500
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0540	0.1080		0.0550	0.1180
V (AT FLOW DEPTH d, CFS)	1.80	1.10		2.36	1.41
Q (AT FLOW DEPTH d, CFS)	4.2	4.2		2.5	2.5
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0592	0.2141		0.0723	0.2929
$.7S_c$	0.0414	0.1498		0.0506	0.2050
$1.3S_c$	0.0769	0.2783		0.0939	0.3807
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	4.43	4.13		4.70	4.50
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	5.0	5.0		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	0.47	0.68		0.92	1.42
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.9 Unveg	3.9 Veg		3.10 Unveg	3.10 Veg
PROTECTIVE LINING **	SC250	SC250		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	10.50	10.50		9.00	9.00
CHANNEL TOP WIDTH (FT)@ d	4.91	5.83		6.13	6.96
CHANNEL SIDE SLOPES (H:V)	2, 3	2,3		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.38	0.56		0.79	0.99
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	8:1	5:1		4:1	3:1
A (AREA IN SQ. FT.)	1.50	2.48		3.61	4.90
R (HYDRAULIC RADIUS)	0.30	0.40		0.55	0.66
S (BED SLOPE, FT/FT)*	0.0667	0.0667		0.0500	0.0500
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0400	0.0820		0.0340	0.0530
V (AT FLOW DEPTH d, CFS)	4.27	2.58		6.51	4.80
Q (AT FLOW DEPTH d, CFS)	6.4	6.4		23.5	23.5
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0359	0.1363		0.0218	0.0500
$.7S_c$	0.0251	0.0954		0.0152	0.0350
$1.3S_c$	0.0466	0.1771		0.0283	0.0650
STABLE FLOW? (Y/N)	Y	Y		Y	N
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	0.51
FREEBOARD BASED ON STABLE FLOW FT	1.12	0.93		0.72	-
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	9.5	15.0		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.58	2.34		2.46	3.07
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	8.00		3.00	8.00

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.11 Unveg	3.11 Veg		3.12 Unveg	3.12 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	6.00	6.00		9.00	9.00
CHANNEL TOP WIDTH (FT)@ d	0.65	1.14		5.49	6.35
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	0.0	0.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.20	0.35		0.62	0.83
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	0:1	0:1		5:1	4:1
A (AREA IN SQ. FT.)	0.08	0.24		2.62	3.89
R (HYDRAULIC RADIUS)	0.09	0.16		0.45	0.58
S (BED SLOPE, FT/FT)*	0.0571	0.0571		0.0381	0.0381
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.2500		0.0380	0.066
V (AT FLOW DEPTH d, CFS)	1.28	0.41		4.54	3.06
Q (AT FLOW DEPTH d, CFS)	0.1	0.1		11.9	11.9
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.1181	2.0192		0.0288	0.0808
$.7S_c$	0.0826	1.4134		0.0201	0.0565
$1.3S_c$	0.1535	2.6249		0.0374	0.1050
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.34	1.21		0.88	0.66
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		1.5	1.5
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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.70	1.24		1.47	1.98
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.00	8.00

* 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: NKG DATE: 07/22/11

CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.13 Unveg	3.13 Veg		3.14 Unveg	3.14 Veg
PROTECTIVE LINING **	SC250	SC250		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	9.00	9.00		10.00	10.00
CHANNEL TOP WIDTH (FT)@ d	4.33	4.95		6.62	8.56
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)	0.33	0.48		1.16	1.63
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	9:1	6:1		2:1	1:1
A (AREA IN SQ. FT.)	1.20	1.92		5.00	8.60
R (HYDRAULIC RADIUS)	0.27	0.37		0.70	0.92
S (BED SLOPE, FT/FT)*	0.1000	0.1000		0.0136	0.0136
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0400	0.0790		0.0270	0.0570
V (AT FLOW DEPTH d, CFS)	4.90	3.08		5.00	2.91
Q (AT FLOW DEPTH d, CFS)	5.9	5.9		25.0	25.0
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0373	0.1320		0.0130	0.0529
$.7S_c$	0.0261	0.0924		0.0091	0.0370
$1.3S_c$	0.0484	0.1716		0.0169	0.0687
STABLE FLOW? (Y/N)	Y	N		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	1.01		1.09	-
FREEBOARD BASED ON STABLE FLOW FT	1.17	-		-	0.61
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		2:25	2.25
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	9.5	15.0		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	2.05	3.02		0.98	
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	8.00		3.00	8.00

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	3.15			3.16	
PROTECTIVE LINING **	CONC			CONC	
CHANNEL TOP WIDTH (FT)@ D	10.00			10.00	
CHANNEL TOP WIDTH (FT)@ d	3.97			4.26	
CHANNEL SIDE SLOPES (H:V)	2			2	
CHANNEL BOTTOM WIDTH (FT)	2.0			2.0	
d (FLOW DEPTH IN FT)	0.49			0.57	
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1			3:1	
A (AREA IN SQ. FT.)	1.47			1.77	
R (HYDRAULIC RADIUS)	0.35			0.39	
S (BED SLOPE, FT/FT)*	0.2130			0.2130	
VEGETATIVE LINING RETARDANCE	-			-	
n (MANNING'S COEFFICIENT)**	0.0200			0.0200	
V (AT FLOW DEPTH d, CFS)	17.04			18.34	
Q (AT FLOW DEPTH d, CFS)	25.1			32.5	
Q_r (REQUIRED CAPACITY) CFS	-			-	
S_c (CRITICAL SLOPE)	0.0087			0.0085	
$.7S_c$	0.0060			0.0059	
$1.3S_c$	0.0113			0.0110	
STABLE FLOW? (Y/N)	Y			Y	
FREEBOARD BASED ON UNSTABLE FLOW FT	-			-	
FREEBOARD BASED ON STABLE FLOW FT	1.51			1.43	
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)	S			S	
V_a (ALLOWABLE VELOCITY) FPS	14.5			14.5	
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	6.56			7.52	
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	N/A			N/A	

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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	5.1 Unveg	5.1 Veg		5.2 Unveg	5.2 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	12.00	12.00		15.00	15.00
CHANNEL TOP WIDTH (FT)@ d	7.40	8.60		7.90	9.79
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.73	0.93		0.81	1.13
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4:1	3:1		4:1	3:1
A (AREA IN SQ. FT.)	3.78	5.36		4.43	7.19
R (HYDRAULIC RADIUS)	0.50	0.60		0.54	0.71
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0500	0.0810		0.0340	0.0660
V (AT FLOW DEPTH d, CFS)	2.65	1.86		4.13	2.54
Q (AT FLOW DEPTH d, CFS)	10.0	10.0		18.3	18.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0474	0.1167		0.0213	0.0737
$.7S_c$	0.0331	0.0816		0.0149	0.0515
$1.3S_c$	0.0616	0.1517		0.0276	0.0958
STABLE FLOW? (Y/N)	Y	Y		N	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		1.18	-
FREEBOARD BASED ON STABLE FLOW FT	0.77	0.57		-	0.87
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.91	1.16		1.02	1.41
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.00	8.00

* Slopes may not be averaged.
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*** 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	5.3 Unveg	5.3 Veg		5.4 Unveg	5.4 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	6.06	7.65		7.17	9.06
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.67	0.94		0.86	1.17
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		2:1	2:1
A (AREA IN SQ. FT.)	2.70	4.50		3.92	6.45
R (HYDRAULIC RADIUS)	0.43	0.57		0.53	0.69
S (BED SLOPE, FT/FT)*	0.0150	0.0150		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0510	0.1020		0.0470	0.0920
V (AT FLOW DEPTH d, CFS)	2.04	1.22		2.07	1.26
Q (AT FLOW DEPTH d, CFS)	5.5	5.5		8.1	8.1
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0518	0.1899		0.0413	0.1454
$.7S_c$	0.0362	0.1329		0.0289	0.1017
$1.3S_c$	0.0673	0.2468		0.0536	0.1890
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.32	1.06		1.14	0.82
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	0.63	0.88		0.53	0.73
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	5.5 Unveg	5.5 Veg		5.6 Unveg	5.6 Veg
PROTECTIVE LINING **	SC250	SC250		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		13.00	13.00
CHANNEL TOP WIDTH (FT)@ d	7.08	8.94		7.85	10.34
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)	1.27	1.73		1.45	2.09
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	1:1		1:1	1:1
A (AREA IN SQ. FT.)	5.77	9.43		7.11	12.92
R (HYDRAULIC RADIUS)	0.75	0.97		0.84	1.14
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0125	0.0125
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0250	0.0490		0.0220	0.0480
V (AT FLOW DEPTH d, CFS)	6.92	4.23		6.83	3.76
Q (AT FLOW DEPTH d, CFS)	39.9	39.9		48.6	48.6
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0109	0.0385		0.0081	0.0352
$.7S_c$	0.0076	0.0269		0.0056	0.0246
$1.3S_c$	0.0141	0.0500		0.0105	0.0457
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.98	0.51		1.29	0.66
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.25	2.25		2.75	2.75
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	9.5	15.0		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.59	2.16		1.13	1.63
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	8.00		3.00	8.00

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	5.7 Unveg	5.7 Veg		5.8 Unveg	5.8 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	5.19	6.07		3.84	5.03
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)	0.80	1.01		0.42	0.66
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		5:1	3:1
A (AREA IN SQ. FT.)	2.86	4.05		1.20	2.21
R (HYDRAULIC RADIUS)	0.51	0.62		0.31	0.44
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0480	0.0780		0.0550	0.1290
V (AT FLOW DEPTH d, CFS)	2.80	1.98		1.75	0.95
Q (AT FLOW DEPTH d, CFS)	8.0	8.0		2.1	2.1
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0449	0.1117		0.0673	0.3284
$.7S_c$	0.0314	0.0781		0.0471	0.2298
$1.3S_c$	0.0583	0.1452		0.0874	0.4269
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.20	0.98		1.04	0.74
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		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	0.99	1.26		0.53	0.83
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	5.9 Unveg	5.9 Unveg		5.10 Unveg	5.10 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	4.56	5.86		4.46	5.49
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)	0.61	0.89		0.61	0.84
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3:1	2:1		3:1	2:1
A (AREA IN SQ. FT.)	1.94	3.38		1.97	3.08
R (HYDRAULIC RADIUS)	0.41	0.56		0.42	0.54
S (BED SLOPE, FT/FT)*	0.0125	0.125		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.0530	0.1130		0.0520	0.0970
V (AT FLOW DEPTH d, CFS)	1.75	1.00		2.23	1.43
Q (AT FLOW DEPTH d, CFS)	3.4	3.4		4.4	4.4
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0577	0.2375		0.0561	0.1794
$.7S_c$	0.0403	0.1662		0.0392	0.1255
$1.3S_c$	0.0750	0.3087		0.0729	0.2332
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.86	0.53		0.89	0.63
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		1.5	1.5
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	0.70		0.76	1.05
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	6.1 Unveg	6.1 Veg		6.2 Unveg	6.2 Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	32.00	32.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	9.28	12.06		5.28	7.20
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	1.22	1.68		0.54	0.80
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2:1	1:1		4:1	3:1
A (AREA IN SQ. FT.)	6.87	11.82		1.94	3.55
R (HYDRAULIC RADIUS)	0.71	0.94		0.36	0.50
S (BED SLOPE, FT/FT)*	0.0150	0.0150		0.0150	0.0150
VEGETATIVE LINING RETARDANCE	-	-		-	-
n (MANNING'S COEFFICIENT)**	0.0260	0.0540		0.0540	0.1230
V (AT FLOW DEPTH d, CFS)	5.53	3.21		1.70	0.93
Q (AT FLOW DEPTH d, CFS)	38.0	38.0		3.3	3.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0115	0.0454		0.0614	0.2824
$.7S_c$	0.0080	0.0317		0.0429	0.1976
$1.3S_c$	0.0149	0.0590		0.0798	0.3671
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	3.79	3.32		0.95	0.63
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	5.0	5.0		1.5	1.5
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	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.14	1.57		0.50	0.75
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	8.00		1.55	4.20

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	6.3 Unveg	6.3 Veg			
PROTECTIVE LINING **	S75	Grass			
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00			
CHANNEL TOP WIDTH (FT)@ d	4.72	6.71			
CHANNEL SIDE SLOPES (H:V)	3	3			
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0			
d (FLOW DEPTH IN FT)	0.41	0.68			
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	5:1	3:1			
A (AREA IN SQ. FT.)	1.34	2.76			
R (HYDRAULIC RADIUS)	0.29	0.44			
S (BED SLOPE, FT/FT)*	0.0160	0.0160			
VEGETATIVE LINING RETARDANCE	-	C			
n (MANNING'S COEFFICIENT)**	0.0550	0.0550			
V (AT FLOW DEPTH d, CFS)	1.50	0.72			
Q (AT FLOW DEPTH d, CFS)	2.0	2.0			
Q_r (REQUIRED CAPACITY) CFS	-	-			
S_c (CRITICAL SLOPE)	0.0669	0.4310			
$.7S_c$	0.0468	0.3017			
$1.3S_c$	0.0869	0.5603			
STABLE FLOW? (Y/N)	Y	Y			
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-			
FREEBOARD BASED ON STABLE FLOW FT	1.05	0.71			
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5			
D (TOTAL DEPTH) FT	1.5	1.5			
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	0.41	0.68			
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20			

* 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: NKG DATE: 07/22/11
CHECKED BY: JFM DATE: 07/27/11

CHANNEL OR CHANNEL SECTION	10.1 Unveg	10.1 Veg		10.2 Unveg	10.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	3.94	5.29		3.99	5.35
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		2.0	2.0
d (FLOW DEPTH IN FT)	0.32	0.50		0.32	0.51
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	4:1		6:1	4:1
A (AREA IN SQ. FT.)	0.93	1.75		0.96	1.79
R (HYDRAULIC RADIUS)	0.23	0.34		0.24	0.34
S (BED SLOPE, FT/FT)*	0.0444	0.0444		0.0444	0.0444
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.1330		0.0550	0.1310
V (AT FLOW DEPTH d, CFS)	2.15	1.14		2.18	1.18
Q (AT FLOW DEPTH d, CFS)	2.0	2.0		2.1	2.1
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0730	0.3722		0.0725	0.3596
$.7S_c$	0.0511	0.2605		0.0507	0.2517
$1.3S_c$	0.0949	0.4838		0.0942	0.4674
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.18	0.95		1.17	0.94
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		1.5	1.5
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	0.87	1.39		0.90	1.41
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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)
	Lawn		0.40	1.950	0.780

Total Area, A: 1.950 acres
Weighted C: 0.40

Total A * C: 0.78 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

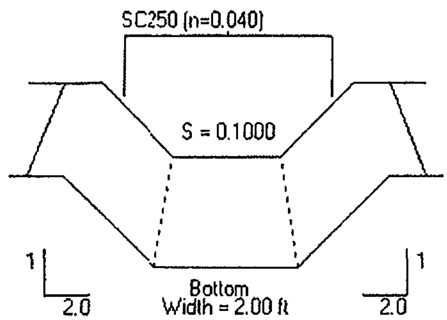
Calculated Flow, Q (cfs) = 4.2

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.1

North American Green - ECMDS Version 4.3		7/22/2011	10:03 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.1		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.2	0.1	4.72	0.89	0.25	0.33



Not to Scale

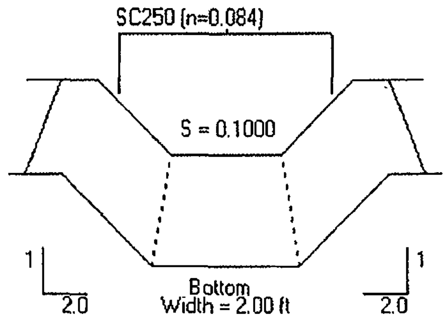
LINER RESULTS

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	SC250	Unvegetated	1				3.00	2.08	1.44	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		7/19/2011	03:15 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH:	DRAINAGE AREA: SWALE 1.1		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.2	0.1	2.79	1.50	0.35	0.50



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stablity Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	SC250	Vegetation	3	C	Bunch	75-95%	10.00	3.13	3.20	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.351	2.28	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	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=	2.0	2.0	2.0	feet
Bed slope, s=	0.1000	0.1000	0.1000	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0840	0.0840	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.34**	**0.51**	**0.51**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.16	0.99	0.99	feet
Calculated Velocity, V=	4.65	2.76	2.76	fps
Flow Top Width, T=	3.35	4.02	4.02	feet
Flow Area, A=	0.90	1.52	1.52	sq ft
Wetted Perimeter, P=	3.51	4.26	4.26	feet
Hydraulic Radius, R=	0.26	0.36	0.36	feet
Shear stress on channel bottom, τ =	2.11	3.16	3.16	lbs/sf
Critical Slope, S_c=	0.0384	0.1533	0.1533	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.013	0.012
	Lawn		0.40	1.020	0.408

Total Area, A: 1.033 acres
Weighted C: 0.41

Total A * C: 0.42035 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 2.3

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.2

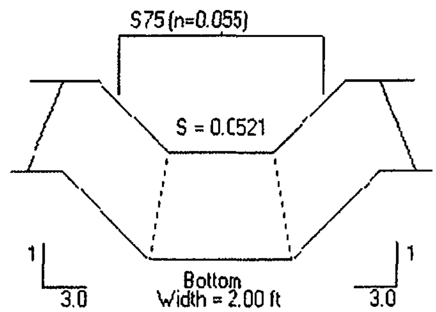
North American Green - ECMDS Version 4.3 | 7/20/2011 | 11 42 AM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: SWALE 1.2 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.3	0.1	2.37	0.97	0.24	0.33



Not to Scale

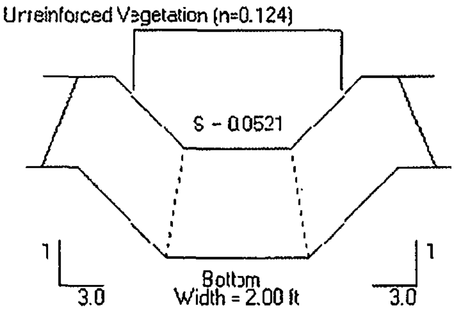
LINER RESULTS

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	1.06	1.46	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011 11:43 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BENPP	PROJECT NO.: PPLS0902	
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.2	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.3	0.1	1.33	1.73	0.34	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.61	2.60	STABLE
		Soil	Sandy Loam				0.035	0.013	2.73	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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=	2.30	2.30	2.30	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0521	0.0521	0.0521	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1240	0.1240	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.33**	**0.55**	**0.55**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.17	0.95	0.95	feet
Calculated Velocity, V=	2.29	1.16	1.16	fps
Flow Top Width, T=	4.00	5.28	5.28	feet
Flow Area, A=	1.00	1.99	1.99	sq ft
Wetted Perimeter, P=	4.11	5.45	5.45	feet
Hydraulic Radius, R=	0.24	0.36	0.36	feet
Shear stress on channel bottom, τ =	1.08	1.77	1.77	lbs/sf
Critical Slope, S_c=	0.0724	0.3240	0.3240	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	1.820	1.729
	Lawn		0.40	5.150	2.060
	Stone		0.85	4.200	3.570

Total Area, A: 11.170 acres
Weighted C: 0.66

Total A * C: 7.359 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C I A

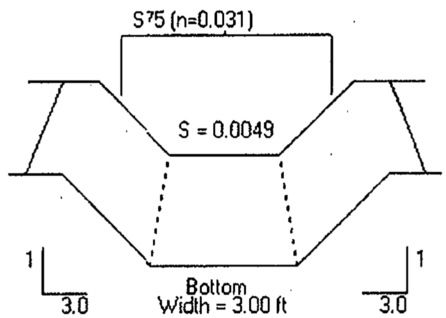
25 year
Calculated Flow, Q (cfs) = 39.7

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.3

North American Green - ECMDS Version 4.3	7/19/2011	03:20 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: UNVEG	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.3	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
39.7	0.1	3.26	12.18	0.94	1.58



Not to Scale

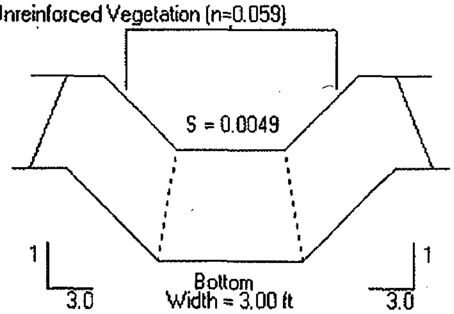
LINER RESULTS

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	0.48	3.22	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	03:37 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: VEG	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.3	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
39.7	0.1	1.99	19.96	1.21	2.13



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.65	6.46	STABLE
		Soil	Sandy Loam				0.035	0.022	1.56	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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=	39.70	39.70	39.70	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0049	0.0049	0.0049	ft/ft
Available depth of channel:	2.75	2.75	2.75	feet
(OPTIONAL) Input Manning's 'n':	0.0310	0.0590	0.0590	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.58**	**2.12**	**2.12**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.17	0.63	0.63	feet
Calculated Velocity, V=	3.23	2.00	2.00	fps
Flow Top Width, T=	12.50	15.71	15.71	feet
Flow Area, A=	12.27	19.81	19.81	sq ft
Wetted Perimeter, P=	13.02	16.39	16.39	feet
Hydraulic Radius, R=	0.94	1.21	1.21	feet
Shear stress on channel bottom, τ =	0.49	0.65	0.65	lbs/sf
Critical Slope, S_c=	0.0149	0.0497	0.0497	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.6	0.6	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.4

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	1.170	0.468

Total Area, A: 1.260 acres
Weighted C: 0.44

Total A * C: 0.5535 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

25 year

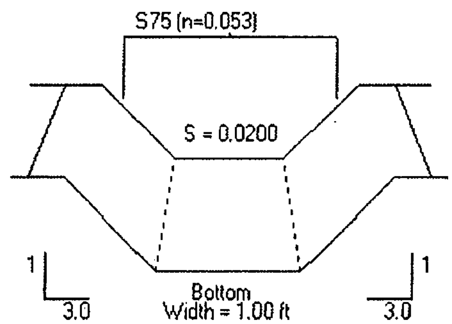
Calculated Flow, Q (cfs) = 3.0

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.4

North American Green - ECMDS Version 4.3		7/19/2011	03:24 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH: UNVEG	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.4		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	0.1	1.91	1.57	0.34	0.58



Not to Scale

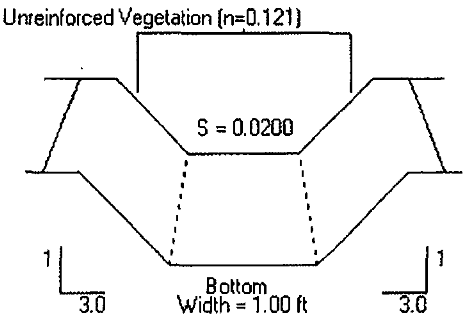
LINER RESULTS

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	0.72	2.16	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	03:25 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: VEG	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.4	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	0.1	1.04	2.89	0.46	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.03	4.06	STABLE
		Soil	Sandy Loam				0.035	0.009	4.07	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.4	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.00	3.00	3.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.1210	0.1210	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.58**	**0.86**	**0.86**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.92	0.64	0.64	feet
Calculated Velocity, V=	1.88	0.98	0.98	fps
Flow Top Width, T=	4.49	6.13	6.13	feet
Flow Area, A=	1.59	3.05	3.05	sq ft
Wetted Perimeter, P=	4.68	6.41	6.41	feet
Hydraulic Radius, R=	0.34	0.48	0.48	feet
Shear stress on channel bottom, τ =	0.73	1.07	1.07	lbs/sf
Critical Slope, S_c=	0.0610	0.2854	0.2854	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by:
JFM

Print Date: 1 Sep 11 11:04 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.5

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)
	Lawn (Swale 1.5)		0.40	0.805	0.322
	Lawn (Swale 1.26)		0.40	4.960	1.984
	Stone		0.85	0.395	0.336

Total Area, A: 6.160 acres
Weighted C: 0.43

Total A * C: 2.64175 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

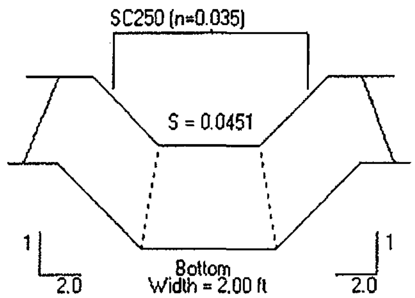
25 year

Calculated Flow, Q (cfs) = 14.3

North American Green - ECMDS Version 4.3	9/1/2011	11:02 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.5	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
14.3	0.1	5.53	2.59	0.49	0.74



Not to Scale

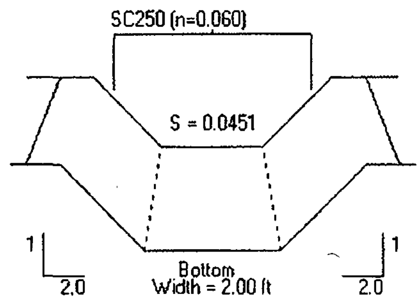
LINER RESULTS

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	SC250	Unvegetated	1				3.00	2.09	1.44	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	9/1/2011	11:01 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.5	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
14.3	0.1	3.77	3.79	0.60	0.97



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.72	3.68	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.367	2.18	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 1 Sep 11 11:4 AM
Project #: PPLS0902

Checked by:
JFM

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 1.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	14.30	14.30	14.30	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=	0.0451	0.0451	0.0451	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0350	0.0600	0.0600	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.74**	**0.97**	**0.97**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.76	0.53	0.53	feet
Calculated Velocity, V=	5.54	3.73	3.73	fps
Flow Top Width, T=	4.97	5.88	5.88	feet
Flow Area, A=	2.58	3.83	3.83	sq ft
Wetted Perimeter, P=	5.32	6.34	6.34	feet
Hydraulic Radius, R=	0.49	0.60	0.60	feet
Shear stress on channel bottom, τ =	2.09	2.73	2.73	lbs/sf
Critical Slope, S_c=	0.0243	0.0669	0.0669	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.6

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)
	Stone		0.85	1.220	1.037
	Lawn		0.40	1.620	0.648

Total Area, A: 2.840 acres
Weighted C: 0.59

Total A * C: 1.685 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

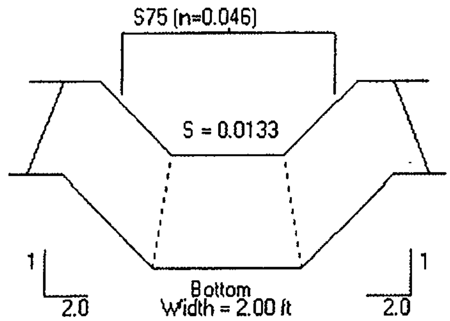
25 year
Calculated Flow, Q (cfs) = 9.1

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.6

North American Green - ECMDS Version 4.3	7/19/2011	03:40 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.6	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.1	0.1	2.60	3.50	0.58	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	0.76	2.04	STABLE
	Staple D									

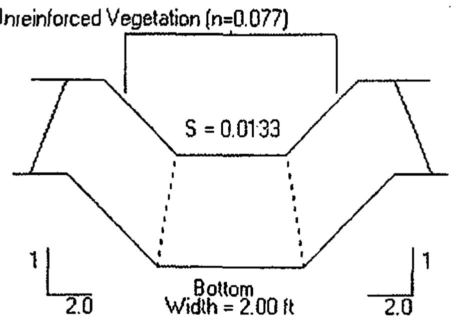
North American Green - ECMDS Version 4.3 | 7/19/2011 | 03:41 PM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 1.6 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.1	0.1	1.76	5.17	0.71	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.98	4.28	STABLE
		Soil	Sandy Loam				0.035	0.020	1.75	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

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 1.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.10	9.10	9.10	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=	0.0133	0.0133	0.0133	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0770	0.0770	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.92**	**1.19**	**1.19**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.08	0.81	0.81	feet
Calculated Velocity, V=	2.56	1.75	1.75	fps
Flow Top Width, T=	5.69	6.74	6.74	feet
Flow Area, A=	3.55	5.19	5.19	sq ft
Wetted Perimeter, P=	6.13	7.30	7.30	feet
Hydraulic Radius, R=	0.58	0.71	0.71	feet
Shear stress on channel bottom, τ =	0.77	0.99	0.99	lbs/sf
Critical Slope, S_c=	0.0398	0.1048	0.1048	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 1.7

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	0.260	0.247
	Lawn		0.40	0.450	0.180
	Stone		0.85	0.150	0.128

Total Area, A: 0.860 acres
Weighted C: 0.64

Total A * C: 0.5545 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

25 year

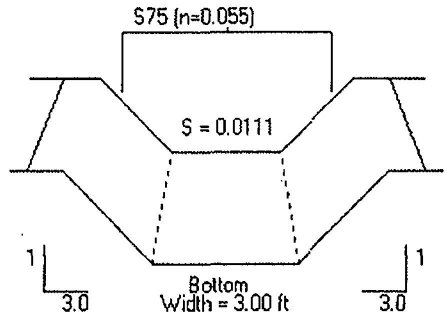
Calculated Flow, Q (cfs) = 3.0

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.7

North American Green - ECMDS Version 4.3		7/19/2011	03:44 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.7		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	0.1	1.42	2.12	0.35	0.48



Not to Scale

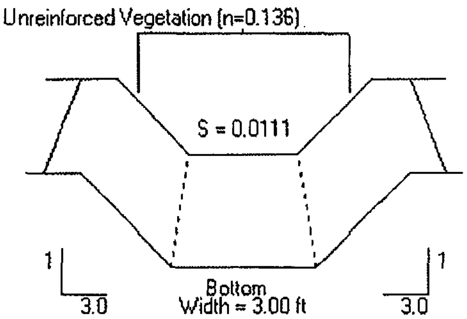
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.33	4.69	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/19/2011 03:45 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.7	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	0.1	0.74	4.05	0.52	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	Unreinforced	Vegetation		C	Bunch	50-75%	4.20	0.53	7.92	STABLE
		Soil	Sandy Loam				0.035	0.004	8.39	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.00	3.00	3.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0111	0.0111	0.0111	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1360	0.1360	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.50**	**0.84**	**0.84**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.00	0.66	0.66	feet
Calculated Velocity, V=	1.32	0.64	0.64	fps
Flow Top Width, T=	6.03	8.07	8.07	feet
Flow Area, A=	2.28	4.67	4.67	sq ft
Wetted Perimeter, P=	6.19	8.34	8.34	feet
Hydraulic Radius, R=	0.37	0.56	0.56	feet
Shear stress on channel bottom, τ =	0.35	0.59	0.59	lbs/sf
Critical Slope, S_c=	0.0631	0.3377	0.3377	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.8

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	6.850	6.508
	Lawn		0.40		
	Stone		0.85	10.360	8.806

Total Area, A = 17.210 acres
Weighted C = 0.89

Total A * C: 15.3135 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

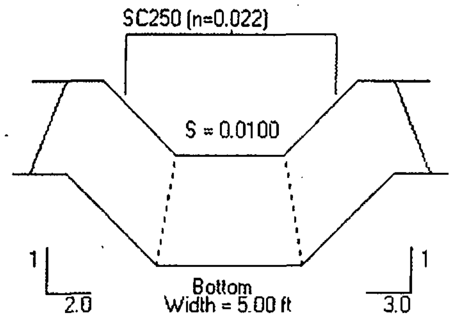
25 year
Calculated Flow, Q (cfs) = 82.7

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.8

North American Green - ECMDS Version 4.3		7/19/2011	03:54 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.8		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
82.7	0.1	6.67	12.39	0.97	1.44



Not to Scale

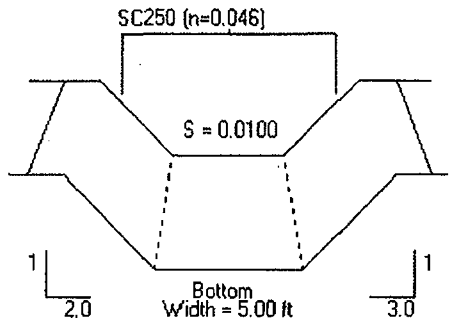
LINER RESULTS

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	SC250	Unvegetated	1				3.00	0.90	3.34	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/19/2011	03:53 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: / TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.8	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
82.7	0.1	3.89	21.26	1.31	2.08



