Storage Volumes vs Storm Duration (1-in-1-year storm) for Site 4 - EXISTING

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.481	0.085	0.000

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	0.0	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	1 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	5.8	23.1	12.3	4.4	0.0	0.0	0	16.7	15.0
0.5	7.3	14.6	7.8	2.8	0.0	0.0	0	10.6	19.1
1	9.0	9.0	4.8	1.7	0.0	0.0	0	6.5	23.5
2	14.1	7.0	3.8	1.3	0.0	0.0	0	5.1	36.7
4	19.4	4.8	2.6	0.9	0.0	0.0	0	3.5	50.5
6	22.4	3.7	2.0	0.7	0.0	0.0	0	2.7	58.3
8	24.4	3.0	1.6	0.6	0.0	0.0	0	2.2	63.5
12	27.0	2.3	1.2	0.4	0.0	0.0	0	1.6	70.4
16	28.9	1.8	1.0	0.3	0.0	0.0	0	1.3	75.2
20	30.3	1.5	0.8	0.3	0.0	0.0	0	1.1	79.0
24	31.6	1.3	0.7	0.2	0.0	0.0	0	1.0	82.3
28	32.7	1.2	0.6	0.2	0.0	0.0	0	0.8	85.1
32	33.7	1.1	0.6	0.2	0.0	0.0	0	0.8	87.8
36	34.6	1.0	0.5	0.2	0.0	0.0	0	0.7	90.3
40	35.5	0.9	0.5	0.2	0.0	0.0	0	0.6	92.6
44	36.4	0.8	0.4	0.2	0.0	0.0	0	0.6	94.8
48	37.2	0.8	0.4	0.1	0.0	0.0	0	0.6	97.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 4 - EXISTING		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S4/A3.1	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 4 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.481	0.085	0.000

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	30 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	46.5	16.5	0.0	0.0	0	63.0	56.7
0.5	28.2	56.4	30.1	10.7	0.0	0.0	0	40.8	73.5
1	34.7	34.7	18.6	6.6	0.0	0.0	0	25.1	90.5
2	44.1	22.1	11.8	4.2	0.0	0.0	0	16.0	114.9
4	53.8	13.5	7.2	2.6	0.0	0.0	0	9.7	140.3
6	59.2	9.9	5.3	1.9	0.0	0.0	0	7.1	154.2
8	62.6	7.8	4.2	1.5	0.0	0.0	0	5.7	163.1
12	67.0	5.6	3.0	1.1	0.0	0.0	0	4.0	174.7
16	70.0	4.4	2.3	0.8	0.0	0.0	0	3.2	182.5
20	72.3	3.6	1.9	0.7	0.0	0.0	0	2.6	188.4
24	74.1	3.1	1.6	0.6	0.0	0.0	0	2.2	193.1
28	75.7	2.7	1.4	0.5	0.0	0.0	0	2.0	197.2
32	77.1	2.4	1.3	0.5	0.0	0.0	0	1.7	200.8
36	78.3	2.2	1.2	0.4	0.0	0.0	0	1.6	204.2
40	79.5	2.0	1.1	0.4	0.0	0.0	0	1.4	207.3
44	80.7	1.8	1.0	0.3	0.0	0.0	0	1.3	210.3
48	81.7	1.7	0.9	0.3	0.0	0.0	0	1.2	213.1

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 4 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S4/A3.2 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 4 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.481	0.085	0.000

