Appendix B – Storm Water Calculations

CONSULTING ENGINEERS
Behan House
10 Lower Mount Street
Dublin
D02 HT71
t: +353 1 6611100
e: info@cora.ie

Job No.	Ref No.	Rev
2223		PL1
Civic Offices		Page No. 1/1
By: JPC	Checked: JFC	
Title: SW Drainage: Input Data	Date: 16-Aug-2023	

Drainage Input Data

Site Coordinates:

	IG	ITM
E:	267521	667466
N:	333834	833850

Standard Average Annual Rainfall, SAAR =	988 mm	(From Met Éireann Historical Data)
SOIL Type =	3	
SOIL =	0.37	
Q_{BAR} =	**4.3 l/s/ha**	
Overall Site Area, ha =	1.84 ha	(From Site Plan)
Q_{BAR} =	**7.92 l/s**	

Soil Infiltration Rate, f =	0.0000427 m/s	(From Soils Tests)
	0.15372 m/hr	

Growth Curve Factors:

1 Year	0.85
30 Year	2.13
100 Year	2.61
200 Year	2.86

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 267521, Northing: 333834,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.5,	3.6,	4.1,	5.0,	5.6,	6.0,	7.5,	9.2,	10.4,	12.0,	13.4,	14.5,	16.2,	17.6,	18.7,	N/A ,
10 mins	3.5,	4.9,	5.7,	6.9,	7.8,	8.4,	10.5,	12.9,	14.4,	16.7,	18.7,	20.2,	22.6,	24.5,	26.0,	N/A ,
15 mins	4.1,	5.8,	6.8,	8.2,	9.1,	9.9,	12.3,	15.1,	17.0,	19.6,	22.0,	23.8,	26.6,	28.8,	30.6,	N/A ,
30 mins	5.4,	7.6,	8.8,	10.5,	11.7,	12.6,	15.6,	19.0,	21.3,	24.4,	27.2,	29.4,	32.7,	35.3,	37.5,	N/A ,
1 hours	7.1,	9.9,	11.4,	13.5,	15.0,	16.1,	19.8,	23.9,	26.6,	30.4,	33.8,	36.4,	40.3,	43.4,	45.9,	N/A ,
2 hours	9.4,	12.9,	14.7,	17.4,	19.2,	20.6,	25.1,	30.1,	33.4,	37.9,	41.9,	44.9,	49.6,	53.2,	56.2,	N/A ,
3 hours	11.1,	15.1,	17.2,	20.2,	22.3,	23.8,	28.9,	34.4,	38.1,	43.1,	47.5,	50.9,	56.0,	60.0,	63.3,	N/A ,
4 hours	12.5,	16.8,	19.1,	22.5,	24.7,	26.4,	31.8,	37.9,	41.8,	47.2,	51.9,	55.6,	61.1,	65.3,	68.8,	N/A ,
6 hours	14.7,	19.7,	22.3,	26.0,	28.5,	30.4,	36.6,	43.3,	47.7,	53.7,	58.9,	62.9,	69.0,	73.7,	77.5,	N/A ,
9 hours	17.3,	23.0,	25.9,	30.2,	33.0,	35.1,	42.0,	49.5,	54.4,	61.0,	66.8,	71.2,	77.9,	83.0,	87.2,	N/A ,
12 hours	19.4,	25.7,	28.9,	33.5,	36.6,	38.9,	46.4,	54.5,	59.7,	66.8,	73.0,	77.8,	84.9,	90.4,	94.9,	N/A ,
18 hours	22.9,	30.0,	33.6,	38.9,	42.3,	44.9,	53.3,	62.3,	68.1,	76.0,	82.8,	88.0,	95.9,	101.9,	106.8,	N/A ,
24 hours	25.7,	33.5,	37.4,	43.1,	46.9,	49.7,	58.8,	68.5,	74.7,	83.2,	90.6,	96.2,	104.6,	111.0,	116.2,	134.0,
2 days	33.2,	41.9,	46.3,	52.5,	56.5,	59.5,	68.9,	78.9,	85.2,	93.7,	101.0,	106.4,	114.6,	120.8,	125.8,	142.7,
3 days	39.6,	49.1,	53.7,	60.3,	64.6,	67.7,	77.6,	87.9,	94.3,	103.0,	110.3,	115.8,	124.0,	130.1,	135.1,	151.8,
4 days	45.3,	55.5,	60.4,	67.4,	71.8,	75.1,	85.3,	95.9,	102.5,	111.3,	118.8,	124.3,	132.6,	138.7,	143.7,	160.3,
6 days	55.7,	67.0,	72.4,	79.9,	84.7,	88.2,	99.1,	110.3,	117.1,	126.2,	133.9,	139.6,	148.0,	154.2,	159.3,	175.9,
8 days	65.2,	77.4,	83.2,	91.2,	96.3,	100.0,	111.4,	123.1,	130.2,	139.6,	147.4,	153.2,	161.8,	168.1,	173.2,	190.0,
10 days	74.2,	87.1,	93.3,	101.7,	107.0,	111.0,	122.8,	134.9,	142.2,	151.8,	159.9,	165.8,	174.5,	180.9,	186.1,	203.0,
12 days	82.7,	96.4,	102.9,	111.7,	117.2,	121.3,	133.5,	145.9,	153.4,	163.3,	171.5,	177.5,	186.4,	192.9,	198.1,	215.2,
16 days	99.0,	113.9,	120.9,	130.4,	136.2,	140.6,	153.5,	166.5,	174.4,	184.6,	193.1,	199.3,	208.4,	215.0,	220.3,	237.6,
20 days	114.6,	130.5,	137.9,	147.9,	154.1,	158.6,	172.2,	185.7,	193.8,	204.3,	213.0,	219.4,	228.6,	235.4,	240.8,	258.3,
25 days	133.4,	150.4,	158.2,	168.8,	175.3,	180.0,	194.2,	208.2,	216.6,	227.4,	236.3,	242.8,	252.3,	259.2,	264.6,	282.4,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

