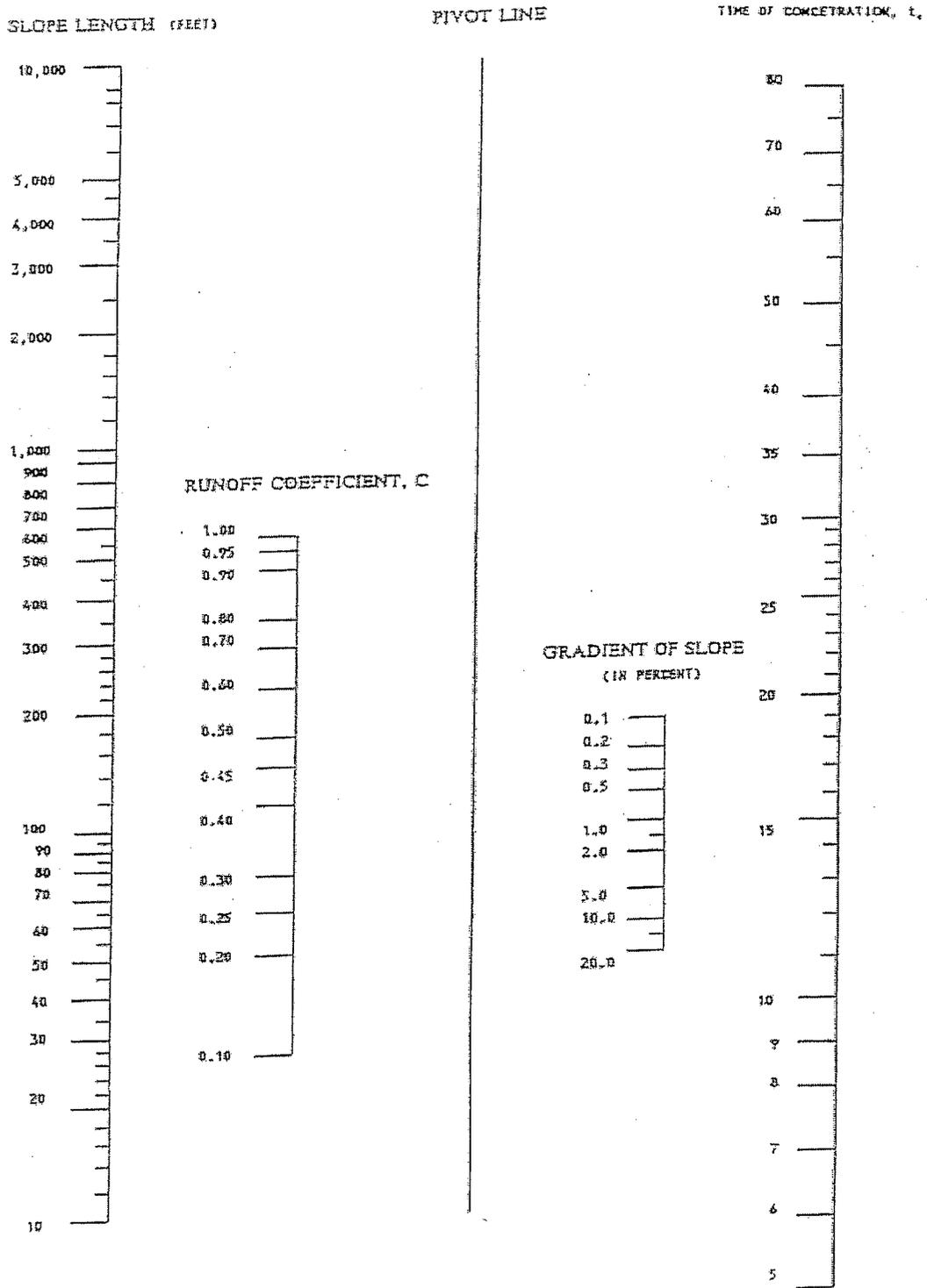


# OVERLAND FLOW CHART



Worksheet 2: Runoff curve number and runoff

Project \_\_\_\_\_ By \_\_\_\_\_ Date \_\_\_\_\_

Location \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

Circle one: Present      Developed \_\_\_\_\_

1. Runoff curve number (CN)

Soil name and hydrologic group (Appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN <sup>1/</sup>			Area <input type="checkbox"/> acres <input type="checkbox"/> mi <sup>2</sup> <input type="checkbox"/> %	Product of CN % area
		Table 2-2	Fig. 2-3	Fig. 2-4		
1/ Use only one CN source per line				Totals =		

