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Synder's Synthetic Unit Hydrograph Formulas

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List of 34 Synder's Synthetic Unit Hydrograph Formulas

Synder's Synthetic Unit Hydrograph

1) Basin Lag given Modified Basin Lag

$$fx \quad t_p = \frac{t'_p - \left(\frac{t_R}{4}\right)}{\frac{21}{22}}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 5.992381h = \frac{6.22h - \left(\frac{2h}{4}\right)}{\frac{21}{22}}$$

2) Basin Lag given Modified Basin Lag for Effective Duration

$$fx \quad t_p = \frac{4 \cdot t'_p + t_r - t_R}{4}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 6.22h = \frac{4 \cdot 6.22h + 2h - 2h}{4}$$

3) Basin Lag given Peak Discharge

$$fx \quad t_p = 2.78 \cdot C_p \cdot \frac{A}{Q_p}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 5.616162h = 2.78 \cdot 0.6 \cdot \frac{3.00km^2}{0.891m^3/s}$$



4) Basin Lag given Standard Duration of Effective Rainfall

$$fx \quad t_p = 5.5 \cdot t_r$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 11h = 5.5 \cdot 2h$$

5) Basin Length Measured along Water Course given Basin Lag

$$fx \quad L_{\text{basin}} = \frac{\left(\frac{t_p}{C_r}\right)^1}{0.3} \cdot \left(\frac{1}{L_{ca}}\right)$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 1.141553\text{km} = \frac{\left(\frac{6h}{1.46}\right)^1}{0.3} \cdot \left(\frac{1}{12.0\text{km}}\right)$$

6) Basin Length Measured along Water Course given Modified Equation for Basin Lag

$$fx \quad L_{\text{basin}} = \left(\frac{t_p}{C_{rL}}\right)^{\frac{1}{n_B}} \cdot \left(\frac{\sqrt{S_B}}{L_{ca}}\right)$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)


$$ex \quad 9.026084\text{km} = \left(\frac{6h}{1.03}\right)^{\frac{1}{0.38}} \cdot \left(\frac{\sqrt{1.1}}{12.0\text{km}}\right)$$



7) Basin Slope given Basin Lag [Open Calculator](#) 

$$fx \quad S_B = \left(\frac{L_{\text{basin}} \cdot L_{\text{ca}}}{\left(\frac{t_p}{C_{rL}} \right)^{\frac{1}{n_B}}} \right)^2$$

$$ex \quad 1.193025 = \left(\frac{9.4\text{km} \cdot 12.0\text{km}}{\left(\frac{6\text{h}}{1.03} \right)^{\frac{1}{0.38}}} \right)^2$$

8) Catchment Area given Peak Discharge for Nonstandard Effective Rainfall [Open Calculator](#) 

$$fx \quad A = Q_p \cdot \frac{t'_p}{2.78 \cdot C_r}$$

$$ex \quad 1.365433\text{km}^2 = 0.891\text{m}^3/\text{s} \cdot \frac{6.22\text{h}}{2.78 \cdot 1.46}$$

9) Catchment Area given Peak Discharge of Unit Hydrograph [Open Calculator](#) 

$$fx \quad A = Q_p \cdot \frac{t_p}{2.78 \cdot C_p}$$

$$ex \quad 3.205036\text{km}^2 = 0.891\text{m}^3/\text{s} \cdot \frac{6\text{h}}{2.78 \cdot 0.6}$$



10) Distance along Main Water Course from Gauging Station given Basin Lag

$$fx \quad L_{ca} = \left(\left(\frac{t_p}{C_r} \right)^{\frac{1}{0.3}} \right) \cdot \left(\frac{1}{L_{basin}} \right)$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 11.82679km = \left(\left(\frac{6h}{1.46} \right)^{\frac{1}{0.3}} \right) \cdot \left(\frac{1}{9.4km} \right)$$

11) Distance along Main Water Course from Gauging Station to Watershed

$$fx \quad L_{ca} = \frac{\left(\frac{t_p}{C_{rL}} / \left(\frac{L_b}{\sqrt{S_B}} \right)^n - \{B\} \right)^1}{n_B}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 15.43091km = \frac{\left(\frac{6h}{1.03} / \left(\frac{30m}{\sqrt{1.1}} \right)^{0.38} \right)^1}{0.38}$$