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.30	7.69	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.038	21.26	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.8

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	82.70	82.70	82.70	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	2.75	2.75	2.75	feet
(OPTIONAL) Input Manning's 'n':	0.0290	0.0460	0.0460	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.66**	**2.09**	**2.09**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.09	0.66	0.66	feet
Calculated Velocity, V=	5.43	3.87	3.87	fps
Flow Top Width, T=	13.32	15.44	15.44	feet
Flow Area, A=	15.23	21.35	21.35	sq ft
Wetted Perimeter, P=	13.96	16.25	16.25	feet
Hydraulic Radius, R=	1.09	1.31	1.31	feet
Shear stress on channel bottom, τ =	1.04	1.30	1.30	lbs/sf
Critical Slope, S_c=	0.0125	0.0296	0.0296	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.7	0.6	0.6	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.9

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	0.530	0.504
	Stone		0.85	2.980	2.533

Total Area, A: 3.510 acres
Weighted C: 0.87

Total A * C: 3.0365 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

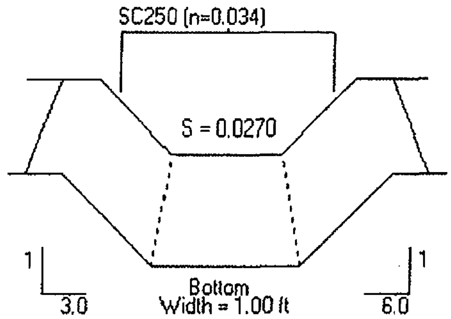
25 year
Calculated Flow, Q (cfs) = 16.4

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.9

North American Green - ECMDS Version 4.3		7/19/2011	04:26 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.9		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
16.4	0.1	4.24	3.87	0.45	0.82



Not to Scale

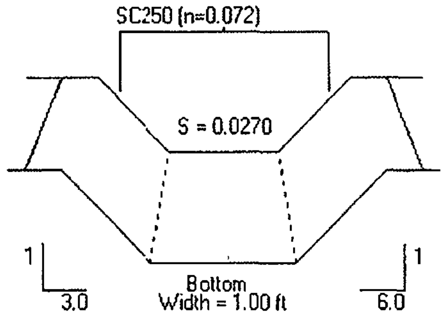
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.39	2.17	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		7/19/2011	04:28 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.9		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
16.4	0.1	2.40	6.82	0.60	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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.90	5.27	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.142	5.64	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	16.40	16.40	16.40	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	6.0	6.0	6.0	H:1V
Base width of Channel, b=	1.0	1.0	1.0	feet
Bed slope, s=	0.0270	0.0270	0.0270	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0450	0.0720	0.0720	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.93**	**1.13**	**1.13**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.07	0.87	0.87	feet
Calculated Velocity, V=	3.41	2.40	2.40	fps
Flow Top Width, T=	9.35	11.13	11.13	feet
Flow Area, A=	4.80	6.83	6.83	sq ft
Wetted Perimeter, P=	9.56	11.38	11.38	feet
Hydraulic Radius, R=	0.50	0.60	0.60	feet
Shear stress on channel bottom, τ =	1.56	1.90	1.90	lbs/sf
Critical Slope, S_c=	0.0379	0.0915	0.0915	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.10

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	0.410	0.390
	Lawn		0.40	1.950	0.780

Total Area, A: 2.360 acres
Weighted C: 0.50

Total A * C: 1.1695 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

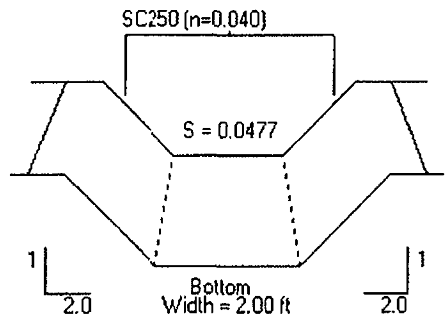
Calculated Flow, Q (cfs) = 6.3

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.10

North American Green - ECMDS Version 4.3		7/19/2011	04:34 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.10		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.3	0.1	4.11	1.53	0.36	0.51



Not to Scale

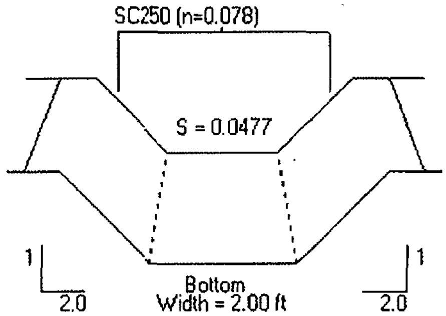
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.51	1.98	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/19/2011	04:33 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.10	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.3	0.1	2.55	2.47	0.47	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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.14	4.67	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.228	3.51	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.10

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.30	6.30	6.30	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=	0.0477	0.0477	0.0477	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0477	0.0780	0.0780	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.56**	**0.73**	**0.73**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.94	0.77	0.77	feet
Calculated Velocity, V=	3.58	2.51	2.51	fps
Flow Top Width, T=	4.25	4.91	4.91	feet
Flow Area, A=	1.76	2.51	2.51	sq ft
Wetted Perimeter, P=	4.52	5.25	5.25	feet
Hydraulic Radius, R=	0.39	0.48	0.48	feet
Shear stress on channel bottom, τ =	1.67	2.16	2.16	lbs/sf
Critical Slope, S_c=	0.0482	0.1212	0.1212	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.11

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	0.210	0.200
	Lawn		0.40	0.500	0.200

Total Area, A = 0.710 acres
Weighted C = 0.56

Total A * C: 0.3995 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): 5.40

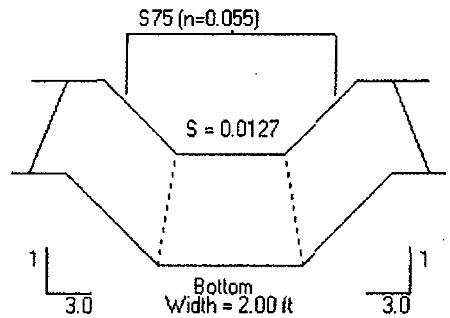
STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	2.2

North American Green - ECMDS Version 4.3	7/19/2011	04:40 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.11	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.2	0.1	1.41	1.56	0.32	0.46



Not to Scale

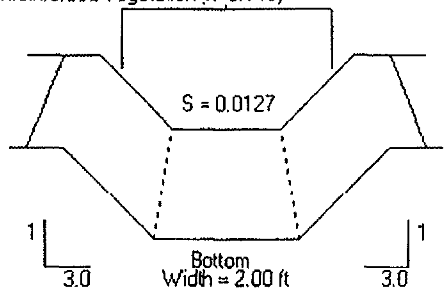
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.36	4.25	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	04:41 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.11	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocty (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.2	0.1	0.69	3.20	0.47	0.75



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Cass	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.60	7.05	STABLE
		Soil	Sandy Loam				0.035	0.003	10.55	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.11

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.20	2.20	2.20	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0127	0.0127	0.0127	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1480	0.1480	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.51**	**0.86**	**0.86**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.99	0.64	0.64	feet
Calculated Velocity, V=	1.24	0.56	0.56	fps
Flow Top Width, T=	5.03	7.13	7.13	feet
Flow Area, A=	1.78	3.90	3.90	sq ft
Wetted Perimeter, P=	5.19	7.41	7.41	feet
Hydraulic Radius, R=	0.34	0.53	0.53	feet
Shear stress on channel bottom, τ =	0.40	0.68	0.68	lbs/sf
Critical Slope, S_c=	0.0650	0.4102	0.4102	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.12

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	0.390	0.371
	Lawn		0.40	0.930	0.372

Total Area, A: 1.320 acres
Weighted C: 0.56

Total A * C: 0.7425 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

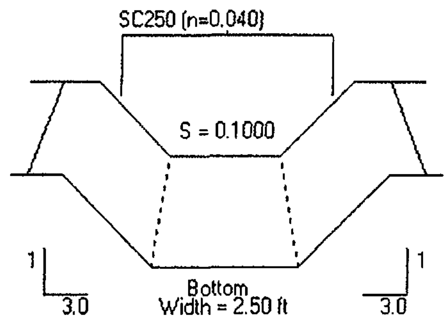
25 year
Calculated Flow, Q (cfs) = 4.0

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.12

North American Green - ECMDS Version 4.3	7/19/2011	04:49 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.12	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.0	0.1	4.27	0.94	0.22	0.28



Not to Scale

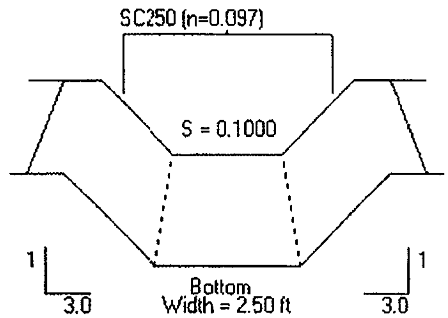
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.75	1.71	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		7/19/2011	04:44 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.12		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.0	0.1	2.30	1.74	0.33	0.45



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.82	3.55	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.241	3.32	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.12

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.00	4.00	4.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.5	2.5	2.5	feet
Bed slope, s=	0.1000	0.1000	0.1000	ft/ft
Available depth of channel:	1.00	1.00	1.00	feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0970	0.0970	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.28**	**0.46**	**0.46**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.72	0.54	0.54	feet
Calculated Velocity, V=	4.22	2.26	2.26	fps
Flow Top Width, T=	4.20	5.25	5.25	feet
Flow Area, A=	0.95	1.77	1.77	sq ft
Wetted Perimeter, P=	4.29	5.39	5.39	feet
Hydraulic Radius, R=	0.22	0.33	0.33	feet
Shear stress on channel bottom, τ =	1.77	2.86	2.86	lbs/sf
Critical Slope, S_c=	0.0394	0.2041	0.2041	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 1.13

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	0.110	0.105
	Lawn		0.40	1.720	0.688

Total Area, A: 1.830 acres
Weighted C: 0.43

Total A * C: 0.7925 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,I\,A$

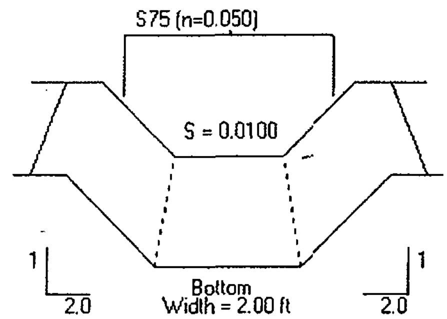
	25 year
Calculated Flow, Q (cfs) =	4.3

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.13

North American Green - ECMDS Version 4.3		7/19/2011	04:52 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.13		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.3	0.1	1.78	2.42	0.47	0.71



Not to Scale

LINER RESULTS

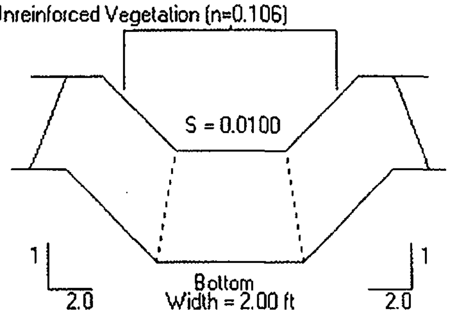
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.44	3.51	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/19/2011	04:53 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.13		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.3	0.1	1.03	4.16	0.63	1.03

Unreinforced Vegetation (n=0.106)



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.64	6.56	STABLE
		Soil	Sandy Loam				0.035	0.007	5.02	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.13

	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=	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':	0.0100	0.1060	0.1060	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.30**	**1.08**	**1.08**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.70	0.92	0.92	feet
Calculated Velocity, V=	5.53	0.95	0.95	fps
Flow Top Width, T=	3.20	6.33	6.33	feet
Flow Area, A=	0.78	4.51	4.51	sq ft
Wetted Perimeter, P=	3.34	6.84	6.84	feet
Hydraulic Radius, R=	0.23	0.66	0.66	feet
Shear stress on channel bottom, τ =	0.19	0.68	0.68	lbs/sf
Critical Slope, S_c=	0.0025	0.2031	0.2031	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.14

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	0.129	0.123
	Lawn		0.40	0.451	0.180
	Cultivated		0.25		

Total Area A: 0.580 acres
Weighted C: 0.52

Total A * C: 0.30295 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

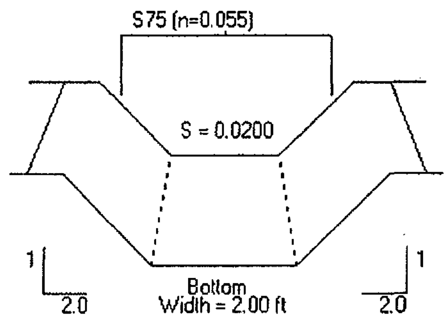
25 year
Calculated Flow, Q (cfs) = 1.6

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.14

North American Green - ECMDS Version 4.3		7/19/2011	04:56 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.14		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.6	0.1	1.61	0.99	0.27	0.36



Not to Scale

LINER RESULTS

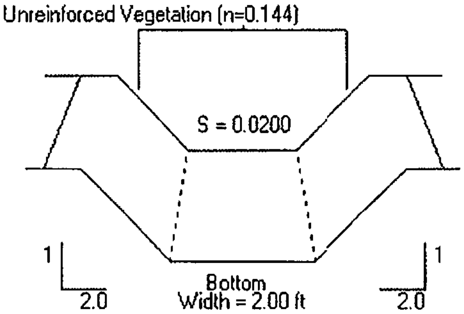
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.45	3.41	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/19/2011	04:56 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.14		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.6	0.1	0.81	1.97	0.42	0.61

Unreinforced Vegetation (n=0.144)



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
Straght	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.76	5.50	STABLE
		Soil	Sandy Loam				0.035	0.004	7.85	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.14

	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=	2.0	2.0	2.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1440	0.1440	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.42**	**0.71**	**0.71**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.08	0.79	0.79	feet
Calculated Velocity, V=	1.34	0.66	0.66	fps
Flow Top Width, T=	3.68	4.83	4.83	feet
Flow Area, A=	1.20	2.41	2.41	sq ft
Wetted Perimeter, P=	3.88	5.16	5.16	feet
Hydraulic Radius, R=	0.31	0.47	0.47	feet
Shear stress on channel bottom, τ =	0.53	0.88	0.88	lbs/sf
Critical Slope, S_c=	0.0687	0.4160	0.4160	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 12
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 1.15

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	0.010	0.010
	Lawn		0.40	1.793	0.717
	Stone		0.85	1.667	1.417

Total Area, A: 3.470 acres
Weighted C: 0.62

Total A * C: 2.14365 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

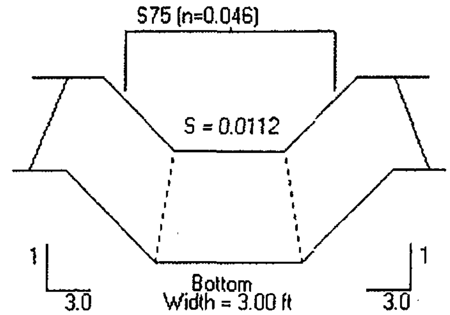
Calculated Flow, Q (cfs) = 11.6

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.15

North American Green - ECMDS Version 4.3		7/19/2011	04:59 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.15		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.6	0.1	2.35	4.94	0.58	0.88



Not to Scale

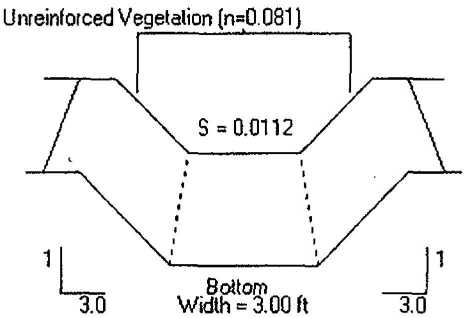
LINER RESULTS

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	0.61	2.53	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	05:00 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.15	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.6	0.1	1.56	7.43	0.72	1.15



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.80	5.22	STABLE
		Soil	Sandy Loam				0.035	0.015	2.35	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.15	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	11.60	11.60	11.60	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0112	0.0112	0.0112	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0810	0.0810	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.87**	**1.15**	**1.15**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.13	0.85	0.85	feet
Calculated Velocity, V=	2.36	1.56	1.56	fps
Flow Top Width, T=	8.25	9.92	9.92	feet
Flow Area, A=	4.92	7.46	7.46	sq ft
Wetted Perimeter, P=	8.53	10.30	10.30	feet
Hydraulic Radius, R=	0.58	0.72	0.72	feet
Shear stress on channel bottom, τ =	0.61	0.81	0.81	lbs/sf
Critical Slope, S_c=	0.0383	0.1104	0.1104	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **14 Oct 10**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.16

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	0.332	0.315
	Lawn		0.40	2.878	1.151

Total Area, A: 3.210 acres
Weighted C: 0.46

Total A * C: 1.4666 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

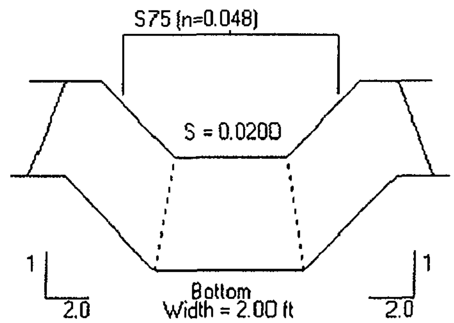
25 year
Calculated Flow, Q (cfs) = 7.9

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.16

North American Green - ECMDS Version 4.3	7/19/2011	05:02 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.16	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.9	0.1	2.78	2.84	0.51	0.79



Not to Scale

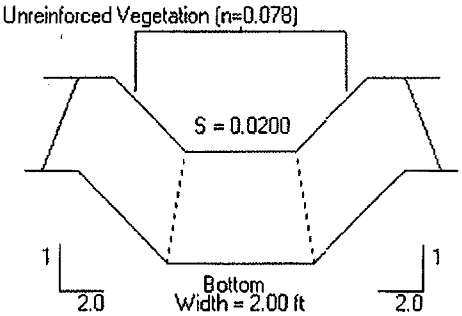
LINER RESULTS

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	0.99	1.57	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	05:03 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.16	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.9	0.1	1.96	4.03	0.62	˙.00



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
Straght	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.25	3.35	STABLE
		Soil	Sandy Loam				0.035	0.025	1.39	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.16

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.90	7.90	7.90	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0780	0.0780	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.79**	**1.01**	**1.01**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.21	0.99	0.99	feet
Calculated Velocity, V=	2.78	1.94	1.94	fps
Flow Top Width, T=	5.17	6.04	6.04	feet
Flow Area, A=	2.84	4.07	4.07	sq ft
Wetted Perimeter, P=	5.55	6.52	6.52	feet
Hydraulic Radius, R=	0.51	0.62	0.62	feet
Shear stress on channel bottom, τ =	0.99	1.26	1.26	lbs/sf
Critical Slope, S_c=	0.0449	0.1119	0.1119	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.17

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	0.291	0.276
	Lawn		0.40	0.529	0.212

Total Area A 0.820 acres
Weighted C 0.60

Total A * C: 0.48805 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

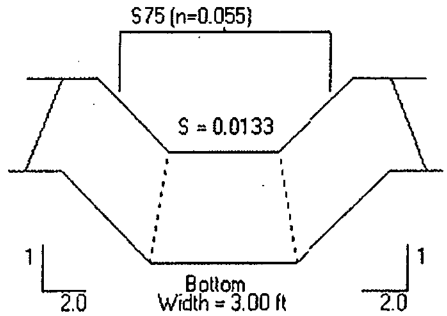
25 year
Calculated Flow, Q (cfs) = 2.6

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.17

North American Green - ECMDS Version 4.3		7/19/2011	05:06 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.17		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.6	0.1	1.53	1.70	0.34	0.44



Not to Scale

LINER RESULTS

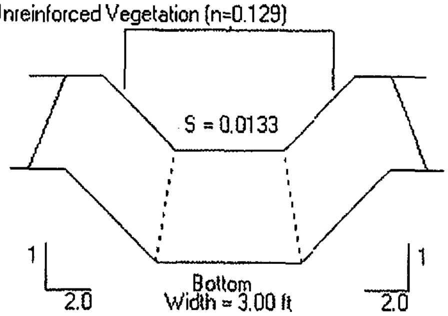
Reach	Matting Type	Stability Analysis	Vegetation Characteristics				Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
	Staple Pattern		Phase	Class	Type	Density				
Straght	S75	Unvegetated					1.55	0.36	4.25	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	05:07 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.17	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.6	0.1	0.84	3.10	0.50	0.70

Unreinforced Vegetation (n=0.129)



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
Straght	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.58	7.20	STABLE
		Soil	Sandy Loam				0.035	0.004	8.25	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.17

	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=	3.0	3.0	3.0	feet
Bed slope, s=	0.0133	0.0133	0.0133	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1290	0.1290	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.46**	**0.79**	**0.79**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.04	0.71	0.71	feet
Calculated Velocity, V=	1.44	0.71	0.71	fps
Flow Top Width, T=	4.84	6.18	6.18	feet
Flow Area, A=	1.80	3.65	3.65	sq ft
Wetted Perimeter, P=	5.06	6.56	6.56	feet
Hydraulic Radius, R=	0.36	0.56	0.56	feet
Shear stress on channel bottom, τ =	0.38	0.66	0.66	lbs/sf
Critical Slope, S_c=	0.0649	0.3124	0.3124	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 1.18

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	0.453	0.430
	Lawn		0.40	1.097	0.439
	Stone		0.85		

Total Area, A: 1.550 acres
Weighted C: 0.56

Total A * C: 0.86915 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

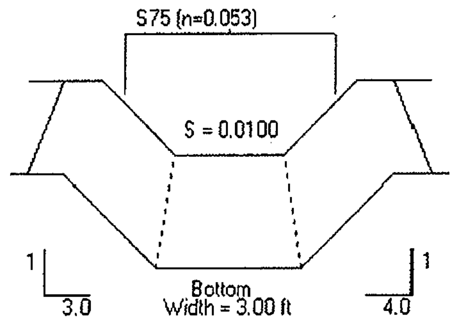
25 year
Calculated Flow, Q (cfs) = 4.7

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.18

North American Green - ECMDS Version 4.3	7/19/2011	05:09 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.18	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.7	0.1	1.56	3.02	0.41	0.59



Not to Scale

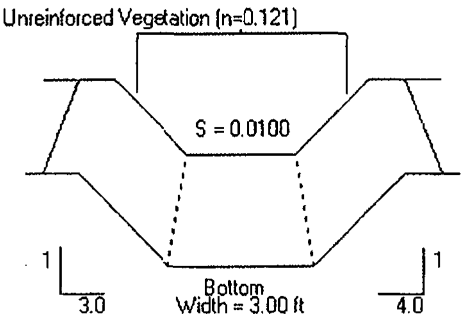
LINER RESULTS

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	4.18	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/19/2011	05:09 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.18	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.7	0.1	0.85	5.51	0.58	0.90



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.56	7.50	STABLE
		Soil	Sandy Loam				0.035	0.005	7.49	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.18

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.70	4.70	4.70	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	4.0	4.0	4.0	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:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.1210	0.1210	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.60**	**0.94**	**0.94**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.40	1.06	1.06	feet
Calculated Velocity, V=	1.53	0.80	0.80	fps
Flow Top Width, T=	7.21	9.55	9.55	feet
Flow Area, A=	3.07	5.87	5.87	sq ft
Wetted Perimeter, P=	7.38	9.81	9.81	feet
Hydraulic Radius, R=	0.42	0.60	0.60	feet
Shear stress on channel bottom, τ =	0.38	0.58	0.58	lbs/sf
Critical Slope, S_c=	0.0561	0.2599	0.2599	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by:
JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.19

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	0.229	0.218
	Lawn		0.40	0.801	0.320

Total Area, A: 1.030 acres
Weighted C: 0.52

Total A * C: 0.53795 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

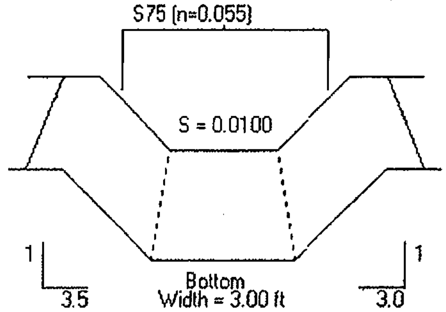
25 year
Calculated Flow, Q (cfs) = 2.9

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.19

North American Green - ECMDS Version 4.3		7/19/2011	05:12 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.19		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.9	0.1	1.34	2.17	0.35	0.48



Not to Scale

LINER RESULTS

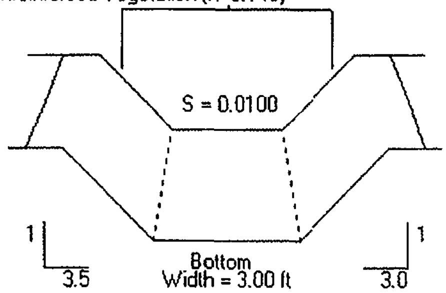
Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.30	5.21	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/19/2011 05:13 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.19	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.9	0.1	0.67	4.31	0.52	0.78

Unreinforced Vegetation (n=0.143)



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
Straght	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.49	8.63	STABLE
		Soil	Sandy Loam				0.035	0.003	12.07	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.19

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	2.90	2.90	2.90	cfs
Left Side Slope =	3.5	3.5	3.5	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	2.50	2.50	2.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1430	0.1430	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.51**	**0.85**	**0.85**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.99	1.65	1.65	feet
Calculated Velocity, V=	1.22	0.59	0.59	fps
Flow Top Width, T=	6.31	8.54	8.54	feet
Flow Area, A=	2.37	4.92	4.92	sq ft
Wetted Perimeter, P=	6.47	8.80	8.80	feet
Hydraulic Radius, R=	0.37	0.56	0.56	feet
Shear stress on channel bottom, τ =	0.32	0.53	0.53	lbs/sf
Critical Slope, S_c=	0.0630	0.3722	0.3722	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.20

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	0.765	0.727
	Lawn		0.40	1.875	0.750

Total Area, A: 2.640 acres
Weighted C: 0.56

Total A * C: 1.47675 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

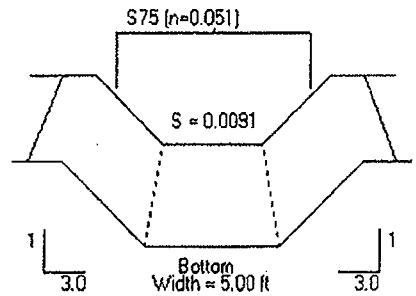
Calculated Flow, Q (cfs) = 8.0 (25 year)

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.20

North American Green - ECMDS Version 4.3	7/21/2011	11:40 AM	COMPUTED BY: NKG
PROJECT NAME: PPL 88NPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.20	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.0	0.1	1.74	4.60	0.50	0.66



Not to Scale

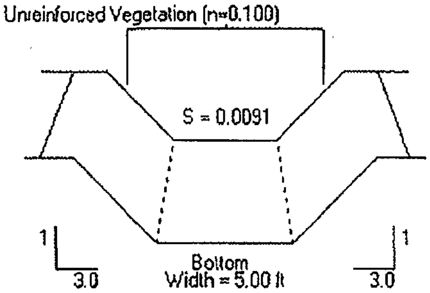
LINER RESULTS

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	4.14	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/21/2011 11:42 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.20	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.0	0.1	1.09	7.35	0.67	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.53	7.87	STABLE
		Soil	Sandy Loam				0.035	0.007	5.38	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.20

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	8.00	8.00	8.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	5.0	5.0	5.0	feet
Bed slope, s=	0.0091	0.0091	0.0091	ft/ft
Available depth of channel:	3.50	3.50	3.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1150	0.1150	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.69**	**1.02**	**1.02**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	2.81	2.48	2.48	feet
Calculated Velocity, V=	1.65	0.98	0.98	fps
Flow Top Width, T=	9.13	11.11	11.11	feet
Flow Area, A=	4.86	8.20	8.20	sq ft
Wetted Perimeter, P=	9.35	11.44	11.44	feet
Hydraulic Radius, R=	0.52	0.72	0.72	feet
Shear stress on channel bottom, τ =	0.39	0.58	0.58	lbs/sf
Critical Slope, S_c=	0.0561	0.2215	0.2215	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.21

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	0.205	0.195
	Lawn		0.40	0.618	0.247
	Stone		0.85	0.057	0.048

Total Area, A: 0.880 acres
Weighted C: 0.56

Total A * C: 0.4904 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

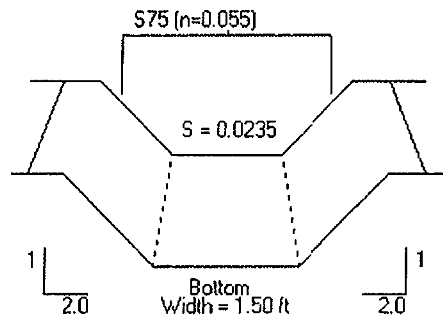
25 year
Calculated Flow, Q (cfs) = 2.6

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.21

North American Green - ECMDS Version 4.3		7/19/2011	05:19 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.21		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.6	0.1	2.02	1.28	0.34	0.51



Not to Scale

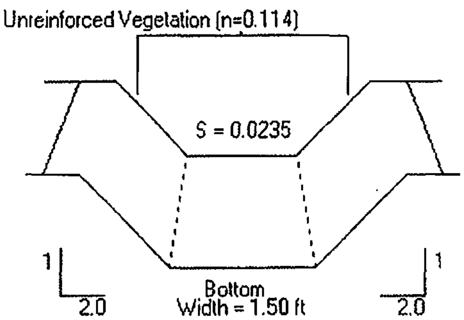
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.75	2.07	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/19/2011	05:20 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.21		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.6	0.1	1.18	2.19	0.46	0.74



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stablity Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.08	3.88	STABLE
		Soil	Sandy Loam				0.035	0.010	3.46	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.21

	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=	1.5	1.5	1.5	feet
Bed slope, s=	0.0235	0.0235	0.0235	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1140	0.1140	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.53**	**0.76**	**0.76**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.97	0.74	0.74	feet
Calculated Velocity, V=	1.90	1.13	1.13	fps
Flow Top Width, T=	3.63	4.54	4.54	feet
Flow Area, A=	1.37	2.29	2.29	sq ft
Wetted Perimeter, P=	3.88	4.90	4.90	feet
Hydraulic Radius, R=	0.35	0.47	0.47	feet
Shear stress on channel bottom, τ =	0.78	1.11	1.11	lbs/sf
Critical Slope, S_c=	0.0667	0.2629	0.2629	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 1.22

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	0.296	0.281
	Stone		0.85	0.924	0.785

Total Area A: 1.220 acres
Weighted C: 0.87

Total A * C: 1.0666 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year

Calculated Flow, Q (cfs) = 5.8

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.22

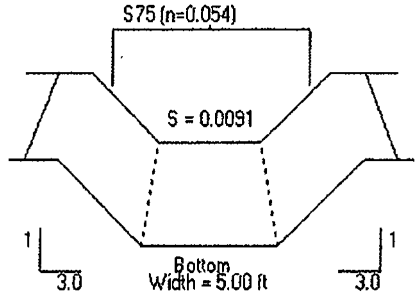
North American Green - ECMDS Version 4.3 | 7/21/2011 | 01:09 PM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: SWALE 1.22 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.8	0.1	1.53	3.78	0.44	0.56