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	60.5	21.5	0.0	0.0	0	82.0	73.8
0.5	36.9	73.8	39.4	14.0	0.0	0.0	0	53.4	96.2
1	45.8	45.8	24.5	8.7	0.0	0.0	0	33.2	119.4
2	57.4	28.7	15.3	5.4	0.0	0.0	0	20.8	149.6
4	70.4	17.6	9.4	3.3	0.0	0.0	0	12.7	183.4
6	77.7	12.9	6.9	2.5	0.0	0.0	0	9.4	202.4
8	82.6	10.3	5.5	2.0	0.0	0.0	0	7.5	215.3
12	88.9	7.4	4.0	1.4	0.0	0.0	0	5.4	231.8
16	92.9	5.8	3.1	1.1	0.0	0.0	0	4.2	242.2
20	95.8	4.8	2.6	0.9	0.0	0.0	0	3.5	249.6
24	97.9	4.1	2.2	0.8	0.0	0.0	0	3.0	255.3
28	99.6	3.6	1.9	0.7	0.0	0.0	0	2.6	259.7
32	101.1	3.2	1.7	0.6	0.0	0.0	0	2.3	263.5
36	102.4	2.8	1.5	0.5	0.0	0.0	0	2.1	266.8
40	103.5	2.6	1.4	0.5	0.0	0.0	0	1.9	269.8
44	104.6	2.4	1.3	0.5	0.0	0.0	0	1.7	272.6
48	105.6	2.2	1.2	0.4	0.0	0.0	0	1.6	275.2

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 4 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S4/A3.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-1-year storm) for Site 4 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.272	0.149	0.145

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase) 0 %

Infiltration loss through soakaway 3.0 l/s

Area of Soakaway 10 m^2
Infiltration Rate 3.00E-04 m/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	1 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	5.8	23.1	7.0	7.6	8.8	0.0	-3	20.5	18.4
0.5	7.3	14.6	4.4	4.8	5.6	0.0	-3	11.9	21.4
1	9.0	9.0	2.7	3.0	3.4	0.0	-3	6.2	22.1
2	14.1	7.0	2.1	2.3	2.7	0.0	-3	4.2	30.0
4	19.4	4.8	1.5	1.6	1.9	0.0	-3	1.9	27.7
6	22.4	3.7	1.1	1.2	1.4	0.0	-3	0.8	17.1
8	24.4	3.0	0.9	1.0	1.2	0.0	-3	0.1	2.8
12	27.0	2.3	0.7	0.7	0.9	0.0	-3	-0.7	-30.7
16	28.9	1.8	0.5	0.6	0.7	0.0	-3	-1.2	-67.2
20	30.3	1.5	0.5	0.5	0.6	0.0	-3	-1.5	-105.1
24	31.6	1.3	0.4	0.4	0.5	0.0	-3	-1.7	-143.7
28	32.7	1.2	0.4	0.4	0.4	0.0	-3	-1.8	-182.9
32	33.7	1.1	0.3	0.3	0.4	0.0	-3	-1.9	-222.3
36	34.6	1.0	0.3	0.3	0.4	0.0	-3	-2.0	-262.0
40	35.5	0.9	0.3	0.3	0.3	0.0	-3	-2.1	-301.9
44	36.4	0.8	0.3	0.3	0.3	0.0	-3	-2.2	-342.0
48	37.2	0.8	0.2	0.3	0.3	0.0	-3	-2.2	-382.1

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 4 - PROPOSED
Project: Sandown Park
Calc Sheet: 2661_OPA/S4/A4.1
Date: Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 4 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.272	0.149	0.145

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	0	%

	Infiltration loss through soakaway	3.0	l/s

Area of Soakaway **10** m^2
Infiltration Rate **3.00E-04** m/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	30 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	26.3	28.9	33.3	0.0	-3	85.5	77.0
0.5	28.2	56.4	17.1	18.7	21.6	0.0	-3	54.3	97.8
1	34.7	34.7	10.5	11.5	13.3	0.0	-3	32.3	116.3
2	44.1	22.1	6.7	7.3	8.4	0.0	-3	19.4	139.8
4	53.8	13.5	4.1	4.5	5.2	0.0	-3	10.7	153.8
6	59.2	9.9	3.0	3.3	3.8	0.0	-3	7.0	151.7
8	62.6	7.8	2.4	2.6	3.0	0.0	-3	5.0	142.6
12	67.0	5.6	1.7	1.9	2.1	0.0	-3	2.7	115.7
16	70.0	4.4	1.3	1.5	1.7	0.0	-3	1.4	83.5
20	72.3	3.6	1.1	1.2	1.4	0.0	-3	0.7	48.5
24	74.1	3.1	0.9	1.0	1.2	0.0	-3	0.1	12.0
28	75.7	2.7	0.8	0.9	1.0	0.0	-3	-0.3	-25.5
32	77.1	2.4	0.7	0.8	0.9	0.0	-3	-0.6	-63.6
36	78.3	2.2	0.7	0.7	0.8	0.0	-3	-0.8	-102.1
40	79.5	2.0	0.6	0.7	0.8	0.0	-3	-1.0	-140.8
44	80.7	1.8	0.6	0.6	0.7	0.0	-3	-1.1	-179.9
48	81.7	1.7	0.5	0.6	0.7	0.0	-3	-1.3	-219.2