M5-60m = 16.1

M5-2d = 59.5

Ratio R = M5-60m/M5-2d

R = 16.1/59.5

R = 0.271

SAAR = 988mm (from Historical Data)

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	John Callanan
Site name:	2223 - MCC
Site location:	Roosky, Monaghan

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	54.24982° N
Longitude:	6.96516° W
Reference:	2827752064
Date:	Aug 17 2023 11:19

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 1

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	1016	988
Hydrological region:	13	13
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	1.65	1.65
Growth curve factor 100 years:	1.95	1.95
Growth curve factor 200 years:	2.15	2.15

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited

Q_{BAR} (l/s):	7.47	4.3
1 in 1 year (l/s):	6.35	3.65
1 in 30 years (l/s):	12.32	7.09
1 in 100 year (l/s):	14.56	8.38
1 in 200 years (l/s):	16.05	9.24

CORA CONSULTING ENGINEERS	Behan House 10 Lower Mount Street Dublin D02 HT71 t: +353 1 6611100 e: info@cora.ie	Job No. 2223	Ref No.	Rev PL1
		Civic Offices		Page No. 1/1
		By: JPC	Checked: JFC	
Title: SW Drainage: Impermeable Areas			Date: 16-Aug-2023	

Breakdown of Impermeable Areas

				(Run-off Coefficient)			Overall Run-off Coefficient for Analysis
	Overall Area						
Catchment Area 1:	Upper Car Park	A_{CP1} =	1140.0 m²	@ 1.0 =	1140.0 m²		
	Landscaping	A_{L1} =	774.0 m²	@ 0.3 =	232.2 m²	**1372.2 m²**	**(0.717)**
	Overall Area	$A_{O/A}$ =	1914.0 m²				
Catchment Area 2:	Middle Car Park	A_{CP2} =	988.0 m²	@ 1.0 =	988.0 m²		
	Ramp to Upper CP	A_{R1} =	84.0 m²	@ 1.0 =	84.0 m²		
	Ramp from Upper CP	A_{R2} =	140.0 m²	@ 1.0 =	140.0 m²		
	Landscaping	A_{L2} =	943.0 m²	@ 0.3 =	282.9 m²	**1494.9 m²**	**(0.694)**
	Overall Area	$A_{O/A}$ =	2155.0 m²				
Catchment Area 3:	Lower Car Park	A_{CP3} =	1088.0 m²	@ 1.0 =	1088.0 m²		
	Ramp to Middle CP	A_{R3} =	422.0 m²	@ 1.0 =	422.0 m²		
	Site Entrance	A_{SE} =	143.0 m²	@ 1.0 =	143.0 m²		
	Landscaping	A_{L3} =	1419.0 m²	@ 0.3 =	425.7 m²	**2078.7 m²**	**(0.677)**
	Overall Area	$A_{O/A}$ =	3072.0 m²				
Catchment Area 4:	Pedestrian Entrance & Footpaths	A_{PE} =	963.0 m²	@ 1.0 =	963.0 m²		
	ESB Sub-Station	A_{ESB} =	235.0 m²	@ 1.0 =	235.0 m²		
	Hardstanding near Car Park	A_{HS} =	163.0 m²	@ 1.0 =	163.0 m²	**1361.0 m²**	**(1.0)**
	Overall Area	$A_{O/A}$ =	1361.0 m²				
Catchment Area 5:	Roofs	A_{RF} =	3832.0 m²	@ 1.0 =	3832.0 m²	**3832.0 m²**	**(1.0)**
	Overall Area	$A_{O/A}$ =	3832.0 m²				
Catchment Area 6:	Entrance Area at St. Davnet's Row	A_{E} =	239.0 m²	@ 1.0 =	239.0 m²	**239.0 m²**	**(1.0)**
	Overall Area	$A_{O/A}$ =	239.0 m²				
Catchment Area 7:	Podium Level	A_{P} =	494.0 m²	@ 1.0 =	494.0 m²	**494.0 m²**	**(1.0)**
	Overall Area	$A_{O/A}$ =	494.0 m²				
				Overall Impermeable Site Area:		**10871.8 m²**	