Not to Scale

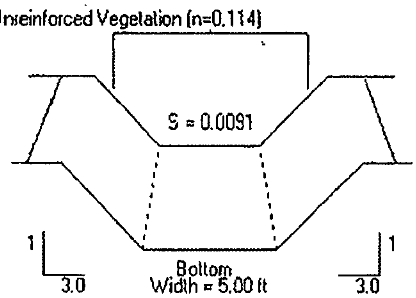
LINER RESULTS

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	0.32	4.83	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/21/2011	01:10 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.22	DESIGN FREQUENCY: 25YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.8	0.1	0.90	6.43	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.48	8.69	STABLE
		Soil	Sandy Loam				0.035	0.005	7.76	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.22

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.80	5.80	5.80	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	5.0	5.0	5.0	feet
Bed slope, s=	0.0091	0.0091	0.0091	ft/ft
Available depth of channel:	3.50	3.50	3.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1320	0.1320	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.58**	**0.95**	**0.95**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	2.92	2.55	2.55	feet
Calculated Velocity, V=	1.49	0.78	0.78	fps
Flow Top Width, T=	8.47	10.69	10.69	feet
Flow Area, A=	3.89	7.44	7.44	sq ft
Wetted Perimeter, P=	8.66	11.00	11.00	feet
Hydraulic Radius, R=	0.45	0.68	0.68	feet
Shear stress on channel bottom, τ =	0.33	0.54	0.54	lbs/sf
Critical Slope, S_c=	0.0588	0.2973	0.2973	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by:
JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.23

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)
	Lawn		0.40	1.130	0.452

Total Area, A: 1.130 acres
Weighted C: 0.40

Total A * C: 0.452 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

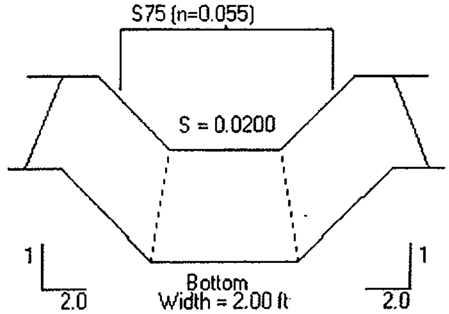
25 year
Calculated Flow, Q (cfs) = 2.4

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.23

North American Green - ECMDS Version 4.3		7/20/2011	08:04 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.23		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.4	0.1	1.82	1.32	0.33	0.45



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									

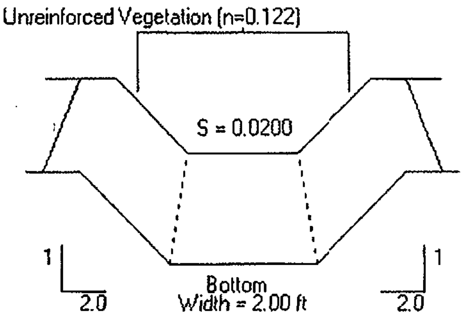
North American Green - ECMDS Version 4.3 | 7/20/2011 | 08:05 AM | COMPUTED BY: NKG

PROJECT NAME: PPL 8BNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 1.23 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.4	0.1	1.02	2.34	0.46	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.86	4.86	STABLE
		Soil	Sandy Loam				0.035	0.007	4.97	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.23

	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1220	0.1220	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.49**	**0.78**	**0.78**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.01	0.72	0.72	feet
Calculated Velocity, V=	1.63	0.86	0.86	fps
Flow Top Width, T=	3.97	5.13	5.13	feet
Flow Area, A=	1.47	2.78	2.78	sq ft
Wetted Perimeter, P=	4.20	5.49	5.49	feet
Hydraulic Radius, R=	0.35	0.51	0.51	feet
Shear stress on channel bottom, τ =	0.61	0.98	0.98	lbs/sf
Critical Slope, S_c=	0.0662	0.2914	0.2914	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.24

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	0.225	0.214
	Lawn		0.40	3.065	1.226

Total Area, A: 3.290 acres
Weighted C: 0.44

Total A * C: 1.43975 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

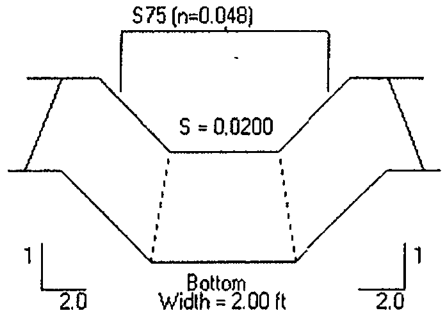
	25 year
Calculated Flow, Q (cfs) =	**7.8**

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.24

North American Green - ECMDS Version 4.3	7/20/2011	08:07 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.24	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.8	0.1	2.77	2.82	0.51	0.79



Not to Scale

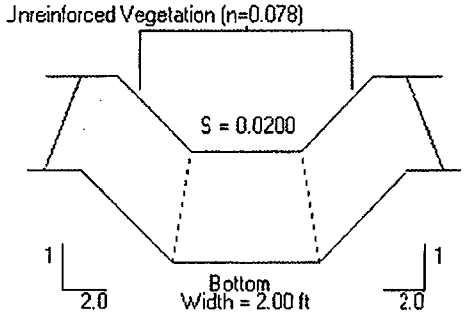
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.98	1.58	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	08:08 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.24		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.8	0.1	1.95	4.00	0.62	1.00



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.25	3.36	STABLE
		Soil	Sandy Loam				0.035	0.025	1.41	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.24

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.80	7.80	7.80	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0780	0.0780	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.79**	**1.00**	**1.00**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.71	0.50	0.50	feet
Calculated Velocity, V=	2.77	1.94	1.94	fps
Flow Top Width, T=	5.15	6.02	6.02	feet
Flow Area, A=	2.82	4.03	4.03	sq ft
Wetted Perimeter, P=	5.52	6.49	6.49	feet
Hydraulic Radius, R=	0.51	0.62	0.62	feet
Shear stress on channel bottom, τ =	0.98	1.25	1.25	lbs/sf
Critical Slope, S_c=	0.0450	0.1120	0.1120	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by:
JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 1.25

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	0.031	0.029
	Stone		0.85	0.609	0.518

Total Area, A: 0.640 acres
Weighted C: 0.85

Total A * C: 0.5471 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): 5.40

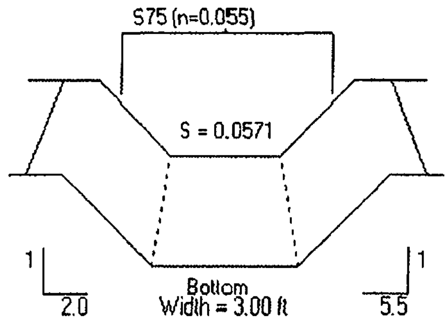
***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k C i A$

25 year
Calculated Flow, Q (cfs) = 3.0

North American Green - ECMDS Version 4.3	7/20/2011	08:10 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.25	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	0.1	2.43	1.23	0.23	0.30



Not to Scale

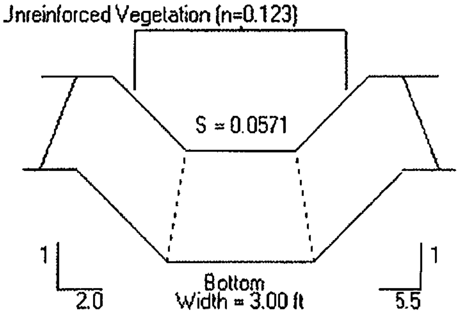
LINER RESULTS

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	7/20/2011	08:11 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.25	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	0.1	1.38	2.17	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.64	2.56	STABLE
		Soil	Sandy Loam				0.035	0.013	2.64	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.25

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.00	3.00	3.00	cfs
Left Side Slope =	2.0	2.0	2.0	H:1V
Right Side Slope =	5.5	5.5	5.5	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0571	0.0571	0.0571	ft/ft
Available depth of channel:	1.00	1.00	1.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1230	0.1230	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.30**	**0.47**	**0.47**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.70	0.53	0.53	feet
Calculated Velocity, V=	2.38	1.35	1.35	fps
Flow Top Width, T=	5.28	6.50	6.50	feet
Flow Area, A=	1.26	2.22	2.22	sq ft
Wetted Perimeter, P=	5.36	6.63	6.63	feet
Hydraulic Radius, R=	0.23	0.33	0.33	feet
Shear stress on channel bottom, τ =	1.08	1.67	1.67	lbs/sf
Critical Slope, S_c=	0.0725	0.3231	0.3231	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.26

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)
	Lawn		0.40	4.960	1.984

Total Area, A: 4.960 acres
Weighted C: 0.40

Total A * C: 1.984 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 10.7

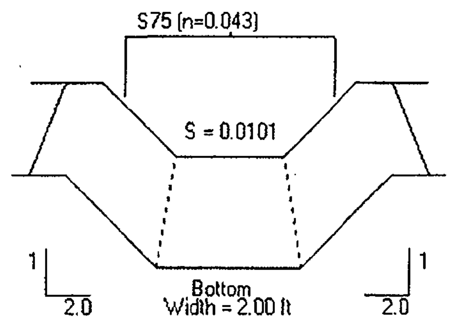
North American Green - ECMDS Version 4.3	7/20/2011	08:15 AM	COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: SWALE 1.26 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.7	0.1	2.56	4.18	0.63	1.03



Not to Scale

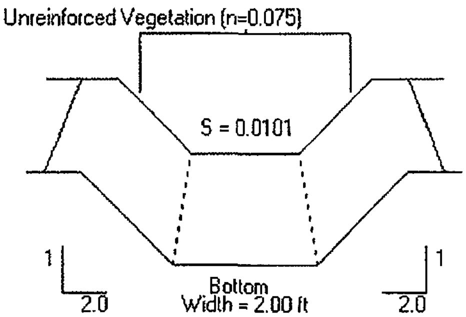
LINER RESULTS

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	0.65	2.39	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	08:15 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.26		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.7	0.1	1.69	6.32	0.79	1.35



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.85	4.95	STABLE
		Soil	Sandy Loam				0.035	0.018	1.92	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.26

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	10.70	10.70	10.70	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=	0.0101	0.0101	0.0101	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0430	0.0750	0.0750	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.03**	**1.35**	**1.35**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.97	0.65	0.65	feet
Calculated Velocity, V=	2.54	1.69	1.69	fps
Flow Top Width, T=	6.14	7.40	7.40	feet
Flow Area, A=	4.21	6.35	6.35	sq ft
Wetted Perimeter, P=	6.63	8.04	8.04	feet
Hydraulic Radius, R=	0.64	0.79	0.79	feet
Shear stress on channel bottom, τ =	0.65	0.85	0.85	lbs/sf
Critical Slope, S_c=	0.0338	0.0962	0.0962	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 18 Aug 11 3:21 PM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 1.27

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 (1.27)			0.95	0.095	0.090
Impervious (Swale 1.14)			0.95	0.129	0.123
Lawn (Swale 1.27)			0.40	1.455	0.582
Lawn (Swale 1.14			0.40	0.451	0.180

Total Area A: 2.130 acres
Weighted C: 0.46

Total A * C: 0.9752 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

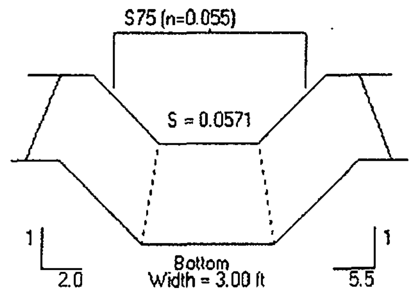
	25 year
Calculated Flow, Q (cfs) =	5.3

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.27

North American Green - ECMDS Version 4.3		8/18/2011 03:30 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH: UNVEG	TO STATION/REACH:	DRAINAGE AREA: SWALE 1.27	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.3	0.1	2.88	1.84	0.30	0.41



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	1.45	1.07	STABLE
	Staple D									

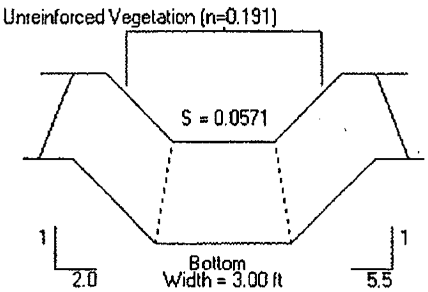
North American Green - ECMDS Version 4.3 | 8/18/2011 | 03:31 PM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: VEG | TO STATION/REACH: | DRAINAGE AREA: SWALE 1.27 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.3	0.1	1.17	4.51	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	Unreinforced	Vegetation		B	Bunch	75-95%	5.73	2.73	2.10	STABLE
		Soil	Sandy Loam				0.035	0.009	3.82	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 18 Aug 11 3:35 PM
Project #: PPLS0902

Checked by: JFM

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 1.27

	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 =	5.5	5.5	5.5	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0571	0.0571	0.0571	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1910	0.1910	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.41**	**0.78**	**0.78**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.09	0.72	0.72	feet
Calculated Velocity, V=	2.85	1.14	1.14	fps
Flow Top Width, T=	6.07	8.86	8.86	feet
Flow Area, A=	1.86	4.63	4.63	sq ft
Wetted Perimeter, P=	6.18	9.06	9.06	feet
Hydraulic Radius, R=	0.30	0.51	0.51	feet
Shear stress on channel bottom, τ =	1.46	2.78	2.78	lbs/sf
Critical Slope, S_c=	0.0669	0.6798	0.6798	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 18 Aug 11 3:21 PM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.28

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 (Swale 1.28)			0.95	0.138	0.131
Impervious (Swale 1.14)			0.95	0.129	0.123
Impervious (Swale 1.27)			0.95	0.095	0.090
Lawn (Swale 1.28)			0.40	1.502	0.601
Lawn (Swale 1.14)			0.40	0.451	0.180
Lawn (Swale 1.27)			0.40	1.455	0.582

Total Area, A: 3.770 acres
Weighted C: 0.45

Total A * C: 1.7071 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): 5.40

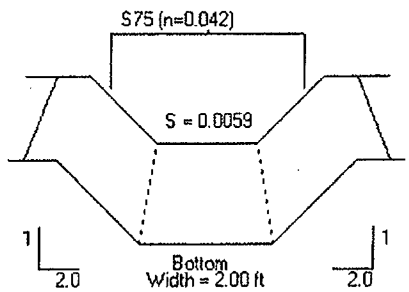
***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 9.2

North American Green - ECMDS Version 4.3		8/18/2011	03:44 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.28		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.2	0.1	2.06	4.47	0.66	1.08



Not to Scale

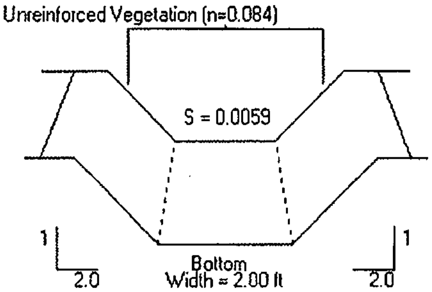
LINER RESULTS

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	0.40	3.91	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		8/18/2011	03:44 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.28		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.2	0.1	1.23	7.49	0.86	1.50



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.55	7.61	STABLE
		Soil	Sandy Loam				0.035	0.010	3.68	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 18 Aug 11 3:47 PM
Project #: PPLS0902

Checked by:
JFM

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 1.28

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.20	9.20	9.20	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=	0.0059	0.0059	0.0059	ft/ft
Available depth of channel:	2.25	2.25	2.25	feet
(OPTIONAL) Input Manning's 'n':	0.0420	0.0840	0.0840	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.08**	**1.51**	**1.51**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.17	0.74	0.74	feet
Calculated Velocity, V=	2.04	1.22	1.22	fps
Flow Top Width, T=	6.33	8.02	8.02	feet
Flow Area, A=	4.51	7.54	7.54	sq ft
Wetted Perimeter, P=	6.84	8.73	8.73	feet
Hydraulic Radius, R=	0.66	0.86	0.86	feet
Shear stress on channel bottom, τ =	0.40	0.55	0.55	lbs/sf
Critical Slope, S_c=	0.0319	0.1174	0.1174	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 1**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.29

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	0.104	0.099
	Lawn		0.40	0.726	0.290

Total Area, A: 0.830 acres
Weighted C: 0.47

Total A * C: 0.3892 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): 5.40

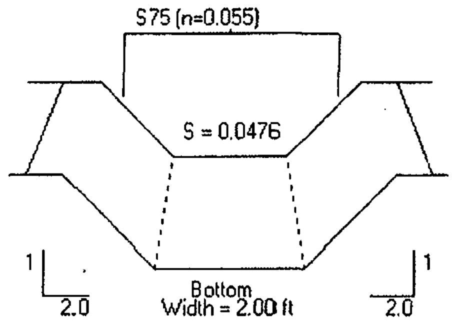
STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 2.1

North American Green - ECMDS Version 4.3		7/20/2011	08:26 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.29		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	0.1	2.37	0.89	0.25	0.33



Not to Scale

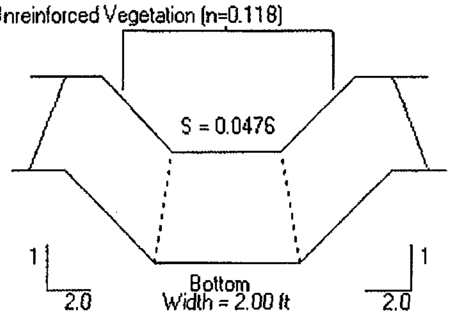
LINER RESULTS

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	0.99	1.57	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	08:26 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.29		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	0.1	1.38	1.52	0.36	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.50	2.80	STABLE
		Soil	Sandy Loam				0.035	0.013	2.68	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 1.29

	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=	2.0	2.0	2.0	feet
Bed slope, s=	0.0476	0.0476	0.0476	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1180	0.1180	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.35**	**0.56**	**0.56**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.15	0.94	0.94	feet
Calculated Velocity, V=	2.25	1.20	1.20	fps
Flow Top Width, T=	3.38	4.25	4.25	feet
Flow Area, A=	0.93	1.76	1.76	sq ft
Wetted Perimeter, P=	3.55	4.51	4.51	feet
Hydraulic Radius, R=	0.26	0.39	0.39	feet
Shear stress on channel bottom, τ =	1.03	1.67	1.67	lbs/sf
Critical Slope, S_c=	0.0721	0.2950	0.2950	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 1
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 1.30

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	0.055	0.052
	Lawn		0.40	0.625	0.250

Total Area A: 0.680 acres
Weighted C: 0.44

Total A * C: 0.30225 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year

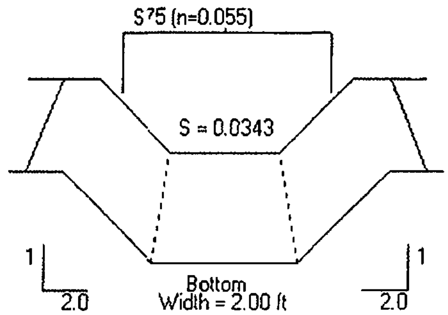
Calculated Flow, Q (cfs) = 1.6

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 1.30

North American Green - ECMDS Version 4.3		7/20/2011 08:28 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 1.30	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.6	0.1	1.94	0.82	0.24	0.31



Not to Scale

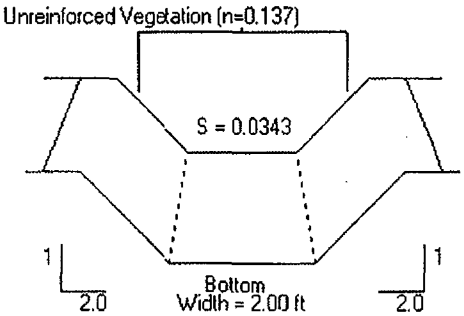
LINER RESULTS

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	2.31	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011	08:30 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 1.30	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
1.6	0.1	1.03	1.56	0.36	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.10	3.81	STABLE
		Soil	Sandy Loam				0.035	0.007	4.86	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 1
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 1.30

	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=	2.0	2.0	2.0	feet
Bed slope, s=	0.0343	0.0343	0.0343	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1370	0.1370	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.35**	**0.62**	**0.62**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.15	0.88	0.88	feet
Calculated Velocity, V=	1.72	0.80	0.80	fps
Flow Top Width, T=	3.38	4.47	4.47	feet
Flow Area, A=	0.93	1.99	1.99	sq ft
Wetted Perimeter, P=	3.55	4.76	4.76	feet
Hydraulic Radius, R=	0.26	0.42	0.42	feet
Shear stress on channel bottom, τ =	0.74	1.32	1.32	lbs/sf
Critical Slope, S_c=	0.0721	0.3890	0.3890	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 2
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.845	0.803
	Lawn		0.40	0.481	0.192
	Stone		0.85	0.534	0.454

Total Area, A: 1.860 acres
Weighted C: 0.78

Total A * C: 1.44905 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): 5.40

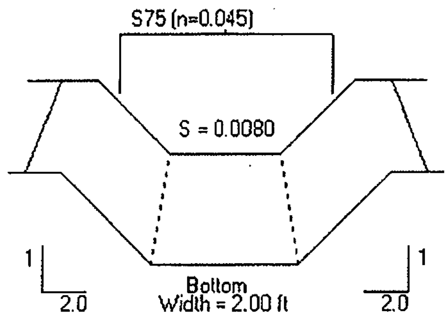
STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

	25 year
Calculated Flow, Q (cfs) =	7.8

North American Green - ECMDS Version 4.3	7/20/2011	08:33 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 2.1	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.8	0.1	2.10	3.72	0.59	0.95



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	3.26	STABLE
	Staple D									

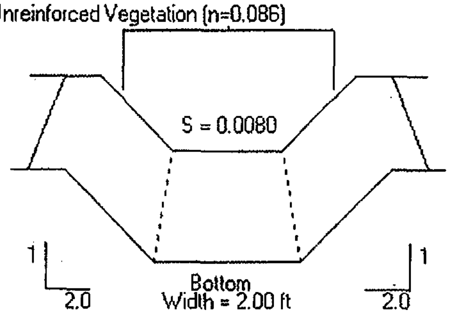
North American Green - ECMDS Version 4.3 | 7/20/2011 | 08:33 AM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 2.1 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.8	0.1	1.29	6.03	0.77	1.31



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stablity Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.65	6.44	STABLE
		Soil	Sandy Loam				0.035	0.011	3.28	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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=	7.80	7.80	7.80	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=	0.0080	0.0080	0.0080	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0450	0.0860	0.0860	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.96**	**1.31**	**1.31**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.04	0.69	0.69	feet
Calculated Velocity, V=	2.07	1.28	1.28	fps
Flow Top Width, T=	5.84	7.25	7.25	feet
Flow Area, A=	3.76	6.07	6.07	sq ft
Wetted Perimeter, P=	6.29	7.87	7.87	feet
Hydraulic Radius, R=	0.60	0.77	0.77	feet
Shear stress on channel bottom, τ =	0.48	0.66	0.66	lbs/sf
Critical Slope, S_c=	0.0377	0.1274	0.1274	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 2**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	1.632	1.550
	Lawn		0.40	1.078	0.431

Total Area, A: 2.710 acres
Weighted C: 0.73

Total A * C: 1.9816 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): 5.40

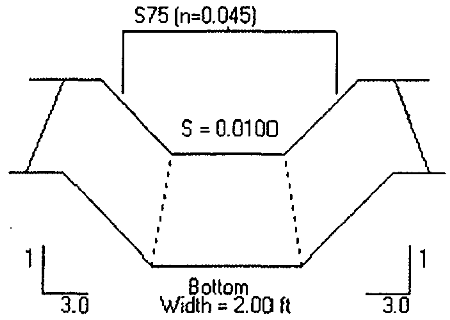
STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 10.7

North American Green - ECMDS Version 4.3	7/20/2011	08:38 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 2.2	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.7	0.1	2.31	4.64	0.58	0.95



Not to Scale

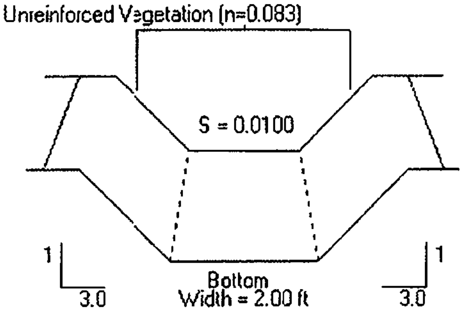
LINER RESULTS

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	0.60	2.60	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	08:36 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 22		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.7	0.1	1.45	7.36	0.73	1.27



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stabilty Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.79	5.31	STABLE
		Soil	Sandy Loam				0.035	0.014	2.52	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	10.70	10.70	10.70	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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':	0.0450	0.0830	0.0830	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.96**	**1.27**	**1.27**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.04	0.73	0.73	feet
Calculated Velocity, V=	2.28	1.45	1.45	fps
Flow Top Width, T=	7.76	9.63	9.63	feet
Flow Area, A=	4.69	7.40	7.40	sq ft
Wetted Perimeter, P=	8.07	10.04	10.04	feet
Hydraulic Radius, R=	0.58	0.74	0.74	feet
Shear stress on channel bottom, τ =	0.60	0.79	0.79	lbs/sf
Critical Slope, S_c=	0.0368	0.1158	0.1158	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 2
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 29 Aug 11 10:52 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 2.3

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 (Swale 2.3)		0.95	1.515	1.439
	Impervious (Swale 2.5)		0.95	0.277	0.263
	Impervious (Swale 2.6)		0.95	1.057	1.004
	Lawn (Swale 2.3)		0.40	0.558	0.223
	Lawn (Swale 2.5)		0.40	0.191	0.076
	Lawn (Swale 2.6)		0.40	1.601	0.640
	Stone (Swale 2.3)		0.85	2.197	1.867
	Stone (Swale 2.5)		0.85	0.952	0.809
	Stone (Swale 2.6)		0.85	4.362	3.708

Total Area A: 12.710 acres
Weighted C: 0.79

Total A * C: 10.0309 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

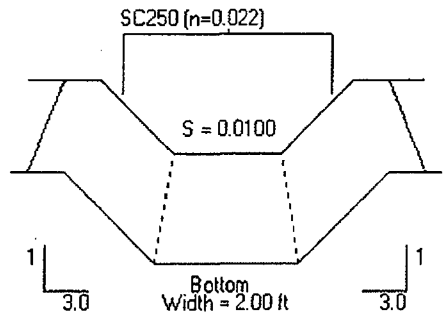
Calculated Flow, Q (cfs) = 54.2

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 2.3

North American Green - ECMDS Version 4.3		8/29/2011	10:44 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 2.3		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
54.2	0.1	5.96	9.10	0.82	1.44



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	SC250	Unvegetated	1				3.00	0.90	3.34	STABLE
	Staple E									

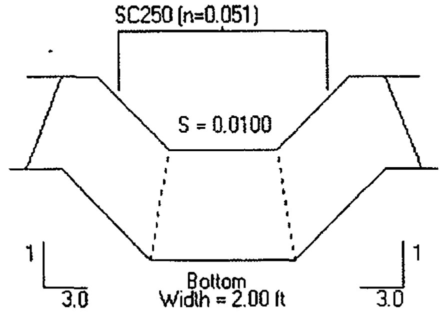
North American Green - ECMDS Version 4.3 | 8/29/2011 | 10:42 AM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 2.3 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
54.2	0.1	3.15	17.20	1.13	2.08



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.30	7.69	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.030	26.72	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 29 Aug 11 10:52 AM
Project #: PPLS0902

Checked by:
JML

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 2.3	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	54.20	54.20	54.20	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	2.75	2.75	2.75	feet
(OPTIONAL) Input Manning's 'n':	0.0220	0.0510	0.0510	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.44**	**2.08**	**2.08**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.31	0.67	0.67	feet
Calculated Velocity, V=	5.92	3.16	3.16	fps
Flow Top Width, T=	10.67	14.48	14.48	feet
Flow Area, A=	9.15	17.14	17.14	sq ft
Wetted Perimeter, P=	11.14	15.16	15.16	feet
Hydraulic Radius, R=	0.82	1.13	1.13	feet
Shear stress on channel bottom, τ =	0.90	1.30	1.30	lbs/sf
Critical Slope, S_c=	0.0079	0.0380	0.0380	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.7	0.6	0.6	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 2
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 2.4

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	0.607	0.577
	Lawn		0.40	0.413	0.165

Total Area A: 1.020 acres
Weighted C: 0.73

Total A * C: 0.74185 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

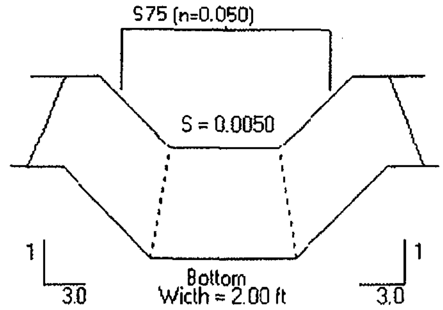
25 year

Calculated Flow, Q (cfs) = 4.0

North American Green - ECMDS Version 4.3	7/20/2011	08:43 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 2.4	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.0	0.1	1.28	3.13	0.47	0.74



Not to Scale

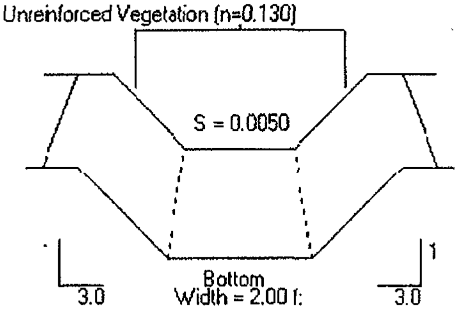
LINER RESULTS

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	6.71	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	08:44 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 2.4		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.0	0.1	0.62	6.40	0.68	1.16



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.36	11.56	STABLE
		Soil	Sandy Loam				0.035	0.003	13.46	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 2.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.00	4.00	4.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0500	0.1300	0.1300	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.76**	**1.23**	**1.23**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.24	0.77	0.77	feet
Calculated Velocity, V=	1.22	0.57	0.57	fps
Flow Top Width, T=	6.58	9.39	9.39	feet
Flow Area, A=	3.28	7.01	7.01	sq ft
Wetted Perimeter, P=	6.83	9.79	9.79	feet
Hydraulic Radius, R=	0.48	0.72	0.72	feet
Shear stress on channel bottom, τ =	0.24	0.38	0.38	lbs/sf
Critical Slope, S_c=	0.0482	0.2867	0.2867	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 2
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 2.5

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	0.277	0.263
	Lawn		0.40	0.191	0.076
	Stone		0.85	0.952	0.809

Total Area, A: 1.420 acres
Weighted C: 0.81

Total A * C: 1.14875 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

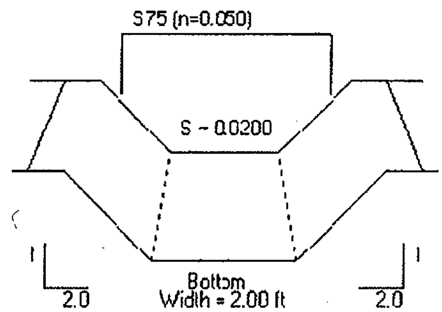
25 year
Calculated Flow, Q (cfs) = 6.2

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 2.5

North American Green - ECMDS Version 4.3	7/20/2011	08:48 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BENPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 25	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.2	0.1	2.54	2.44	0.47	0.71



Not to Scale

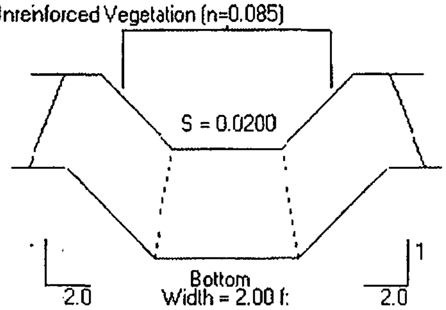
LINER RESULTS

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	0.89	1.74	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011 08:48 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 2.5	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.2	0.1	1.73	3.59	0.58	0.93



