# 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 0.73 | 0.91 | | 0.73 | 0.91 |
| $\tau_a$ (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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 1.20 | 1.61 | | 1.03 | 1.26 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | 3.00 | 10.00 | | 1.55 | 4.20 |

* Slopes may not be averaged.
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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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 0.70 | 0.88 | | 1.24 | 1.63 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | 1.55 | 4.20 | | 1.55 | 4.20 |

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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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 2.82 | | | 1.21 | 1.44 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | N/A | | | 1.55 | 4.20 |

* Slopes may not be averaged.
** For vegetated channels, provide data for temporary linings and vegetated conditions in separate columns.
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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 | 10.2D | | | 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 4.26 | | | 1.31 | 1.76 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | N/A | | | 3.00 | 10.00 |

* Slopes may not be averaged.
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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 | 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 1.35 | 1.81 | | 0.26 | 0.43 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | 3.00 | 10.00 | | 1.55 | 4.20 |

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PROJECT NAME: PPL Bell Bend, PPLS0902
LOCATION: Salem Township
PREPARED BY: JMO DATE: 09/15/11
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| 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 0.66 | 0.84 | | 0.65 | 0.82 |
| $\tau_a$ (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 | 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 2.92 | | | 3.47 | 4.29 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | N/A | | | 4.00 | 14.00 |

* 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 | 21.1 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 1.12 | 1.56 | | 0.72 | 0.91 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | 1.55 | 4.20 | | 1.55 | 4.20 |

* Slopes may not be averaged.
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## 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 | 21.3 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 0.75 | 0.96 | | 2.73 | 3.45 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | 1.55 | 4.20 | | 3.00 | 10.00 |

* Slopes may not be averaged.
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# 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 | 21.5A 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 3.67 | 4.45 | | 0.22 | 0.55 |
| $\tau_a$ (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.
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## 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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 4.76 | | | 1.54 | 2.20 |
| $\tau_a$ (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 |
| $\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$ | 1.71 | 2.33 | | 0.93 | 1.18 |
| $\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$ | 3.00 | 10.00 | | 3.00 | 10.00 |

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## 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 | | | | |
| **$\tau_d$ (SHEAR STRESS AT FLOW DEPTH d) LB/FT$^2$** | 11.07 | | | | |
| **$\tau_a$ (MAX ALLOWABLE SHEAR STRESS) LB/FT$^2$** | N/A | | | | |

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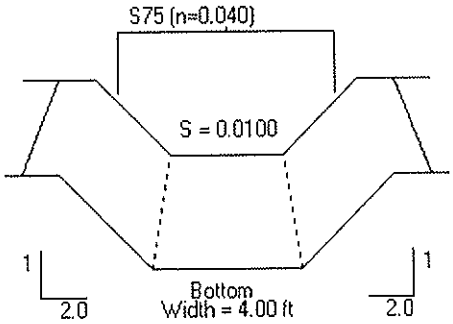
**** Permissible velocity lining design method is not acceptable for channels with a bed slope of 10% or greater. Shear stress lining design method is recommended for channels with a bed slope of 10% or greater. Shear stress lining design method may be used for any channel bed slope.

| | | | |
|---|---|---|---|
| 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

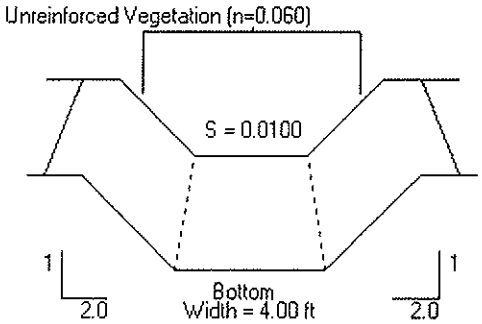
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | - | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.73 | 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 | | | | 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 | 4.63 | 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

Checked by: JFM

Print Date: 6 Sep 11 11:18 AM
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 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, $\tau$ = | 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 |