CORA CONSULTING ENGINEERS	Behan House 10 Lower Mount Street Dublin D02 HT71 t: +353 1 6611100 e: info@cora.ie	Job No. 2223	Ref No.	Rev PL1
		Civic Offices		Page No. 1/1
		By: JPC	Checked: JFC	
Title: SW Drainage: Storage Volume & Infiltration under Car Park (80.920)			Date: 16-Aug-2023	

Calculation of Storage Volume & Infiltration

Length, l =	71.5 m	Area: 1144.0 m²
Width, w =	16 m	
Depth, d =	300 mm	
Free Volume, V_{free} =	30%	
M5-60min from Met Éireann Data =	16.1 mm	
M5-60m/M5-2d from Met Éireann Data, r =	0.271	
Return Period, years =	100 year	+ 20%
Impermeable Area, A =	1372.2 m²	
Soil Infiltration Rate, f =	0.0000427 m/s	
Surface Area to 50% storage depth, A_{s50} =	26.25 m²	
Outflow Factor, AF =	0.001120875 m³/s	
Max. Inflow (from Podium Permavoid) =	0.0 l/s =	0 m³/s

Duration	M5 Rainfalls	100 year Rainfall	100 year Rainfall + 20%	Inflow (m³)	Additional Inflow (m³)	Outflow (m³)	Storage Required (m³)
5 mins	6.0 mm	14.5 mm	17.4 mm	23.9	0	0.3	23.5
10 mins	8.4 mm	20.2 mm	24.2 mm	33.3	0	0.7	32.6
15 mins	9.9 mm	23.8 mm	28.6 mm	39.2	0	1.0	38.2
30 mins	12.6 mm	29.4 mm	35.3 mm	48.4	0	2.0	46.4
1 hour	16.1 mm	36.4 mm	43.7 mm	59.9	0	4.0	55.9
2 hours	20.6 mm	44.9 mm	53.9 mm	73.9	0	8.1	65.9
3 hours	23.8 mm	50.9 mm	61.1 mm	83.8	0	12.1	71.7
4 hours	26.4 mm	55.6 mm	66.7 mm	91.6	0	16.1	75.4
6 hours	30.4 mm	62.9 mm	75.5 mm	103.6	0	24.2	79.4
9 hours	35.1 mm	71.2 mm	85.4 mm	117.2	0	36.3	80.9
12 hours	38.9 mm	77.8 mm	93.4 mm	128.1	0	48.4	79.7
18 hours	44.9 mm	88.0 mm	105.6 mm	144.9	0	72.6	72.3
24 hours	49.7 mm	96.2 mm	115.4 mm	158.4	0	96.8	61.6

Rainfall Values are taken from Met Éirean Data for the site (see separate data sheet)

Required Storage, S_{reqd} = **80.9 m³**

Actual Storage, S_{act} = **102.96 m³** **(0.79)**

Storage Volume is OK

Time for emptying half volume:

T_{s50} = **00 days 10 hr 01 min 39 s**

Discharge Time is OK

CONSULTING ENGINEERS	Behan House 10 Lower Mount Street Dublin D02 HT71 t: +353 1 6611100 e: info@cora.ie	Job No. 2223	Ref No.	Rev PL1
		Civic Offices		Page No. 1/1
		By: JPC	Checked: JFC	
Title: SW Drainage: Storage Volume & Infiltration under Car Park (78.920)			Date: 16-Aug-2023	

Calculation of Storage Volume & Infiltration

Length, l =	66 m	Area: 1056.0 m²
Width, w =	16 m	
Depth, d =	300 mm	
Free Volume, V_{free} =	30%	
M5-60min from Met Éireann Data =	16.1 mm	
M5-60m/M5-2d from Met Éireann Data, r =	0.271	
Return Period, years =	100 year	+ 20%
Impermeable Area, A =	1494.9 m²	
Soil Infiltration Rate, f =	0.0000427 m/s	
Surface Area to 50% storage depth, A_{s50} =	24.6 m²	
Outflow Factor, AF =	0.00105042 m³/s	
Max. Inflow (from Podium Permavoid) =	0.0 l/s	= 0 m³/s

Duration	M5 Rainfalls	100 year Rainfall	100 year Rainfall + 20%	Inflow (m³)	Additional Inflow (m³)	Outflow (m³)	Storage Required (m³)
5 mins	6.0 mm	14.5 mm	17.4 mm	26.0	0	0.3	25.7
10 mins	8.4 mm	20.2 mm	24.2 mm	36.2	0	0.6	35.6
15 mins	9.9 mm	23.8 mm	28.6 mm	42.7	0	0.9	41.7
30 mins	12.6 mm	29.4 mm	35.3 mm	52.7	0	1.9	50.8
1 hour	16.1 mm	36.4 mm	43.7 mm	65.3	0	3.8	61.5
2 hours	20.6 mm	44.9 mm	53.9 mm	80.5	0	7.6	73.0
3 hours	23.8 mm	50.9 mm	61.1 mm	91.3	0	11.3	80.0
4 hours	26.4 mm	55.6 mm	66.7 mm	99.7	0	15.1	84.6
6 hours	30.4 mm	62.9 mm	75.5 mm	112.8	0	22.7	90.1
9 hours	35.1 mm	71.2 mm	85.4 mm	127.7	0	34.0	93.7
12 hours	38.9 mm	77.8 mm	93.4 mm	139.6	0	45.4	94.2
18 hours	44.9 mm	88.0 mm	105.6 mm	157.9	0	68.1	89.8
24 hours	49.7 mm	96.2 mm	115.4 mm	172.6	0	90.8	81.8

Rainfall Values are taken from Met Éirean Data for the site (see separate data sheet)

Required Storage, S_{reqd} = **94.2 m³**

Actual Storage, S_{act} = **95.04 m³** **(0.99)**

Storage Volume is OK

Time for emptying half volume:

T_{s50} = **00 days 12 hr 27 min 12 s**

Discharge Time is OK

CONSULTING ENGINEERS	Behan House 10 Lower Mount Street Dublin D02 HT71 t: +353 1 6611100 e: info@cora.ie	Job No. 2223	Ref No.	Rev PL1
		Civic Offices		Page No. 1/1
		By: JPC	Checked: JFC	
Title: SW Drainage: Storage Volume & Infiltration under Car Park (75.000)			Date: 16-Aug-2023	

Calculation of Storage Volume & Infiltration

Length, l =	69 m	Area: 1104.0 m²
Width, w =	16 m	
Depth, d =	350 mm	
Free Volume, V_{free} =	30%	
M5-60min from Met Éireann Data =	16.1 mm	
M5-60m/M5-2d from Met Éireann Data, r =	0.271	
Return Period, years =	100 year	+ 20%
Impermeable Area, A =	2078.7 m²	
Soil Infiltration Rate, f =	0.0000427 m/s	
Surface Area to 50% storage depth, A_{s50} =	29.75 m²	
Outflow Factor, AF =	0.001270325 m³/s	
Max. Inflow (from Podium Permavoid) =	0.0 l/s =	0 m³/s

