DEPTH-DURATION-FREQUENCY
Climate Change - Rainfall Depth (mm) & Intensity (mm/h)

(using Daily Rainfall Depth maps TP108 with climate change adjustments)

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Calculations By:	**JF**	Date:	**17/10/2025**
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ARI	AEP	AEP - Design Catchment Maps: Appendix A of TP108 24hr
2	0.5	77
5	0.2	116
10	0.1	139
20	0.05	162
50	0.02	194
100	0.01	215

Table 4.1: Percentage Increase in 24-hour Design Rainfall Depth
(inclusive of climate change as per Auckland Council SW CoP Version 4 dated March 2024)

API	AEP	Percentage increase in 24hr design rainfall depth due to future climate change - 2.1°	Percentage increase in 24hr design rainfall depth due to future climate change - 3.8°
2	50%	15.1	27.4
5	20%	16.4	29.6
10	10%	17	30.8
20	5%	17.2	31.2
50	2%	17.6	31.9
100	1%	18.1	32.7

Rainfall Depth (mm)

Duration/ARI	24hr (2.1°)	24hr (3.8°)
2 yr (50%)	88.63	98.10
5 yr (20%)	135.02	150.34
10 yr (10%)	162.63	181.81
20 yr (5%)	189.86	212.54
50 yr (2%)	228.14	255.89
100 yr (1%)	253.92	285.31

Table 2: Ratio to convert 24-hour Rainfall Depth to Intensities

Duration	24hr without climate change	24hr with climate change allownces
10min	67.5	69.4
20min	51.9	53.2
30min	42.8	43.7
1hr	30.3	30.8
2hr	20.5	20.8
6hr	10.5	10.6
12hr	6.8	6.8
20hr	4.2	4.2

Rainfall Intensity (mm/h)

	10min	20min	30min	1hr	2hr	6hr	12hr	24hr
2 yr (50%)	61.5	47.1	38.7	27.3	18.4	9.4	6.0	3.7
5 yr (20%)	93.7	71.8	59.0	41.6	28.1	14.3	9.2	5.7
10 yr (10%)	112.9	86.5	71.1	50.1	33.8	17.2	11.1	6.8
20 yr (5%)	131.8	101.0	83.0	58.5	39.5	20.1	12.9	8.0
50 yr (2%)	158.3	121.4	99.7	70.3	47.5	24.2	15.5	9.6
100 yr (1%)	176.2	135.1	111.0	78.2	52.8	26.9	17.3	10.7

TP108: WORKSHEET

Runoff Parameters and T_c / Graphical Peak Flow Rate

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Worksheet 1: Runoff Parameters and Time of Concentration

Select: Pre Development

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m^2= 1ha	Product of CN x area	
Group C	*lawn, parks in good condition*	74	0.131	9.67	P
Group A	*Parks, pasture in good condition*	39		0.00	P
.	*Unconnected impervious*	98	0.168	16.46	I
.	*Connected impervious*	98		0.00	I
.		0		0.00	I
.		0		0.00	I
* from Table 24		Totals =	0.299	26.14	

CN (weighted) = total product / total area = 87.5

Ia (weighted) = 5 x pervious area / total area = 5 x 0.1307 / 0.2987 = 2.2 mm

2. Time of Concentration

Channelisation factor, C = 1 (From Table 4.2)

Catchment length, L = 0.04 km (along drainage path)

Catchment Slope, S_c = 0.029 m/m (by equal area method)

Runoff factor, CN/(200-CN) = 87.5 / = 0.78

$$t_c = 0.14\ C\ L^{0.66} \left(\frac{CN}{200-CN}\right)^{-0.55} S_c^{-0.30}$$ = 0.056 hrs

SCS Lag for HEC-HMS…. t_p = 2/3 t_c = 0.037 hrs

Worksheet 2: Graphical Peak Flow Rate

1. Data

Catchment Area	A=	0.00299	km^2 (100ha =1km^2)
Runoff curve number	CN=	87	(from worksheet 1)
Initial abstraction	Ia=	2.2	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 36 mm