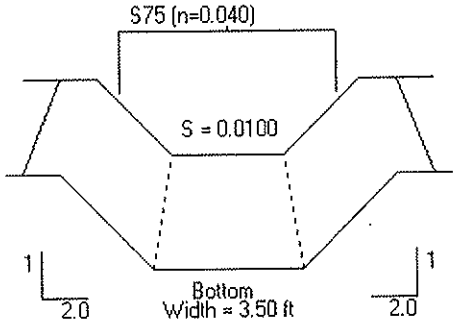
**Conclusions**

**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

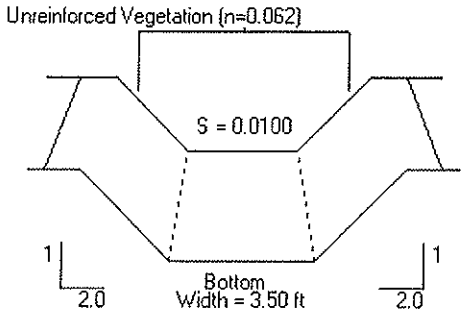
## LINER RESULTS

| Reach | Matting Type / Staple Pattern | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| 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 |




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 | 4.62 | 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

Checked by: JFM

Print Date: 6 Sep 11 11:18 AM
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 6.1A | 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, $\tau$ = | 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 |

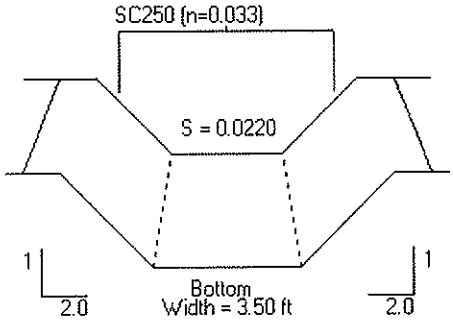
**Conclusions**

**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

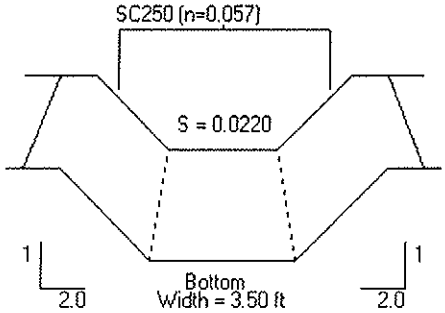
## LINER RESULTS

| Reach | Matting Type | 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 | 1.20 | 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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

Checked by: JFM

Print Date: 6 Sep 11 11:18 AM
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 6.1 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, $\tau$ = | 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 |

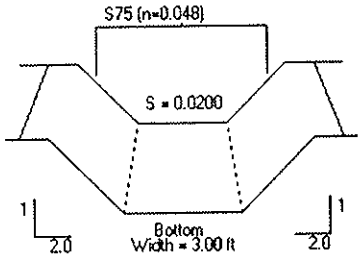
**Conclusions**

**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

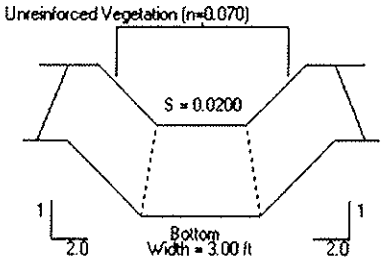
## LINER RESULTS

| Reach | Matting Type / Staple Pattern | Stability Analysis | Vegetation Characteristics: Phase | Class | Type | Density | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 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: JMD |
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | 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, $\tau$ = | 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.**

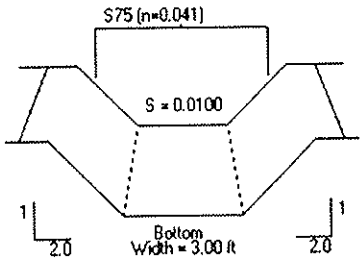
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:30 PM | COMPUTED BY: JMO

PROJECT NAME: PPL BBNNP | PROJECT NO.: PPLS0902

FROM STATION/REACH: | TO STATION/REACH: UNVEG | DRAINAGE AREA: ES SWALE 10.1B | DESIGN FREQUENCY: 2.25 CFS

## HYDRAULIC RESULTS

| Discharge (cfs) | Peak Flow Period (hrs) | Velocity (fps) | Area (sq.ft) | Hydraulic Radius(ft) | Normal Depth (ft) |
|---|---|---|---|---|---|
| 17.1 | 0.1 | 2.93 | 5.83 | 0.73 | 1.11 |




