TCCALC
Time of Concentration Calculator

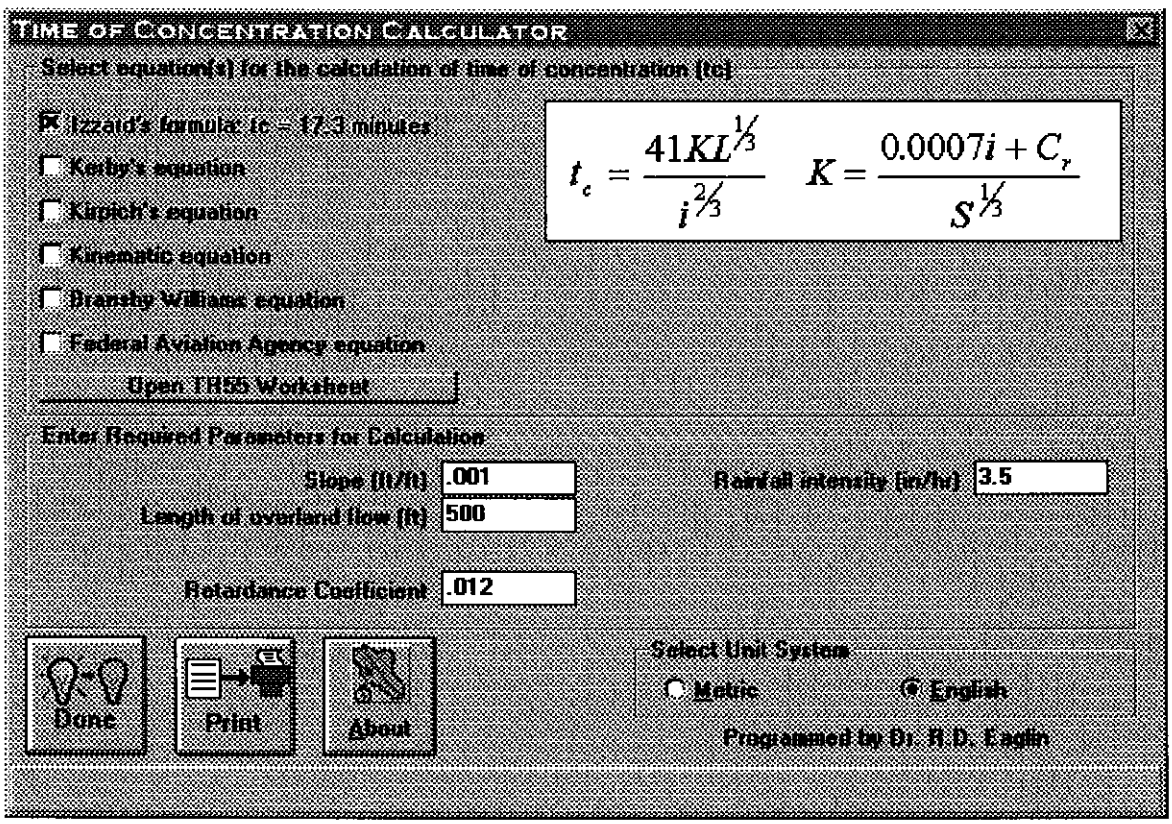
Introduction

The TC calculator is designed to allow for easy comparison of different methods for the calculation of time of concentration. Included are a number of commonly used time of concentration equations, including TR-55 methodology.

Using the TC Calculator

The TC Calculator is designed to make it easy to use common equations to calculate time of concentration and to compare the results of these different equations. To select an equation to be used, click on the check box for that equation. When the equation is selected the required inputs for that equation will appear on the bottom of the screen.

When all required data are entered, the time of concentration will automatically be calculated and shown in the upper portion of the screen. The equation for any method can be shown by clicking on the name of the equation.



When the check button for any equation has "focus" the equation will appear in the window on the right side.

The results of any equation can be printed by clicking on the **Print** button. The input values and the output will be included in the printout. If more than one equation is selected, the results of each equation is shown. An example of a TCCALC printout is:

```
              ------  Izzard's equation ------
Time of concentration (minutes) = 17.7
Overland flow distance (ft) =  400
Retardance Coefficient =  .012
Rainfall intensity (in/hr) =  3
Watershed slope =  .001


              ------  Kerby's equation ------
Time of concentration (minutes) = 11.
Overland flow distance (ft) =  400
Retardance Roughness Coefficient =  .02
Watershed slope =  .001


              ------  Bransby Williams equation ------
Time of concentration (minutes) = 8.1
Watershed area (square miles) =  .1
Overland flow distance (ft) =  400
Watershed slope =  .001
```

Note that the results of using different equations can be compared by looking at the output. This should allow the engineer to get a reasonable idea of the possible range for the actual time of concentration.