CN (weighted) = total product/total area = \_\_\_\_\_ = \_\_\_\_\_; Use CN =

2. Runoff

Frequency.....yr

Rainfall, P (24-hour) .....in

Runoff, Q .....in  
(Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)

Storm #1	Storm #2	Storm #3

Worksheet 3: Time of concentration ( $T_c$ ) or travel time ( $T_t$ )

Project \_\_\_\_\_ By \_\_\_\_\_ Date \_\_\_\_\_

Location \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

Circle one: Present      Developed \_\_\_\_\_

Circle one:  $T_c$        $T_t$  \_\_\_\_\_

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (applicable to  $T_c$  only)

	Segment ID		
1. Surface description (table 3-1) .....			
2. Manning's roughness coeff., n (table 3-1).....			
3. Flow length, L (total L $\leq$ 300 ft) .....	ft		
4. Two-yr 24-hr rainfall, $P_2$ .....	in		
5. Land slope, s .....	ft/ft		
6. $T_t = 0.007(nL)^{0.8}/P_2^{0.5}s^{0.4}$ .....	Compute $T_t$ ...hr		
		+	
		=	

Shallow concentrated flow

	Segment ID		
7. Surface description. (paved or unpaved) .....			
8. Flow length, L .....	ft		
9. Watercourse slope, s .....	ft/ft		
10. Average velocity V (figure 3-1) .....	ft/s		
11. $T_t = L/360V$ .....	Compute $T_t$ .....hr		
		+	
		=	

Channel flow

	Segment ID		
12. Cross sectional flow area, a .....	ft <sup>2</sup>		
13. Wetted perimeter, $P_w$ .....	ft		
14. Hydraulic radius, $r = a/P_w$ Compute r .....	ft		
15. Channel slope, s .....	ft/ft		
16. Manning's roughness coeff., n .....			
17. $V = 1.49 r^{2/3} s^{1/2} / n$ .....	Compute V ..ft/s		
18. Flow length, L .....	ft		
19. $T_t = L/3600V$ .....	Compute $T_t$ ..... hr		
		+	
		=	
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11 and 19) .....			

Worksheet 4: Graphical Peak Discharge method

Project \_\_\_\_\_ By \_\_\_\_\_ Date \_\_\_\_\_

Location \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

Circle one: Present      Developed \_\_\_\_\_

1. Data:

Drainage area .....  $A_m =$  \_\_\_\_\_  $\text{mi}^2$  (acres/640)

Runoff curve number .....  $CN =$  \_\_\_\_\_ (From worksheet 2)

Time of concentration .....  $T_c =$  \_\_\_\_\_ hr (From worksheet 3)

Rainfall distribution type = \_\_\_\_\_ (I, II, III)

Pond and swamp areas spread throughout watershed..... = \_\_\_\_\_ percent of  $A_m$  (\_\_\_\_\_ acres or  $\text{mi}^2$  covered)

2. Frequency ..... yr

3. Rainfall, P (24-hour) ..... in

4. Initial abstraction,  $I_a$  ..... in  
(Use CN with table 4-1.)

5. Compute  $I_a/P$  .....

6. Unit peak discharge,  $q_u$  ..... csm/in  
(Use  $T_c$  and  $I_a/P$  with exhibit 4 - \_\_\_\_\_)

7. Runoff, Q ..... in  
(From worksheet 2).

8. Pond and swamp adjustment factor,  $F_p$  .....  
(Use percent pond and swamp area with table 4-2.  
Factor is 1.0 for zero percent pond and swamp area.)