Not to Scale

## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.70 | 2.23 | STABLE |
| | Staple D | | | | | | | | | |

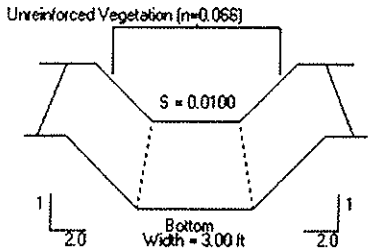
North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:29 PM | COMPUTED BY: JMO

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 |




## LINER RESULTS

Not to Scale

| Reach | Matting Type / Staple Pattern | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| Straight | 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, $\tau$ = | 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 |

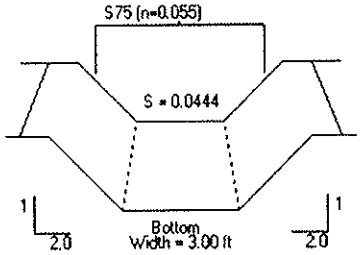
**Conclusions**

**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

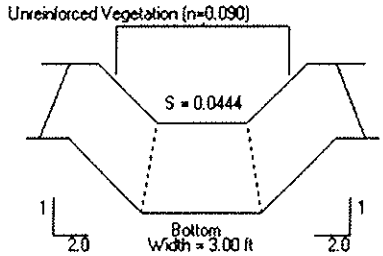
## LINER RESULTS

| 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 B8NNP | 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

Checked by: JML

Print Date: 6 Sep 11 11:18 AM
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 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, $\tau$ = | 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 |

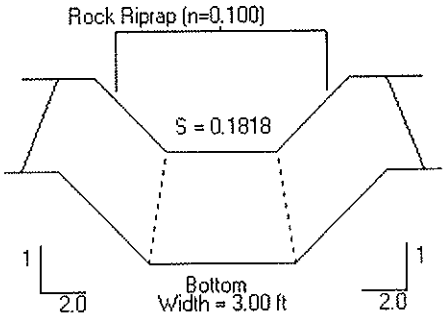
**Conclusions**

**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

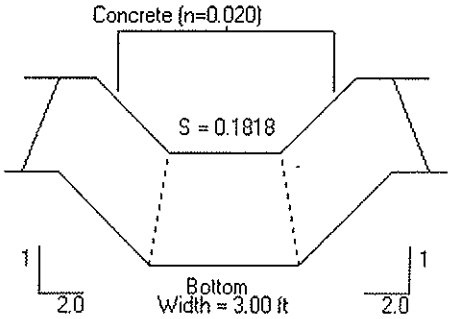
## LINER RESULTS

| Reach | Matting Type / Staple Pattern | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | - | 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, $\tau$ = | 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 |

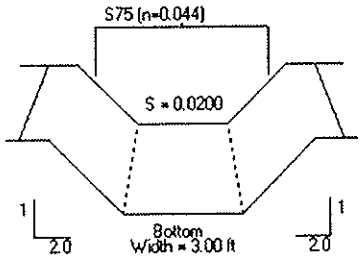
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:36 PM | COMPUTED BY: JMO |
| 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

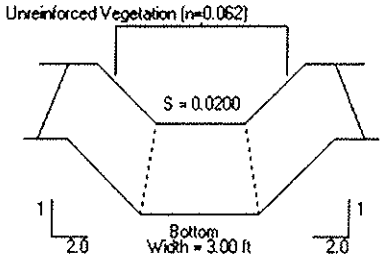
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 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 | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| 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, $\tau$ = | 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 |