12) Equation for Catchment Parameter

$$fx \quad C = L_b \cdot \frac{L}{\sqrt{S_B}}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)


$$ex \quad 1430.194 = 30m \cdot \frac{50m}{\sqrt{1.1}}$$



13) Modified Basin Lag for Effective Duration [Open Calculator](#) 

$$fx \quad t'_p = \left(21 \cdot \frac{t_p}{22} \right) + \left(\frac{t_R}{4} \right)$$

$$ex \quad 6.227273h = \left(21 \cdot \frac{6h}{22} \right) + \left(\frac{2h}{4} \right)$$

14) Modified Basin Lag given Peak Discharge for Nonstandard Effective Rainfall [Open Calculator](#) 

$$fx \quad t'_p = 2.78 \cdot C_r \cdot \frac{A}{Q_p}$$

$$ex \quad 0.003796h = 2.78 \cdot 1.46 \cdot \frac{3.00km^2}{0.891m^3/s}$$

15) Modified Basin Lag given Time Base [Open Calculator](#) 

$$fx \quad t'_p = \frac{t_b - 72}{3}$$

$$ex \quad 6h = \frac{90h - 72}{3}$$




16) Modified Equation for Basin Lag 

$$fx \quad t_p = C_{rL} \cdot \left(L_b \cdot \frac{L_{ca}}{\sqrt{S_B}} \right)^n - \{B\}$$

Open Calculator 

$$ex \quad 0.036313h = 1.03 \cdot \left(30m \cdot \frac{12.0km}{\sqrt{1.1}} \right)^{0.38}$$

17) Modified Equation for Basin Lag for Effective Duration 

$$fx \quad t'_p = t_p + \frac{t_R - t_r}{4}$$

Open Calculator 

$$ex \quad 6h = 6h + \frac{2h - 2h}{4}$$

18) Non-Standard Rainfall Duration given Modified Basin Lag 

$$fx \quad t_R = \left(t'_p - \left(\frac{21}{22} \right) \cdot t_p \right) \cdot 4$$

Open Calculator 

$$ex \quad 1.970909h = \left(6.22h - \left(\frac{21}{22} \right) \cdot 6h \right) \cdot 4$$

19) Peak Discharge for Nonstandard Effective Rainfall 

$$fx \quad Q_p = 2.78 \cdot C_p \cdot \frac{A}{t'_p}$$

Open Calculator 

$$ex \quad 0.804502m^3/s = 2.78 \cdot 0.6 \cdot \frac{3.00km^2}{6.22h}$$



20) Peak Discharge per Unit Catchment Area [Open Calculator](#) 


$$fx \quad Q = \frac{Q_p}{A_{\text{catchment}}}$$

$$ex \quad 0.4455 \text{m}^3/\text{s} = \frac{0.891 \text{m}^3/\text{s}}{2.0 \text{m}^2}$$

21) Peak discharge per unit Catchment Area given Unit Hydrograph Width at 50 percent Peak Discharge [Open Calculator](#) 

$$fx \quad Q = \left(\frac{5.87}{W_{50}} \right)^{\frac{1}{1.08}}$$

$$ex \quad 2.987711 \text{m}^3/\text{s} = \left(\frac{5.87}{1.8 \text{mm}} \right)^{\frac{1}{1.08}}$$

22) Regional Constant given Peak Discharge [Open Calculator](#) 

$$fx \quad C_r = Q_p \cdot \frac{t_p}{2.78} \cdot A_{\text{catchment}}$$

$$ex \quad 3.846043 = 0.891 \text{m}^3/\text{s} \cdot \frac{6 \text{h}}{2.78} \cdot 2.0 \text{m}^2$$



23) Regional Constant given Peak Discharge for Nonstandard Effective Rainfall

$$fx \quad C_p = Q_p \cdot \frac{t'_p}{2.78 \cdot A}$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$ex \quad 0.664511 = 0.891 \text{m}^3/\text{s} \cdot \frac{6.22\text{h}}{2.78 \cdot 3.00 \text{km}^2}$$

24) Regional Constant representing Watershed Slope and Storage Effects

$$fx \quad C_r = \frac{t_p}{(L_b \cdot L_{ca})^{0.3}}$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$ex \quad 0.129199 = \frac{6\text{h}}{(30\text{m} \cdot 12.0\text{km})^{0.3}}$$