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 4 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S4/A4.2	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 4 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.272	0.149	0.145

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase)	0	%

Infiltration loss through soakaway	3.0	l/s

Area of Soakaway 10 m^2
Infiltration Rate 3.00E-04 m/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	34.3	37.5	43.4	0.0	-3	112.1	100.9
0.5	36.9	73.8	22.3	24.5	28.3	0.0	-3	72.0	129.7
1	45.8	45.8	13.9	15.2	17.5	0.0	-3	43.6	156.9
2	57.4	28.7	8.7	9.5	11.0	0.0	-3	26.2	188.5
4	70.4	17.6	5.3	5.8	6.7	0.0	-3	14.9	214.3
6	77.7	12.9	3.9	4.3	5.0	0.0	-3	10.2	219.5
8	82.6	10.3	3.1	3.4	4.0	0.0	-3	7.5	215.9
12	88.9	7.4	2.2	2.5	2.8	0.0	-3	4.5	195.9
16	92.9	5.8	1.8	1.9	2.2	0.0	-3	2.9	167.3
20	95.8	4.8	1.4	1.6	1.8	0.0	-3	1.9	134.5
24	97.9	4.1	1.2	1.4	1.6	0.0	-3	1.1	99.3
28	99.6	3.6	1.1	1.2	1.4	0.0	-3	0.6	62.3
32	101.1	3.2	1.0	1.0	1.2	0.0	-3	0.2	24.4
36	102.4	2.8	0.9	0.9	1.1	0.0	-3	-0.1	-14.1
40	103.5	2.6	0.8	0.9	1.0	0.0	-3	-0.4	-53.1
44	104.6	2.4	0.7	0.8	0.9	0.0	-3	-0.6	-92.4
48	105.6	2.2	0.7	0.7	0.8	0.0	-3	-0.8	-132.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 4 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S4/A4.3	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm+CC) for Site 4 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.272	0.149	0.145

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase) 20 %

Infiltration loss through soakaway 3.0 l/s

Area of Soakaway 10 m^2
Infiltration Rate 3.00E-04 m/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
Duration	**100 year event**								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	41.1	45.0	52.0	0.0	-3	135.2	121.7
0.5	36.9	73.8	26.8	29.3	33.9	0.0	-3	87.0	156.7
1	45.8	45.8	16.6	18.2	21.1	0.0	-3	52.9	190.4
2	57.4	28.7	10.4	11.4	13.2	0.0	-3	32.0	230.5
4	70.4	17.6	6.4	7.0	8.1	0.0	-3	18.5	265.8
6	77.7	12.9	4.7	5.1	5.9	0.0	-3	12.8	276.4
8	82.6	10.3	3.7	4.1	4.7	0.0	-3	9.6	276.4
12	88.9	7.4	2.7	2.9	3.4	0.0	-3	6.0	261.0
16	92.9	5.8	2.1	2.3	2.7	0.0	-3	4.1	235.4
20	95.8	4.8	1.7	1.9	2.2	0.0	-3	2.8	204.6
24	97.9	4.1	1.5	1.6	1.9	0.0	-3	2.0	171.0
28	99.6	3.6	1.3	1.4	1.6	0.0	-3	1.3	135.2
32	101.1	3.2	1.1	1.3	1.5	0.0	-3	0.9	98.4
36	102.4	2.8	1.0	1.1	1.3	0.0	-3	0.5	60.8
40	103.5	2.6	0.9	1.0	1.2	0.0	-3	0.2	22.7
44	104.6	2.4	0.9	0.9	1.1	0.0	-3	-0.1	-15.8
48	105.6	2.2	0.8	0.9	1.0	0.0	-3	-0.3	-54.7

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 4 - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/S4/A4.4 Date: Jan-19

6 SANDOWN PARK – SITE 5

6.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site 5 (Villas Residential and Day Nursery or D1 Use), shown on *Drawing 2661/OPA-S5/01*.

