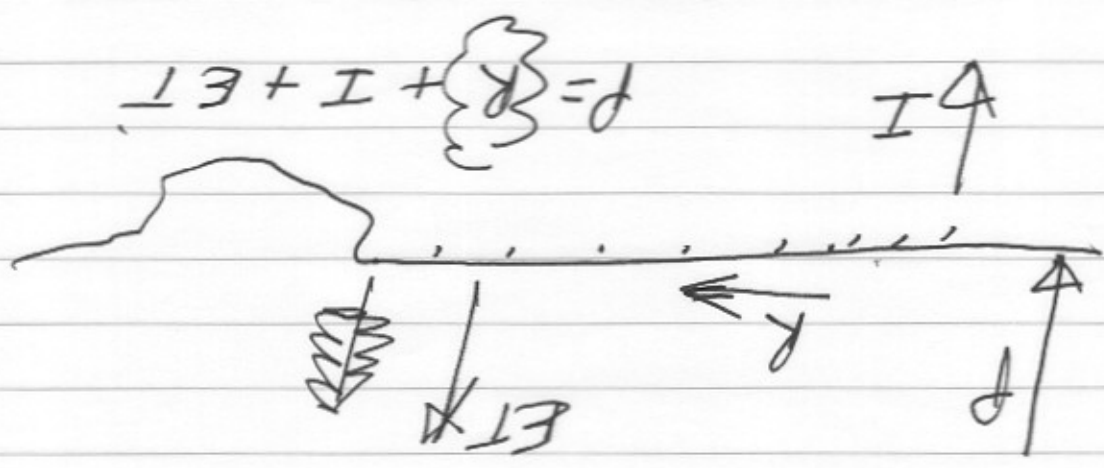


Nov. 8, 2004  
 CIEG 490 Water Resources Engineering

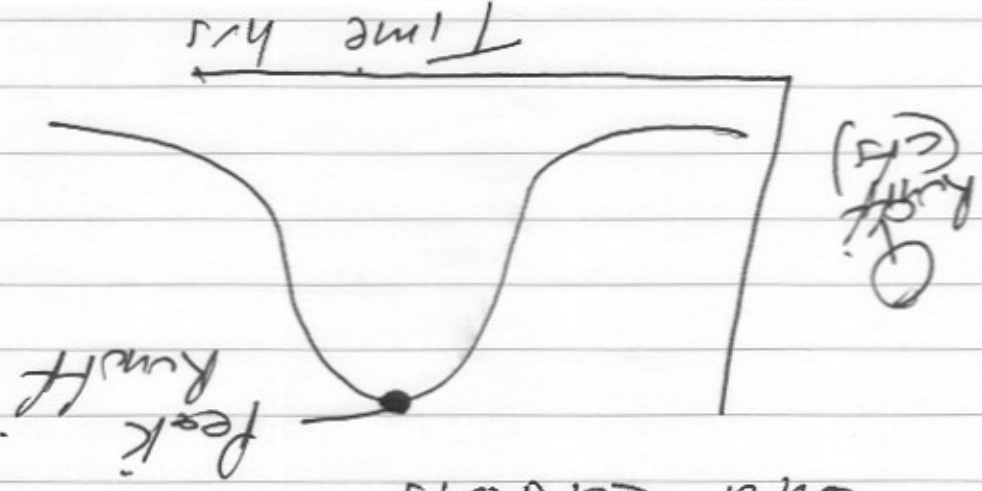
Surface Water Hydrology

- Precipitation Data
- New Castle County Intensity-Duration-Frequency Curve
  - Precipitation Depth Maps

Using rainfall-runoff models, we can calculate runoff (R):



Peak Runoff - design of storm sewers and culverts



# Rational Method

$$Q = C I A$$

where:

$Q =$  peak runoff (cfs)

$C =$  runoff coefficient

- Table 3.1-2 (B-1) NIDEP

Stream Encroachment  
Manual

$A =$  watershed Area (acres)

$I =$  intensity (in/hr)  
(From IDF curve, using time of concentration)

Time of concentration (Worksheet 3, TR55 Manual)

$$T_c = T_{\text{SHEETFLOW}} + T_{\text{SHALLOW CONCENTRATED}} + T_{\text{CHANNEL FLOW}}$$

$$T_c = T_{SF} + T_{SC} + T_{CH}$$

$$\textcircled{1} T_{SF} = \frac{0.007 (nL)^{0.8}}{(f)^{0.5} (s)^{0.4}}$$

where:

$$T_{SF} = \text{hr.}$$

$n$  = manning's roughness value, Table 3-1  
dense grass = 0.29 TR55

$L$  = Length (ft), 300 feet max.