Equations Used in TCCALC

I. Izzard's Formula

$$t_c = \frac{41KL^{1/3}}{i^{2/3}} \qquad K = \frac{0.0007i + C_r}{S^{1/3}}$$

results in minutes

where:

i = rainfall intensity in inches/hr
C_r = retardance coefficient
S = watershed slope (ft/ft)
L = overland flow distance (ft)

assumptions:

iL less than 500
overland flow (pavement and turf)
laminar flow

Type of Surface	Retardance Coefficient
Very Smooth Asphalt	0.007
Tar and Sand Pavement	0.0075
Crushed Slate Roof	0.0082
Concrete	0.012
Tar and Gravel Pavement	0.017
Closely Clipped Sod	0.046
Dense Bluegrass	0.060

Source:

C.F. Izzard, "The Surface Profile of Overland Flow" Transactions of the American Geophysics Union, 25, 1944

II. Kerby's Equation

$$t_c = c\left(\frac{Ln}{S^{1/2}}\right)^{0.467}$$

results in minutes

where:

c = conversion (0.83 with L in feet, 1.44 with L in meters)
L = length of overland flow (ft or meters)
S = slope (ft/ft or m/m)
n = retardance roughness coefficient

assumptions:

L < 365 m (1000 ft)
overland flow

Surface Type	n
Smooth Pavement	0.02
Poor grass, bare sod	0.30
Average grass	0.40
Dense grass	0.80

Source:

W.S. Kerby, "Time of Concentration for Overland Flow", Civil Engineering, 29(3), 1959.

III. Kirpich's Equation

$$t_c = 0.0078\left(\frac{L^{0.77}}{S^{0.385}}\right)$$

answer in minutes

where:

L = length of overland flow
S = slope (ft/ft)

assumptions:

Agricultural watersheds, less than 56% timber coverage
Well drained soils
Steep watershed slopes
Watershed area between 1.2 and 112 acres

Source:

Z.P. Kirpich, "Time of Concentration of Small Agricultural Watershed", ASCE Civil Engineering, 10(6), 1940.

IV. Kinematic Wave Equation

$$t_c = 0.93\left(\frac{L^{0.6}N^{0.6}}{i^{0.4}S^{0.3}}\right)$$

answer in minutes

where:

L = length of overland flow (ft)
N = Manning's roughness coefficient for overland flow
I = rainfall intensity (in/hr)
S = average slope (ft/ft)

assumptions:

L is less than 300 feet

Surface Type	N (recommended)
Concrete	0.011
Asphalt	0.012
Bare Sand	0.010
Graveled Surface	0.012
Bare clay-loam	0.012
Fallow (no residue)	0.05
Plow	0.06
Range (natural)	0.13
Range (clipped)	0.08
Grass (bluegrass sod)	0.45
Short Grass Prairie	0.15
Dense Grass	0.24
Bermuda Grass	0.41
Woods	0.45

Source:

R.M. Ragan, "A Nomograph Based on Kinematic Wave Theory for Determining Time of Concentration For Overland Flow", Report #44, College Park, MD, University of Maryland, 1971.

G Fleming, *Computer Simulation Techniques in Hydrology*, Elsevier, New York, 1975.

V. Bransby Williams Equation

$$t_c = 21.3\, L \frac{1}{A^{0.1} S^{0.2}}$$

where:

L = length of channel from divide to outlet in miles
A = watershed area in square miles
S = slope of a linear profile having the same area under it as the actual profile of the main stream in ft/ft.

Source:

Bransby Williams, G., "Flood Discharge and the Dimensions of Spillways in India", *The Engineer* (London), vol. 121, pp. 321-322, September 1922.

VI. Federal Aviation Agency Equation

$$t_c = 1.8(1.1 - C)\frac{L^{0.50}}{S^{0.33}}$$

answer in minutes

where:

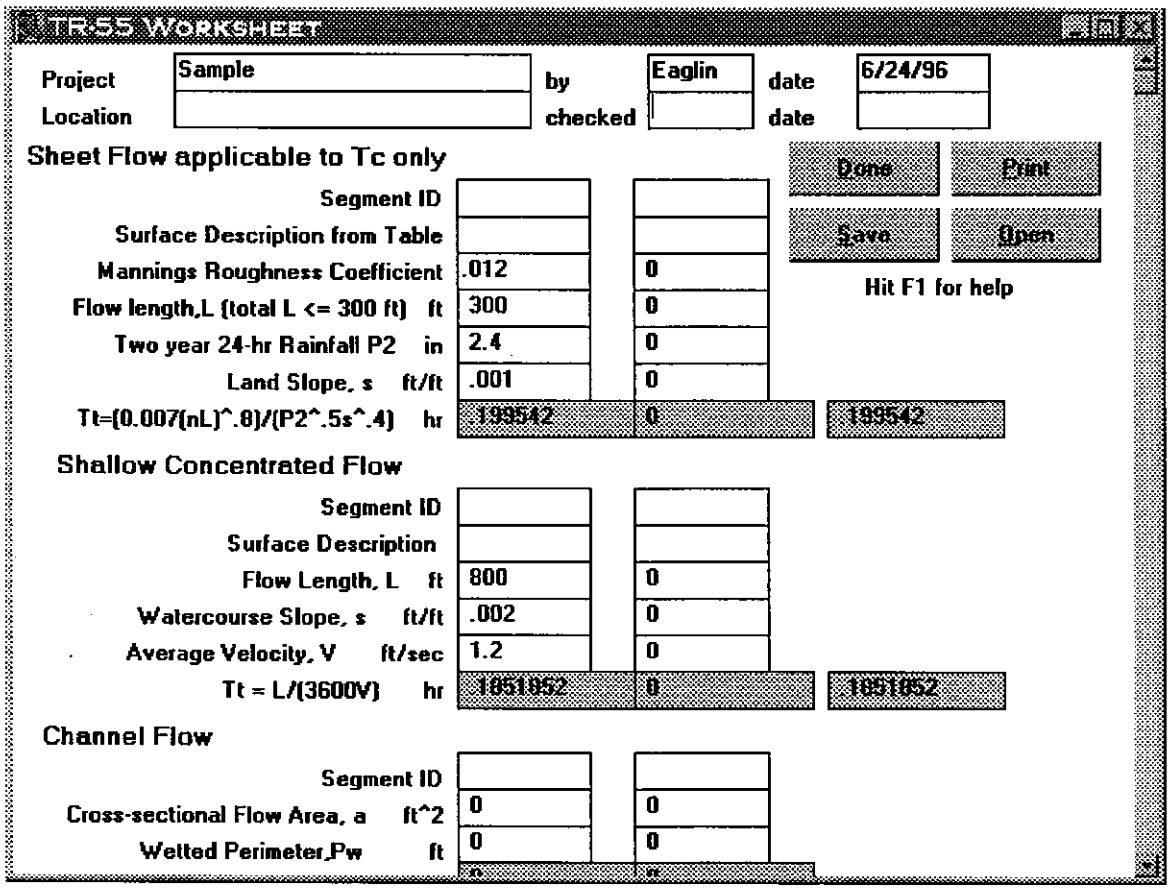
C = rational coefficient (0 - 1)
L = maximum length of overland flow in feet
S = slope in percent of longest overland flow path in percent

Source:

Federal Aviation Authority (FAA), "Advisory circular on airport drainage", Report A/C 150-5320-58, U.S. Department of Transportation. Washington, D.C., 1970.

TR-55 Method

Clicking on the **Open TR-55 Worksheet** button will bring up the TR-55 worksheet. This worksheet is a duplicate of the form from Technical Release 55 - Chapter 3, for use in calculating time of concentration.



This form will not fit on most screens, however it is a scrollable form - to access the bottom half of the form use the scroll bar to the right of the form. Values will automatically be calculated as the required values are entered.

The results can be printed (**Print**) or saved (**Save**) to a file. Results of the TR-55 spreadsheet will be saved to a file with a T53 extension.

The printed results appear as:

TR-55 WORKSHEET 3 Time of Concentration or Travel Time

Project : Sample — By : Eaglin — Date : 6/24/96
Location: — Checked: — Date :

Circle One: Present Developed _____
Circle One: Tc Tt 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 Tc only)		Segment ID		
1. Surface Description (table 3-1)				
2. Manning's roughness coeff.,n (table 3-1).....			.012	0.
3. Flow Length, L (total L <= 300 ft)	ft		300	
4. Two-yr 24-hr rainfall, P2	in		2.4	0.
5. Land slope ,s .....ft/ft			0.001	0.
6. Tt = 0.007(nL)^.8/P2^.5 s^.4	Compute Tt....	hr	0.1995	0.
				0.1995

SHALLOW CONCENTRATED FLOW		Segment ID		
7. Surface Description (paved or unpaved)				
8. Flow Length, L	ft		800	
9. Watercourse Slope, s .....ft/ft			0.002	0.
10. Average Velocity, v (from figure) .....ft/s			1.2	0.
11. Tt = L/(3600V)	Compute Tt....	hr	0.1852	0.
				0.1852

CHANNEL FLOW		Segment ID		
12. Cross Sectional Flow Area, ...ft^2			6.5	0.
13. Wetted Perimeter, Pw	ft		9.	.
14. Hydraulic Radius r = a/Pw	ft		.7	.
15. Channel Slope, s .....ft/ft			0.002	0.
16. Manning's roughness coeff.,n			.02	0.
17. V=1.49 r^2/3 s^1/2 / n Compute V .....ft/s			2.68	0.
18. Flow Length, L	ft		1800	
19. Tt = L/(3600V)	Compute Tt....	hr	0.1864	0.
				0.1864

20. Watershed or subarea Tc or Tt .add Tc in steps 6,11, and 19 — hr 0.571

One of the nice features of the TC Calculator is its ability to allow comparisons of different formulas.