9. Peak discharge,  $q_p$  ..... cfs  
(Where  $q_p = q_u A_m Q F_p$ )

Storm #1	Storm #2	Storm #3



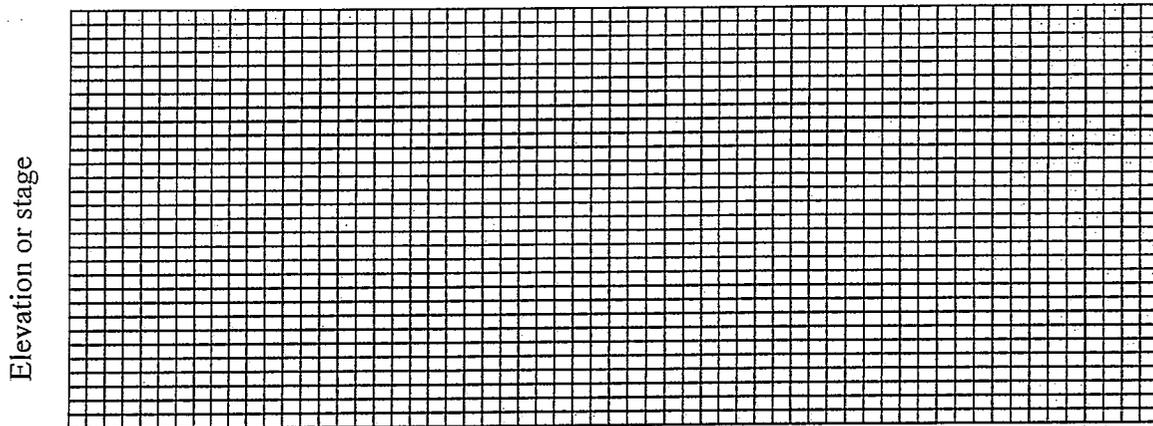


Worksheet 6a: Detention basin storage,  
peak outflow discharge ( $q_o$ ) known

Project \_\_\_\_\_ By \_\_\_\_\_ Date \_\_\_\_\_

Location \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

Circle one: Present Developed



Detention basin storage

1. Data:
  - Drainage area .....  $A_m =$  \_\_\_\_\_  $mi^2$
  - Rainfall distribution  
Type (I, IA, II, III) = \_\_\_\_\_
2. Frequency ..... yr
 

1 <sup>st</sup> stage	2 <sup>nd</sup> stage
3. Peak inflow discharge  
 $q_i$  ..... cfs  
(from worksheet 4 or 5b)
 

--	--
4. Peak outflow discharge,  
 $q_o$  ..... cfs
 

--	--
5. Compute  $q_o / q_i$  .....
 

--	--
6.  $V_s/V_r$  .....  
(Use  $q_o/q_i$  with figure 6-1)
 

--	--
7. Runoff, Q ..... in  
(From worksheet 2)
 

--	--
8. Runoff volume,  
 $V_r$  ..... ac-ft  
( $V_r = QA_m 53.33$ )
 

--	--
9. Storage volume,  
 $V_s$  ..... ac-ft  
( $V_s = V_r (V_s/V_r)$ )
 

--	--
10. Maximum stage ,  
(From plot)  $E_{max}$ 

--	--

1/ 2<sup>nd</sup> stage  $q_o$  includes 1<sup>st</sup> stage  $q_o$

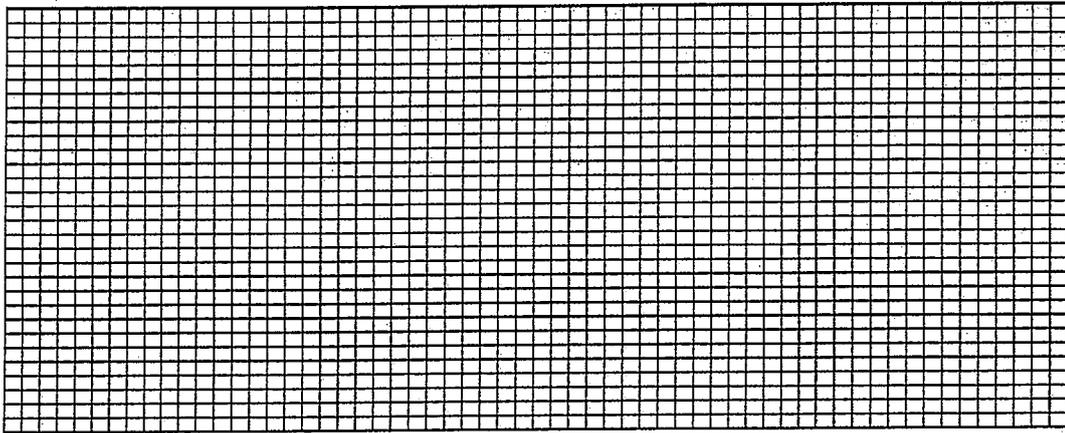
Appendix A – Exhibit II (8 of 8)  
 Worksheet 6b: Detention basin, peak outflow,  
 storage volume ( $V_s$ ) known