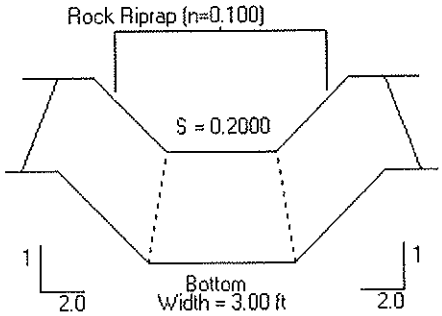
**Conclusions**

**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

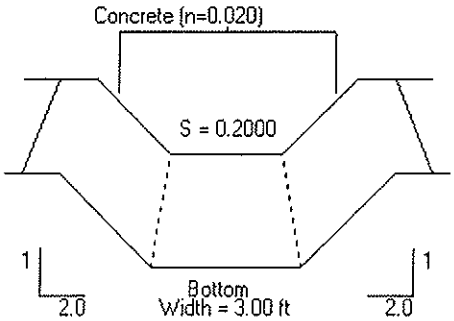
## LINER RESULTS

| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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, $\tau$ = | | 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 |

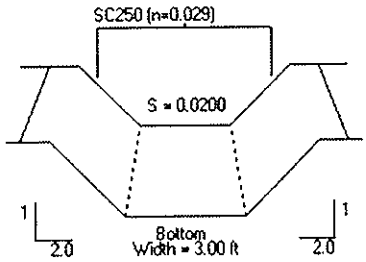
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:39 PM | COMPUTED BY: JMO |
| 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

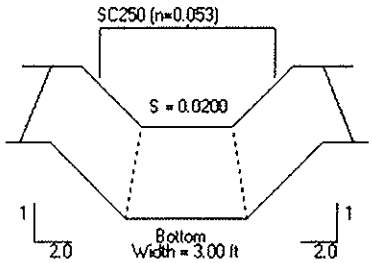
## LINER RESULTS

| Reach | Matting Type | 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 | 1.31 | 2.29 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:40 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL BBNNP | 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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
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/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, $\tau$ = | 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 |

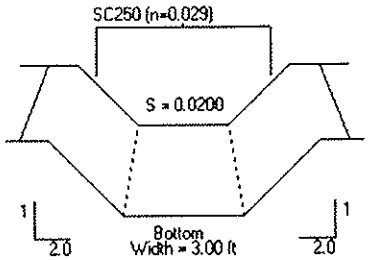
**Conclusions**

**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

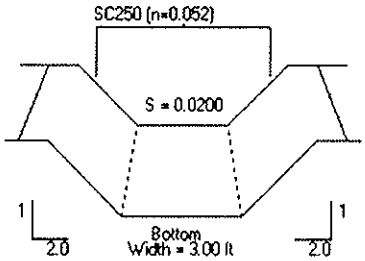
## LINER RESULTS

| Reach | Matting Type | 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 | 1.35 | 2.23 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:44 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL BBNNP | | 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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, $\tau$ = | 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 |

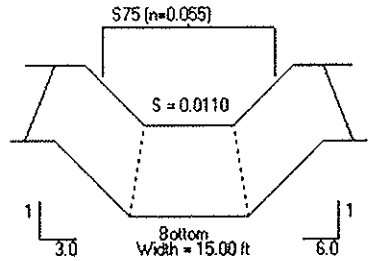
**Conclusions**

**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 88NNP | 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

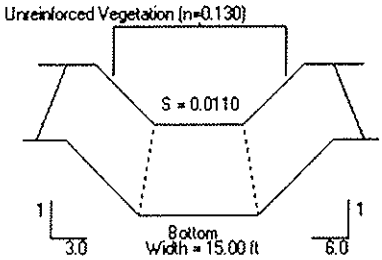
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.26 | 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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, $\tau$ = | 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 |

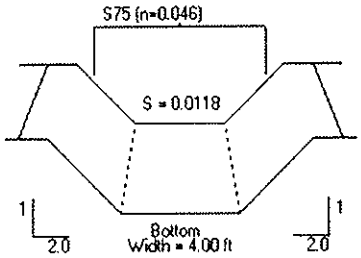
**Conclusions**

**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

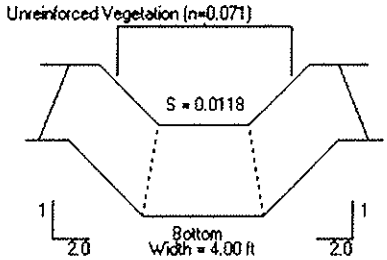
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.66 | 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | 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, $\tau$ = | 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 |

