

\_\_\_\_ Project No. \_\_\_\_

date designer initials

**Project name**

**Energy Dissipator Calculations** CSU Rigid Boundary Type

| Discharge<br>(2-barrels) | Depth    | Velocity     | Flow<br>Area | Froude<br>Number | Width<br>Ratio | Width<br>Ratio | Block<br>Width | Height<br>Ratio | Length<br>Ratio | Length  | Block<br>Height | Number<br>Rows | Number<br>Elements | Drag<br>Coef | Approach<br>Depth | Approach<br>Velocity | Momentum<br>Coef | Frontal<br>Area | Basin<br>Length | From<br>Equation | From<br>Table | Tailwater<br>Velocity | Tailwater<br>Depth | Flow<br>Area | Channel<br>Width |
|--------------------------|----------|--------------|--------------|------------------|----------------|----------------|----------------|-----------------|-----------------|---------|-----------------|----------------|--------------------|--------------|-------------------|----------------------|------------------|-----------------|-----------------|------------------|---------------|-----------------------|--------------------|--------------|------------------|
| Q<br>cfs                 | Yo<br>ft | Vo<br>ft/sec | a<br>sq ft   | Fr               | WB/Wo          | W1/Wo          | W1<br>ft       | h/Ya            | L/h             | L<br>ft | h<br>ft         | Nr             | N                  | Cb           | Ya<br>ft          | Va<br>ft/sec         | Cp               | Af<br>ft^2      | Lb<br>ft        | CbAfN            | CbAfN         | Vb<br>ft/sec          | Yb<br>ft           | Ab<br>ft^2   | Wb<br>ft         |
| (1)                      | (2)      | (3)          | (4)          | (5)              | (6)            | (7)            | (8)            | (9)             | (10)            | (11)    | (12)            | (13)           | (14)               | (15)         | (16)              | (17)                 | (18)             | (19)            | (20)            | (21)             | (22)          | (23)                  | (24)               | (25)         | (26)             |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.91            | 6               | 3.31    | 0.55            | 4              | 14                 | 0.21         | 0.61              | 15.01                | 0.3              | 7.72            | 63.24           | 62.91            | 22.70         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.71            | 6               | 2.58    | 0.43            | 4              | 14                 | 0.29         | 0.61              | 15.01                | 0.3              | 6.02            | 60.33           | 62.91            | 24.46         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.31            | 6               | 1.13    | 0.19            | 4              | 14                 | 0.38         | 0.61              | 15.01                | 0.3              | 2.63            | 54.51           | 62.91            | 13.99         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.48            | 12              | 3.49    | 0.29            | 4              | 14                 | 0.45         | 0.61              | 15.01                | 0.3              | 4.07            | 63.96           | 62.91            | 25.66         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.37            | 12              | 2.69    | 0.22            | 4              | 14                 | 0.52         | 0.61              | 15.01                | 0.3              | 3.14            | 60.76           | 62.91            | 22.85         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.91            | 6               | 3.31    | 0.55            | 5              | 17                 | 0.20         | 0.61              | 15.01                | 0.3              | 7.72            | 66.54           | 62.91            | 26.25         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.71            | 6               | 2.58    | 0.43            | 5              | 17                 | 0.27         | 0.61              | 15.01                | 0.3              | 6.02            | 62.91           | 62.91            | 27.65         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.31            | 6               | 1.13    | 0.19            | 5              | 17                 | 0.36         | 0.61              | 15.01                | 0.3              | 2.63            | 55.64           | 62.91            | 16.10         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.48            | 12              | 3.49    | 0.29            | 5              | 17                 | 0.42         | 0.61              | 15.01                | 0.3              | 4.07            | 67.45           | 62.91            | 29.08         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.37            | 12              | 2.69    | 0.22            | 5              | 17                 | 0.50         | 0.61              | 15.01                | 0.3              | 3.14            | 63.45           | 62.91            | 26.68         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.91            | 6               | 3.31    | 0.55            | 6              | 21                 | 0.48         | 0.61              | 15.01                | 0.3              | 7.72            | 69.85           | 62.91            | 77.82         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.71            | 6               | 2.58    | 0.43            | 6              | 21                 | 0.40         | 0.61              | 15.01                | 0.3              | 6.02            | 65.49           | 62.91            | 50.60         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.31            | 6               | 1.13    | 0.19            | 6              | 21                 | 0.34         | 0.61              | 15.01                | 0.3              | 2.63            | 56.76           | 62.91            | 18.78         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.48            | 12              | 3.49    | 0.29            | 6              | 21                 | 0.25         | 0.61              | 15.01                | 0.3              | 4.07            | 70.94           | 62.91            | 21.38         | 2.67                  | 5                  | 337.50       | 60               |
| 900                      | 5.05     | 10.57        | 80.60        | 0.83             | 2.40           | 0.57           | 14             | 0.37            | 12              | 2.69    | 0.22            | 6              | 21                 | 0.18         | 0.61              | 15.01                | 0.3              | 3.14            | 66.14           | 62.91            | 11.87         | 2.67                  | 5                  | 337.50       | 60               |

Design equations and criteria:

$$u_e = \frac{4}{7} + \left( \frac{10}{7} \right) \frac{L}{W_0}$$

$$\rho V_0 Q + C_p \gamma \left( \frac{Y_0^2}{2} \right) W_0 = C_B A_F N \rho \frac{V_A^2}{2} + \rho V_B Q + \frac{\gamma Q^2}{2 V_B^2 W_B}$$

$$F_r = \frac{V_o}{\sqrt{g Y_o}}$$

Variables and design data

Wo = 25

culverts are 2 barrel 120" diameter

bottom width of basin/channel is 60', maximum bottom width of structure is 40'

Ye = (a / 2)^.5

Ue = flare divergence recommend that 4 <= WB/Wo <= 8 recommend that WB = 100

CP = momentum correction coefficient for the pressure at the culvert outlet per fig VII-A-6

Yo, Vo and Wo are depth, velocity and culvert width at the culvert outlet

VA and YA = the approach velocity and depth at two culvert widths downstream of the culvert outlet

VB, WB = exit velocity and basin width just downstream of the last row of roughness elements

N = total number of roughness elements in the basin

Af = the frontal area of one full roughness element

CB = basin drag coefficient from fig VII-A-5

$\rho$  &  $\gamma$  = unit weight 62.4 lb/ft and density 1.94 lb-sec/ft of water, respectively

Recommended Design

Design Q = 900 cfs

L = 3.3

Lb = 70

h = 0.6

Nr = 6

N = 21

Comments