6.2 Location and setting

The Application Area is located on the southeastern boundary of the landholding and comprises a rectangular area of land which is bounded by Portsmouth Road (A307) to the east and southeast. It extends to approximately 0.99 hectares (ha).

6.3 The proposed development

The area of the proposed development currently comprises a car park and two buildings currently used as a nursery (see *Photographs 2661/OPA-S5/P1, P2 and P3*). It is proposed to renovate the original Toll House for use as a community facility, demolish the other building and remove large areas of hardstanding in order to construct up to 68 one, two and three bedroom apartments and a new purpose built nursery. The current and proposed land uses are shown on *Drawing 2661/OPA-S5/01*.

6.4 Baseline conditions

6.4.1 Landform

The ground elevation within the Application Area declines northeastwards from approximately 18.6 mAOD to17.4 mAOD.

6.5 Hydrology

A poorly maintained drainage ditch is located immediately southeast of the site adjacent to Portsmouth Road. Three small waterbodies are located in the vicinity of the site, two of these waterbodies are located up to 140 m northwest of the Application Area and the third approximately 140 m to the north.

6.6 Geology

The area of the site is underlain directly by the Claygate Member, with no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-S5/02*.

The Claygate Member comprises dark grey clays with sand laminae, passing up into thin alternations of clays, silts and fine-grained sand, with beds of silt. Its average thickness is 16 m in the London area.

6.7 Fluvial flood mapping

The Application Area is located within the Environment Agency's indicative Flood Zone 1, where the probability of fluvial flooding in any one year is less than 1 in 1,000 (Annual Exceedance Probability, AEP <0.1%) (*Drawing 2661/OPA-S5/03)*. There are generally few restrictions in terms of flood risk to development within Flood Zone 1, the exception being for development over 1 ha in extent, for which Flood Risk Assessment must be undertaken.

The Application Area is 0.99 ha in size, therefore a Flood Risk Assessment is not required.

6.8 Drainage characteristics

The Application Area is located within Flood Zone 1 and therefore not deemed to be at risk of fluvial flooding. There is no history of fluvial flooding within the Application Area.

The majority of the southern section of the site is noted as being at a low, medium and high risk of surface water flooding, with a likelihood of flooding up to 3.3%, the extent of which are shown on *Drawing 2661/OPA-05/04*. This coincides with an area of pooled surface water shown on the satellite image on *Drawing 2661/OPA-05/01*.

The majority of the site comprises hardstanding which slopes gently eastwards. Site experience also indicates an area immediately north of the site to be waterlogged in part.

The site is located on Claygate Member and London Clay which are impermeable. The natural drainability of the sub-surface is therefore poor and infiltration in the vicinity of the site is not considered to be viable.

Three "soakaways" are shown on the 'as-built' infrastructure plan (see *Drawing 2661/OPA-S5/05)*. A buried pipe conveys water northeastwards from them to a flow balancing pond. The outfall from the pond is north-northwestwards, ultimately discharging to the watercourse which parallels the northern boundary of Sandown Park.

6.9 Assessment of flood risk and drainage

6.9.1 Flood risk to the development

The situation of the Application Area within Flood Zone 1 and the absence of potential for fluvial flooding is such that flood risk to the proposed development is not anticipated.

There are areas designated as at low, medium and high risk of surface water (pluvial) flooding, however the existing surface water drainage across the site will be improved by the development. Therefore surface water flooding to the proposed development is not anticipated.