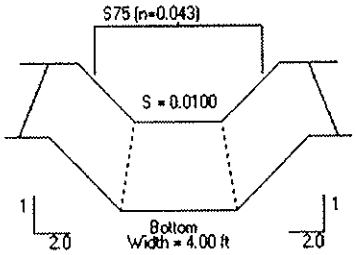
**Conclusions**

**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

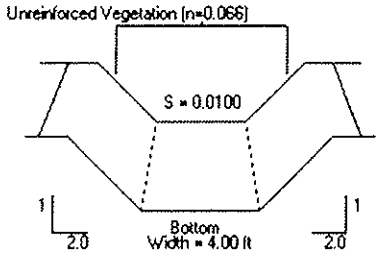
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.65 | 2.38 | STABLE |
| | Staple D | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:50 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL BBNNP | PROJECT NO.: PPLS0902 | | |
| FROM STATION/REACH: | TO STATION/REACH: VEG | DRAINAGE AREA: ES SWALE 12.2B | DESIGN FREQUENCY: 2.25 CFS |

## HYDRAULIC RESULTS

| Discharge (cfs) | Peak Flow Period (hrs) | Velocity (fps) | Area (sq.ft) | Hydraulic Radius(ft) | Normal Depth (ft) |
|---|---|---|---|---|---|
| 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, $\tau$ = | 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 |

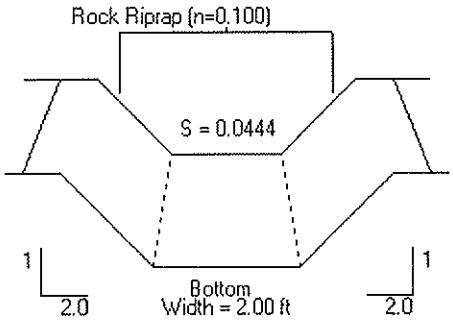
**Conclusions**

**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

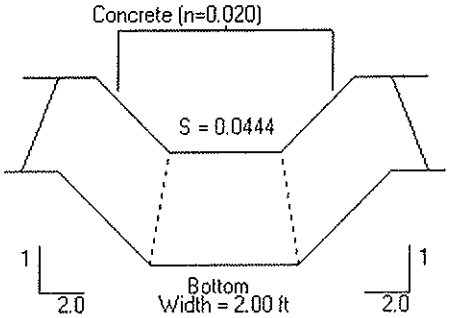
## LINER RESULTS

| Reach | Matting Type / Staple Pattern | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| 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.: PPLS0902 | |
| 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 | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| 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, $\tau$ = | | 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 |

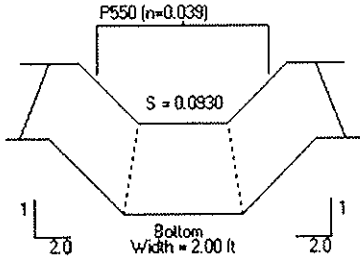
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| 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 |




Not to Scale

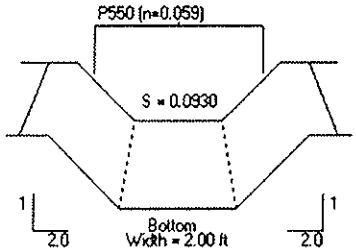
## LINER RESULTS

| 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 | P550 | Unvegetated | 1 | | | | 4.00 | 3.47 | 1.15 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:54 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL BBNNP | 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 / 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 | 4.29 | 3.27 | STABLE |
| | Staple E | Soil | Sandy Loam | | | | 3.250 | 0.827 | 3.93 | STABLE |

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, $\tau$ = | 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 |

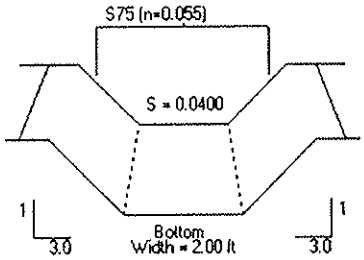
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 03:57 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

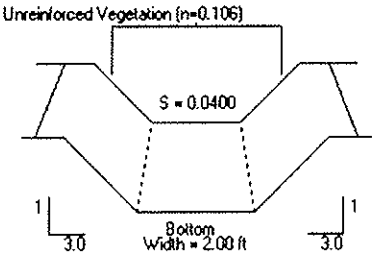
| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 1.12 | 1.39 | STABLE |
| | Staple D | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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 |