Project \_\_\_\_\_ By \_\_\_\_\_ Date \_\_\_\_\_

Location \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

Circle one: Present      Developed \_\_\_\_\_

Elevation or stage



Detention basin storage

1. Data:

Drainage area .....  
 Rainfall distribution  
 type (I, IA, II, III)

$A_m =$  \_\_\_\_\_  $mi^2$   
 = \_\_\_\_\_

1 <sup>st</sup> stage	2 <sup>nd</sup> stage
--------------------------	--------------------------

2. Frequency..... yr

--	--

3. Storage volume,  
 $V_s$ ..... ac ft

--	--

4. Runoff,  $Q$ ..... in  
 (From worksheet 2)

--	--

5. Runoff volume,  
 $V_r$ ..... ac ft  
 ( $V_r = QA_m 53.33$ )

--	--

6. Compute  $V_s/V_r$ .....

--	--

7.  $q_o/q_i$ ..... in  
 (Use  $V_s/V_r$  and figure 6-1)

--	--

8. Peak inflow discharge,  
 $q_i$ ..... cfs  
 (From worksheet 4 or 5b)

--	--

9. Peak outflow discharge,  
 $q_o$ ..... cfs  
 ( $q_o = q_i (q_o/q_i)$ )

--	--

10. Maximum stage,  
 $E_{max}$   
 (From plot)

--	--

1/ 2<sup>nd</sup> stage  $q_o$  includes 1<sup>st</sup> stage  $q_o$

Appendix A - Exhibit III (1 of 4)

DETENTION BASIN STORAGE DESIGN

I Calculate the peak flow in cfs due to the two year frequency storm under predeveloped conditions.

$$q_2 = A * C * i \quad (\text{allowable detention basin outflow release rate - stage one})$$

$$\text{Area, "A"} = [ \quad ] \text{ acres}$$

$$\text{Runoff Coefficient, "C"} = [ \quad ]$$

$$\text{Intensity, "i"} = a/(t_c + b) = [ \quad ] \text{ in/hr}$$

$$\text{Where:} \quad a = 106 \text{ (Table IV)}$$

$$b = 17 \text{ (Table IV)}$$

$t_c$  = time of concentration (minutes) as determined from Appendix C - Ex. I or other acceptable means.

$$q_2 = A [ \quad ] * C [ \quad ] * i [ \quad ] = [ \quad ] \text{ cfs}$$

II Calculation for the two year frequency storm under postdevelopment conditions.

$$Q_2 = A * C * i$$

$$\text{Area, "A"} = [ \quad ] \text{ acres}$$

$$\text{Runoff Coefficient, "C"} = [ \quad ]$$

$$\text{Intensity, "i"} = a/(t_c + b) = [ \quad ] \text{ in/hr}$$

$$\text{Where:} \quad a = 106$$

$$b = 17$$

$t_c$  = time of concentration (in minutes)

$$Q_2 = A [ \quad ] * C [ \quad ] * i [ \quad ] = [ \quad ] \text{ cfs}$$

III Critical storm calculation.

$$[(Q_2 / q_2) - 1.0] * 100 = PC \quad Pc = [ \quad ] \text{ (see Table II on page 29)}$$

IV Calculate maximum storm duration,  $T_{cr}$ , for the critical storm frequency (in minutes).

$$T_{cr} = \left[ \frac{(A * C * a * b)}{(2 * q_2 / 3) - [(q_2^2 * t_c) / (6 * C * A * a)]} \right]^{1/2} - b$$

Appendix A – Exhibit III (2 of 4)

Where:  $a$  = determined from Table IV (for critical storm frequency)