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.16	3.62	STABLE
		Soil	Sandy Loam				0.035	0.020	1.79	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 2.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.20	6.20	6.20	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0500	0.0850	0.0850	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.72**	**0.94**	**0.94**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.78	0.56	0.56	feet
Calculated Velocity, V=	2.52	1.71	1.71	fps
Flow Top Width, T=	4.87	5.75	5.75	feet
Flow Area, A=	2.46	3.63	3.63	sq ft
Wetted Perimeter, P=	5.21	6.19	6.19	feet
Hydraulic Radius, R=	0.47	0.59	0.59	feet
Shear stress on channel bottom, τ =	0.89	1.17	1.17	lbs/sf
Critical Slope, S_c=	0.0500	0.1353	0.1353	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 2**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JMF

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 2.6

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	1.057	1.004
	Lawn		0.40	1.601	0.640
	Stone		0.85	4.362	3.708

Total Area, A: 7.020 acres
Weighted C: 0.76

Total A * C: 5.35225 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

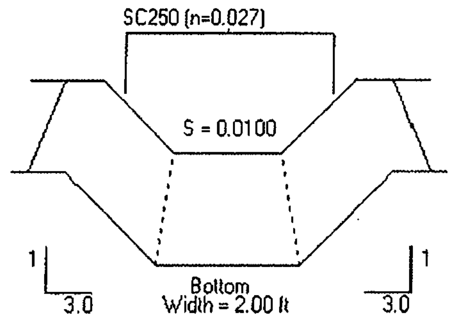
25 year

Calculated Flow, Q (cfs) = 28.9

North American Green - ECMDS Version 4.3	7/20/2011	08:54 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 2.6	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
28.9	0.1	4.37	6.61	0.70	1.19



Not to Scale

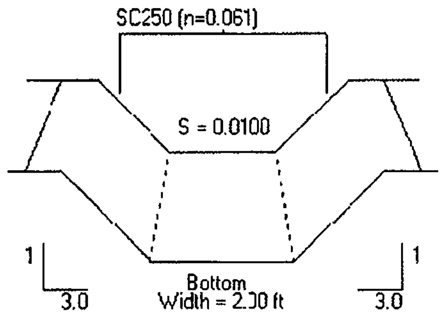
LINER RESULTS

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	SC250	Unvegetated	1				3.00	0.74	4.05	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/20/2011	08:54 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS3902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 2.6	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
28.9	0.1	2.37	12.18	0.95	1.71



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.07	9.38	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.040	19.94	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 2.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	28.90	28.90	28.90	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	2.25	2.25	2.25	feet
(OPTIONAL) Input Manning's 'n':	0.0270	0.0610	0.0610	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.20**	**1.72**	**1.72**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.05	0.53	0.53	feet
Calculated Velocity, V=	4.33	2.35	2.35	fps
Flow Top Width, T=	9.17	12.30	12.30	feet
Flow Area, A=	6.68	12.27	12.27	sq ft
Wetted Perimeter, P=	9.56	12.86	12.86	feet
Hydraulic Radius, R=	0.70	0.95	0.95	feet
Shear stress on channel bottom, τ =	0.75	1.07	1.07	lbs/sf
Critical Slope, S_c=	0.0125	0.0575	0.0575	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 2**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 2.7

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	0.409	0.389
	Lawn		0.40	0.701	0.280

Total Area, A: 1.110 acres
Weighted C: 0.60

Total A * C: 0.66895 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): 5.40

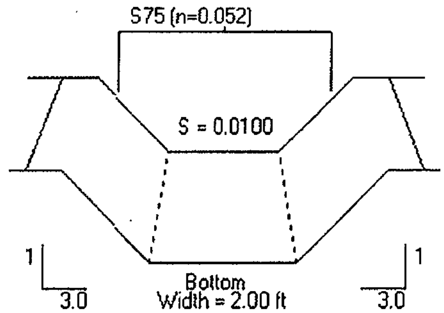
STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year
Calculated Flow, Q (cfs) = 3.6

NorthAmerican Green - ECMDS Version 4.3		7/21/2011	03:17 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 27		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Norma Depth (ft)
3.6	0.1	1.54	2.34	0.40	0.61



Not to Scale

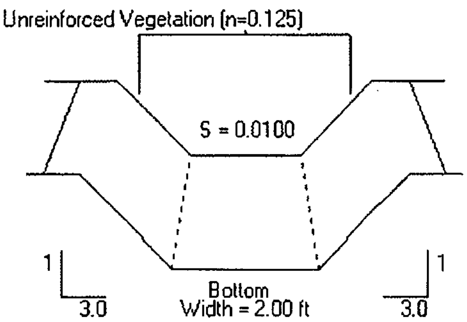
LINER RESULTS

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	0.38	4.06	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/21/2011	03:18 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 2.7		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.6	0.1	0.81	4.44	0.56	0.93



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.58	7.26	STABLE
		Soil	Sandy Loam				0.035	0.005	7.77	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 2
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 2.7

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.60	3.60	3.60	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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':	0.0550	0.1480	0.1480	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.64**	**1.07**	**1.07**	**feet**

Calculated Results:

Freeboard, f=	1.36	0.93	0.93	feet
Calculated Velocity, V=	1.43	0.65	0.65	fps
Flow Top Width, T=	5.85	8.42	8.42	feet
Flow Area, A=	2.51	5.57	5.57	sq ft
Wetted Perimeter, P=	6.05	8.77	8.77	feet
Hydraulic Radius, R=	0.42	0.64	0.64	feet
Shear stress on channel bottom, τ =	0.40	0.67	0.67	lbs/sf
Critical Slope, S_c=	0.0611	0.3862	0.3862	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 3**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	1.110	1.055
	Lawn		0.40	0.386	0.154
	Stone		0.85	0.124	0.105

Total Area, A: 1.620 acres
Weighted C: 0.81

Total A * C: 1.3143 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

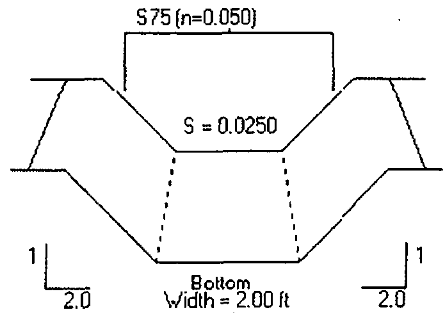
25 year
Calculated Flow, Q (cfs) = 7.1

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.1

North American Green - ECMDS Version 4.3	7/20/2011	09:01 AM	COMPUTED BY: NKG
PROJECT NAME: PP_BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.1	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.1	0.1	2.86	2.48	0.47	0.72



Not to Scale

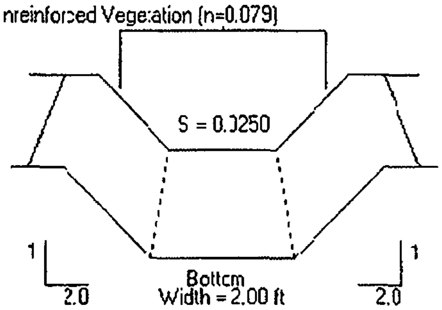
LINER RESULTS

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	1.12	1.38	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/201˙	09:02 AM	COMPUTED BY: NKG
PROJECT NAME: FPL BBNP⁵	PROJECT NO: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.1	DESIGN FREQUENCY: 25 YF

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.1	0.1	2.05	3.47	0.57	0.91



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.42	2.96	STABLE
		Soil	Sandy Loam				0.035	0.028	1.27	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	7.10	7.10	7.10	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=	0.0250	0.0250	0.0250	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0500	0.0790	0.0790	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.73**	**0.91**	**0.91**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.77	0.59	0.59	feet
Calculated Velocity, V=	2.84	2.03	2.03	fps
Flow Top Width, T=	4.90	5.66	5.66	feet
Flow Area, A=	2.50	3.50	3.50	sq ft
Wetted Perimeter, P=	5.24	6.09	6.09	feet
Hydraulic Radius, R=	0.48	0.57	0.57	feet
Shear stress on channel bottom, τ =	1.13	1.43	1.43	lbs/sf
Critical Slope, S_c=	0.0498	0.1176	0.1176	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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)
	Stone		0.85	9.835	8.360
	Lawn		0.40	0.075	0.030

Total Area, A: 9.910 acres
Weighted C: 0.85

Total A * C: 8.38975 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): 5.40

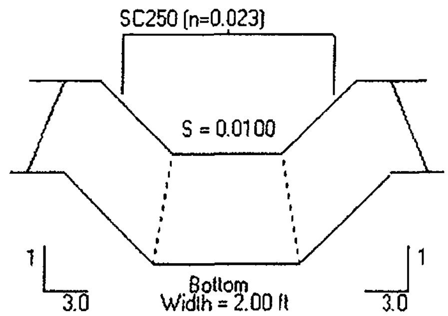
STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 45.3

North American Green - ECMDS Version 4.3		7/20/2011	09:06 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.2		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
45.3	0.1	5.43	8.34	0.78	1.37



Not to Scale

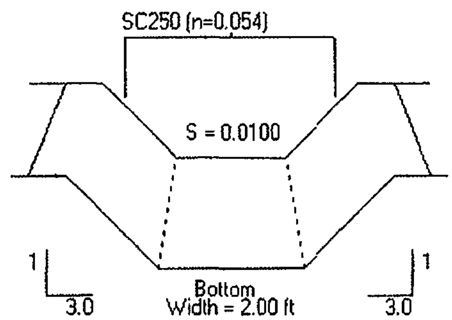
LINER RESULTS

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	SC250	Unvegetated	1				3.00	0.85	3.52	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/20/2011	09:05 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.2	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
45.3	0.1	2.91	15.56	1.08	·.97



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
Straght	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.23	8.14	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.029	27.79	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

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=	45.30	45.30	45.30	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	2.50	2.50	2.50	feet
(OPTIONAL) Input Manning's 'n':	0.0230	0.0540	0.0540	
Lining Type:	**ECB**	**Grass**	**Grass**	
Retardance Factor for Grass Cover:		**B**	**B**	

Calculate Flow Depth:

Flow depth, d=	**1.36**	**1.97**	**1.97**	**feet**

Calculated Results:

Design Acceptable?	V too high	Yes	Yes	
Freeboard, f=	1.14	0.53	0.53	feet
Calculated Velocity, V=	5.47	2.90	2.90	fps
Flow Top Width, T=	10.17	13.84	13.84	feet
Flow Area, A=	8.29	15.63	15.63	sq ft
Wetted Perimeter, P=	10.61	14.48	14.48	feet
Hydraulic Radius, R=	0.78	1.08	1.08	feet
Shear stress on channel bottom, τ =	0.85	1.23	1.23	lbs/sf
Critical Slope, S_c=	0.0087	0.0433	0.0433	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.6	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 3**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.680	0.646
	Lawn		0.40	3.596	1.438
	Stone		0.85	4.724	4.015

Total Area, A: 9.000 acres
Weighted C: 0.68

Total A * C: 6.0998 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** **Q = k C i A**

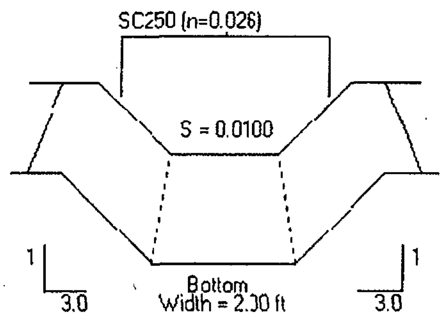
25 year
Calculated Flow, Q (cfs) = 32.9

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.3

North American Green - ECMDS Version 4.3		7/20/2011	09:11 AM	COMPUTED BY: NKG
PROJECT NAME: PPL 8BNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.3		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
32.9	0.1	4.64	7.08	0.72	1.24



Not to Scale

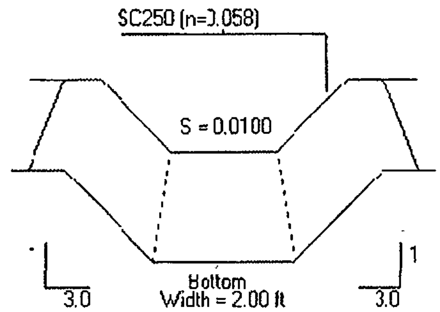
LINER RESULTS

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	SC250	Unvegetated	1				3.00	0.77	3.88	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/20/2011	09:10 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.3	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
32.9	0.1	2.52	13.06	0.99	1.78



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.11	9.00	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.038	21.12	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	32.90	32.90	32.90	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0260	0.0580	0.0580	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.25**	**1.78**	**1.78**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	3.75	3.22	3.22	feet
Calculated Velocity, V=	4.60	2.53	2.53	fps
Flow Top Width, T=	9.48	12.65	12.65	feet
Flow Area, A=	7.15	13.01	13.01	sq ft
Wetted Perimeter, P=	9.88	13.23	13.23	feet
Hydraulic Radius, R=	0.72	0.98	0.98	feet
Shear stress on channel bottom, τ =	0.78	1.11	1.11	lbs/sf
Critical Slope, S_c=	0.0114	0.0515	0.0515	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	1.231	1.169
	Lawn		0.40	0.505	0.202
	Stone		0.85	0.074	0.063

Total Area, A: 1.810 acres
Weighted C: 0.79

Total A * C: 1.43435 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

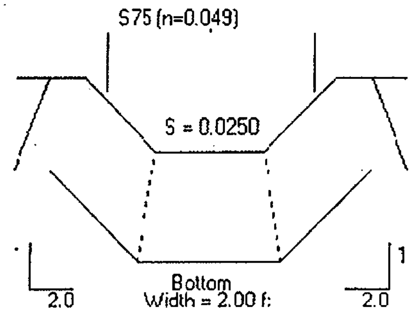
Calculated Flow, Q (cfs) = 7.7

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.4

North American Green - ECMDS Version 4.3	7/20/2011	09:13 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.4	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.7	0.1	2.95	2.61	0.49	0.75



Not to Scale

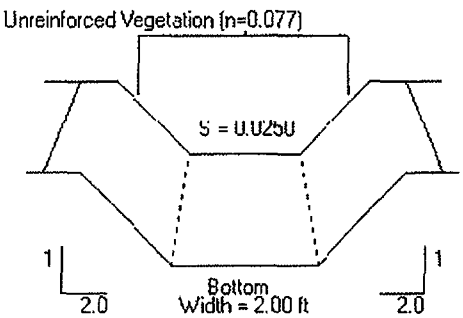
LINER RESULTS

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					1.65	1.17	1.33	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/23/2011 09:14 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.4	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.7	0.1	2.14	3.60	0.58	0.93



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.45	2.89	STABLE
		Soil	Sandy Loam				0.035	0.030	1.17	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	7.70	7.70	7.70	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=	0.0250	0.0250	0.0250	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0490	0.0770	0.0770	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.75**	**0.94**	**0.94**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.75	0.56	0.56	feet
Calculated Velocity, V=	2.94	2.11	2.11	fps
Flow Top Width, T=	4.99	5.76	5.76	feet
Flow Area, A=	2.62	3.64	3.64	sq ft
Wetted Perimeter, P=	5.35	6.20	6.20	feet
Hydraulic Radius, R=	0.49	0.59	0.59	feet
Shear stress on channel bottom, τ =	1.17	1.47	1.47	lbs/sf
Critical Slope, S_c=	0.0475	0.1110	0.1110	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 3**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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)
	Stone		0.85	0.355	0.302
	Lawn		0.40	1.461	0.584
	Cultivated		0.25	2.804	0.701

Total Area, A: 4.620 acres
Weighted C: 0.34

Total A * C: 1.58715 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

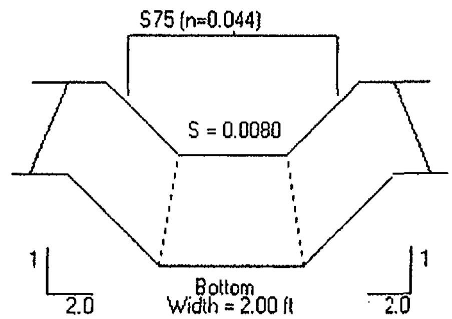
25 year
Calculated Flow, Q (cfs) = 8.6

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.5

North American Green - ECMDS Version 4.3		7/20/2011	09:16 AM	COMPUTED BY: NKG
PROJECT NAME: PPL 88NPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.5		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.6	0.1	2.18	3.94	0.61	0.99



Not to Scale

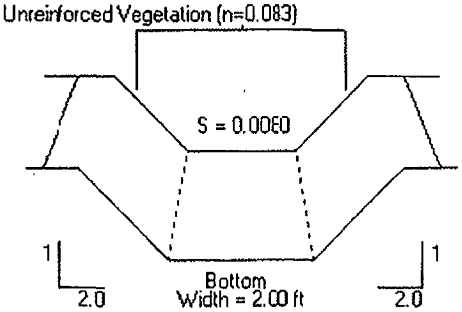
LINER RESULTS

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	0.49	3.14	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011	09:_6 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.5	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.6	0.1	1.36	6.32	0.79	1.35



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.67	6.25	STABLE
		Soil	Sandy Loam				0.035	0.012	2.97	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM /

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=	8.60	8.60	8.60	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=	0.0080	0.0080	0.0080	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0440	0.0830	0.0830	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.00**	**1.35**	**1.35**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.00	0.65	0.65	feet
Calculated Velocity, V=	2.17	1.35	1.35	fps
Flow Top Width, T=	5.98	7.40	7.40	feet
Flow Area, A=	3.97	6.35	6.35	sq ft
Wetted Perimeter, P=	6.45	8.04	8.04	feet
Hydraulic Radius, R=	0.62	0.79	0.79	feet
Shear stress on channel bottom, τ =	0.50	0.67	0.67	lbs/sf
Critical Slope, S_c=	0.0357	0.1179	0.1179	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by:
JFM

Print Date: 17 Aug 11 11:49 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	0.263	0.250
	Lawn		0.40	0.320	0.128
	Stone		0.85	4.617	3.924

Total Area, A: 5.200 acres
Weighted C: 0.83

Total A * C: 4.3023 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): 5.40

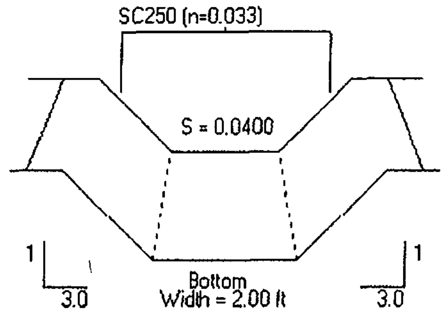
STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 23.2

North American Green - ECMDS Version 4.3		7/20/2011	09:19 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.6		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocty (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
23.2	0.1	5.89	3.94	0.53	0.86



Not to Scale

LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Cass	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	SC250	Unvegetated	1				3.00	2.15	1.40	STABLE
	Staple E									

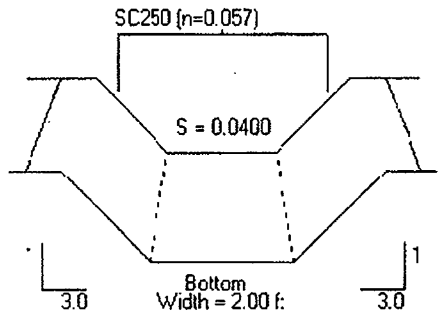
North American Green - ECMDS Version 4.3 | 7/20/2011 | 09:20 AM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 3.6 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
23.2	0.1	3.94	5.88	0.65	1.11



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.76	3.62	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.342	2.34	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

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=	23.20	23.20	23.20	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0400	0.0400	0.0400	ft/ft
Available depth of channel:	4.00	4.00	4.00	feet
(OPTIONAL) Input Manning's 'n':	0.0330	0.0570	0.0570	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.86**	**1.11**	**1.11**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	3.14	2.89	2.89	feet
Calculated Velocity, V=	5.88	3.92	3.92	fps
Flow Top Width, T=	7.17	8.66	8.66	feet
Flow Area, A=	3.95	5.91	5.91	sq ft
Wetted Perimeter, P=	7.45	9.02	9.02	feet
Hydraulic Radius, R=	0.53	0.66	0.66	feet
Shear stress on channel bottom, τ =	2.15	2.77	2.77	lbs/sf
Critical Slope, S_c=	0.0204	0.0567	0.0567	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	no	no	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by:
JFM

Print Date: 17 Aug 11 11:49 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)
	Lawn		0.40	1.950	0.780

Total Area, A: 1.950 acres
Weighted C: 0.40

Total A * C: 0.78 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): 5.40

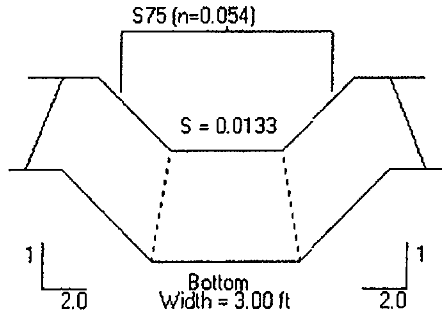
***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 4.2

North American Green - ECMDS Version 4.3	7/20/2011	09:22 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.7	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.2	0.1	1.80	2.33	0.42	0.56



Not to Scale

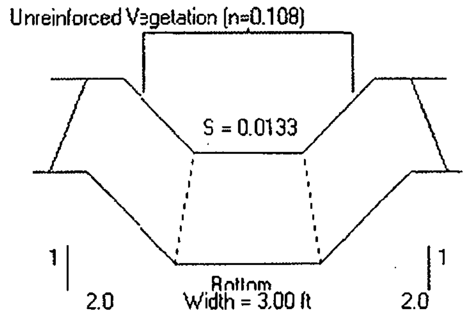
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straght	S75	Unvegetated					1.55	0.47	3.31	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	09:23 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.7		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Norma Depth (ft)
4.2	0.1	1.10	3.82	0.57	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.68	6.15	STABLE
		Soil	Sandy Loam				0.035	0.007	4.87	STABLE

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

Client/Subject: PPL Bell Bend .

Description: POI 3

Prepared by: JMO

Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 3:6 PM

Project #: PPLS0902

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=	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=	3.0	3.0	3.0	feet
Bed slope, s=	0.0133	0.0133	0.0133	ft/ft
Available depth of channel:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.1080	0.1080	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.57**	**0.87**	**0.87**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	4.43	4.13	4.13	feet
Calculated Velocity, V=	1.76	1.01	1.01	fps
Flow Top Width, T=	5.30	6.49	6.49	feet
Flow Area, A=	2.38	4.14	4.14	sq ft
Wetted Perimeter, P=	5.57	6.90	6.90	feet
Hydraulic Radius, R=	0.43	0.60	0.60	feet
Shear stress on channel bottom, τ =	0.48	0.72	0.72	lbs/sf
Critical Slope, S_c=	0.0592	0.2141	0.2141	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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)
	Lawn		0.40	1.099	0.440
	Stone		0.85	0.031	0.026

Total Area, A: 1.130 acres
Weighted C: 0.41

Total A * C: 0.46595 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,I\,A$

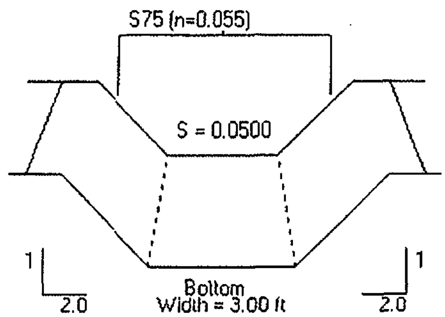
Calculated Flow, Q (cfs) = 25 year 2.5

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.8

NorthAmerican Green - ECMDS Version 4.3	7/20/2011	09:25 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FRON STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 38	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.5	0.1	2.36	1.06	0.24	0.29



Not to Scale

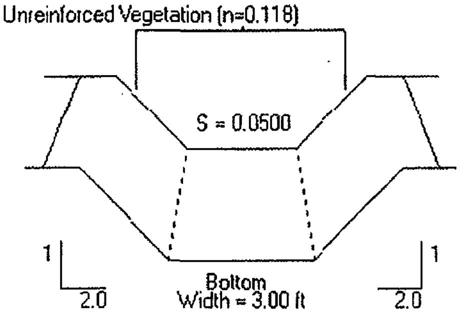
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stabilty Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.92	1.69	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/23/2011	09:25 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.8	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.5	0.1	1.41	1.77	0.35	0.45



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.42	2.97	STABLE
		Soil	Sandy Loam				0.035	0.012	2.81	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	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=	3.0	3.0	3.0	feet
Bed slope, s=	0.0500	0.0500	0.0500	ft/ft
Available depth of channel:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1180	0.1180	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.30**	**0.50**	**0.50**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	4.70	4.50	4.50	feet
Calculated Velocity, V=	2.31	1.26	1.26	fps
Flow Top Width, T=	4.20	4.99	4.99	feet
Flow Area, A=	1.08	1.99	1.99	sq ft
Wetted Perimeter, P=	4.35	5.23	5.23	feet
Hydraulic Radius, R=	0.25	0.38	0.38	feet
Shear stress on channel bottom, τ =	0.94	1.55	1.55	lbs/sf
Critical Slope, S_c=	0.0723	0.2929	0.2929	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 3.9

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)
	Lawn		0.40	2.651	1.060
	Cultivated		0.25	0.469	0.117

Total Area A: 3.120 acres
Weighted C: 0.38

Total A * C: 1.17765 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): 5.40

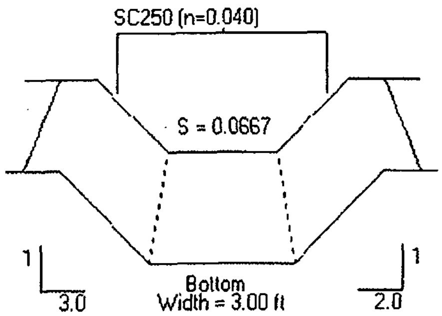
STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

	25 year
Calculated Flow, Q (cfs) =	**6.4**

North American Green - ECMDS Version 4.3	7/2?/2011	09:29 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.9	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.4	0.1	4.27	1.50	0.30	0.38



Not to Scale

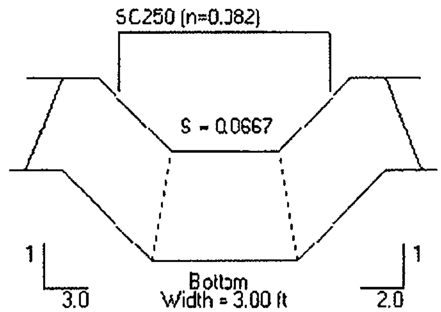
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.58	1.90	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/20/2011	09:29 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BENPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.9	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
6.4	0.1	2.58	2.48	0.41	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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.34	4.27	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.262	3.05	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 3.9

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	6.40	6.40	6.40	cfs
Left Side Slope =	3.0	3.0	3.0	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=	0.0667	0.0667	0.0667	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0820	0.0820	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.38**	**0.57**	**0.57**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.12	0.93	0.93	feet
Calculated Velocity, V=	4.23	2.56	2.56	fps
Flow Top Width, T=	4.91	5.83	5.83	feet
Flow Area, A=	1.51	2.50	2.50	sq ft
Wetted Perimeter, P=	5.06	6.05	6.05	feet
Hydraulic Radius, R=	0.30	0.41	0.41	feet
Shear stress on channel bottom, τ =	1.59	2.36	2.36	lbs/sf
Critical Slope, S_c=	0.0359	0.1363	0.1363	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 29 Aug 11 11:36 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.10

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)
	Stone (Swale 3.10)		0.85	0.639	0.543
	Stone (Swale 3.1)		0.85	0.105	0.089
	Impervious (Swale 3.1)		0.95	1.055	1.002
	Lawn (Swale 3.10)		0.40	4.767	1.907
	Lawn (Swale 3.1)		0.40	0.154	0.062
	Cultivated		0.25	2.964	0.741

Total Area, A 9.684 acres
Weighted C 0.45

Total A * C: 4.34405 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) 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

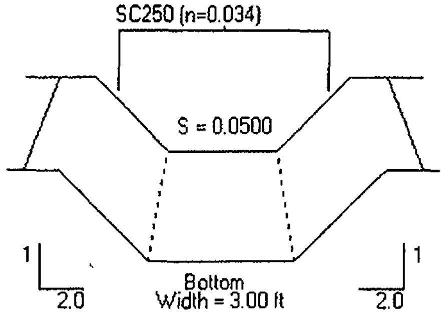
25 year
Calculated Flow, Q (cfs) = 23.5

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.10

North American Green - ECMDS Version 4.3		8/29/2011	11:34 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.10		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
23.5	0.1	6.51	3.61	0.55	0.79



Not to Scale

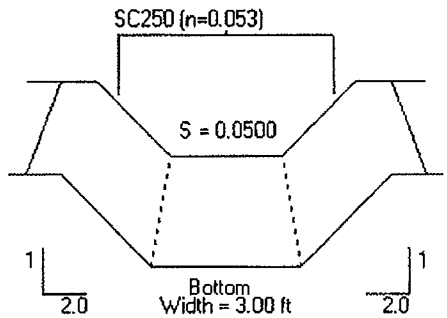
LINER RESULTS

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	SC250	Unvegetated	1				3.00	2.46	1.22	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		8/29/2011	11:34 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.10		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
23.5	0.1	4.80	4.90	0.66	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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	3.07	3.25	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.521	1.53	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 29 Aug 11 11:36 AM
Project #: PPLS0902

Checked by: JFM

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 3.10

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	23.50	23.50	23.50	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=	0.0500	0.0500	0.0500	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0340	0.0530	0.0530	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.78**	**0.99**	**0.99**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.72	0.51	0.51	feet
Calculated Velocity, V=	6.58	4.76	4.76	fps
Flow Top Width, T=	6.13	6.96	6.96	feet
Flow Area, A=	3.57	4.94	4.94	sq ft
Wetted Perimeter, P=	6.50	7.43	7.43	feet
Hydraulic Radius, R=	0.55	0.66	0.66	feet
Shear stress on channel bottom, τ =	2.44	3.09	3.09	lbs/sf
Critical Slope, S_c=	0.0218	0.0500	0.0500	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	no	no	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 3**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.11

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)
	Cultivated		0.25	0.100	0.025

Total Area, A = 0.100 acres
Weighted C = 0.25

Total A * C: 0.025 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

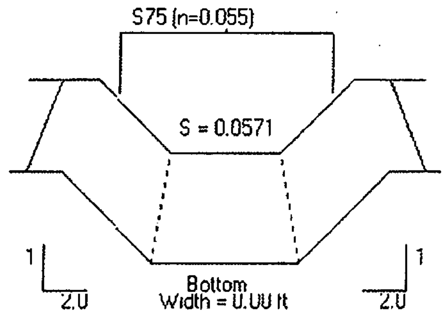
	25 year
Calculated Flow, Q (cfs) =	**0.1**

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.11

NorthAmerican Green - ECMDS Version 4.3	7/22/2011	07:40 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 311	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Norma Depth (ft)
0.1	0.1	1.28	0.08	0.09	0.20



Not to Scale

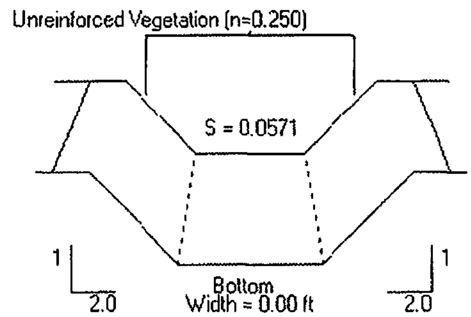
LINER RESULTS

Reach	Matting Type / Staple Pattern	Stabilty Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	S75	Unvegetated					1.55	0.70	2.20	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/22/2011 07:41 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.11	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.1	0.1	0.41	0.24	0.16	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.24	3.38	STABLE
		Soil	Sandy Loam				0.035	0.002	14.50	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 3.11

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	0.10	0.10	0.10	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=				feet
Bed slope, s=	0.0571	0.0571	0.0571	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.2500	0.2500	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.16**	**0.29**	**0.29**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.34	1.21	1.21	feet
Calculated Velocity, V=	1.91	0.61	0.61	fps
Flow Top Width, T=	0.65	1.14	1.14	feet
Flow Area, A=	0.05	0.16	0.16	sq ft
Wetted Perimeter, P=	0.72	1.28	1.28	feet
Hydraulic Radius, R=	0.07	0.13	0.13	feet
Shear stress on channel bottom, τ =	0.58	1.02	1.02	lbs/sf
Critical Slope, S_c=	0.1181	2.0192	2.0192	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 3**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.12