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 | 1.56 | 2.70 | STABLE |
| | | Soil | Sandy Loam | | | | 0.035 | 0.017 | 2.09 | STABLE |

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, $\tau$ = | 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 |

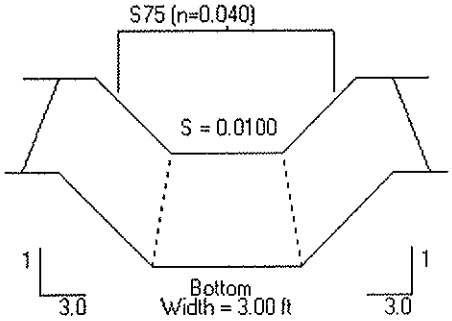
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/29/2011 | 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

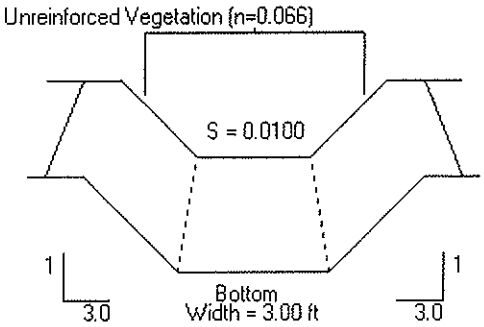
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.72 | 2.15 | STABLE |
| | Staple D | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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: 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 | 4.61 | 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: **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, $\tau$ = | 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 |

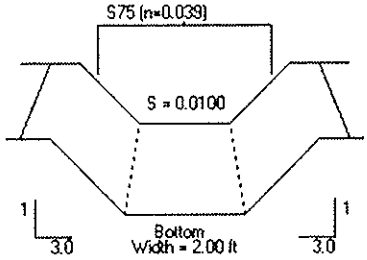
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:01 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL B8NNP | 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

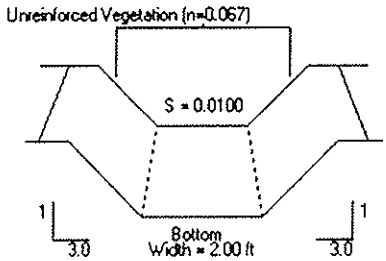
## LINER RESULTS

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

| | | | |
|---|---|---|---|
| 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 | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| Straight | Unreinforced | Vegetation | | C | Bunch | 75-95% | 4.20 | 0.96 | 4.39 | STABLE |
| | | Soil | Sandy Loam | | | | 0.035 | 0.026 | 1.37 | STABLE |

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, $\tau$ = | 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 |

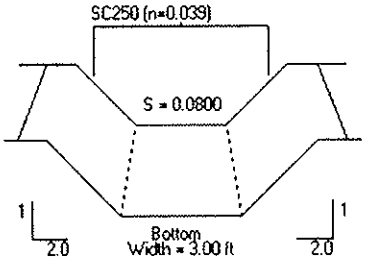
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:04 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

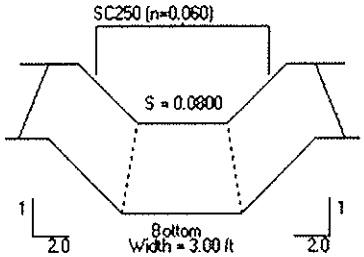
## LINER RESULTS

| Reach | Matting Type | 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 | 2.73 | 1.10 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | 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 |

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, $\tau$ = | 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 |

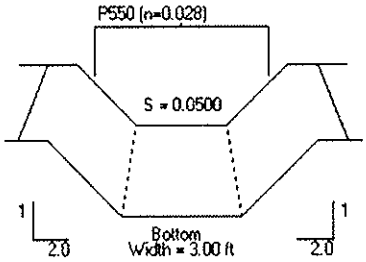
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - 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