$b$  = determined from Table IV (for critical storm frequency)

$C$  = the two year postdeveloped weighted runoff coefficient

$A$  = area in acres

$$T_{ocr} = [ \text{_____} ] \text{ minutes}$$

IV Calculate  $I_{cr}$ :

$$I_{cr} = [ a / (T_{ocr} + b) ] = [ \text{_____} ] \text{ in/hr}$$

V Calculate  $Q_{cr}$ , flow at maximum duration for the critical storm frequency:

$$Q_{cr} = A [ \text{_____} ] * C [ \text{_____} ] * I_{cr} [ \text{_____} ] = [ \text{_____} ] \text{ cfs}$$

VI Calculate the required storage volume due to critical storm criteria,  $SV_{cr}$ :

$$SV_{cr} = (60 * Q_{cr} * T_{ocr}) - \{ [ 2 * q_2 * (T_{ocr} + t_c) * 60 ] / 3 \} + [ (q_2^2 * t_c * 60) / (6 * Q_{cr}) ]$$

$$SV_{cr} = [ \text{_____} ] \text{ ft}^3$$

VII Calculate the peak flow in cfs due to the one-hundred year frequency storm under predeveloped conditions.

$$q_{100} = A * C * i \text{ (allowable detention basin outflow release rate - stages one + two)}$$

$$\text{Area, "A"} = [ \text{_____} ] \text{ acres}$$

$$\text{Runoff Coefficient, "C"} = [ \text{_____} ]$$

$$\text{Intensity, "i"} = a / (t_c + b) = [ \text{_____} ] \text{ in/hr}$$

$$\text{Where: } a = 290 \text{ (Table IV)}$$

$$b = 31 \text{ (Table IV)}$$

$t_c$  = time of concentration (minutes) as determined from Appendix C - Ex. I, for predeveloped

$$q_{100} = A [ \text{_____} ] * C [ \text{_____} ] * i [ \text{_____} ] = [ \text{_____} ] \text{ cfs}$$

VII Calculate maximum storm duration  $T_{c100}$  for the one-hundred year frequency (in minutes) storm under postdeveloped conditions.

Appendix A – Exhibit III (3 of 4)

$$T_{c100} = \left[ \frac{(A * C * a * b)}{(2 * q_{100} / 3) - [(q_{100}^2 * t_c) / (6 * C * A * a)]} \right]^{1/2} - b$$

Where: a = 290

b = 31

c = the one-hundred year postdeveloped weighted runoff coefficient

A = area in acres

$$T_{c100} = [ \text{_____} ] \text{ minutes}$$

VIII Calculate  $I_{100}$ :

$$I_{100} = [a / (T_{c100} + b)] = [ \text{_____} ] \text{ in/hr}$$

IX Calculate  $Q_{100}$ ; the flow at maximum duration for the one-hundred year storm frequency.

$$Q_{100} = a [ \text{_____} ] * C [ \text{_____} ] * I_{100} [ \text{_____} ] = [ \text{_____} ] \text{ cfs}$$

X Calculate  $SV_{100}$ ; the storage volume required due to the one-hundred year storm.

$$SV_{100} = (60 * Q_{100} * T_{c100}) - \{ [ 2 * q_{100} * (T_{c100} + t_c) * 60 ] / 3 \} + [ (q_{100}^2 * t_c * 60 / (6 * Q_{100})) ]$$