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)
	Lawn		0.40	4.853	1.941
	Cultivated		0.25	1.067	0.267

Total Area, A: 5.920 acres
Weighted C: 0.37

Total A * C: 2.20795 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

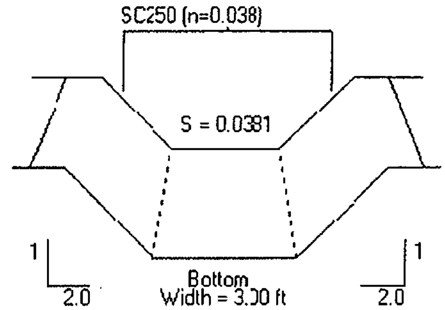
25 year
Calculated Flow, Q (cfs) = 11.9

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.12

North American Green - ECMDS Version 4.3	7/20/2011	09:38 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS3902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.12	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.9	0.1	4.54	2.62	0.45	0.62



Not to Scale

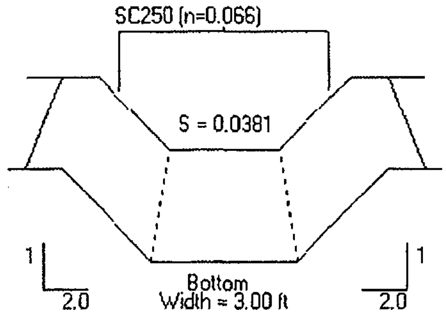
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.47	2.04	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	7/20/2011	09:39 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.12	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.9	0.1	3.06	3.89	0.58	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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.98	5.04	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.257	3.11	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 3.12

	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=	0.0381	0.0381	0.0381	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0380	0.0660	0.0660	
Lining Type:			**R-6**	

Calculate Flow Depth:

Flow depth, d=	**0.62**	**0.84**	**0.84**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	Yes	
Freeboard, f=	0.88	0.66	0.66	feet
Calculated Velocity, V=	4.50	3.04	3.04	fps
Flow Top Width, T=	5.49	6.35	6.35	feet
Flow Area, A=	2.64	3.92	3.92	sq ft
Wetted Perimeter, P=	5.78	6.75	6.75	feet
Hydraulic Radius, R=	0.46	0.58	0.58	feet
Shear stress on channel bottom, τ =	1.48	1.99	1.99	lbs/sf
Critical Slope, S_c=	0.0288	0.0808	0.0808	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=	0.0		13.0	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 29 Aug 11 12:24 PM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 3.13

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)
	Lawn		0.40	2.750	1.100

Total Area, A: 2.750 acres
Weighted C: 0.40

Total A * C: 1.1 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): 5.40

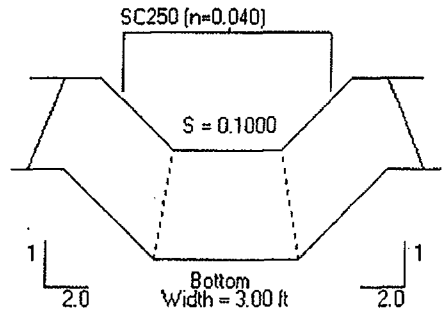
STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 5.9

North American Green - ECMDS Version 4.3		8/29/2011	12:23 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.13		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.9	0.1	4.90	1.20	0.27	0.33



Not to Scale

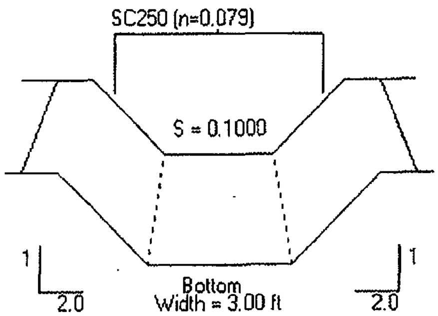
LINER RESULTS

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	SC250	Unvegetated	1				3.00	2.05	1.46	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		8/29/2011	12:24 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.13		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.9	0.1	3.08	1.92	0.37	0.48



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	3.02	3.32	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.387	2.06	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: JMO
Date: 15 Sep 11

Print Date: 29 Aug 11 12:24 PM
Project #: PPLS0902

Checked by: JFM

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 3.13

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	5.90	5.90	5.90	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=	0.1000	0.1000	0.1000	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0790	0.0790	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.33**	**0.49**	**0.49**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.17	1.01	1.01	feet
Calculated Velocity, V=	4.85	3.04	3.04	fps
Flow Top Width, T=	4.33	4.95	4.95	feet
Flow Area, A=	1.22	1.94	1.94	sq ft
Wetted Perimeter, P=	4.48	5.18	5.18	feet
Hydraulic Radius, R=	0.27	0.37	0.37	feet
Shear stress on channel bottom, τ =	2.07	3.04	3.04	lbs/sf
Critical Slope, S_c=	0.0373	0.1320	0.1320	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	no	no	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 29 Aug 11 1:14 PM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 3.14

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)
	Lawn		0.40	4.160	1.664
	Stone		0.85	3.490	2.967

Total Area, A: 7.650 acres
Weighted C: 0.61

Total A * C: 4.6305 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): 5.40

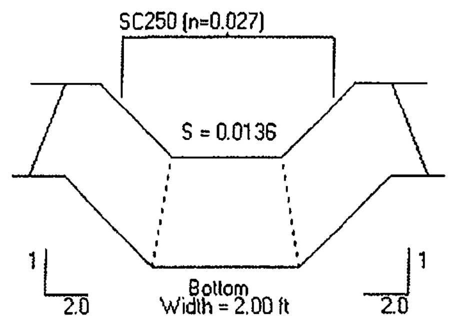
***STEP 4*: Calculate Peak Rate of Runoff, Q:** $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 25.0

North American Green - ECMDS Version 4.3		8/29/2011	01:11 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 3.14		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
25.0	0.1	5.00	5.00	0.70	1.16



Not to Scale

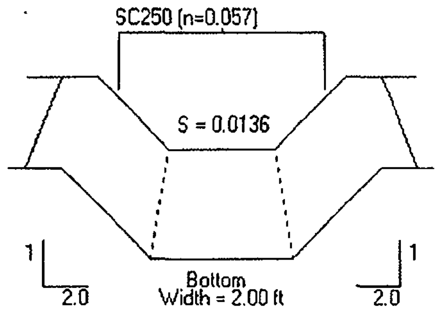
LINER RESULTS

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	SC250	Unvegetated	1				3.00	0.98	3.05	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	8/29/2011	01:12 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 3.14	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
25.0	0.1	2.91	8.60	0.92	1.63



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.39	7.22	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.071	11.26	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: NKG
Date: 15 Sep 11

Print Date: 29 Aug 11 1:14 PM
Project #: PPLS0902

Checked by: JFM

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 3.14

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	25.00	25.00	25.00	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=	0.0136	0.0136	0.0136	ft/ft
Available depth of channel:	2.25	2.25	2.25	feet
(OPTIONAL) Input Manning's 'n':	0.0270	0.0570	0.0570	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.16**	**1.64**	**1.64**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.09	0.61	0.61	feet
Calculated Velocity, V=	5.02	2.88	2.88	fps
Flow Top Width, T=	6.62	8.56	8.56	feet
Flow Area, A=	4.98	8.67	8.67	sq ft
Wetted Perimeter, P=	7.17	9.34	9.34	feet
Hydraulic Radius, R=	0.69	0.93	0.93	feet
Shear stress on channel bottom, τ =	0.98	1.39	1.39	lbs/sf
Critical Slope, S_c=	0.0130	0.0529	0.0529	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 29 Aug 11 2:03 PM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.15

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)
	Lawn (Swale 3.14)		0.40	4.160	1.664
	Lawn (Swale 3.15)		0.40	0.030	0.012
	Stone (Swale 3.14)		0.85	3.490	2.967
					#VALUE!

Total Area A = 7.680 acres
Weighted C = #VALUE!

#VALUE! 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

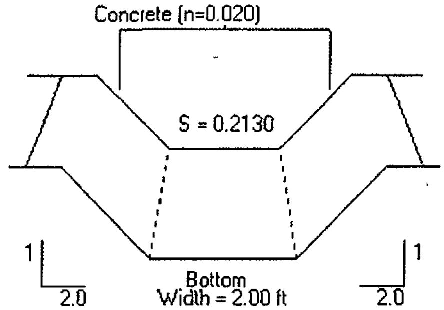
	25 year			
Calculated Flow, Q (cfs) =	#######	#######	#######	#######

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.15

North American Green - ECMDS Version 4.3		8/29/2011	02:01 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: CONC.	DRAINAGE AREA: SWALE 3.15		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
25.1	0.1	17.04	1.47	0.35	0.49



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	Concrete	Unvegetated					N/A	6.56	N/A	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **POI 3**
Prepared by: **NKG**
Date: **15 Sep 11**

Print Date: 29 Aug 11 2:3 PM
Project #: PPLS0902

Checked by: JFM

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 3.15

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	25.10	25.10	25.10	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=	0.2130	0.2130	0.2130	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0200	0.0200	0.0200	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.49**	**0.49**	**0.49**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.51	1.51	1.51	feet
Calculated Velocity, V=	17.07	17.07	17.07	fps
Flow Top Width, T=	3.97	3.97	3.97	feet
Flow Area, A=	1.47	1.47	1.47	sq ft
Wetted Perimeter, P=	4.20	4.20	4.20	feet
Hydraulic Radius, R=	0.35	0.35	0.35	feet
Shear stress on channel bottom, τ =	6.55	6.55	6.55	lbs/sf
Critical Slope, S_c=	0.0087	0.0087	0.0087	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 3
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 1 Sep 11 3:16 PM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 3.16

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)
	Cultivated (Swale 3.9)		0.25	0.469	0.117
	Cultivated (Swale 3.16)		0.25	0.380	0.095
	Lawn (Swale 3.16)		0.40	0.240	0.096
	Lawn (Swale 3.9)		0.40	2.651	1.060
	Lawn (Swale 3.14)		0.40	4.160	1.664
	Lawn (Swale 3.15)		0.40	0.030	0.012
	Stone (Swale 3.14)		0.85	3.490	2.967

Total Area, A: 11.420 acres
Weighted C: 0.53

Total A * C: 6.01115 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

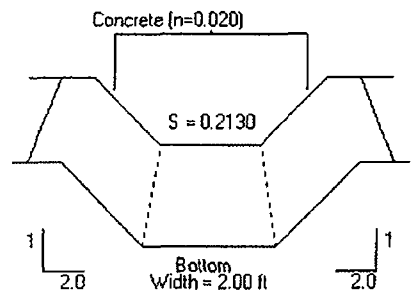
Calculated Flow, Q (cfs) = 32.5

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 3.16

North American Green - ECMDS Version 4.3	9/1/2011	03:21 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: CONC	DRAINAGE AREA: SWALE 3.16	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
32.5	0.1	18.34	1.77	0.39	0.57



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	Concrete	Unvegetated					N/A	7.52	N/A	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 3
Prepared by: NKG
Date: 15 Sep 11

Print Date: 1 Sep 11 3:22 PM
Project #: PPLS0902

Checked by: JFM

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 3.16

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	32.50	32.50	32.50	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=	0.2130	0.2130	0.2130	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0200	0.0200	0.0200	
Lining Type:				

Calculate Flow Depth:

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

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.43	1.43	1.43	feet
Calculated Velocity, V=	18.36	18.36	18.36	fps
Flow Top Width, T=	4.26	4.26	4.26	feet
Flow Area, A=	1.77	1.77	1.77	sq ft
Wetted Perimeter, P=	4.53	4.53	4.53	feet
Hydraulic Radius, R=	0.39	0.39	0.39	feet
Shear stress on channel bottom, τ =	7.52	7.52	7.52	lbs/sf
Critical Slope, S_c=	0.0085	0.0085	0.0085	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 5**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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)
	Stone		0.85	0.438	0.372
	Lawn		0.40	2.062	0.825
	Cultivated		0.25	2.490	0.623
	Woods		0.08	0.366	0.029

Total Area A: 5.356 acres
Weighted C: 0.35

Total A * C: 1.84888 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

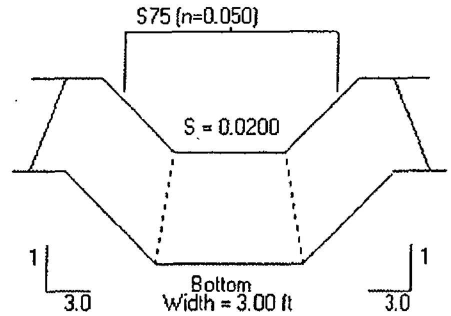
25 year
Calculated Flow, Q (cfs) = 10.0

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.1

North American Green - ECMDS Version 4.3	7/20/2011	09:45 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.1	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.0	0.1	2.65	3.78	0.50	0.73



Not to Scale

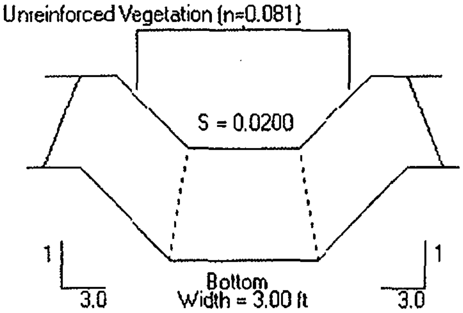
LINER RESULTS

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	0.91	1.70	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/23/2011	09:46 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 5.1	DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
10.0	0.1	1.86	5.36	0.60	0.93



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.16	3.63	STABLE
		Soil	Sandy Loam				0.035	0.022	1.62	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	10.00	10.00	10.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0500	0.0810	0.0810	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.73**	**0.93**	**0.93**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.77	0.57	0.57	feet
Calculated Velocity, V=	2.63	1.85	1.85	fps
Flow Top Width, T=	7.40	8.60	8.60	feet
Flow Area, A=	3.81	5.42	5.42	sq ft
Wetted Perimeter, P=	7.63	8.91	8.91	feet
Hydraulic Radius, R=	0.50	0.61	0.61	feet
Shear stress on channel bottom, τ =	0.91	1.17	1.17	lbs/sf
Critical Slope, S_c=	0.0474	0.1167	0.1167	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 5**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	1.574	1.495
	Lawn		0.40	3.830	1.532
	Stone		0.85	0.436	0.371

Total Area, A: 5.840 acres
Weighted C: 0.58

Total A * C: 3.3979 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): 5.40

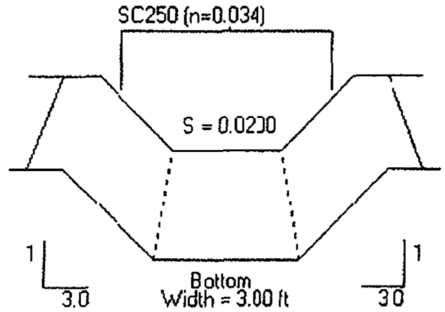
STEP 4: Calculate Peak Rate of Runoff, Q: **Q = k C i A**

25 year
Calculated Flow, Q (cfs) = 18.3

North American Green - ECMDS Version 4.3	7/20/2011	09:49 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 52	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
18.3	0.1	4.13	4.43	0.54	0.81



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	SC250	Unvegetated	1				3.00	1.02	2.95	STABLE
	Staple E									

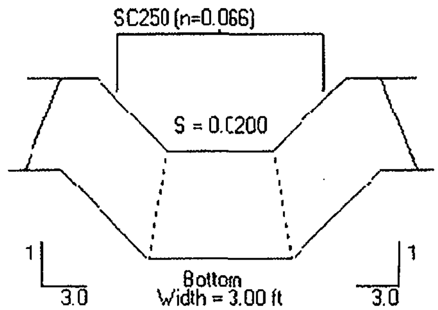
North American Green - ECMDS Version 4.3 | 7/20/2011 | 09 50 AM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 5.2 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
18.3	0.1	2.54	7.19	0.71	1.13



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.41	7.[illegible]1	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.126	6.33	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	18.30	18.30	18.30	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	3.0	3.0	3.0	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':	0.0340	0.0660	0.0660	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.82**	**1.13**	**1.13**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.18	0.87	0.87	feet
Calculated Velocity, V=	4.11	2.53	2.53	fps
Flow Top Width, T=	7.90	9.79	9.79	feet
Flow Area, A=	4.45	7.23	7.23	sq ft
Wetted Perimeter, P=	8.17	10.16	10.16	feet
Hydraulic Radius, R=	0.55	0.71	0.71	feet
Shear stress on channel bottom, τ =	1.02	1.41	1.41	lbs/sf
Critical Slope, S_c=	0.0213	0.0737	0.0737	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes	yes	
Required Freeboard=	0.5	0.5	0.5	feet
Allowable Velocity for Lining Material=	0.0			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 5.2

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by:
JFM

Print Date: 17 Aug 11 11:49 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	0.527	0.501
	Lawn		0.40	1.097	0.439
	Stone		0.85	0.086	0.073

Total Area A: 1.710 acres
Weighted C: 0.59

Total A * C: 1.01255 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): 5.40

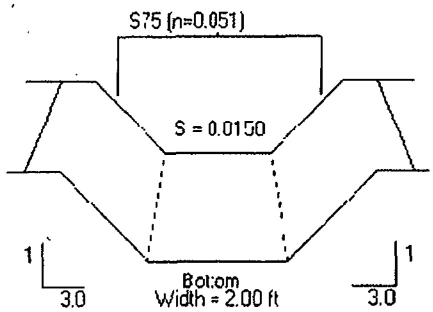
***STEP 4*: Calculate Peak Rate of Runoff, Q:** Q = k C i A

25 year
Calculated Flow, Q (cfs) = 5.5

North American Green - ECMDS Version 4.3	7/2C/2011	09:52 AM	COMPUTED BY: NKG
PROJECT NAME PPL BBNPP	PROJECT NO.: PPLS0902		
FROM S⁻ATION/REACH	⁻O STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.3	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocty (fps)	Area (sq ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.5	0.1	2.04	2.70	0.43	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	0.63	2.46	STABLE
	Staple D									

North American Green - ECMDS Version 4.3 | 7/20/2011 | 09:53 AM | COMPUTED BY: NKG

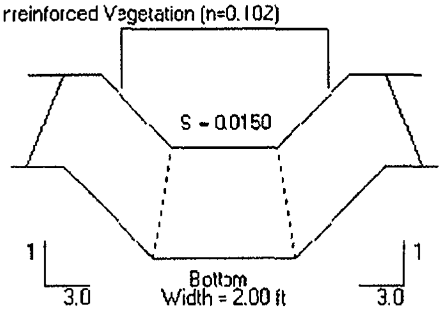
PROJECT NAME: PPL BENPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 5.3 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
5.5	0.1	1.22	4.50	0.57	0.94

Unreinforced Vegetation (n=0.102)



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.88	4.80	STABLE
		Soil	Sandy Loam				0.035	0.010	3.42	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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=	5.50	5.50	5.50	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	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':	0.0510	0.1020	0.1020	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.68**	**0.94**	**0.94**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.32	1.06	1.06	feet
Calculated Velocity, V=	2.02	1.21	1.21	fps
Flow Top Width, T=	6.06	7.65	7.65	feet
Flow Area, A=	2.73	4.54	4.54	sq ft
Wetted Perimeter, P=	6.28	7.95	7.95	feet
Hydraulic Radius, R=	0.43	0.57	0.57	feet
Shear stress on channel bottom, τ =	0.63	0.88	0.88	lbs/sf
Critical Slope, S_c=	0.0518	0.1899	0.1899	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 5.4

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	1.000	0.950
	Lawn		0.40	0.781	0.312
	Stone		0.85	0.269	0.229

Total Area, A: 2.050 acres
Weighted C: 0.73

Total A * C: 1.49105 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

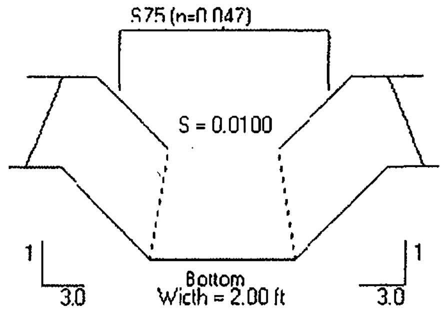
25 year
Calculated Flow, Q (cfs) = 8.1

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.4

North American Green - ECMDS Version 4.3		7/20/2011	09:55 AM	COMPUTED BY: NKG
PROJECT NAME: PPL 88NPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.4		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.1	0.1	2.07	3.92	0.53	0.86



Not to Scale

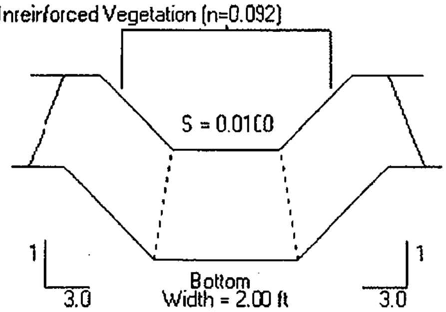
LINER RESULTS

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	0.53	2.90	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	09:55 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 5.4		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.1	0.1	1.26	6.45	0.69	1.17



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.73	5.75	STABLE
		Soil	Sandy Loam				0.035	0.010	3.34	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 5.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	8.10	8.10	8.10	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	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':	0.0470	0.0920	0.0920	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.86**	**1.18**	**1.18**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.14	0.82	0.82	feet
Calculated Velocity, V=	2.05	1.25	1.25	fps
Flow Top Width, T=	7.17	9.06	9.06	feet
Flow Area, A=	3.95	6.50	6.50	sq ft
Wetted Perimeter, P=	7.45	9.44	9.44	feet
Hydraulic Radius, R=	0.53	0.69	0.69	feet
Shear stress on channel bottom, τ =	0.54	0.73	0.73	lbs/sf
Critical Slope, S_c=	0.0413	0.1454	0.1454	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=	0.0			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 5.4

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 18 Aug 11 3:21 PM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 5.5

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 (Swale 5.5)			0.95	1.246	1.184
Impervious (Swale 5.4)			0.95	1.000	0.950
Lawn (Swale 5.5)			0.40	1.024	0.410
Lawn (Swale 5.4)			0.40	0.781	0.312
Stone (Swale 5.5)			0.85	5.070	4.310
Stone (Swale 5.4)			0.85	0.269	0.229

Total Area, A: 9.390 acres
Weighted C: 0.79

Total A * C: 7.39385 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

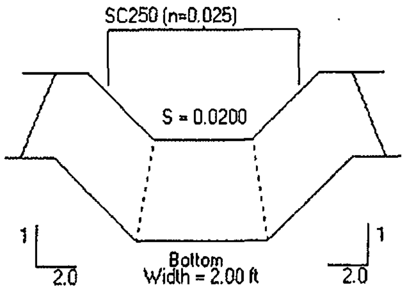
25 year
Calculated Flow, Q (cfs) = 39.9

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.5

North American Green - ECMDS Version 4.3		8/18/2011	03:52 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.5		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
39.9	0.1	6.92	5.77	0.75	1.27



Not to Scale

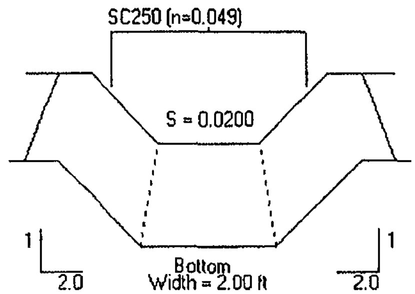
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.59	1.89	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		8/18/2011	03:52 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 5.5		DESIGN FREQUENCY: 25YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
39.9	0.1	4.23	9.43	0.97	1.73



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.16	4.64	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.121	6.63	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 18 Aug 11 3:53 PM
Project #: PPLS0902

Checked by:
JFM

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 5.5

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	39.90	39.90	39.90	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	2.25	2.25	2.25	feet
(OPTIONAL) Input Manning's 'n':	0.0250	0.0490	0.0490	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.27**	**1.74**	**1.74**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.98	0.51	0.51	feet
Calculated Velocity, V=	6.93	4.20	4.20	fps
Flow Top Width, T=	7.08	8.94	8.94	feet
Flow Area, A=	5.76	9.49	9.49	sq ft
Wetted Perimeter, P=	7.68	9.76	9.76	feet
Hydraulic Radius, R=	0.75	0.97	0.97	feet
Shear stress on channel bottom, τ =	1.58	2.17	2.17	lbs/sf
Critical Slope, S_c=	0.0109	0.0385	0.0385	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 18 Aug 11 3:21 PM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 5.6

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 (Swale 5.6)			0.95	0.258	0.245
Impervious (Swale 5.9)			0.95	0.060	0.057
Lawn (Swale 5.6)			0.40	0.601	0.240
Lawn (Swale 5.9)			0.40	0.172	0.069
Stone (Swale 5.6)			0.85	9.281	7.889
Stone (Swale 5.9)			0.85	0.598	0.508

Total Area, A: 10.970 acres
Weighted C: 0.82

Total A * C: 9.00845 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

25 year

Calculated Flow, Q (cfs) = 48.6

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.6

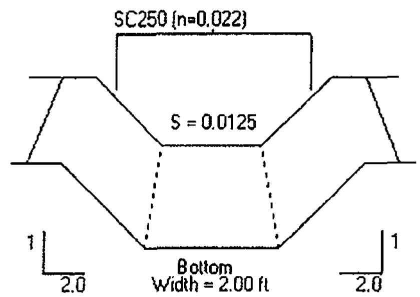
North American Green - ECMDS Version 4.3 | 8/18/2011 | 03:56 PM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: SWALE 5.6 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
48.6	0.1	6.83	7.11	0.84	1.45



Not to Scale

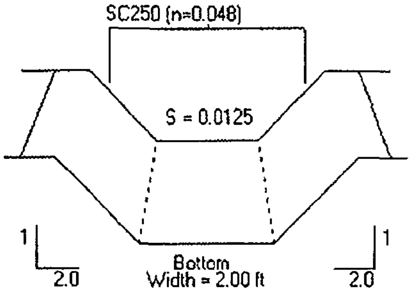
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.13	2.65	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		8/18/2011	03:56 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 5.6		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
48.6	0.1	3.76	12.92	1.14	2.09



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.63	6.13	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.043	18.81	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 18 Aug 11 3:57 PM
Project #: PPLS0902

Checked by: JFM

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 5.6

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	48.60	48.60	48.60	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=	0.0125	0.0125	0.0125	ft/ft
Available depth of channel:	2.75	2.75	2.75	feet
(OPTIONAL) Input Manning's 'n':	0.0220	0.0480	0.0480	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.46**	**2.09**	**2.09**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.29	0.66	0.66	feet
Calculated Velocity, V=	6.75	3.78	3.78	fps
Flow Top Width, T=	7.85	10.34	10.34	feet
Flow Area, A=	7.20	12.87	12.87	sq ft
Wetted Perimeter, P=	8.54	11.33	11.33	feet
Hydraulic Radius, R=	0.84	1.14	1.14	feet
Shear stress on channel bottom, τ =	1.14	1.63	1.63	lbs/sf
Critical Slope, S_c=	0.0081	0.0352	0.0352	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes	yes	
Required Freeboard=	0.5	0.6	0.6	feet
Allowable Velocity for Lining Material=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 18 Aug 11 3:21 PM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 5.7

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)
	Stone (Swale 5.10)		0.85	0.939	0.798
	Lawn (Swale 5.7)		0.40	0.730	0.292
	Lawn (Swale 5.10)		0.40	0.041	0.016
	Lawn (Swale 5.8)		0.40	0.950	0.380

Total Area A: 2.660 acres
Weighted C: 0.56

Total A * C: 1.48655 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

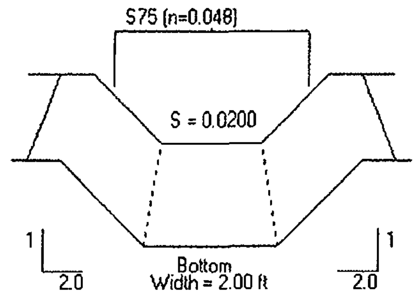
25 year
Calculated Flow, Q (cfs) = 8.0

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.7

North American Green - ECMDS Version 4.3	8/18/2011	04:00 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.7	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.0	0.1	2.80	2.86	0.51	0.80



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	0.99	1.56	STABLE
	Staple D									

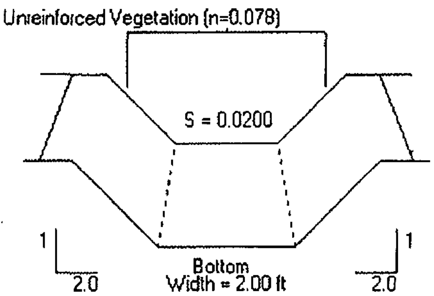
North American Green - ECMDS Version 4.3 | 8/18/2011 | 04:01 PM | COMPUTED BY: NKG

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: SWALE 5.7 | DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.0	0.1	1.98	4.05	0.62	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.26	3.34	STABLE
		Soil	Sandy Loam				0.035	0.025	1.37	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **POI 5**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 18 Aug 11 4:1 PM
Project #: PPLS0902

Checked by:
JFM

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 5.7	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	8.00	8.00	8.00	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	2.00	2.00	2.00	feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0780	0.0780	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.80**	**1.02**	**1.02**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.20	0.98	0.98	feet
Calculated Velocity, V=	2.79	1.95	1.95	fps
Flow Top Width, T=	5.19	6.07	6.07	feet
Flow Area, A=	2.87	4.10	4.10	sq ft
Wetted Perimeter, P=	5.57	6.55	6.55	feet
Hydraulic Radius, R=	0.52	0.63	0.63	feet
Shear stress on channel bottom, τ =	1.00	1.27	1.27	lbs/sf
Critical Slope, S_c=	0.0449	0.1117	0.1117	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k\,C\,i\,A$ (where k = 1 for english units)

Description: SWALE 5.8

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)
	Lawn		0.40	0.950	0.380

Total Area, A = 0.950 acres
Weighted C = 0.40

Total A * C: 0.38 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): 5.40

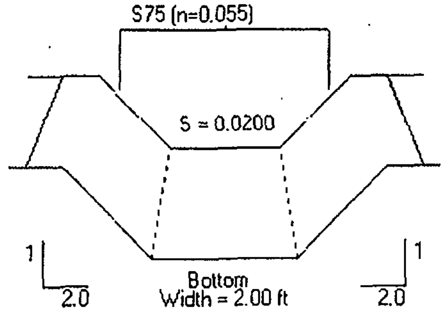
STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

25 year
Calculated Flow, Q (cfs) = 2.1

North American Green - ECMDS Version 4.3	7/2?/2011	10:08 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE E8	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	0.1	1.75	1.20	0.31	0.42



Not to Scale

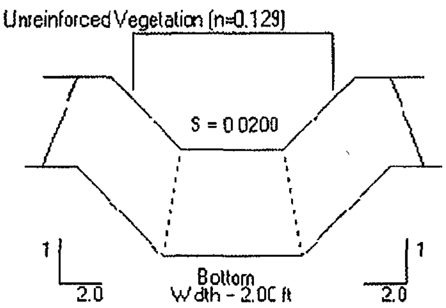
LINER RESULTS

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	0.53	2.94	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011 10:09 AM	COMPUTED BY: NKG	
PROJECT NAME: FPL B3NPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 5.8	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	0.1	0.95	2.21	0.44	0.66



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.83	5.07	STABLE
		Soil	Sandy Loam				0.035	0.006	5.76	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 5.8

	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=	2.0	2.0	2.0	feet
Bed slope, s=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1290	0.1290	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.46**	**0.76**	**0.76**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.04	0.74	0.74	feet
Calculated Velocity, V=	1.56	0.79	0.79	fps
Flow Top Width, T=	3.84	5.03	5.03	feet
Flow Area, A=	1.34	2.66	2.66	sq ft
Wetted Perimeter, P=	4.06	5.38	5.38	feet
Hydraulic Radius, R=	0.33	0.49	0.49	feet
Shear stress on channel bottom, τ =	0.57	0.94	0.94	lbs/sf
Critical Slope, S_c=	0.0673	0.3284	0.3284	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 5
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: $Q = k C i A$ (where k = 1 for english units)