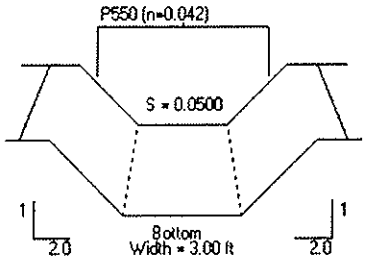
## LINER RESULTS

| Reach | Matting Type / Staple Pattern | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase | Class | Type | Density | | | | |
| Straight | P550 | Unvegetated | 1 | | | | 4.00 | 3.67 | 1.09 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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 | 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 | 4.45 | 3.14 | STABLE |
| | Staple E | Soil | Sandy Loam | | | | 3.250 | 0.711 | 4.57 | STABLE |

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, $\tau$ = | 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 |

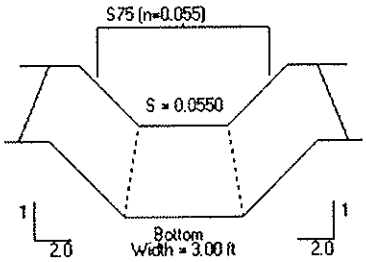
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:18 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 | 0.99 | 0.20 | 0.06 | 0.06 |




Not to Scale

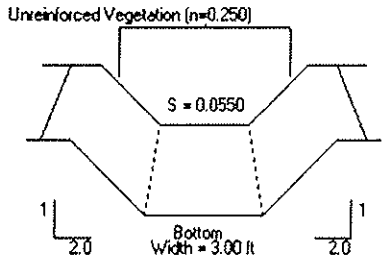
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | S75 | Unvegetated | | | | | 1.55 | 0.22 | 6.98 | STABLE |
| | Staple D | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:16 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL BBNNP | 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: 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 | 7.70 | STABLE |
| | | Soil | Sandy Loam | | | | 0.035 | 0.001 | 33.01 | STABLE |

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, $\tau$ = | 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 |

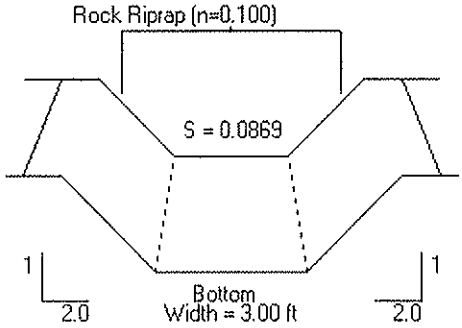
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/29/2011 | 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

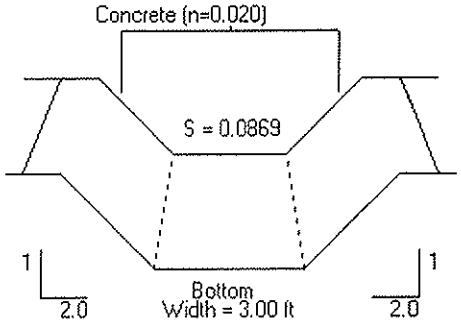
## LINER RESULTS

| 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 | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | Concrete | Unvegetated | | | | | N/A | 4.76 | N/A | STABLE |
| | | | | | | | | | | |

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, $\tau$ = | | 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 |

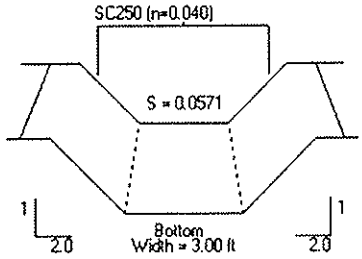
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:20 PM | COMPUTED BY: JMO |
| PROJECT NAME: PPL 88NNP | 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

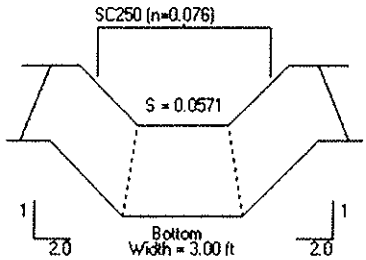
## LINER RESULTS

| Reach | Matting Type | 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 | 1.54 | 1.95 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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 |

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

Checked by: JFM

Print Date: 6 Sep 11 11:18 AM
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 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, $\tau$ = | 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 |