6.9.2 Flood risk from the development

The majority of the surrounds of the Application Area is also located within Flood Zone 1 which is classified as having a 'very low' fluvial flood risk. Other areas approximately 100 to 250 m north of the site are located in Flood Zone 2 which is classified as having a 'medium' fluvial flood risk.

The proposed development will modify the run-off characteristics of the site due to the change in the ground profile and surface cover. The existing surface water management system is to be improved upon as part of the development and will ensure that volumes of surface water run-off can be retained and attenuated within the site boundary. The surface water drainage within the proposed development will be designed to manage volumes of off-site discharge to rates equivalent to the greenfield run-off rate.

Therefore the development is not anticipated to increase fluvial or pluvial flood risk to external receptors.

6.9.3 Drainage requirements

Infiltration to ground via soakaway would appear not to be feasible at this site. Therefore discharge to a watercourse utilising the existing disposal route is recommended. SuDS methods to retain and temporarily store water generated during storm events prior to discharge off-site would be required, to limit flood risk to flood receptors downstream, and to conform to best practice.

Small soil bunds will be added into the proposed soft landscape areas surrounding the western extent of the proposed parking area, in order to prevent any 'low' to 'medium' surface water flows entering from off-site. Post-development the 'high' risk area shown on *Drawing 2661/OPA-05/04* will no longer exist as the new parking area will be positively drained via gullies to below ground geo-cellular storage prior to discharging into the existing soakaways. The geo-cellular storage will be sized appropriately for the 1 in 100-year event and located beneath proposed hardstanding parking areas, which comprises an area of approximately 2,500 m^2. The geo-cellular storage will provide 543.5 m^3 for the 1 in 100-year plus 20% climate change event, assuming discharge to the watercourse at the greenfield

Q_{BAR} rate of 2.9 l/s. The outfall from the site to the existing drainage network (see Section 6.8) would be located along the western boundary.

The surface water drainage within the proposed development will need to manage off-site discharge to rates equivalent to the greenfield run-off rate. The Surrey County Council Surface Water Drainage Summary Pro-forma (2017) has been completed for the site, which provides data and details of the proposed drainage provision.

6.9.4 Betterment

The proposed development is an opportunity for betterment of the existing drainage and water management across the Application Area. If SuDS methods to retain and attenuate water are incorporated into the development design, it is considered that the risk of increasing flood risk to or from the development is 'very low'.

6.10 Summary and conclusions

The Application Area is located at the southeastern boundary of Sandown Park and is 0.99 ha in size.

The site is located within the Environment Agency's indicative Flood Zone 1, where the probability of fluvial flooding in any one year is less than 1 in 1,000 (Annual Exceedance Probability, AEP <0.1%). Therefore, the site is not deemed to be at risk of fluvial flooding. There is no history of flooding within the site and it is less than 1 ha in size, hence a Flood Risk Assessment is not required.

Areas of the site are noted as being at low, medium and high risk of surface water flooding, with a likelihood of flooding up to 3.3 %, however these are likely to be improved upon as a result of the development.

Soakaways are unlikely to be successful at the site, therefore drainage designs will need to attenuate storm run-off such that discharge from the site will not exceed greenfield run-off rates.

2661/OPA-S5/01: Existing development
Google earth imagery (May 2018)