Description: SWALE 5.9

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	0.060	0.057
	Lawn		0.40	0.172	0.069
	Stone		0.85	0.598	0.508

Total Area, A: 0.830 acres
Weighted C: 0.76

Total A * C: 0.6341 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k C i A$

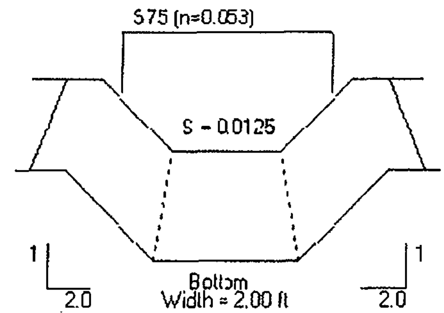
25 year
Calculated Flow, Q (cfs) = 3.4

PLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.9

North American Green - ECMDS Version 4.3	7/20/2011	10:11 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BENPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.9	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.4	0.1	1.75	1.94	0.41	0.61



Not to Scale

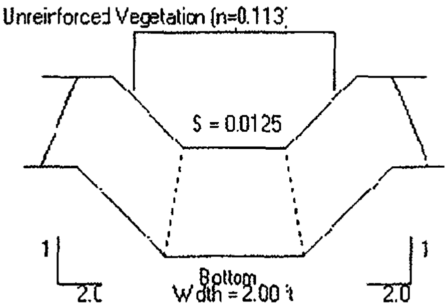
LINER RESULTS

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	0.47	3.28	STABLE
	Staple D									

North American Green - ECNDS Version 4.3	7/20/2011	10:12 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TC STATION/REACH: VEG	DRAINAGE AREA: SWALE 5.9	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharce (cfs)	Feak Flow Feriod (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radus(ft)	Normal Depth (ft)
3.4	0.1	1.00	3.36	0.56	0.89



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LINER RESULTS

Reach	Matting Type / Staple Fattern	Stability Analysis	Vegetation Characteristics: Phase	Class	Type	Density	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.70	6.03	STABLE
		Soil	Sandy Loam				0.035	0.007	5.26	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JFM

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 5.9

	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=	0.0125	0.0125	0.0125	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0530	0.1130	0.1130	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.64**	**0.97**	**0.97**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.86	0.53	0.53	feet
Calculated Velocity, V=	1.62	0.90	0.90	fps
Flow Top Width, T=	4.56	5.86	5.86	feet
Flow Area, A=	2.10	3.79	3.79	sq ft
Wetted Perimeter, P=	4.86	6.32	6.32	feet
Hydraulic Radius, R=	0.43	0.60	0.60	feet
Shear stress on channel bottom, τ =	0.50	0.75	0.75	lbs/sf
Critical Slope, S_c=	0.0577	0.2375	0.2375	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 5**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by:
JFM

Print Date: 17 Aug 11 11:49 AM
Project #: PPL0902

Governing Equation: **Q = k C i A** (where k = 1 for english units)

Description: SWALE 5.10

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)
	Stone		0.85	0.939	0.798
	Lawn		0.40	0.041	0.016

Total Area, A = 0.980 acres
Weighted C = 0.83

Total A * C: 0.81455 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** **Q = k C i A**

25 year

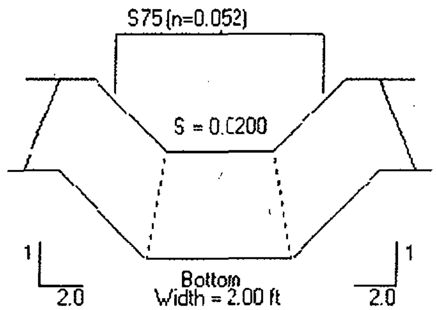
Calculated Flow, Q (cfs) = 4.4

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 5.10

North American Green - ECMDS Version 4.3	7/20/2011	10:14 AM	COMPUTED BY: NKG	
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 5.10	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.4	0.1	2.23	1.97	0.42	0.61



Not to Scale

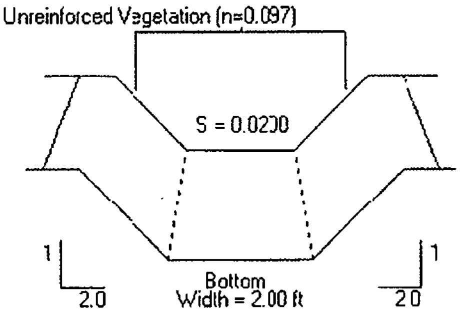
LINER RESULTS

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	0.76	2.03	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011	10:14 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 510	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft	Normal Depth (ft)
4.4	0.1	1.43	3.06	0.54	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.05	4.02	STABLE
		Soil	Sandy Loam				0.035	0.014	2.59	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 5
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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 5.10

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.40	4.40	4.40	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=	0.0200	0.0200	0.0200	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0520	0.0970	0.0970	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.61**	**0.87**	**0.87**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.89	0.63	0.63	feet
Calculated Velocity, V=	2.22	1.35	1.35	fps
Flow Top Width, T=	4.46	5.49	5.49	feet
Flow Area, A=	1.99	3.27	3.27	sq ft
Wetted Perimeter, P=	4.75	5.90	5.90	feet
Hydraulic Radius, R=	0.42	0.55	0.55	feet
Shear stress on channel bottom, τ =	0.77	1.09	1.09	lbs/sf
Critical Slope, S_c=	0.0561	0.1794	0.1794	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 18 Aug 11 3:21 PM
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 (Swale 6.1)			0.95	0.069	0.066
Impervious (Swale 6.2)			0.95	0.284	0.270
Impervious (Swale 6.3)			0.95	0.162	0.154
Lawn (Swale 6.1)			0.40	1.064	0.426
Lawn (Swale 6.2)			0.40	0.682	0.273
Lawn (Swale 6.3)			0.40	0.553	0.221
Stone (Swale 6.1)			0.85	6.547	5.565
Stone (Swale 6.2)			0.85	0.084	0.071

Total Area, A: 9.445 acres
Weighted C: 0.75

Total A * C: 7.0452 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

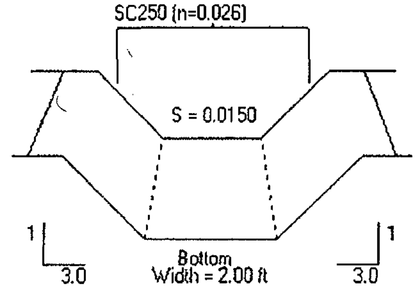
	25 year
Calculated Flow, Q (cfs) =	**38.0**

PPLS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 6.1

North American Green - ECMDS Version 4.3		8/18/2011 04:05 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 6.1	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
38.0	0.1	5.53	6.87	0.71	1.22



Not to Scale

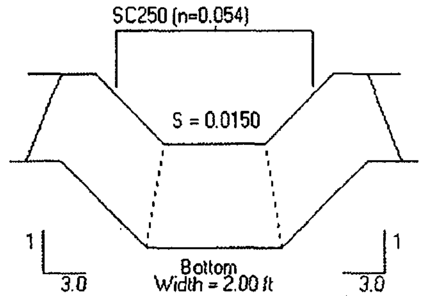
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.14	2.64	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	8/18/2011	04:06 PM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 6.1	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
38.0	0.1	3.21	11.82	0.94	1.68



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.57	6.36	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.079	10.11	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 6
Prepared by: JMO
Date: 15 Sep 11

Print Date: 18 Aug 11 4:7 PM
Project #: PPLS0902

Checked by: JFM

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=	38.00	38.00	38.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0150	0.0150	0.0150	ft/ft
Available depth of channel:	5.00	5.00	5.00	feet
(OPTIONAL) Input Manning's 'n':	0.0260	0.0540	0.0500	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.21**	**1.68**	**1.62**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	3.79	3.32	3.38	feet
Calculated Velocity, V=	5.55	3.22	3.41	fps
Flow Top Width, T=	9.28	12.06	11.73	feet
Flow Area, A=	6.84	11.79	11.14	sq ft
Wetted Perimeter, P=	9.67	12.61	12.26	feet
Hydraulic Radius, R=	0.71	0.94	0.91	feet
Shear stress on channel bottom, τ =	1.14	1.57	1.52	lbs/sf
Critical Slope, S_c=	0.0115	0.0454	0.0393	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 6
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.284	0.270
	Lawn		0.40	0.682	0.273
	Stone		0.85	0.084	0.071

Total Area, A: 1.050 acres
Weighted C: 0.58

Total A * C: 0.614 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): 5.40

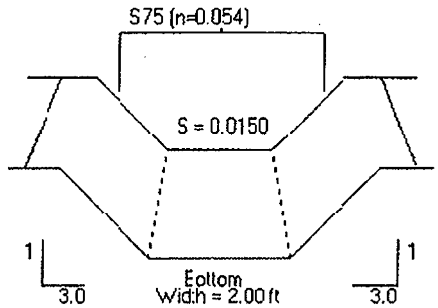
STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C I A

25 year
Calculated Flow, Q (cfs) = 3.3

North American Green - ECMDS Version 4.3	7/20/2011	10:26 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 62	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.3	0.1	1.70	1.94	0.36	0.54



Not to Scale

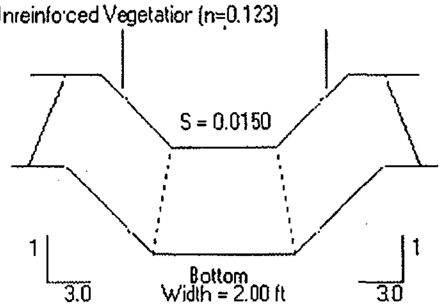
LINER RESULTS

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	0.50	3.08	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011	10:26 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0802	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 6.2	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.3	0.1	0.93	3.55	0.50	0.80



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.75	5.58	STABLE
		Soil	Sandy Loam				0.035	0.006	5.81	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 6
Prepared by: JMO
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

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=	3.30	3.30	3.30	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0150	0.0150	0.0150	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0540	0.1230	0.1230	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.55**	**0.87**	**0.87**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	0.95	0.63	0.63	feet
Calculated Velocity, V=	1.66	0.83	0.83	fps
Flow Top Width, T=	5.28	7.20	7.20	feet
Flow Area, A=	1.99	3.98	3.98	sq ft
Wetted Perimeter, P=	5.45	7.48	7.48	feet
Hydraulic Radius, R=	0.36	0.53	0.53	feet
Shear stress on channel bottom, τ =	0.51	0.81	0.81	lbs/sf
Critical Slope, S_c=	0.0614	0.2824	0.2824	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 6**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.162	0.154
	Lawn		0.40	0.553	0.221

Total Area, A: 0.715 acres
Weighted C: 0.52

Total A * C: 0.3751 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: Q = k C i A

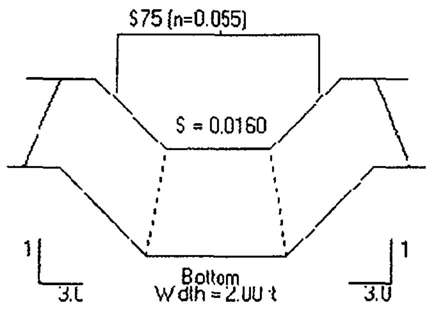
25 year

Calculated Flow, Q (cfs) = 2.0

North American Green - ECMDS Version 4.3		7/20/2011	10:29 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 6.3		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.0	0.1	1.50	1.34	0.29	0.41



Not to Scale

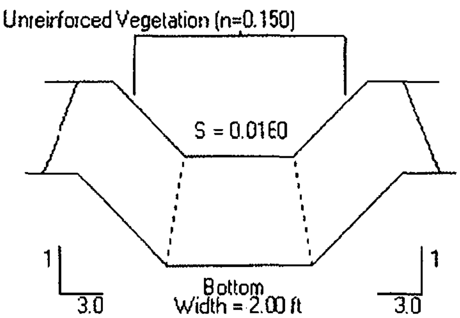
LINER RESULTS

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	3.76	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	10:30 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 6.3		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.0	0.1	0.72	2.76	0.44	0.68



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.68	6.16	STABLE
		Soil	Sandy Loam				0.035	0.004	9.46	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 6
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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=	2.00	2.00	2.00	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0160	0.0160	0.0160	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1500	0.1500	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.45**	**0.79**	**0.79**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.05	0.71	0.71	feet
Calculated Velocity, V=	1.31	0.58	0.58	fps
Flow Top Width, T=	4.72	6.71	6.71	feet
Flow Area, A=	1.53	3.42	3.42	sq ft
Wetted Perimeter, P=	4.87	6.97	6.97	feet
Hydraulic Radius, R=	0.31	0.49	0.49	feet
Shear stress on channel bottom, τ =	0.45	0.78	0.78	lbs/sf
Critical Slope, S_c=	0.0669	0.4310	0.4310	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: **PPL0902**
Project: **POI 10**
Prepared by: **NKG**
Date: **15 Sep 11**

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.225	0.214
	Lawn		0.40	0.385	0.154

Total Area, A: 0.610 acres
Weighted C: 0.60

Total A * C: 0.36775 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): 5.40

***STEP 4*: Calculate Peak Rate of Runoff, Q:** **Q = k C i A**

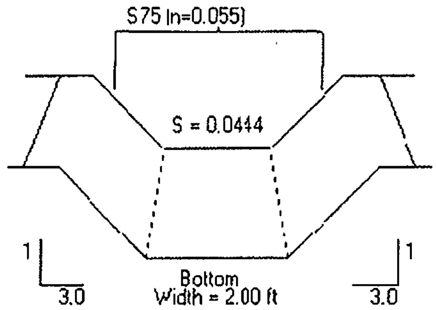
25 year
Calculated Flow, Q (cfs) = 2.0

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 10.1

North American Green - ECMDS Version 4.3	7/20/2011 10:33 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	
DRAINAGE AREA: SWALE 10.1	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.0	0.1	2.15	0.93	0.23	0.32



Not to Scale

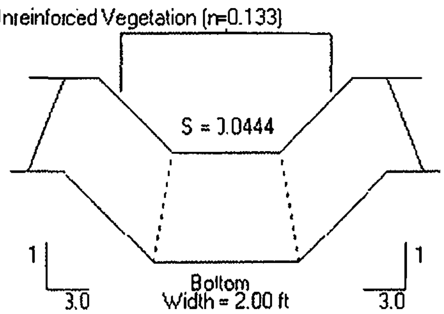
LINER RESULTS

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	0.87	1.77	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	7/20/2011 10:34 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902	
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 10.1	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.0	0.1	1.14	1.75	0.34	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.39	3.03	STABLE
		Soil	Sandy Loam				0.035	0.009	3.69	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 10
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by:
JFM

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=	2.00	2.00	2.00	cfs
Left Side Slope =	3.0	3.0	-3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0444	0.0444	0.0444	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1330	0.1330	
Lining Type:			**R-6**	

Calculate Flow Depth:

Flow depth, d=	**0.32**	**0.55**	**0.73**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	Yes	
Freeboard, f=	1.18	0.95	0.77	feet
Calculated Velocity, V=	2.08	1.00	1.37	fps
Flow Top Width, T=	3.94	5.29	2.00	feet
Flow Area, A=	0.96	2.00	1.46	sq ft
Wetted Perimeter, P=	4.04	5.47	3.46	feet
Hydraulic Radius, R=	0.24	0.37	0.42	feet
Shear stress on channel bottom, τ =	0.90	1.52	2.02	lbs/sf
Critical Slope, S_c=	0.0730	0.3722	0.5937	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=	0.0		13.0	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

Rational Equation Stormwater Calculations

Pennoni

Client: PPL0902
Project: POI 10
Prepared by: NKG
Date: 15 Sep 11

Checked by: JFM

Print Date: 17 Aug 11 11:49 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	0.161	0.153
	Lawn		0.40	0.589	0.236

Total Area, A: 0.750 acres
Weighted C: 0.52

Total A * C: 0.38855 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): 5.40

STEP 4: Calculate Peak Rate of Runoff, Q: $Q = k\,C\,i\,A$

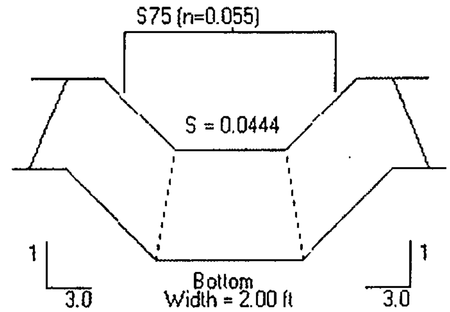
25 year
Calculated Flow, Q (cfs) = 2.1

'LS\PPLS0902-Bell Bend Land Development\ANALYTICAL\CALCULATIONS\SWALE CALCS\PERMANENT\[PPLS0902-Rational Method-Conveyance.xlsm]Swale 10.2

North American Green - ECMDS Version 4.3	7/20/2011	10:42 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: SWALE 10.2	DESIGN FREQUENCY: 25 YR	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	0.1	2.18	0.96	0.24	0.32



Not to Scale

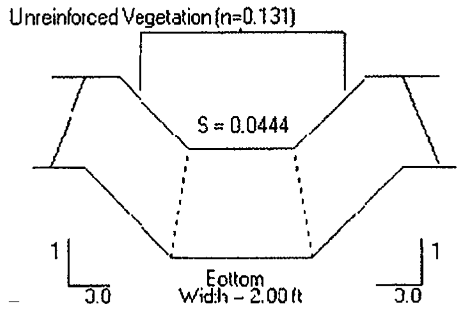
LINER RESULTS

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	0.90	1.73	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		7/20/2011	10:43 AM	COMPUTED BY: NKG
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 10.2		DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
2.1	0.1	1.18	1.79	0.34	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.41	2.99	STABLE
		Soil	Sandy Loam				0.035	0.010	3.49	STABLE

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

Client/Subject: PPL Bell Bend
Description: POI 10
Prepared by: JMO
Date: 15 Sep 11

Print Date: 17 Aug 11 3:6 PM
Project #: PPLS0902

Checked by: JML

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=	2.10	2.10	2.10	cfs
Left Side Slope =	3.0	3.0	3.0	H:1V
Right Side Slope =	3.0	3.0	3.0	H:1V
Base width of Channel, b=	2.0	2.0	2.0	feet
Bed slope, s=	0.0444	0.0444	0.0444	ft/ft
Available depth of channel:	1.50	1.50	1.50	feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1310	0.1310	
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.33**	**0.56**	**0.56**	**feet**

Calculated Results:

Design Acceptable?	V too high	V too high	V too high	
Freeboard, f=	1.17	0.94	0.94	feet
Calculated Velocity, V=	2.11	1.02	1.02	fps
Flow Top Width, T=	3.99	5.35	5.35	feet
Flow Area, A=	0.99	2.05	2.05	sq ft
Wetted Perimeter, P=	4.10	5.53	5.53	feet
Hydraulic Radius, R=	0.24	0.37	0.37	feet
Shear stress on channel bottom, τ =	0.92	1.55	1.55	lbs/sf
Critical Slope, S_c=	0.0725	0.3596	0.3596	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=	0.0			fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

EROSION AND SEDIMENTATION TEMPORARY E&S SWALE CALCULATIONS

Bell Bend Nuclear Power Plant
Salem Township
Luzerne County, PA

SWALE ID	SWALE SEGMENT ID	DRAINAGE AREA (ACRES)	FLOW RATE PER SEGMENT (CFS) (2.25 CFS / ACRE)	TOTAL FLOW RATE (CFS)
1A.1	1A.1	10.72	24.12	24.12
6.1	6.1A	9.50	21.38	21.38
	6.1B	0.52	1.17	22.55
10.1	10.1A	5.22	11.75	11.75
	10.1B	2.38	5.36	17.10
10.2	10.2A	2.16	4.86	4.86
	10.2B	2.19	4.93	9.79
	10.2C	3.25	7.31	17.10
	10.2D	0.31	0.70	17.80
	10.2E	5.39	12.13	29.93
10A.1	10A.1	14.41	32.42	32.42
12.1	12.1	3.89	8.75	8.75
12.2	12.2A	6.07	13.66	13.66
	12.2B	1.92	4.32	17.98
	12.2C	14.47	32.56	50.54
15A.1	15A.1	5.42	12.20	12.20
21.1	21.1	1.62	3.65	3.65
21.2	21.2	9.91	22.30	22.30
21.3	21.3	8.99	20.23	20.23
21.4	21.4	5.92	13.32	13.32
21.5	21.5A*	6.72	15.12	61.29
	21.5B	0.1	0.23	0.23
	21.5C	1.65	3.71	65.23
21.6	21.6A	3.21	7.22	7.22
	21.6B	4.04	9.09	9.09
	21.6C	22.32	50.22	59.31
	21.6D	0.76	1.71	75.62

*Total flow includes total flow rate from swales 21.1, 21.2, and 21.3

STANDARD WORKSHEET #21
Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY:JMO DATE:09/15/11
CHECKED BY:JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	1A.1 Unveg	1A.1 Veg		6.1A Unveg	6.1A Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	12.00	12.00		11.50	11.50
CHANNEL TOP WIDTH (FT)@ d	8.72	9.82		8.17	9.34
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	4.0	4.0		3.5	3.5
d (FLOW DEPTH IN FT)	1.17	1.46		1.16	1.46
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3.42:1	2.74:1		3.02:1	2.40:1
A (AREA IN SQ. FT.)	7.45	10.05		6.79	9.34
R (HYDRAULIC RADIUS)	0.81	0.96		0.78	0.93
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.040	0.060		0.040	0.062
V (AT FLOW DEPTH d, CFS)	3.24	2.40		3.15	2.29
Q (AT FLOW DEPTH d, CFS)	24.1	24.1		21.4	21.4
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0266	0.0569		0.0270	0.0615
$.7S_c$	0.0186	0.0398		0.0189	0.0431
$1.3S_c$	0.0346	0.0740		0.0351	0.0800
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.82	0.54		0.83	0.54
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2	2		2	2
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	0.73	0.91		0.73	0.91
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	6.1B Unveg	6.1B Veg		10.1A Unveg	10.1A Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	11.50	11.50		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	7.02	8.20		6.33	7.06
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	3.5	3.5		3.0	3.0
d (FLOW DEPTH IN FT)	0.88	1.18		0.83	1.01
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3.98:1	2.97:1		3.61:1	2.97:1
A (AREA IN SQ. FT.)	4.61	6.88		3.86	5.09
R (HYDRAULIC RADIUS)	0.62	0.79		.58	.68
S (BED SLOPE, FT/FT)*	0.0220	0.0220		0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.033	0.0570		0.0480	0.070
V (AT FLOW DEPTH d, CFS)	4.90	3.29		3.06	2.32
Q (AT FLOW DEPTH d, CFS)	22.6	22.6		11.8	11.8
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0197	0.0547		0.0428	0.0867
$.7S_c$	0.0138	0.0383		0.0300	0.0607
$1.3S_c$	0.0256	0.0711		0.0556	0.1127
STABLE FLOW? (Y/N)	N	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	1.12	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	-	0.82		1.17	.98
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		2.00	2.00
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	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.20	1.61		1.03	1.26
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	10.00		1.55	4.20

* 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	10.1B Unveg	10.1B Veg		10.2A Unveg	10.2A Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	7.46	8.67		4.80	5.36
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)	1.11	1.41		0.45	0.59
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2.70:1	2.13:1		6.66:1	5.08:1
A (AREA IN SQ. FT.)	5.83	8.22		1.74	2.46
R (HYDRAULIC RADIUS)	0.73	0.88		0.35	0.44
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0444	0.0444
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.041	0.660		0.055	0.090
V (AT FLOW DEPTH d, CFS)	2.93	2.08		2.82	1.99
Q (AT FLOW DEPTH d, CFS)	17.1	17.1		4.9	4.9
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0291	0.0711		0.0653	0.1634
$.7S_c$	0.0204	0.0498		0.0457	0.1144
$1.3S_c$	0.0378	0.0924		0.0849	0.2124
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.88	0.58		1.55	1.41
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		2.00	2.00
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	0.70	0.88		1.24	1.63
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	10.2B			10.2C Unveg	10.2C Veg
PROTECTIVE LINING **	Concrete (Rip Rap)			S75	Grass
CHANNEL TOP WIDTH (FT)@ D	9.00			11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	4.00			6.88	7.62
CHANNEL SIDE SLOPES (H:V)	2			2	2
CHANNEL BOTTOM WIDTH (FT)	3.0			3.0	3.0
d (FLOW DEPTH IN FT)	0.25			0.97	1.15
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	12:1			3.09:1	2.61:1
A (AREA IN SQ. FT.)	0.87			4.79	6.11
R (HYDRAULIC RADIUS)	0.21			0.97	1.31
S (BED SLOPE, FT/FT)*	0.1818			0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-			-	C
n (MANNING'S COEFFICIENT)**	0.020			0.0440	0.0620
V (AT FLOW DEPTH d, CFS)	11.25			3.57	2.80
Q (AT FLOW DEPTH d, CFS)	9.8			17.1	17.1
Q_r (REQUIRED CAPACITY) CFS	-			-	-
S_c (CRITICAL SLOPE)	0.010			0.0347	0.0660
$.7S_c$	0.007			0.0243	0.0462
$1.3S_c$	0.013			0.0451	0.0858
STABLE FLOW? (Y/N)	Y			Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-			-	-
FREEBOARD BASED ON STABLE FLOW FT	1.25			1.03	0.85
MINIMUM REQUIRED FREEBOARD FT	0.5			0.5	0.5
D (TOTAL DEPTH) FT	1.5			2.0	2.0
d_{50} STONE SIZE (IN)	15			-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S			V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	14.5			5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	2.82			1.21	1.44
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	N/A			1.55	4.20

* 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.

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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
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CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	10.2D			10.2E Unveg	10.2E Veg
PROTECTIVE LINING **	Concrete (Rip Rap)			SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	9.00			11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	4.37			7.17	8.65
CHANNEL SIDE SLOPES (H:V)	2			2	2
CHANNEL BOTTOM WIDTH (FT)	3.0			3.0	3.0
d (FLOW DEPTH IN FT)	0.34			1.05	1.41
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	8.80:1			2.86:1	2.13:1
A (AREA IN SQ. FT.)	1.26			5.34	8.18
R (HYDRAULIC RADIUS)	0.28			0.69	0.88
S (BED SLOPE, FT/FT)*	0.2000			0.0200	0.0200
VEGETATIVE LINING RETARDANCE	-			-	C
n (MANNING'S COEFFICIENT)**	0.0200			0.0290	0.0530
V (AT FLOW DEPTH d, CFS)	14.15			5.60	3.66
Q (AT FLOW DEPTH d, CFS)	17.8			29.9	29.9
Q_r (REQUIRED CAPACITY) CFS	-			-	-
S_c (CRITICAL SLOPE)	0.0093			0.0148	0.0459
$.7S_c$	0.0065			0.0104	0.0321
$1.3S_c$	0.0121			0.0192	0.0597
STABLE FLOW? (Y/N)	Y			Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-			-	-
FREEBOARD BASED ON STABLE FLOW FT	1.16			0.96	0.59
MINIMUM REQUIRED FREEBOARD FT	0.5			0.5	0.5
D (TOTAL DEPTH) FT	1.5			2.0	2.0
d_{50} STONE SIZE (IN)	15			-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S			V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	14.5			9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	4.26			1.31	1.76
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	N/A			3.00	10.00

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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
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PREPARED BY: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	10A.1 Unveg	10A.1 Veg		12.1 Unveg	12.1 Veg
PROTECTIVE LINING **	SC250	SC250		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		48.75	48.75
CHANNEL TOP WIDTH (FT)@ d	7.34	8.82		18.42	20.64
CHANNEL SIDE SLOPES (H:V)	2	2		3,6	3,6
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		15	15
d (FLOW DEPTH IN FT)	1.08	1.45		0.38	0.62
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2.78:1	2.07:1		12:1	12:1
A (AREA IN SQ. FT.)	5.57	8.54		6.34	11.10
R (HYDRAULIC RADIUS)	0.71	0.90		0.34	0.53
S (BED SLOPE, FT/FT)*	0.0200	0.0200		0.0110	0.0110
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0290	0.0520		0.0550	0.1300
V (AT FLOW DEPTH d, CFS)	5.82	3.79		1.39	0.79
Q (AT FLOW DEPTH d, CFS)	32.4	32.4		8.8	8.8
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0147	0.0439		0.0632	0.3047
$.7S_c$	0.0103	0.0307		0.0442	0.2133
$1.3S_c$	0.0191	0.0571		0.0822	0.3961
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.91	0.55		2.12	1.87
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		2.50	2.50
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	9.5	15.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.35	1.81		0.26	0.43
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	10.00		1.55	4.20

* 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
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PREPARED BY: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	12.2A Unveg	12.2A Veg		12.2B Unveg	12.2B Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	12.00	12.00		12.00	12.00
CHANNEL TOP WIDTH (FT)@ d	7.60	8.54		8.20	9.26
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	4.0	4.0		4.0	4.0
d (FLOW DEPTH IN FT)	0.90	1.13		1.04	1.31
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4.44:1	3.54:1		3.85:1	3.05:1
A (AREA IN SQ. FT.)	5.20	7.11		6.36	8.69
R (HYDRAULIC RADIUS)	0.65	0.78		0.73	0.88
S (BED SLOPE, FT/FT)*	0.0118	0.0118		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0460	0.0710		0.0430	0.0660
V (AT FLOW DEPTH d, CFS)	2.63	1.93		2.83	2.07
Q (AT FLOW DEPTH d, CFS)	13.7	13.7		18.0	18.0
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0375	0.0846		0.0316	0.0706
$.7S_c$	0.0263	0.0592		0.0221	0.0494
$1.3S_c$	0.0488	0.1100		0.0411	0.0918
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.10	0.87		0.95	0.68
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		2.00	2.00
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	0.66	0.84		0.65	0.82
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* Slopes may not be averaged.
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*** 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	12.2C			15A.1 Unveg	15A.1 Veg
PROTECTIVE LINING **	Concrete (Rip Rap)			P550	P550
CHANNEL TOP WIDTH (FT)@ D	10.00			8.00	8.00
CHANNEL TOP WIDTH (FT)@ d	6.21			4.40	4.97
CHANNEL SIDE SLOPES (H:V)	2			2	2
CHANNEL BOTTOM WIDTH (FT)	2.00			2.0	2.0
d (FLOW DEPTH IN FT)	1.05			0.60	0.74
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1.90:1			3.33:1	2.70:1
A (AREA IN SQ. FT.)	4.32			1.91	2.57
R (HYDRAULIC RADIUS)	0.64			0.41	0.48
S (BED SLOPE, FT/FT)*	0.0444			0.0930	0.0930
VEGETATIVE LINING RETARDANCE	-			-	C
n (MANNING'S COEFFICIENT)**	0.020			0.0390	0.590
V (AT FLOW DEPTH d, CFS)	11.68			6.38	4.75
Q (AT FLOW DEPTH d, CFS)	50.5			12.2	12.2
Q_r (REQUIRED CAPACITY) CFS	-			-	-
S_c (CRITICAL SLOPE)	0.0073			0.0317	0.0690
$.7S_c$	0.0051			0.0222	0.0483
$1.3S_c$	0.0095			0.0412	0.0897
STABLE FLOW? (Y/N)	Y			Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-			-	-
FREEBOARD BASED ON STABLE FLOW FT	0.95			0.90	0.76
MINIMUM REQUIRED FREEBOARD FT	0.50			0.5	0.5
D (TOTAL DEPTH) FT	2.00			1.50	1.50
d_{50} STONE SIZE (IN)	15			-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	V/S			V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	14.5			12.5	25.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	2.92			3.47	4.29
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	N/A			4.00	14.00

* Slopes may not be averaged.
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Channel Design Data

PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: JMO DATE: 09/15/11
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CHANNEL OR CHANNEL SECTION	21.1 Unveg	21.1 Veg		21.2 Unveg	21.2 Veg
PROTECTIVE LINING **	S75	Grass		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		15.00	15.00
CHANNEL TOP WIDTH (FT)@ d	4.70	5.80		9.93	11.78
CHANNEL SIDE SLOPES (H:V)	3	3		3	3
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		3.0	3.0
d (FLOW DEPTH IN FT)	0.45	0.62		1.16	1.46
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	4.44:1	3.23:1		2.59:1	2.05:1
A (AREA IN SQ. FT.)	1.50	2.41		7.47	10.77
R (HYDRAULIC RADIUS)	0.31	0.41		0.72	0.88
S (BED SLOPE, FT/FT)*	0.0400	0.0400		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0550	0.1060		0.0400	0.0660
V (AT FLOW DEPTH d, CFS)	2.47	1.53		2.99	2.07
Q (AT FLOW DEPTH d, CFS)	3.7	3.7		22.3	22.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0670	0.2278		0.0269	0.0688
$.7S_c$	0.0469	0.1595		0.0188	0.0482
$1.3S_c$	0.0871	0.2961		0.0350	0.0894
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.05	0.87		0.84	0.54
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	1.5	1.5		2.00	2.00
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	1.12	1.56		0.72	0.91
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		1.55	4.20

* Slopes may not be averaged.
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*** 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	21.3 Unveg	21.3 Veg		21.4 Unveg	21.4 Veg
PROTECTIVE LINING **	S75	Grass		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	20.00	20.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	9.22	11.19		5.19	5.77
CHANNEL SIDE SLOPES (H:V)	3	3		2	2
CHANNEL BOTTOM WIDTH (FT)	2.0	2.0		3.0	3.0
d (FLOW DEPTH IN FT)	1.20	1.53		0.55	0.69
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1.67:1	1.31:1		5.45:1	4.35:1
A (AREA IN SQ. FT.)	6.73	10.10		2.24	3.03
R (HYDRAULIC RADIUS)	0.70	0.86		0.41	0.50
S (BED SLOPE, FT/FT)*	0.0100	0.0100		0.0800	0.0800
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0390	0.0670		0.0390	0.0600
V (AT FLOW DEPTH d, CFS)	3.00	2.00		5.94	4.39
Q (AT FLOW DEPTH d, CFS)	20.2	20.2		13.3	12.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0260	0.0717		0.0313	0.0698
$.7S_c$	0.0182	0.0502		0.0219	0.0489
$1.3S_c$	0.0338	0.0932		0.0407	0.0907
STABLE FLOW? (Y/N)	Y	Y		Y	N
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	1.31
FREEBOARD BASED ON STABLE FLOW FT	1.80	1.47		1.45	-
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	3.0	3.0		2.00	2.00
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		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	0.75	0.96		2.73	3.45
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	1.55	4.20		3.00	10.00

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*** 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: JMO DATE: 09/15/11
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CHANNEL OR CHANNEL SECTION	21.5A Unveg	21.5A Veg		21.5B Unveg	21.5B Veg
PROTECTIVE LINING **	P550	P550		S75	Grass
CHANNEL TOP WIDTH (FT)@ D	11.00	11.00		11.00	11.00
CHANNEL TOP WIDTH (FT)@ d	7.67	8.71		3.51	4.19
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)	1.17	1.43		0.06	0.16
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	2.56:1	2.10:1		12:1	12:1
A (AREA IN SQ. FT.)	6.28	8.36		0.20	0.53
R (HYDRAULIC RADIUS)	0.76	0.89		0.06	0.14
S (BED SLOPE, FT/FT)*	0.0500	0.0500		0.0550	0.0550
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0280	0.0420		0.0550	0.2500
V (AT FLOW DEPTH d, CFS)	9.75	7.34		0.99	0.38
Q (AT FLOW DEPTH d, CFS)	61.3	61.3		0.2	0.2
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0134	0.0288		0.0916	1.4979
$.7S_c$	0.0094	0.0202		0.0641	1.0485
$1.3S_c$	0.0174	0.0374		0.1191	1.9473
STABLE FLOW? (Y/N)	Y	Y		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	-		-	-
FREEBOARD BASED ON STABLE FLOW FT	0.83	0.57		1.87	1.70
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		2.00	2.00
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	12.5	25.0		5.0	3.5
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	3.67	4.45		0.22	0.55
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	4.00	14.00		1.55	4.20

* 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	21.5C			21.6A Unveg	21.6A Veg
PROTECTIVE LINING **	Concrete (Rip Rap)			SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	11.00			9.00	9.00
CHANNEL TOP WIDTH (FT)@ d	6.51			4.74	5.49
CHANNEL SIDE SLOPES (H:V)	2			2	2
CHANNEL BOTTOM WIDTH (FT)	3.0			3.0	3.0
d (FLOW DEPTH IN FT)	0.88			0.43	0.62
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	3.41:1			6.98:1	4.84:1
A (AREA IN SQ. FT.)	4.17			1.67	2.62
R (HYDRAULIC RADIUS)	0.60			0.34	0.45
S (BED SLOPE, FT/FT)*	0.0869			0.0571	0.0571
VEGETATIVE LINING RETARDANCE	-			-	C
n (MANNING'S COEFFICIENT)**	0.020			0.0400	0.0760
V (AT FLOW DEPTH d, CFS)	15.63			4.31	2.75
Q (AT FLOW DEPTH d, CFS)	65.2			7.2	7.2
Q_r (REQUIRED CAPACITY) CFS	-			-	-
S_c (CRITICAL SLOPE)	0.0073			0.0348	0.1151
$.7S_c$	0.0051			0.0244	0.0806
$1.3S_c$	0.0095			0.0452	0.1496
STABLE FLOW? (Y/N)	Y			Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-			-	-
FREEBOARD BASED ON STABLE FLOW FT	1.12			1.06	0.88
MINIMUM REQUIRED FREEBOARD FT	0.5			0.5	0.5
D (TOTAL DEPTH) FT	2.0			1.50	1.50
d_{50} STONE SIZE (IN)	15			-	-
DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)	S			V/S	V/S
V_a (ALLOWABLE VELOCITY) FPS	14.5			9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	4.76			1.54	2.20
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	N/A			3.00	10.00

* 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

CHANNEL OR CHANNEL SECTION	21.6B Unveg	21.6B Veg		21.6C Unveg	21.6C Veg
PROTECTIVE LINING **	SC250	SC250		SC250	SC250
CHANNEL TOP WIDTH (FT)@ D	10.00	10.00		15.00	15.00
CHANNEL TOP WIDTH (FT)@ d	4.69	5.31		9.92	12.58
CHANNEL SIDE SLOPES (H:V)	2	2		2	2
CHANNEL BOTTOM WIDTH (FT)	3.0	3.0		5.0	5.0
d (FLOW DEPTH IN FT)	0.50	0.68		1.48	1.89
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	6:1	4.41:1		3.38:1	2.65:1
A (AREA IN SQ. FT.)	1.99	2.95		8.86	16.59
R (HYDRAULIC RADIUS)	0.38	0.49		0.92	1.23
S (BED SLOPE, FT/FT)*	0.1000	0.1000		0.0100	0.0100
VEGETATIVE LINING RETARDANCE	-	C		-	C
n (MANNING'S COEFFICIENT)**	0.0400	0.700		0.0210	0.0480
V (AT FLOW DEPTH d, CFS)	4.58	3.08		6.70	3.57
Q (AT FLOW DEPTH d, CFS)	9.1	9.1		59.3	59.3
Q_r (REQUIRED CAPACITY) CFS	-	-		-	-
S_c (CRITICAL SLOPE)	0.0351	0.0994		0.0071	0.0335
$.7S_c$	0.0246	0.0696		0.0050	0.0235
$1.3S_c$	0.0456	0.1292		0.0092	0.0436
STABLE FLOW? (Y/N)	Y	N		Y	Y
FREEBOARD BASED ON UNSTABLE FLOW FT	-	1.42		-	-
FREEBOARD BASED ON STABLE FLOW FT	1.58	-		1.27	0.61
MINIMUM REQUIRED FREEBOARD FT	0.5	0.5		0.5	0.5
D (TOTAL DEPTH) FT	2.00	2.00		2.50	2.50
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	9.5	15.0		9.5	15.0
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	1.71	2.33		0.93	1.18
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	3.00	10.00		3.00	10.00

* 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: JMO DATE: 09/15/11
CHECKED BY: JFM DATE: 09/15/11

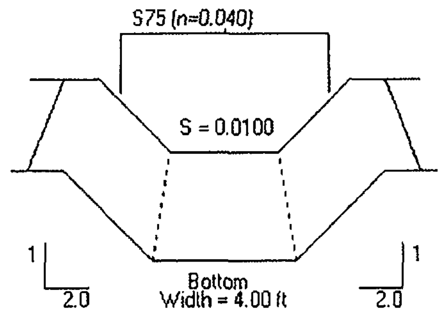
CHANNEL OR CHANNEL SECTION	21.6D				
PROTECTIVE LINING **	Concrete (Rip Rap)				
CHANNEL TOP WIDTH (FT)@ D	14.00				
CHANNEL TOP WIDTH (FT)@ d	5.55				
CHANNEL SIDE SLOPES (H:V)	2				
CHANNEL BOTTOM WIDTH (FT)	2.00				
d (FLOW DEPTH IN FT)	1.90:1				
BOTTOM WIDTH:DEPTH RATIO (12:1 MAX)	1.05:1				
A (AREA IN SQ. FT.)	3.34				
R (HYDRAULIC RADIUS)	0.56				
S (BED SLOPE, FT/FT)*	0.2000				
VEGETATIVE LINING RETARDANCE	-				
n (MANNING'S COEFFICIENT)**	0.0200				
V (AT FLOW DEPTH d, CFS)	22.60				
Q (AT FLOW DEPTH d, CFS)	75.6				
Q_r (REQUIRED CAPACITY) CFS	-				
S_c (CRITICAL SLOPE)	0.0076				
$.7S_c$	0.0053				
$1.3S_c$	0.0099				
STABLE FLOW? (Y/N)	Y				
FREEBOARD BASED ON UNSTABLE FLOW FT	-				
FREEBOARD BASED ON STABLE FLOW FT	2.11				
MINIMUM REQUIRED FREEBOARD FT	0.50				
D (TOTAL DEPTH) FT	3				
d_{50} STONE SIZE (IN)	15				
DESIGN METHOD FOR PROTECTIVE LINING ** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)**	S				
V_a (ALLOWABLE VELOCITY) FPS	14.5				
τ_d (SHEAR STRESS AT FLOW DEPTH d) LB/FT^2	11.07				
τ_a (MAX ALLOWABLE SHEAR STRESS) LB/FT^2	N/A				

* 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.

North American Green - ECMDS Version 4.3		8/29/2011	08:54 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: Swale 1A.1		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
24.1	0.1	3.24	7.45	0.81	1.17



Not to Scale

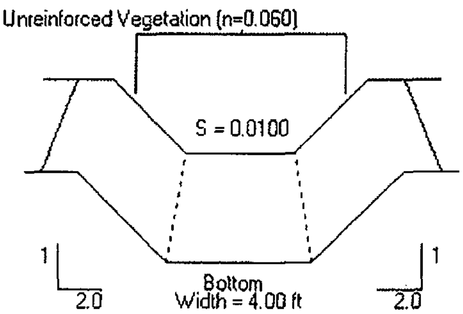
LINER RESULTS

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	0.73	2.12	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	8/29/2011	08:52 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: Swale 1A.1		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
24.1	0.1	2.40	10.05	0.96	1.46



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.91	4.63	STABLE
		Soil	Sandy Loam				0.035	0.030	1.15	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 1A.1 TO SED BASIN 1A
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 1A.1	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	24.12	24.12		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	4.0	4.0		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0600		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.18**	**1.46**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.82	0.54		feet
Calculated Velocity, V=	3.21	2.40		fps
Flow Top Width, T=	8.72	9.82		feet
Flow Area, A=	7.51	10.07		sq ft
Wetted Perimeter, P=	9.28	10.51		feet
Hydraulic Radius, R=	0.81	0.96		feet
Shear stress on channel bottom, τ =	0.74	0.91		lbs/sf
Critical Slope, S_c=	0.0266	0.0569		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

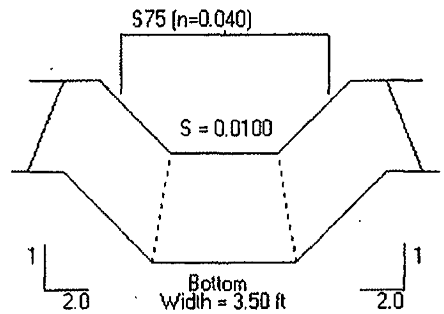
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/29/2011 08:56 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: Swale 6.1A	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
21.4	0.1	3.15	6.79	0.78	1.16



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	0.73	2.13	STABLE
	Staple D									

North American Green - ECMDS Version 4.3 | 8/29/2011 | 08:55 AM | COMPUTED BY: JMO

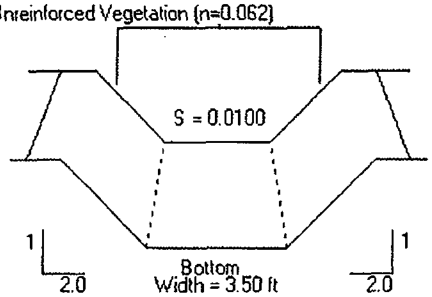
PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: Swale 6.1A | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
21.4	0.1	2.29	9.34	0.93	1.46

Unreinforced Vegetation (n=0.062)



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.91	4.62	STABLE
		Soil	Sandy Loam				0.035	0.029	1.21	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 6.1 (segment A) TO SED BASIN 6
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 6.1A

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	21.38	21.38		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.5	3.5		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0620		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.17**	**1.46**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.83	0.54		feet
Calculated Velocity, V=	3.14	2.28		fps
Flow Top Width, T=	8.17	9.34		feet
Flow Area, A=	6.81	9.37		sq ft
Wetted Perimeter, P=	8.72	10.03		feet
Hydraulic Radius, R=	0.78	0.93		feet
Shear stress on channel bottom, τ =	0.73	0.91		lbs/sf
Critical Slope, S_c=	0.0270	0.0615		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

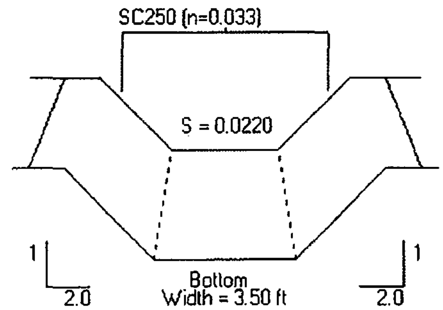
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/29/2011 08:58 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: Swale 6.1B	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
22.6	0.1	4.90	4.61	0.62	0.88



Not to Scale

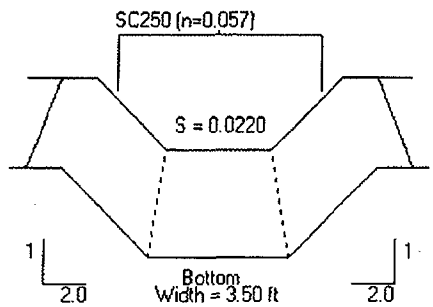
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.20	2.49	STABLE
	Staple E									

North American Green - ECMDS Version 4.3		8/29/2011	08:58 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: Swale 6.18		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
22.6	0.1	3.29	6.88	0.79	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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.61	6.20	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.179	4.46	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 6.1 (segment A and B) TO SED BASIN 6
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 A/B

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	22.55	22.55		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.5	3.5		feet
Bed slope, s=	0.0220	0.0220		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0330	0.0570		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.88**	**1.18**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.12	0.82		feet
Calculated Velocity, V=	4.86	3.28		fps
Flow Top Width, T=	7.02	8.20		feet
Flow Area, A=	4.64	6.88		sq ft
Wetted Perimeter, P=	7.44	8.76		feet
Hydraulic Radius, R=	0.62	0.79		feet
Shear stress on channel bottom, τ =	1.21	1.61		lbs/sf
Critical Slope, S_c=	0.0197	0.0547		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	no	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

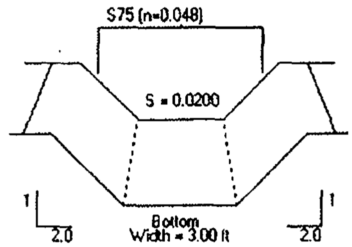
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	03:27 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 10.1A	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.8	0.1	3.06	3.86	0.58	0.83



Not to Scale

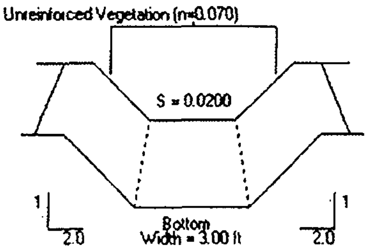
LINER RESULTS

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	1.03	1.50	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	8/25/2011	03:26 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 10.1A	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
11.8	0.1	2.32	5.09	0.68	1.01



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.26	3.32	STABLE
		Soil	Sandy Loam				0.035	0.032	1.11	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 10.1 (segment A) TO SED BASIN 10
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 10.1A

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	11.75	11.75		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0200	0.0200		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0480	0.0700		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.83**	**1.02**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.17	0.98		feet
Calculated Velocity, V=	3.02	2.30		fps
Flow Top Width, T=	6.33	7.06		feet
Flow Area, A=	3.89	5.11		sq ft
Wetted Perimeter, P=	6.73	7.54		feet
Hydraulic Radius, R=	0.58	0.68		feet
Shear stress on channel bottom, τ =	1.04	1.27		lbs/sf
Critical Slope, S_c=	0.0428	0.0867		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

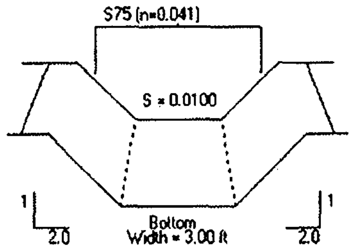
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011 03:30 PM	COMPUTED BY: JMO
PROJECT NAME: PPL 8BNNP	PROJECT NO.: PPLS0902	
FROM STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 10.18	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
17.1	0.1	2.93	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	0.70	2.23	STABLE
	Staple D									

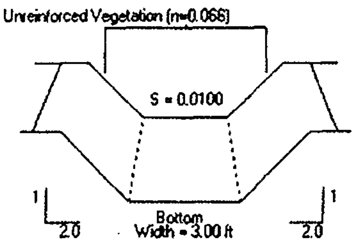
North American Green - ECMDS Version 4.3	8/25/2011 03:29 PM	COMPUTED BY: JMO

PROJECT NAME: PPL BBNNP — PROJECT NO.: PPLS0902

FROM STATION/REACH: — TO STATION/REACH: VEG — DRAINAGE AREA: ES SWALE 10.18 — DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
17.1	0.1	2.08	8.22	0.88	1.41



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.88	4.77	STABLE
		Soil	Sandy Loam				0.035	0.025	1.41	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 10.1 (segment A and B) TO SED BASIN 10
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 A/B

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	17.10	17.10		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0410	0.0660		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.12**	**1.42**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.88	0.58		feet
Calculated Velocity, V=	2.93	2.07		fps
Flow Top Width, T=	7.46	8.67		feet
Flow Area, A=	5.84	8.28		sq ft
Wetted Perimeter, P=	7.99	9.34		feet
Hydraulic Radius, R=	0.73	0.89		feet
Shear stress on channel bottom, τ =	0.70	0.89		lbs/sf
Critical Slope, S_c=	0.0291	0.0711		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

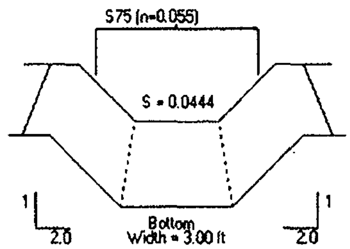
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/25/2011	03:33 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 10.2A		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.9	0.1	2.82	1.74	0.35	0.45



Not to Scale

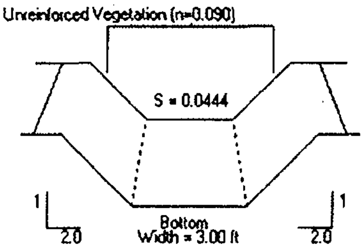
LINER RESULTS

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	1.24	1.25	STABLE
	Staple D									

North American Green - ECMDS Version 4.3		8/25/2011	03:32 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 10.2A		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
4.9	0.1	1.99	2.46	0.44	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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.63	2.58	STABLE
		Soil	Sandy Loam				0.035	0.024	1.44	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 10.2 (segment A)TO SED BASIN 10
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JML

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 10.2A

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	4.86	4.86		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0444	0.0444		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.0900		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.45**	**0.59**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.55	1.41		feet
Calculated Velocity, V=	2.77	1.97		fps
Flow Top Width, T=	4.80	5.36		feet
Flow Area, A=	1.75	2.47		sq ft
Wetted Perimeter, P=	5.01	5.64		feet
Hydraulic Radius, R=	0.35	0.44		feet
Shear stress on channel bottom, τ =	1.24	1.63		lbs/sf
Critical Slope, S_c=	0.0653	0.1634		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

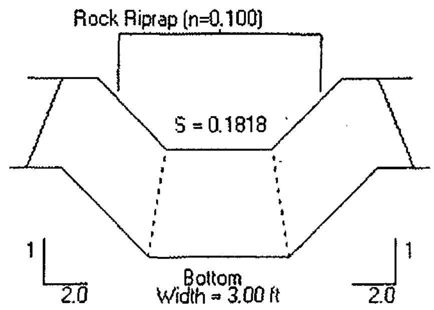
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/29/2011	09:00 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: RIP RAP	DRAINAGE AREA: Swale 10.2B		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.8	0.1	3.74	2.62	0.45	0.62



Not to Scale

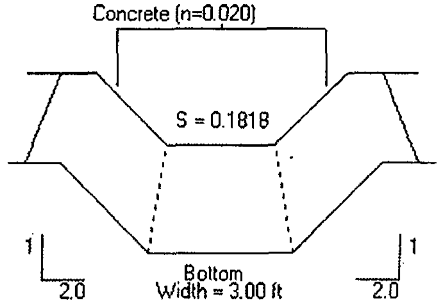
LINER RESULTS

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	Rock Riprap	Unvegetated					5.00	7.01	0.71	UNSTABLE
	15in									

North American Green - ECMDS Version 4.3	8/29/2011	09:05 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: CONCRETE	DRAINAGE AREA: Swale 10.2B	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.8	0.1	11.25	0.87	0.21	0.25



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	Concrete	Unvegetated					N/A	2.82	N/A	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 10.2 (segment A and B) TO SED BASIN 10**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: **6 Sep 11 11:18 AM**
Project #: PPLS0902

Checked by:
JML

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 10.2A/B

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.79			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=	0.1818			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0200			
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.25**	**feet**

Calculated Results:

Design Acceptable?	V too high	
Freeboard, f=	1.25	feet
Calculated Velocity, V=	11.19	fps
Flow Top Width, T=	4.00	feet
Flow Area, A=	0.88	sq ft
Wetted Perimeter, P=	4.12	feet
Hydraulic Radius, R=	0.21	feet
Shear stress on channel bottom, τ =	2.84	lbs/sf
Critical Slope, S_c=	0.0100	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	0.0	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

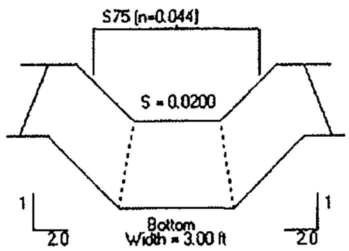
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:36 PM | COMPUTED BY: JMD

PROJECT NAME: PPL BBNNP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: ES SWALE 10.2C | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
17.1	0.1	3.57	4.79	0.65	0.97



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	1.21	1.28	STABLE
	Staple D									

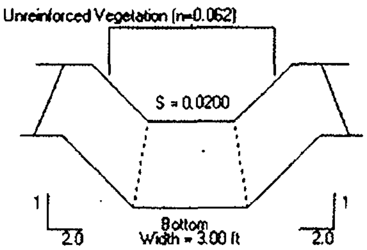
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:35 PM | COMPUTED BY: JMO

PROJECT NAME: PPL BBNNP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: ES SWALE 10.2C | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
17.1	0.1	2.80	6.11	0.75	1.15



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	Unreinforced	Vegetation		C	Sod	75-95%	4.20	1.44	2.92	STABLE
		Soil	Sandy Loam				0.035	0.012	2.95	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 10.2 (segment A , B and C) TO SED BASIN 10**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JML

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 10.2A/B/C	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	17.10	17.10		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0200	0.0200		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0440	0.0620		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.97**	**1.15**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.03	0.85		feet
Calculated Velocity, V=	3.57	2.79		fps
Flow Top Width, T=	6.88	7.62		feet
Flow Area, A=	4.79	6.13		sq ft
Wetted Perimeter, P=	7.33	8.16		feet
Hydraulic Radius, R=	0.65	0.75		feet
Shear stress on channel bottom, τ =	1.21	1.44		lbs/sf
Critical Slope, S_c=	0.0347	0.0660		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

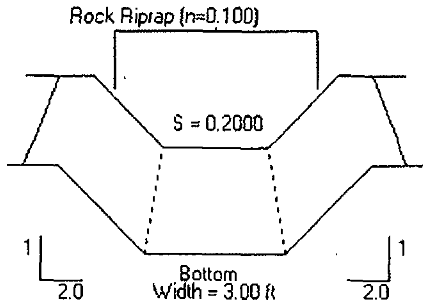
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/29/2011	09:07 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: RIP RAP	DRAINAGE AREA: Swale 10.2D		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
17.8	0.1	4.60	3.87	0.58	0.83



Not to Scale

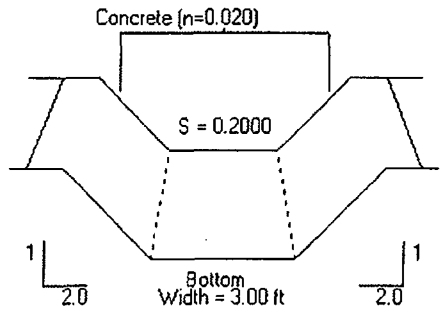
LINER RESULTS

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	Rock Riprap	Unvegetated					5.00	10.36	0.48	UNSTABLE
	15in									

North American Green - ECMDS Version 4.3		8/29/2011	09:08 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: CONCRETE	DRAINAGE AREA: Swale 10.2D		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
17.8	0.1	14.15	1.26	0.28	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	Concrete	Unvegetated					N/A	4.26	N/A	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 10.2 (segment A , B, C and D) TO SED BASIN 10**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JML

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 10.2A/B/C/D	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	17.80			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=	0.2000			ft/ft
Available depth of channel:	1.50			feet
(OPTIONAL) Input Manning's 'n':	0.0200			
Lining Type:				

Calculate Flow Depth:

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

Calculated Results:

Design Acceptable?	V too high	
Freeboard, f=	1.16	feet
Calculated Velocity, V=	14.15	fps
Flow Top Width, T=	4.37	feet
Flow Area, A=	1.26	sq ft
Wetted Perimeter, P=	4.53	feet
Hydraulic Radius, R=	0.28	feet
Shear stress on channel bottom, τ =	4.26	lbs/sf
Critical Slope, S_c=	0.0093	ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	
Required Freeboard=	0.5	feet
Allowable Velocity for Lining Material=	0.0	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

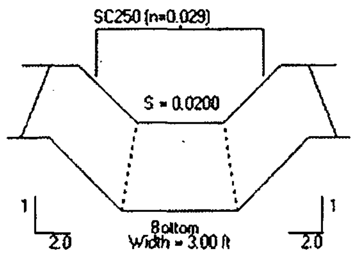
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:39 PM | COMPUTED BY: JMD

PROJECT NAME: PPL BBNNP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: ES SWALE 10.2E | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
29.9	0.1	5.60	5.34	0.69	1.05



Not to Scale

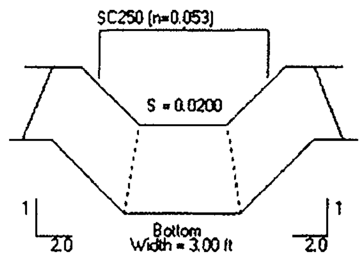
LINER RESULTS

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	SC250	Unvegetated	1				3.00	1.31	2.29	STABLE
	Staple E									

North American Green - ECMDS Version 4.3	8/25/2011	03:40 PM	COMPUTED BY: JMO
PROJECT NAME: PPL 8BNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 10.2E	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
29.9	0.1	3.66	8.18	0.88	1.41



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.76	5.70	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.159	5.03	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 10.2 (segment A , B, C , D and E) TO SED BASIN 1 — Print Date: 6 Sep 11 11:18 AM
Prepared by: JMO — Project #: PPLS0902
Date: 15 Sep 11

Checked by: JML

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 10.2A/B/C/D/E	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	29.93	29.93		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0200	0.0200		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0290	0.0530		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.04**	**1.41**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.96	0.59		feet
Calculated Velocity, V=	5.65	3.64		fps
Flow Top Width, T=	7.17	8.65		feet
Flow Area, A=	5.30	8.22		sq ft
Wetted Perimeter, P=	7.66	9.31		feet
Hydraulic Radius, R=	0.69	0.88		feet
Shear stress on channel bottom, τ =	1.30	1.76		lbs/sf
Critical Slope, S_c=	0.0148	0.0459		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

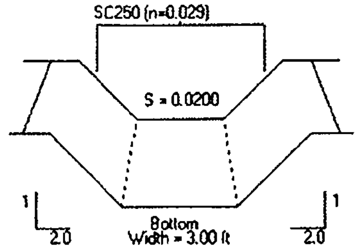
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	03:43 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 10A.1	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
32.4	0.1	5.82	5.57	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	SC250	Unvegetated	1				3.00	1.35	2.23	STABLE
	Staple E									

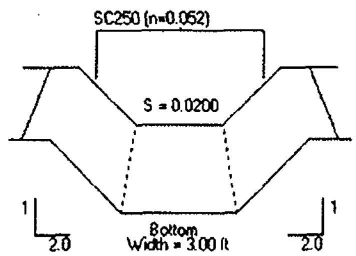
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:44 PM | COMPUTED BY: JMO

PROJECT NAME: PPL 88NNP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: ES SWALE 10A.1 | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
32.4	0.1	3.79	8.54	0.90	1.45



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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.81	5.53	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.159	5.04	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 10A.1 TO SED BASIN 10A**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 10A.1	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	32.42	32.42		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0200	0.0200		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0290	0.0520		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.09**	**1.45**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.91	0.55		feet
Calculated Velocity, V=	5.78	3.77		fps
Flow Top Width, T=	7.34	8.82		feet
Flow Area, A=	5.61	8.59		sq ft
Wetted Perimeter, P=	7.85	9.50		feet
Hydraulic Radius, R=	0.71	0.90		feet
Shear stress on channel bottom, τ =	1.35	1.82		lbs/sf
Critical Slope, S_c=	0.0147	0.0439		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

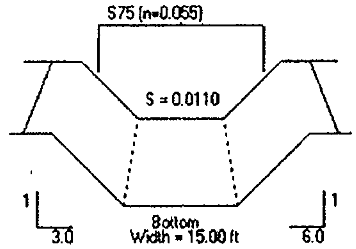
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/25/2011	03:47 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 12.1		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.8	0.1	1.39	6.34	0.34	0.38



Not to Scale

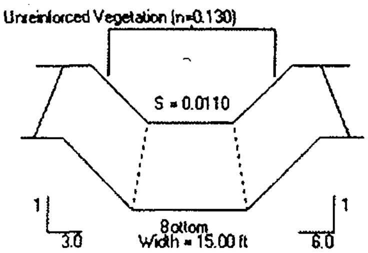
LINER RESULTS

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	0.26	5.95	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	8/25/2011 03:46 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902	
FROM STATION/REACH: / TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 12.1	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
8.8	0.1	0.79	11.10	0.53	0.62