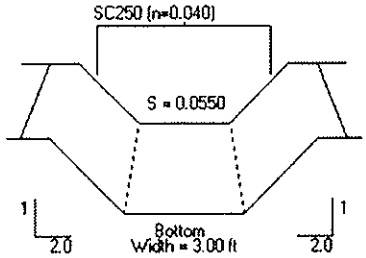
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:25 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

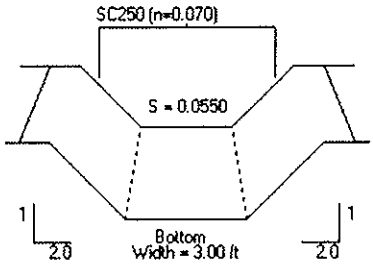
## LINER RESULTS

| Reach | Matting Type | 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 | 1.71 | 1.76 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/25/2011 | 04:26 PM | COMPUTED BY: JMO |
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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 |

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, $\tau$ = | 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 |

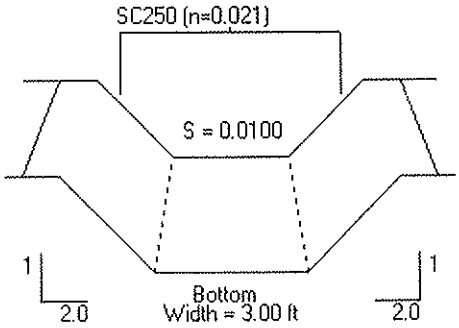
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/29/2011 | 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

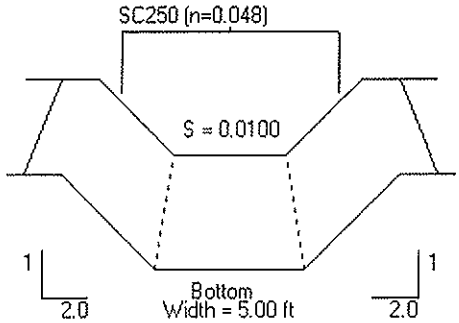
## LINER RESULTS

| Reach | Matting Type | 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 | 0.93 | 3.24 | STABLE |
| | Staple E | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| 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 |

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

Checked by: JFM

Print Date: 6 Sep 11 11:18 AM
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 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, $\tau$ = | 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 |

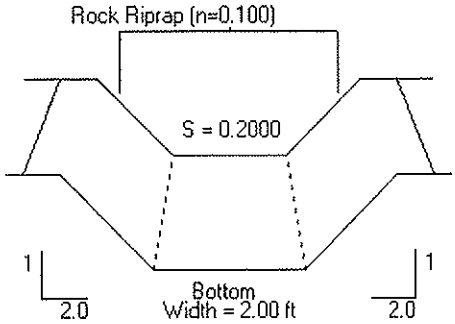
**Conclusions**

**A temporary erosion control blanket (ECB) is needed.**

| | | | |
|---|---|---|---|
| North American Green - ECMDS Version 4.3 | 8/29/2011 | 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

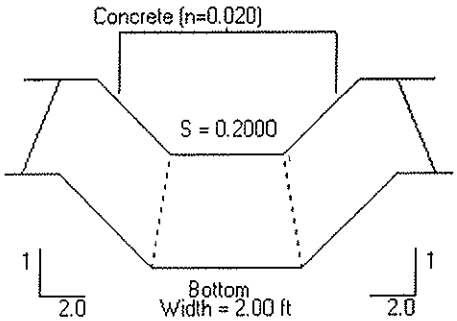
## LINER RESULTS

| Reach | Matting Type | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | Rock Riprap | Unvegetated | | | | | 5.00 | 23.71 | 0.21 | UNSTABLE |
| | 15in | | | | | | | | | |

| | | | |
|---|---|---|---|
| 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 | Stability Analysis | Vegetation Characteristics | | | | Permissible Shear Stress (psf) | Calculated Shear Stress (psf) | Safety Factor | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Staple Pattern | | Phase | Class | Type | Density | | | | |
| Straight | Concrete | Unvegetated | | | | | N/A | 11.07 | N/A | STABLE |
| | | | | | | | | | | |

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, $\tau$ = | 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.**