Duration	M5 Rainfalls	100 year Rainfall	100 year Rainfall + 20%	Inflow (m³)	Additional Inflow (m³)	Outflow (m³)	Storage Required (m³)
5 mins	6.0 mm	14.5 mm	17.4 mm	36.2	0	0.4	35.8
10 mins	8.4 mm	20.2 mm	24.2 mm	50.4	0	0.8	49.6
15 mins	9.9 mm	23.8 mm	28.6 mm	59.4	0	1.1	58.2
30 mins	12.6 mm	29.4 mm	35.3 mm	73.3	0	2.3	71.0
1 hour	16.1 mm	36.4 mm	43.7 mm	90.8	0	4.6	86.2
2 hours	20.6 mm	44.9 mm	53.9 mm	112.0	0	9.1	102.9
3 hours	23.8 mm	50.9 mm	61.1 mm	127.0	0	13.7	113.2
4 hours	26.4 mm	55.6 mm	66.7 mm	138.7	0	18.3	120.4
6 hours	30.4 mm	62.9 mm	75.5 mm	156.9	0	27.4	129.5
9 hours	35.1 mm	71.2 mm	85.4 mm	177.6	0	41.2	136.4
12 hours	38.9 mm	77.8 mm	93.4 mm	194.1	0	54.9	139.2
18 hours	44.9 mm	88.0 mm	105.6 mm	219.5	0	82.3	137.2
24 hours	49.7 mm	96.2 mm	115.4 mm	240.0	0	109.8	130.2

Rainfall Values are taken from Met Éirean Data for the site (see separate data sheet)

Required Storage, S_{reqd} = **139.2 m³**

Actual Storage, S_{act} = **115.92 m³** **(1.20)**

Storage Volume is NOT OK

NOTE: Anything above the following will be directed to the overflow pipe
100yr + 0% Climate Change is 0.92
50yr + 20% Climate Change is 0.96

Time for emptying half volume:

T_{s50} = **00 days 15 hr 13 min 05 s**

Discharge Time is OK

CORA CONSULTING ENGINEERS	Behan House 10 Lower Mount Street Dublin D02 HT71 t: +353 1 6611100 e: info@cora.ie	Job No. 2223	Ref No.	Rev PL1
		Civic Offices		Page No. 1/1
		By: JPC		Checked: JFC
Title: SW Drainage: Attenuation Storage Volume under Podium				Date: 16-Aug-2023

Calculation of Attenuation Volume

Length, l =	33.6 m		Area: 336.0 m²
Width, w =	10 m		
Depth, d =	0.08 m		
Free Volume, V_{free} =	95%		
M5-60min from Met Éireann Data =	16.1 mm		
M5-60m/M5-2d from Met Éireann Data, r =	0.271		
Return Period, years =	100 year	+ 20%	
Contributory Area, A =	494 m²		
Outflow Factor, AF =	2.0 l/s	(0.002 m³/s)	
Max. Inflow (from RWHT) =	0.0 l/s	= 0 m³/s	

Duration	M5 Rainfalls	100 year Rainfall	100 year Rainfall + 20%	Inflow (m³)	Additional Inflow (m³)	Outflow (m³)	Storage Required (m³)
5 mins	6.0 mm	14.5 mm	17.4 mm	8.6	0	0.6	8.0
10 mins	8.4 mm	20.2 mm	24.2 mm	12.0	0	1.2	10.8
15 mins	9.9 mm	23.8 mm	28.6 mm	14.1	0	1.8	12.3
30 mins	12.6 mm	29.4 mm	35.3 mm	17.4	0	3.6	13.8
1 hour	16.1 mm	36.4 mm	43.7 mm	21.6	0	7.2	14.4
2 hours	20.6 mm	44.9 mm	53.9 mm	26.6	0	14.4	12.2
3 hours	23.8 mm	50.9 mm	61.1 mm	30.2	0	21.6	8.6
4 hours	26.4 mm	55.6 mm	66.7 mm	33.0	0	28.8	4.2
6 hours	30.4 mm	62.9 mm	75.5 mm	37.3	0	43.2	-5.9
9 hours	35.1 mm	71.2 mm	85.4 mm	42.2	0	64.8	-22.6
12 hours	38.9 mm	77.8 mm	93.4 mm	46.1	0	86.4	-40.3
18 hours	44.9 mm	88.0 mm	105.6 mm	52.2	0	129.6	-77.4
24 hours	49.7 mm	96.2 mm	115.4 mm	57.0	0	172.8	-115.8

Rainfall Values are taken from Met Éirean Data for the site (see separate data sheet)

Required Storage, S_{reqd} =	**14.4 m³**	
Actual Storage, S_{act} =	**25.54 m³**	**(0.56)**

Storage Volume is OK