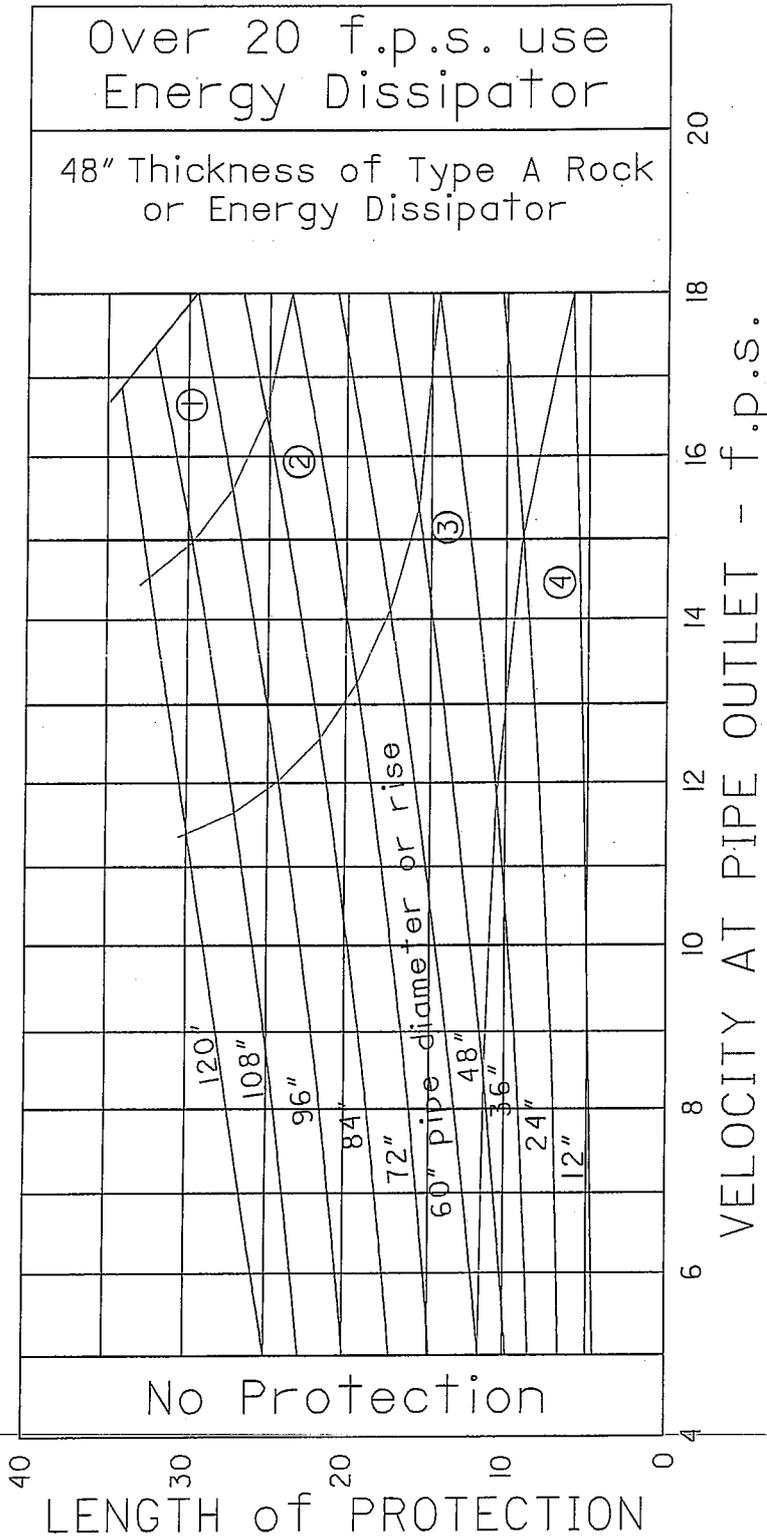
XI Design Notes:

1. Design as a **two stage** outlet
  1. An iterative process is required since the change in elevation head will cause an increase in the outflow of the stage one opening.
  2. Two detention areas can be used to eliminate the iterative two stage outlet design process.
  3. If a one stage outlet is to be used that cannot detain the 100 year storm and release at the 2 year predeveloped rate, explain reasoning.
2. Emergency overflow must be accounted for via a spillway or other means.

General Notes:

1. The formulas used in calculations III through VI assume an orifice controlled outflow condition.
2. Reference pages 98 and 99, Water and Wastes Engineering, "Estimate Detention and Reservoir Storage". By A. S. Paintal, P.E., Ph.D.

ROCK CHANNEL PROTECTION  
AT CULVERT AND STORM  
SEWER OUTLETS



NOTES

Rock size (6", 12", 18") indicates the square opening on which 85% of the material, by weight, will be retained.

The width of protection shall be the width of the headwall, with 4' being the minimum.

(Where a stream bed will withstand the calculated velocity without erosion, no rock channel protection will be required.)