		Storm #1	Storm #2	Storm #3	Storm #4
3.	Average recurrence interval, ARI (yr)		2 yr	10 yr	100 yr
4.	24 hour rainfall depth, P_{24}(mm)		98.1	181.81	285.31
5.	Compute, $c^* = \frac{P_{24} - 2Ia}{P_{24} + 2Ia + 2S}$		0.564	0.710	0.795
6.	Specific peak flow rate q* *(from figure 5.1)*		**0.134**	**0.152**	**0.159**
7.	Peak flow rate, $q_p = q^* A P_{24}$ (m^3/s)		0.039	0.083	0.135
8.	Runoff depth, $Q_{24} = \frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$ (mm)		69.6	149.4	251.0
9.	Runoff volume, $V_{24} = 1000 \times Q_{24}\ A$ (m^3)		208	446	750

TP108: WORKSHEET

Runoff Parameters and T_c / Graphical Peak Flow Rate

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Worksheet 1: Runoff Parameters and Time of Concentration

Select: Post Development

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m^2= 1ha	Product of CN x area	
Group C	*lawn, parks in good condition*	74	0.093	6.87	P
Group A	*permeable pavers*	74	0.027	1.99	P
.	*Unconnected impervious*	98		0.00	I
.	*Connected impervious*	98	0.179	17.53	I
.		0		0.00	I
.		0		0.00	I
* from Table 24		Totals =	0.299	26.40	

CN (weighted) = total product / total area = **88.4**

Ia (weighted) = 5 x pervious area / total area = 5 x 0.1198 / 0.2987 = **2.0** mm

2. Time of Concentration

Channelisation factor, C = 0.6 (From Table 4.2)

Catchment length, L = 0.042 km (along drainage path)

Catchment Slope, S_c = 0.03 m/m (by equal area method)

Runoff factor, CN/(200-CN) = 88.4 / = **0.79**

$$t_c = 0.14\ C\ L^{0.66} \left(\frac{CN}{200-CN}\right)^{-0.55} S_c^{-0.30}$$ = **0.034** hrs

SCS Lag for HEC-HMS…. t_p = 2/3 t_c = **0.023** hrs

Worksheet 2: Graphical Peak Flow Rate

1. Data

Catchment Area	A=	0.00299	km^2 (100ha =1km^2)
Runoff curve number	CN=	88	(from worksheet 1)
Initial abstraction	Ia=	2.0	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = **33** mm

		Storm #1	Storm #2	Storm #3	Storm #4
3.	Average recurrence interval, ARI (yr)		2 yr	10 yr	100 yr
4.	24 hour rainfall depth, P_{24} (mm)		98.1	181.81	285.31
5.	Compute, $c^* = \frac{P_{24} - 2Ia}{P_{24} + 2Ia + 2S}$		0.585	0.727	0.808
6.	Specific peak flow rate q* *(from figure 5.1)*		**0.137**	**0.154**	**0.161**
7.	Peak flow rate, $q_p = q^* A P_{24}$ (m^3/s)		0.040	0.084	0.137
8.	Runoff depth, $Q_{24} = \frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$ (mm)		71.3	151.6	253.4
9.	Runoff volume, $V_{24} = 1000 \times Q_{24}\ A$ (m^3)		213	453	757
	Pre to post detention volumes (m^3)		5	7	7

TP108: WORKSHEET

Runoff Parameters and T_c / Graphical Peak Flow Rate

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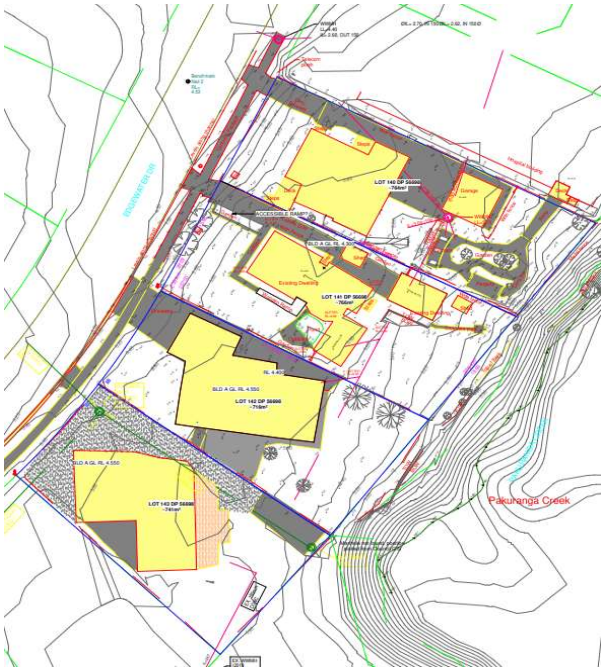
Pre-Development



Post-Development