25) Snyder's Equation

$$fx \quad t_p = C_r \cdot (L_b \cdot L_{ca})^{0.3}$$

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a_img.jpg\)](#)

$$ex \quad 1.074592\text{h} = 1.46 \cdot (30\text{m} \cdot 12.0\text{km})^{0.3}$$

26) Snyder's Equation for Peak Discharge

$$fx \quad Q_p = 2.78 \cdot C_p \cdot \frac{A}{t_p}$$

[Open Calculator !\[\]\(3342c215b2a8b663596a81468d5dc314_img.jpg\)](#)

$$ex \quad 0.834 \text{m}^3/\text{s} = 2.78 \cdot 0.6 \cdot \frac{3.00 \text{km}^2}{6\text{h}}$$



27) Snyder's Equation for Standard Duration of Effective Rainfall 

$$fx \quad t_r = \frac{t_p}{5.5}$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a_img.jpg\)](#)

$$ex \quad 1.090909h = \frac{6h}{5.5}$$

28) Snyder's Equation for Time Base 

$$fx \quad t_b = (72 + 3 \cdot t'_p)$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010_img.jpg\)](#)


$$ex \quad 90.66h = (72 + 3 \cdot 6.22h)$$

29) Standard Duration of Effective Rainfall given Modified Basin Lag 

$$fx \quad t_r = t_R - 4 \cdot (t'_p - t_p)$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd_img.jpg\)](#)

$$ex \quad 1.12h = 2h - 4 \cdot (6.22h - 6h)$$

30) Standard Effective Duration given Modified Basin Lag 

$$fx \quad t_r = -(4 \cdot (t'_p - t_p) - t_R)$$

[Open Calculator !\[\]\(235bfe13ebf007ce2eea9e689707fac7_img.jpg\)](#)

$$ex \quad 1.12h = -(4 \cdot (6.22h - 6h) - 2h)$$




31) Taylor and Schwartz Equation for Time Base 

$$fx \quad t_b = 5 \cdot \left(t'_p + \frac{t_R}{2} \right)$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)


$$ex \quad 36.1h = 5 \cdot \left(6.22h + \frac{2h}{2} \right)$$

32) Width of Unit Hydrograph at 50 percent Peak Discharge 

$$fx \quad W_{50} = \frac{5.87}{Q^{1.08}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)


$$ex \quad 1.792038mm = \frac{5.87}{(3.0m^3/s)^{1.08}}$$

33) Width of Unit Hydrograph at 50 percent Peak Discharge given 75 percent Discharge 

$$fx \quad W_{50} = W_{75} \cdot 1.75$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 1.785mm = 1.02mm \cdot 1.75$$

34) Width of Unit Hydrograph at 75 percent Peak Discharge 

$$fx \quad W_{75} = \frac{W_{50}}{1.75}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 1.028571mm = \frac{1.8mm}{1.75}$$







Variables Used

- **A** Area of Catchment (Square Kilometer)
- **A_{catchment}** Catchment Area (Square Meter)
- **C** Catchment Parameter
- **C_p** Regional Constant (Snyder)
- **C_r** Regional Constant
- **C_{rL}** Basin Constant
- **L** Watershed Length (Meter)
- **L_b** Length of Basin (Meter)
- **L_{basin}** Basin Length (Kilometer)
- **L_{ca}** Distance along Main Water Course (Kilometer)
- **n_B** Basin Constant 'n'
- **Q** Discharge (Cubic Meter per Second)
- **Q_p** Peak Discharge (Cubic Meter per Second)
- **S_B** Basin Slope
- **t_b** Time Base (Hour)
- **t_p** Basin Lag (Hour)
- **t'_p** Modified Basin Lag (Hour)
- **t_r** Standard Duration of Effective Rainfall (Hour)
- **t_R** Non-standard rainfall duration (Hour)
- **W₅₀** Width of Unit Hydrograph at 50% Peak Discharge (Millimeter)
- **W₇₅** Width of Unit Hydrograph at 75% Peak Discharge (Millimeter)






Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Measurement:** **Length** in Kilometer (km), Meter (m), Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Time** in Hour (h)
Time Unit Conversion 
- **Measurement:** **Area** in Square Kilometer (km²), Square Meter (m²)
Area Unit Conversion 
- **Measurement:** **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
Volumetric Flow Rate Unit Conversion 



Check other formula lists

- [SCS Triangular Unit Hydrograph Formulas](#) 
- [Synder's Synthetic Unit Hydrograph Formulas](#) 
- [The Indian Practice Formulas](#) 

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