2661/OPA-S5/01: Proposed development

Please note drawings are illustrative

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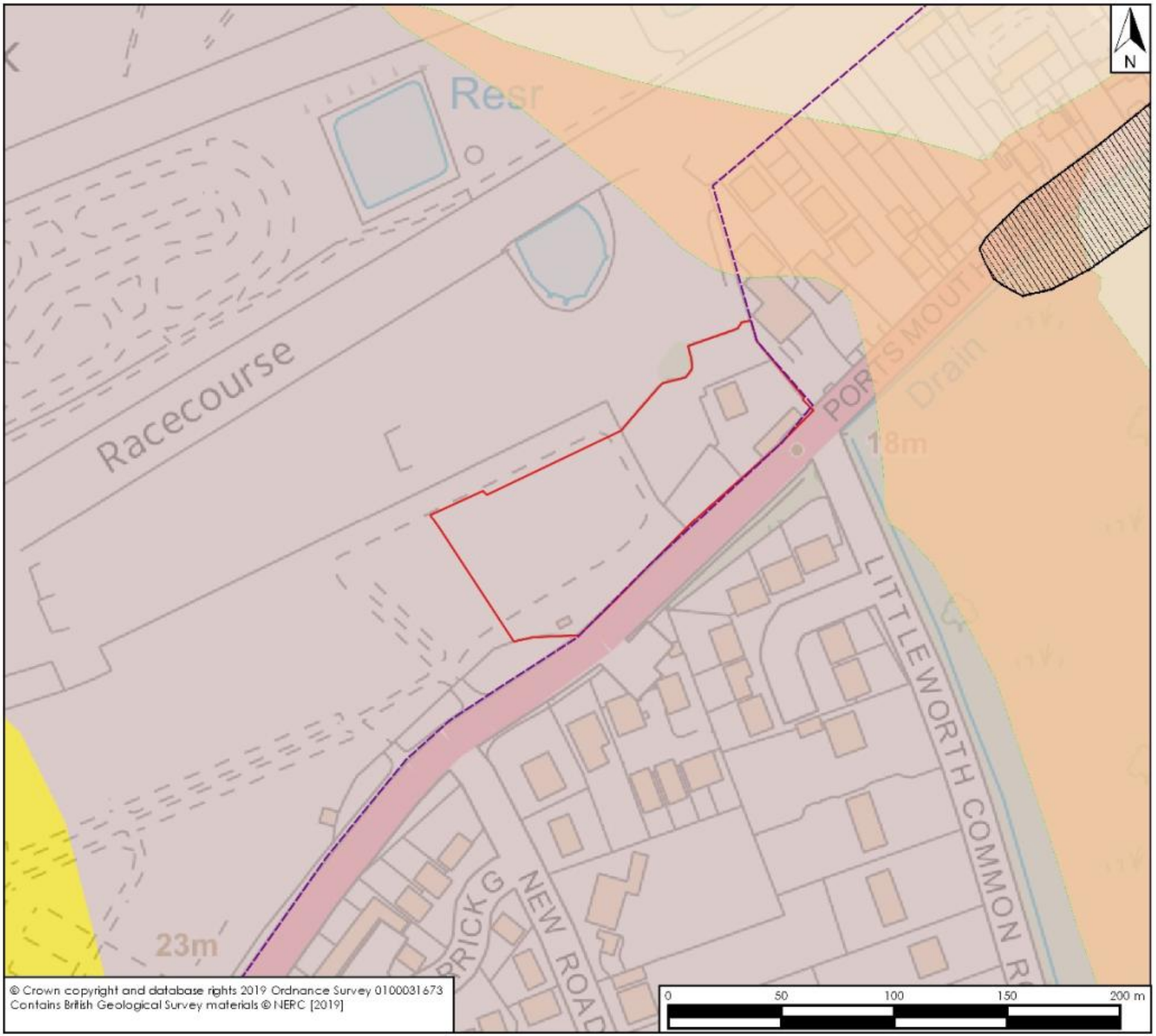
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-S5/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Land Holding
- Site 5 Application Area
- Artificial ground

Superficial Geology

- Kempton Park Gravel Member
- River Terrace Deposit (Undiff)

Bedrock Geology

- Claygate Member

Scale correct at A4

Client	Rapleys LLP
Title	Geology
Project	Sandown Park
Drawing	2661/OPA-S5/02
Version	2
Date	Jan 19
Scale	1:2,500