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.43	9.81	STABLE
		Soil	Sandy Loam				0.035	0.003	11.28	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 12.1 TO SED BASIN 12
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JFM

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=	8.75	8.75		cfs
Left Side Slope =	3.0	3.0		H:1V
Right Side Slope =	6.0	6.0		H:1V
Base width of Channel, b=	15.0	15.0		feet
Bed slope, s=	0.0110	0.0110		ft/ft
Available depth of channel:	2.50	2.50		feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1300		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.38**	**0.63**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	2.12	1.87		feet
Calculated Velocity, V=	1.38	0.78		fps
Flow Top Width, T=	18.42	20.64		feet
Flow Area, A=	6.34	11.16		sq ft
Wetted Perimeter, P=	18.50	20.77		feet
Hydraulic Radius, R=	0.34	0.54		feet
Shear stress on channel bottom, τ =	0.26	0.43		lbs/sf
Critical Slope, S_c=	0.0632	0.3047		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

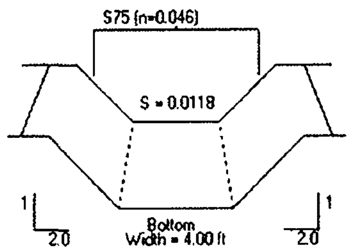
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	03:49 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 12.2A	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
13.7	0.1	2.63	5.20	0.65	0.90



Not to Scale

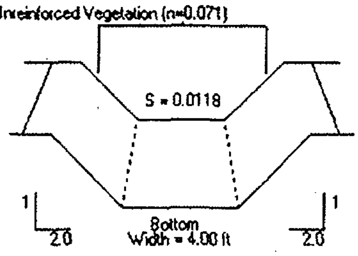
LINER RESULTS

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	0.66	2.34	STABLE
	Staple D									

North American Green - ECMDS Version 4.3	8/25/2011	03:48 PM	COMPUTED BY: JMO
PROJECT NAME: PPL 88NNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 12.2A	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
13.7	0.1	1.93	7.11	0.78	1.13



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.84	5.03	STABLE
		Soil	Sandy Loam				0.035	0.020	1.75	STABLE

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 12.2 (segment A) TO SED BASIN 12**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 12.2A	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	13.66	13.66		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	4.0	4.0		feet
Bed slope, s=	0.0118	0.0118		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0460	0.0710		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.90**	**1.13**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.10	0.87		feet
Calculated Velocity, V=	2.62	1.92		fps
Flow Top Width, T=	7.60	8.54		feet
Flow Area, A=	5.22	7.11		sq ft
Wetted Perimeter, P=	8.02	9.07		feet
Hydraulic Radius, R=	0.65	0.78		feet
Shear stress on channel bottom, τ =	0.66	0.84		lbs/sf
Critical Slope, S_c=	0.0375	0.0846		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

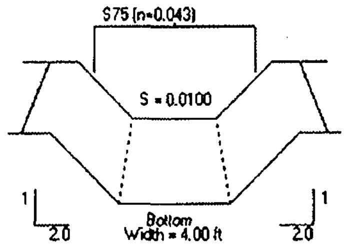
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	03:51 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 12.28	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
18.0	0.1	2.83	6.36	0.73	1.04



Not to Scale

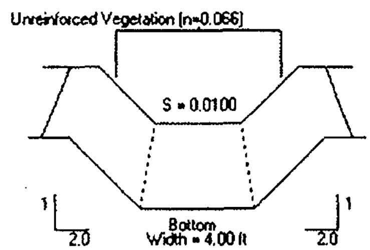
LINER RESULTS

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		8/25/2011	03:50 PM	COMPUTED BY: JMO
PROJECT NAME: PPL 88NNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 12.28		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
18.0	0.1	2.07	8.69	0.88	1.31



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.82	5.13	STABLE
		Soil	Sandy Loam				0.035	0.023	1.53	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 12.2 (segment A and B) TO SED BASIN 12
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 12.2A/B	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	17.98	17.98		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	4.0	4.0		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0430	0.0660		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.05**	**1.32**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.95	0.68		feet
Calculated Velocity, V=	2.81	2.06		fps
Flow Top Width, T=	8.20	9.26		feet
Flow Area, A=	6.41	8.72		sq ft
Wetted Perimeter, P=	8.70	9.88		feet
Hydraulic Radius, R=	0.74	0.88		feet
Shear stress on channel bottom, τ =	0.66	0.82		lbs/sf
Critical Slope, S_c=	0.0316	0.0706		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

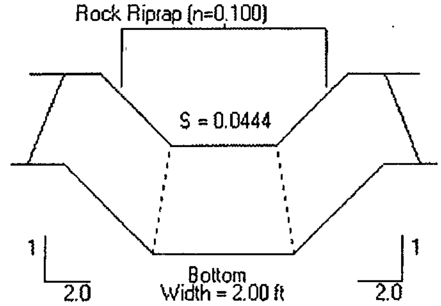
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/29/2011	09:10 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: RIP RAP	DRAINAGE AREA: Swale 12.2C	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
50.5	0.1	3.53	14.29	1.20	2.22



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	Rock Riprap	Unvegetated					5.00	6.15	0.81	UNSTABLE
	15in									

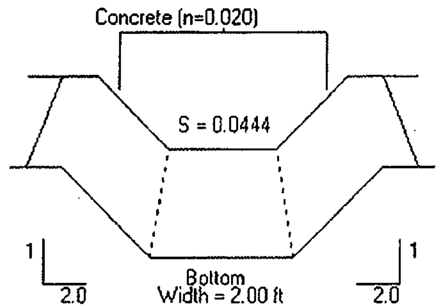
North American Green - ECMDS Version 4.3	8/29/2011	09:11 AM	COMPUTED BY: JMO

PROJECT NAME: PPL BBNPP | PROJECT NO.: PPLS0302

FROM STATION/REACH: | TO STATION/REACH: CONCRETE | DRAINAGE AREA: Swale 12.2C | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
50.5	0.1	11.68	4.32	0.64	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	Concrete	Unvegetated					N/A	2.92	N/A	STABLE

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

Client/Subject: PPL Bell Bend
Description: SWALE 12.2 (segment A,B and C) TO SED BASIN 12
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 12.2A/B/C

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	50.54			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=	0.0444			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0200			
Lining Type:				

Calculate Flow Depth:

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

Calculated Results:

Design Acceptable?	V too high	
Freeboard, f=	0.95	feet
Calculated Velocity, V=	11.68	fps
Flow Top Width, T=	6.21	feet
Flow Area, A=	4.33	sq ft
Wetted Perimeter, P=	6.71	feet
Hydraulic Radius, R=	0.64	feet
Shear stress on channel bottom, τ =	2.92	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=	0.0	fps

Conclusions

A temporary erosion control blanket (ECB) is needed.

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

Client/Subject: PPL Bell Bend
Description: SWALE 21.6D TO SED BASIN 21
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 21.6D	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	75.62			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=	0.2000			ft/ft
Available depth of channel:	3.00			feet
(OPTIONAL) Input Manning's 'n':	0.0200			
Lining Type:				

Calculate Flow Depth:

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

Calculated Results:

Design Acceptable?	V too high			
Freeboard, f=	2.11			feet
Calculated Velocity, V=	22.61			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 =	11.06			lbs/sf
Critical Slope, S_c=	0.0076			ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes			
Required Freeboard=	0.5			feet
Allowable Velocity for Lining Material=	0.0			fps

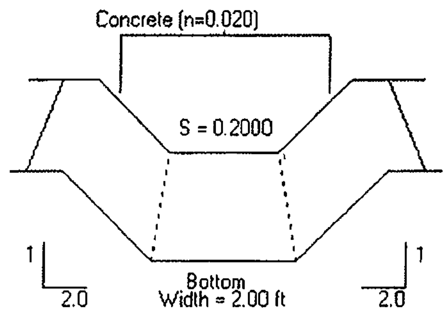
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/29/2011	09:27 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: CONCRETE	DRAINAGE AREA: Swale 21.6D		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
75.6	0.1	22.60	3.35	0.56	0.89



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	Concrete	Unvegetated					N/A	11.07	N/A	STABLE

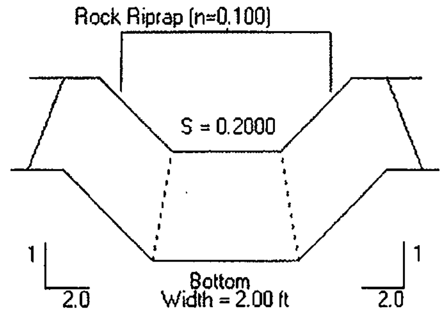
North American Green - ECMDS Version 4.3	8/29/2011	09:26 AM	COMPUTED BY: JMO

PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902

FROM STATION/REACH:	TO STATION/REACH: RIP RAP	DRAINAGE AREA: Swale 21.6D	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
75.6	0.1	6.86	11.01	1.05	1.90



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	Rock Riprap	Unvegetated					5.00	23.71	0.21	UNSTABLE
	15in									

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

Client/Subject: PPL Bell Bend
Description: SWALE 21.6C TO SED BASIN 21
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JFM

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 21.6C	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	59.31	59.31		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	5.0	5.0		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	2.50	2.50		feet
(OPTIONAL) Input Manning's 'n':	0.0210	0.0480		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.23**	**1.89**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.27	0.61		feet
Calculated Velocity, V=	6.47	3.56		fps
Flow Top Width, T=	9.92	12.58		feet
Flow Area, A=	9.17	16.65		sq ft
Wetted Perimeter, P=	10.50	13.47		feet
Hydraulic Radius, R=	0.87	1.24		feet
Shear stress on channel bottom, τ =	0.77	1.18		lbs/sf
Critical Slope, S_c=	0.0071	0.0335		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

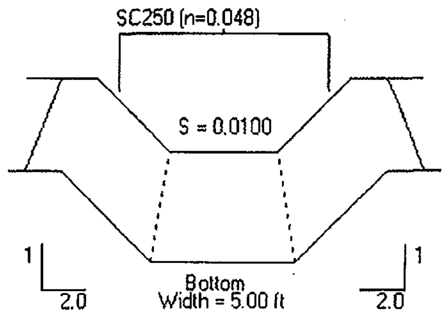
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/29/2011	10:47 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: SWALE 21.6C	DESIGN FREQUENCY: 25 YR

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
59.3	0.1	3.57	16.59	1.23	1.89



Not to Scale

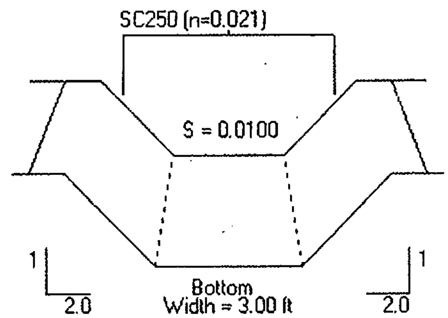
LINER RESULTS

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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	1.18	8.48	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.044	17.99	STABLE

North American Green - ECMDS Version 4.3	8/29/2011	09:19 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: Swale 21.6C	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
59.3	0.1	6.70	8.86	0.92	1.48



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	SC250	Unvegetated	1				3.00	0.93	3.24	STABLE
	Staple E									

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

Client/Subject: PPL Bell Bend
Description: SWALE 21.6B TO SED BASIN 21
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JFM

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 21.6B

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	9.09	9.09		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.1000	0.1000		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0700		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.42**	**0.58**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.58	1.42		feet
Calculated Velocity, V=	5.59	3.79		fps
Flow Top Width, T=	4.69	5.31		feet
Flow Area, A=	1.63	2.40		sq ft
Wetted Perimeter, P=	4.89	5.58		feet
Hydraulic Radius, R=	0.33	0.43		feet
Shear stress on channel bottom, τ =	2.64	3.60		lbs/sf
Critical Slope, S_c=	0.0351	0.0994		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	no		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

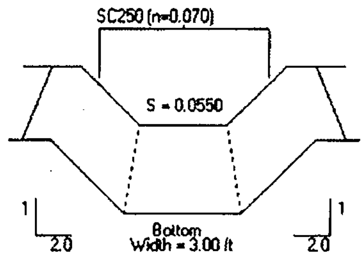
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	04:26 PM	COMPUTED BY: JMD
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.68	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.1	0.1	3.08	2.95	0.49	0.68



Not to Scale

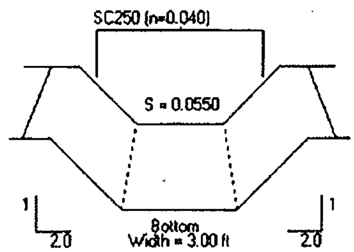
LINER RESULTS

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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.33	4.30	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.316	2.53	STABLE

North American Green - ECMDS Version 4.3		8/25/2011	04:25 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 21.6B		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
9.1	0.1	4.58	1.99	0.38	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	SC250	Unvegetated	1				3.00	1.71	1.76	STABLE
	Staple E									

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

Client/Subject: PPL Bell Bend
Description: SWALE 21.6A TO SED BASIN 21
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 21.6A	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	7.22	7.22		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0571	0.0571		ft/ft
Available depth of channel:	1.50	1.50		feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0760		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.44**	**0.62**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.06	0.88		feet
Calculated Velocity, V=	4.28	2.74		fps
Flow Top Width, T=	4.74	5.49		feet
Flow Area, A=	1.69	2.64		sq ft
Wetted Perimeter, P=	4.95	5.78		feet
Hydraulic Radius, R=	0.34	0.46		feet
Shear stress on channel bottom, τ =	1.55	2.22		lbs/sf
Critical Slope, S_c=	0.0348	0.1151		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

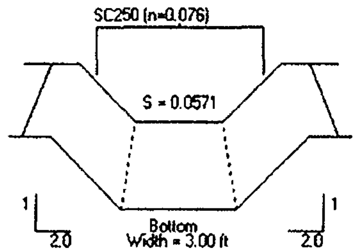
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	04:21 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.6 A	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.2	0.1	2.75	2.62	0.45	0.62



Not to Scale

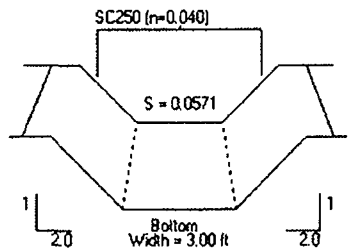
LINER RESULTS

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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	2.20	4.54	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.270	2.97	STABLE

North American Green - ECMDS Version 4.3	8/25/2011	04:20 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 21.6A	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
7.2	0.1	4.31	1.67	0.34	0.43



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	SC250	Unvegetated	1				3.00	1.54	1.95	STABLE
	Staple E									

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 21.5C TO SED BASIN 21**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 21.5C

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	65.23			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=	0.0869			ft/ft
Available depth of channel:	2.00			feet
(OPTIONAL) Input Manning's 'n':	0.0200			
Lining Type:				

Calculate Flow Depth:

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

Calculated Results:

Design Acceptable?	V too high	
Freeboard, f=	1.12	feet
Calculated Velocity, V=	15.64	fps
Flow Top Width, T=	6.51	feet
Flow Area, A=	4.17	sq ft
Wetted Perimeter, P=	6.92	feet
Hydraulic Radius, R=	0.60	feet
Shear stress on channel bottom, τ =	4.76	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=	0.0	fps

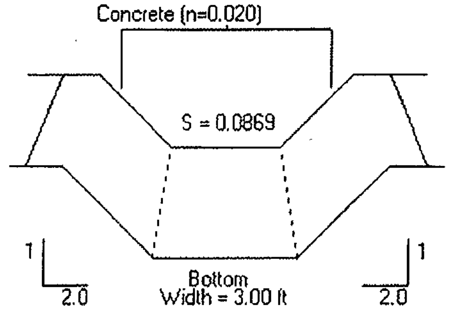
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/29/2011	09:16 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: TO STATION/REACH: CONCRETE	DRAINAGE AREA: Swale 21.5C	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
65.2	0.1	15.63	4.17	0.60	0.88



Not to Scale

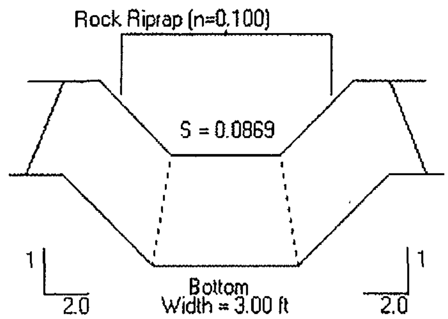
LINER RESULTS

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	Concrete	Unvegetated					N/A	4.76	N/A	STABLE

North American Green - ECMDS Version 4.3	8/29/2011	09:15 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: RIP RAP	DRAINAGE AREA: Swale 21.5C	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
65.2	0.1	4.81	13.54	1.15	1.96



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	Rock Riprap	Unvegetated					5.00	10.62	0.47	UNSTABLE
	15in									

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 21.5B TO SED BASIN 21**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JFM

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 21.5B

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	0.23	0.23		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0550	0.0550		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.2500		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.13**	**0.30**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.87	1.70		feet
Calculated Velocity, V=	0.55	0.21		fps
Flow Top Width, T=	3.51	4.19		feet
Flow Area, A=	0.42	1.07		sq ft
Wetted Perimeter, P=	3.57	4.33		feet
Hydraulic Radius, R=	0.12	0.25		feet
Shear stress on channel bottom, τ =	0.44	1.02		lbs/sf
Critical Slope, S_c=	0.0916	1.4979		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

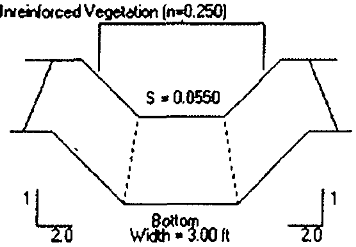
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	04:16 PM	COMPUTED BY: JMO
PROJECT NAME: PPL 8BNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH: / TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.58	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.2	0.1	0.38	0.53	0.14	0.16



Not to Scale

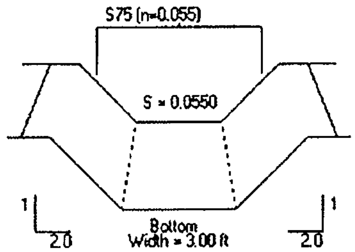
LINER RESULTS

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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.55	7.70	STABLE
		Soil	Sandy Loam				0.035	0.001	33.01	STABLE

North American Green - ECMDS Version 4.3		8/25/2011 04:18 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 21.58	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
0.2	0.1	0.93	0.20	0.06	0.06



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	6.98	STABLE
	Staple D									

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 21.5A TO SED BASIN 21**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 21.5A

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	61.29	61.29		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0500	0.0500		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0280	0.0420		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.17**	**1.43**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.83	0.57		feet
Calculated Velocity, V=	9.85	7.32		fps
Flow Top Width, T=	7.67	8.71		feet
Flow Area, A=	6.22	8.37		sq ft
Wetted Perimeter, P=	8.22	9.39		feet
Hydraulic Radius, R=	0.76	0.89		feet
Shear stress on channel bottom, τ =	3.64	4.46		lbs/sf
Critical Slope, S_c=	0.0134	0.0288		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

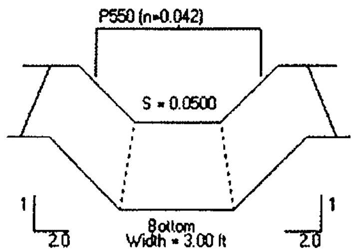
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3	8/25/2011	04:15 PM	COMPUTED BY: JMO	
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.5A	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
61.3	0.1	7.34	8.36	0.89	1.43



Not to Scale

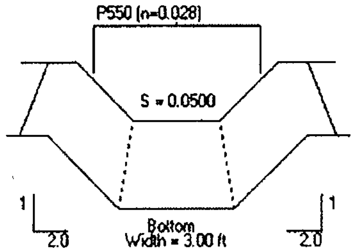
LINER RESULTS

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	P550	Vegetation	3	C	Bunch	75-95%	14.00	4.45	3.14	STABLE
	Staple E	Soil	Sandy Loam				3.250	0.711	4.57	STABLE

North American Green - ECMDS Version 4.3	8/25/2011	04:12 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 21.5A	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
61.3	0.1	9.75	6.28	0.76	1.17



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	P550	Unvegetated	1				4.00	3.67	1.09	STABLE
	Staple E									

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

Client/Subject: PPL Bell Bend
Description: **SWALE 21.4 TO SED BASIN 21**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JFM

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 21.4

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	13.32	13.32		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0800	0.0800		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0390	0.0600		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.55**	**0.69**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.45	1.31		feet
Calculated Velocity, V=	5.94	4.38		fps
Flow Top Width, T=	5.19	5.77		feet
Flow Area, A=	2.24	3.04		sq ft
Wetted Perimeter, P=	5.45	6.10		feet
Hydraulic Radius, R=	0.41	0.50		feet
Shear stress on channel bottom, τ =	2.74	3.46		lbs/sf
Critical Slope, S_c=	0.0313	0.0698		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	no		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

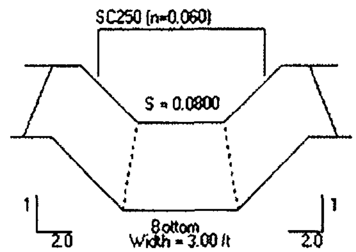
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMOS Version 4.3		8/25/2011 04:05 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.4	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
13.3	0.1	4.39	3.03	0.50	0.69



Not to Scale

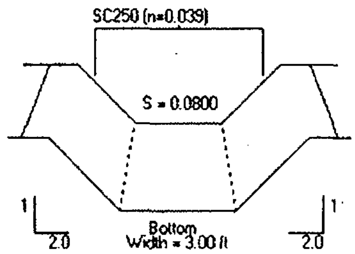
LINER RESULTS

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	SC250	Vegetation	3	C	Bunch	75-95%	10.00	3.45	2.90	STABLE
	Staple E	Soil	Sandy Loam				0.800	0.629	1.27	STABLE

North American Green - ECMDS Version 4.3	8/25/2011	04:04 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 21.4	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
13.3	0.1	5.94	2.24	0.41	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	SC250	Unvegetated	1				3.00	2.73	1.10	STABLE
	Staple E									

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 21.3 TO SED BASIN 21**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by:
JFM

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 21.3	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	20.23	20.23		cfs
Left Side Slope =	3.0	3.0		H:1V
Right Side Slope =	3.0	3.0		H:1V
Base width of Channel, b=	2.0	2.0		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	3.00	3.00		feet
(OPTIONAL) Input Manning's 'n':	0.0390	0.0670		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.20**	**1.53**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.80	1.47		feet
Calculated Velocity, V=	3.00	2.00		fps
Flow Top Width, T=	9.22	11.19		feet
Flow Area, A=	6.74	10.10		sq ft
Wetted Perimeter, P=	9.61	11.69		feet
Hydraulic Radius, R=	0.70	0.86		feet
Shear stress on channel bottom, τ =	0.75	0.96		lbs/sf
Critical Slope, S_c=	0.0260	0.0717		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

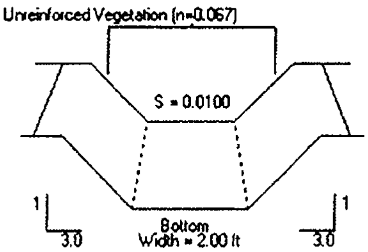
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/25/2011 04:00 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902	
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.3	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
20.2	0.1	2.00	10.10	0.86	1.53



Not to Scale

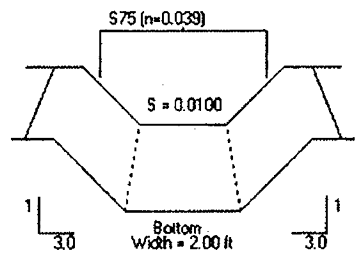
LINER RESULTS

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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.96	4.39	STABLE
		Soil	Sandy Loam				0.035	0.026	1.37	STABLE

North American Green - ECMDS Version 4.3	8/25/2011	04:01 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 21.3	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
20.2	0.1	3.00	6.73	0.70	1.20



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	2.07	STABLE
	Staple D									

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

Client/Subject: **PPL Bell Bend**
Description: **SWALE 21.2 TO SED BASIN 21**
Prepared by: **JMO**
Date: **15 Sep 11**

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 21.2

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	22.30	22.30		cfs
Left Side Slope =	3.0	3.0		H:1V
Right Side Slope =	3.0	3.0		H:1V
Base width of Channel, b=	3.0	3.0		feet
Bed slope, s=	0.0100	0.0100		ft/ft
Available depth of channel:	2.00	2.00		feet
(OPTIONAL) Input Manning's 'n':	0.0400	0.0660		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**1.16**	**1.46**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.84	0.54		feet
Calculated Velocity, V=	2.98	2.06		fps
Flow Top Width, T=	9.93	11.78		feet
Flow Area, A=	7.47	10.81		sq ft
Wetted Perimeter, P=	10.31	12.25		feet
Hydraulic Radius, R=	0.72	0.88		feet
Shear stress on channel bottom, τ =	0.72	0.91		lbs/sf
Critical Slope, S_c=	0.0269	0.0688		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

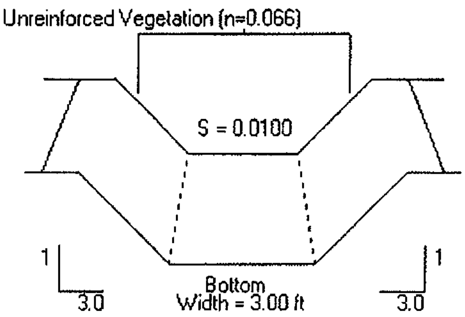
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/29/2011	09:13 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: Swale 21.2		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
22.3	0.1	2.07	10.77	0.88	1.46



Not to Scale

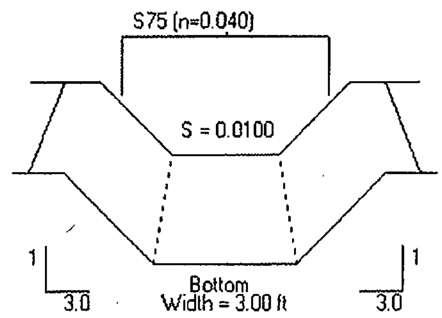
LINER RESULTS

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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	0.91	4.61	STABLE
		Soil	Sandy Loam				0.035	0.025	1.37	STABLE

North American Green - ECMDS Version 4.3		8/29/2011	09:14 AM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNPP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: Swale 21.2		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
22.3	0.1	2.99	7.47	0.72	1.16



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	0.72	2.15	STABLE
	Staple D									

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

Client/Subject: PPL Bell Bend
Description: SWALE 21.1 TO SED BASIN 21
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 21.1	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	3.65	3.65		cfs
Left Side Slope =	3.0	3.0		H:1V
Right Side Slope =	3.0	3.0		H:1V
Base width of Channel, b=	2.0	2.0		feet
Bed slope, s=	0.0400	0.0400		ft/ft
Available depth of channel:	1.50	1.50		feet
(OPTIONAL) Input Manning's 'n':	0.0550	0.1060		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.45**	**0.63**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	1.05	0.87		feet
Calculated Velocity, V=	2.42	1.48		fps
Flow Top Width, T=	4.70	5.80		feet
Flow Area, A=	1.51	2.47		sq ft
Wetted Perimeter, P=	4.85	6.00		feet
Hydraulic Radius, R=	0.31	0.41		feet
Shear stress on channel bottom, τ =	1.12	1.58		lbs/sf
Critical Slope, S_c=	0.0670	0.2278		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

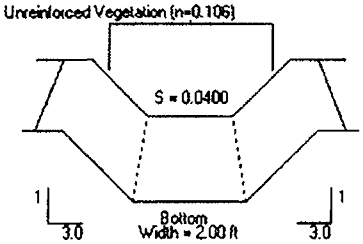
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/25/2011	03:56 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 21.1		DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.7	0.1	1.53	2.41	0.41	0.62



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	Unreinforced	Vegetation		C	Bunch	75-95%	4.20	1.56	2.70	STABLE
		Soil	Sandy Loam				0.035	0.017	2.09	STABLE

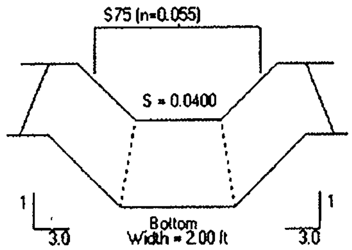
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:57 PM | COMPUTED BY: JMO

PROJECT NAME: PPL BBNNP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: ES SWALE 21.1 | DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
3.7	0.1	2.47	1.50	0.31	0.45



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	1.12	1.39	STABLE
	Staple D									

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

Client/Subject: PPL Bell Bend
Description: SWALE 15A.1 TO SED BASIN 15A
Prepared by: JMO
Date: 15 Sep 11

Print Date: 6 Sep 11 11:18 AM
Project #: PPLS0902

Checked by: JFM

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 15A.1

	Bare - Velocity Check	Grass - Velocity Check	Grass - Capacity Check	
Discharge, Q=	12.20	12.20		cfs
Left Side Slope =	2.0	2.0		H:1V
Right Side Slope =	2.0	2.0		H:1V
Base width of Channel, b=	2.0	2.0		feet
Bed slope, s=	0.0930	0.0930		ft/ft
Available depth of channel:	1.50	1.50		feet
(OPTIONAL) Input Manning's 'n':	0.0390	0.0590		
Lining Type:				

Calculate Flow Depth:

Flow depth, d=	**0.60**	**0.74**		**feet**

Calculated Results:

Design Acceptable?	V too high	V too high		
Freeboard, f=	0.90	0.76		feet
Calculated Velocity, V=	6.36	4.72		fps
Flow Top Width, T=	4.40	4.97		feet
Flow Area, A=	1.92	2.58		sq ft
Wetted Perimeter, P=	4.68	5.32		feet
Hydraulic Radius, R=	0.41	0.49		feet
Shear stress on channel bottom, τ =	3.48	4.31		lbs/sf
Critical Slope, S_c=	0.0317	0.0690		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes	yes		
Required Freeboard=	0.5	0.5		feet
Allowable Velocity for Lining Material=	0.0			fps

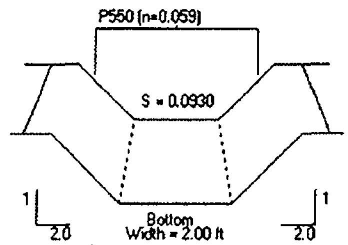
Conclusions

A temporary erosion control blanket (ECB) is needed.

North American Green - ECMDS Version 4.3		8/25/2011	03:54 PM	COMPUTED BY: JMO
PROJECT NAME: PPL 88NNP		PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: VEG	DRAINAGE AREA: ES SWALE 15A.1	DESIGN FREQUENCY: 2.25 CFS	

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.2	0.1	4.75	2.57	0.48	0.74



Not to Scale

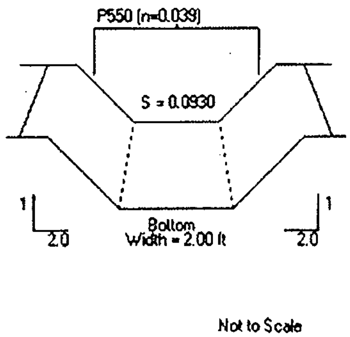
LINER RESULTS

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	P550	Vegetation	3	C	Bunch	75-95%	14.00	4.29	3.27	STABLE
	Staple E	Soil	Sandy Loam				3.250	0.827	3.93	STABLE

North American Green - ECMDS Version 4.3	8/25/2011	03:53 PM	COMPUTED BY: JMO
PROJECT NAME: PPL BBNNP	PROJECT NO.: PPLS0902		
FROM STATION/REACH:	TO STATION/REACH: UNVEG	DRAINAGE AREA: ES SWALE 15A.1	DESIGN FREQUENCY: 2.25 CFS

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft)	Hydraulic Radius(ft)	Normal Depth (ft)
12.2	0.1	6.38	1.91	0.41	0.60



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	P550	Unvegetated	1				4.00	3.47	1.15	STABLE
	Staple E									