$f_2$  = 2-yr, 24-hr rainfall = 3.2 in

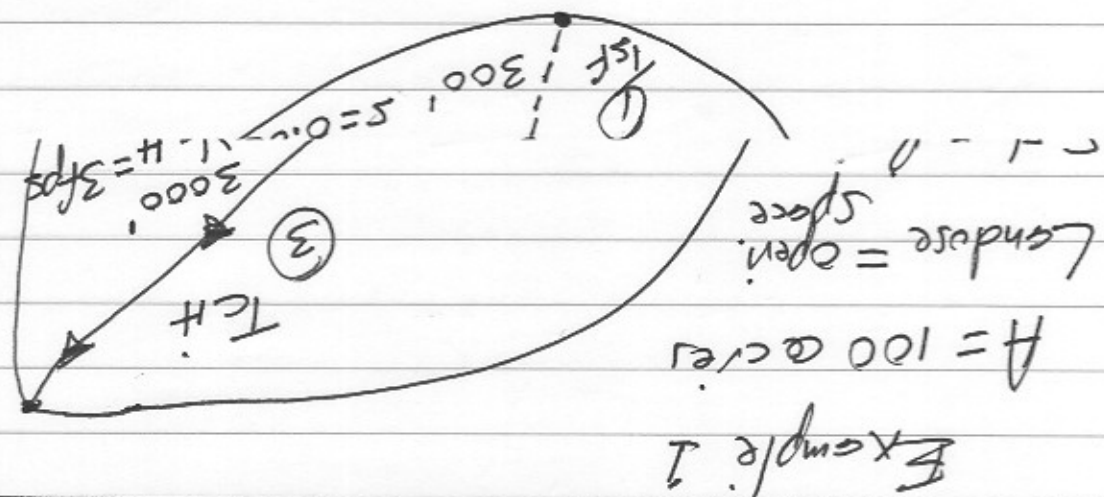
(No. 2E, Fig. B-3, TR55)

$s$  = slope (ft/ft)

$$\textcircled{2} T_{SC} = \frac{3600(V)}{L} = \text{hr.}$$

where:  $L$  = Flow Length (ft)

$V$  = Velocity (fps) Fig. 3.1 of TR55  
based on slope ( $s$ ) and  
paved or unpaved.



Once  $T_c$  is known (in minutes), go to IDF curve to select intensity (!).

$V =$  Velocity in channel from Manning's equation

where:  $L =$  Flow Length (ft)

$$\textcircled{3} \quad T_{cH} = \frac{L}{3600V} = \text{hrs}$$

4/

Worksheet 3: Time of Concentration (T<sub>c</sub>) or travel time (T<sub>t</sub>)

Project	CIEG 990	By	GTK	Date	Nov. 8, 2009
Location	Example 1	Checked		Date	

Check one:  Present  Developed

Check one:  T<sub>c</sub>  T<sub>t</sub> through subarea

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<sub>c</sub> only)

Segment ID	Surface description (table 3-1)	Manning's roughness coefficient, n (table 3-1)	Flow length, L (total L + 300 ft)	Two-year 24-hour rainfall, P <sub>2</sub>	Land slope, s	Compute T <sub>t</sub>
①	grass	0.29	300'	3.2	0.02	hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr
						ft/s
						in
						hr



$$T_c = 57 \text{ min} \quad \therefore \quad \frac{1}{100} = 3.5 \text{ in/hr}$$

$$C = \frac{0.25}{0.51} \text{ (open space, B soils)}$$

$$A = 100 \text{ acres}$$

$$Q_{100} = 0.25 (3.5 \text{ in/hr}) (100 \text{ ac}) = \underline{\underline{87 \text{ cfs}}}$$

TABLE 3.1-2(B-1)  
RUNOFF COEFFICIENTS  
(AMC II)

Hydro. Soil Group				LAND USE DESCRIPTION			
A	B	C	D	Cultivated land			
.49	.67	.81	.88	without conservation treatment			
.27	.43	.61	.67	with conservation treatment			
.38	.63	.78	.84	poor condition		Pasture or range land:	
---	.25	.51	.65	good condition			
---	---	---	---	good condition		Meadow:	
.34	.59	.70	.79	thin stand, poor cover, no mulch		Wood or Forest land:	
---	---	---	---	good cover			
.25	.51	.65	.74	good conditions: grass cover on 75% or more of the area		Open Spaces, lawns, parks, golf courses, cemeteries	
---	---	---	---	fair condition: grass cover on 50% to 75% of the area			
.84	.90	.93	.96	Commercial and business areas (85% impervious)			
.67	.81	.88	.92	Industrial districts (72% impervious)		Residential:	
.59	.76	.86	.90	Average lot size		Average % Impervious	
.25	.55	.70	.80	1/8 acre or less			
.30	.49	.67	.78	1/4 acre			
.25	.45	.65	.76	1/3 acre			
.20	.41	.63	.74	1/2 acre			
---	---	---	---	1 acre			
.99	.99	.99	.99	Paved parking lots, roofs, driveways etc.			
.99	.99	.99	.99	Streets and roads:			
.99	.99	.99	.99	paved with curbs and storm sewers			
.57	.76	.84	.88	gravel			
.49	.69	.80	.84	dirt			

NOTE: Values are based on S.C.S. definitions and are average values derived by an Advisory Committee for this Manual.