LEGEND

- ① 48" of 18" rock
- ② 36" of 18" rock
- ③ 30" of 12" rock
- ④ 18" of 6" rock

ROCK TYPE

- A
- A
- B
- C

## CRITICAL AREA PLANTING

1. TEMPORARY AND PERMANENT SEEDING

## 1.1 SEEDBED PREPARATION

A. **Lime** (in lieu of a soil test recommendation) on acid soil (ph = 5.5 or less) and subsoil at a rate of 100 pounds per 1000 sq. ft. or two (2) tons per acre of agricultural ground limestone.

B. **Fertilizer** (in lieu of soil test recommendation) shall be applied at a rate of 12-15 pounds (25 pounds for permanent seeding) per 1000 sq. ft. of 10-10-10 or 12-12-12 analysis or equivalent.

## 1.2 SEEDING

## A. Species Selection

## (1) Temporary Seeding Mixture

<u>Seeding Period</u>	<u>Type</u>	<u>Rate (1000 ft<sup>2</sup>)</u>
Spring and	1. Oats	3 lbs
Summer	2. Peren. Ryegrass	1 lbs
	3. Tall Fescue	1 lbs
Fall	1. Peren. Ryegrass	1 lbs
	2. Rye	3 lbs
	3. Wheat	3 lbs
	4. Tall Fescue	1 lbs

## (2) Permanent Seeding Mixture

<u>Seeding Period</u>	<u>Type</u>	<u>Rate (1000 ft<sup>2</sup>)</u>
Spring,	1. Creeping Red Fescue	0.5 lbs
Summer, and	Domestic Ryegrass	0.25 lbs
Fall	Kentucky Bluegrass	0.25 lbs
	2. Tall Fescue	1 lbs
	3. Dwarf Fescue	1 lbs

(2-1) Seedings for Steep Banks or Cuts

Spring,	1. Tall Fescue	1 lbs
Summer, and		
Fall	2. Crownvetch	0.25 lbs
	Tall Fescue	0.50 lbs
	3. Flatpea	0.50 lbs
	Tall Fescue	0.50 lbs

(2-2) Seedings for Waterways and Road Ditches

Spring,	1. Tall Fescue	1 lbs
Summer, and		
Fall		

- B. Apply the seed uniformly with a cyclone seeder, drill, cultipacker seeder, or hydroseeder (slurry may include seed and fertilizer) preferably on a firm, moist seedbed. Seed wheat or rye no deeper than one (1) inch. Seed ryegrass no deeper than one quarter (1/4) of an inch.
- C. When feasible, except where a cultipacker type seeder is used, the seedbed should be firmed following seeding operations with a cultipacker, roller, or light drag. On sloping land seeding operations should be on the contour wherever possible.
- D. Other seed species may be substituted for these mixtures.
- E. These seeding rates need to be increased two to three times if they are to be used as a lawn.

2. DORMANT SEEDING

- A. Temporary Seeding - After November 1, use mulch only.
- B. Permanent Seeding - Seedings should not be planted from October 1 through November 20. The following methods may be used to make a "dormant seeding":
  - (1) From October 1 through November 20, prepare the seedbed, add the required amounts of lime and fertilizer, then mulch and anchor. After November 20, and before March 15, broadcast the selected seed mixture. Increase the seeding rates by 50 percent for this type of seeding.
  - (2) From November 20 through March 15, when soil conditions, permit, prepare the seedbed, lime and fertilize, apply the selected seed mixture, and
  - (3) mulch and anchor. Increase the seeding rates by 50 percent for this type of seeding.

3. MULCHING

- A. Mulch shall consist of small grain straw (preferably wheat or rye) and shall be applied at the rate of two tons per acre or 100 pounds per 1000 sq. ft.
- B. Spread the mulch uniformly by hand or mechanically so the soil surface is covered.

C. **Mulch Anchoring Methods**

- (1) Mechanical - Use a disk, crimper, or similar type tool set straight to punch or anchor the mulch material into the soil.
- (2) Asphalt Emulsion - Apply at the rate of 160 gallons per acre into the mulch as it is being applied.
- (3) Mulch Netting - Use according to the manufacturer's recommendations.

4. IRRIGATION

Supply new seedlings with adequate water for plant growth until they are firmly established.