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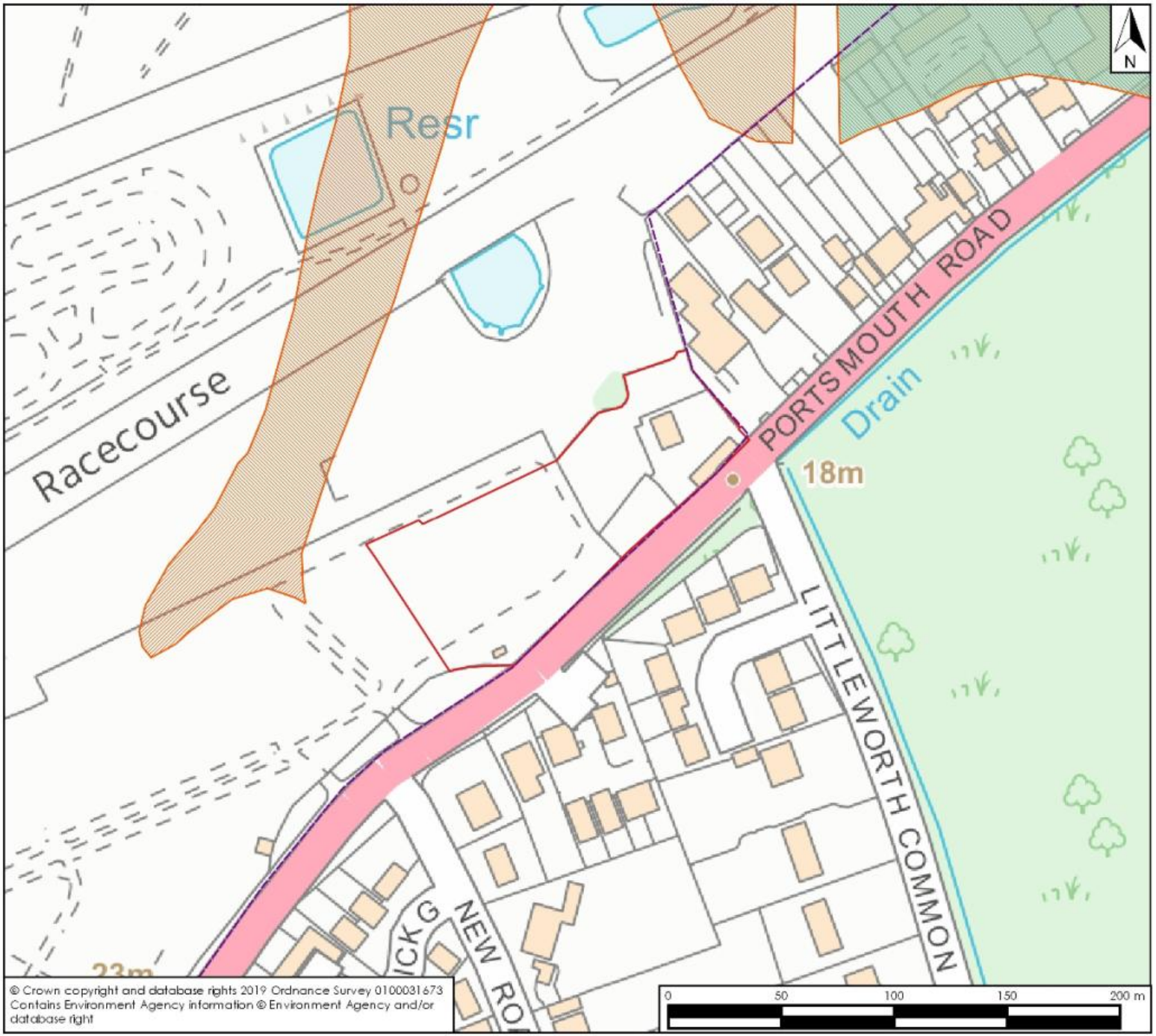

Legend

- Landholding
- Site 5 Application Area

Flood Risk Zones

- Flood Zone 3: High Risk
- Flood Zone 2: Medium Risk
- Flood Zone 1: Low Risk

- Historical Flooding

Scale correct at A4

Client	Rapleys LLP
Title	Fluvial flood risk and historical flooding
Project	Sandown Park
Drawing	2661/OPA-S5/03
Version	2
Date	Jan 19
Scale	1:2,500

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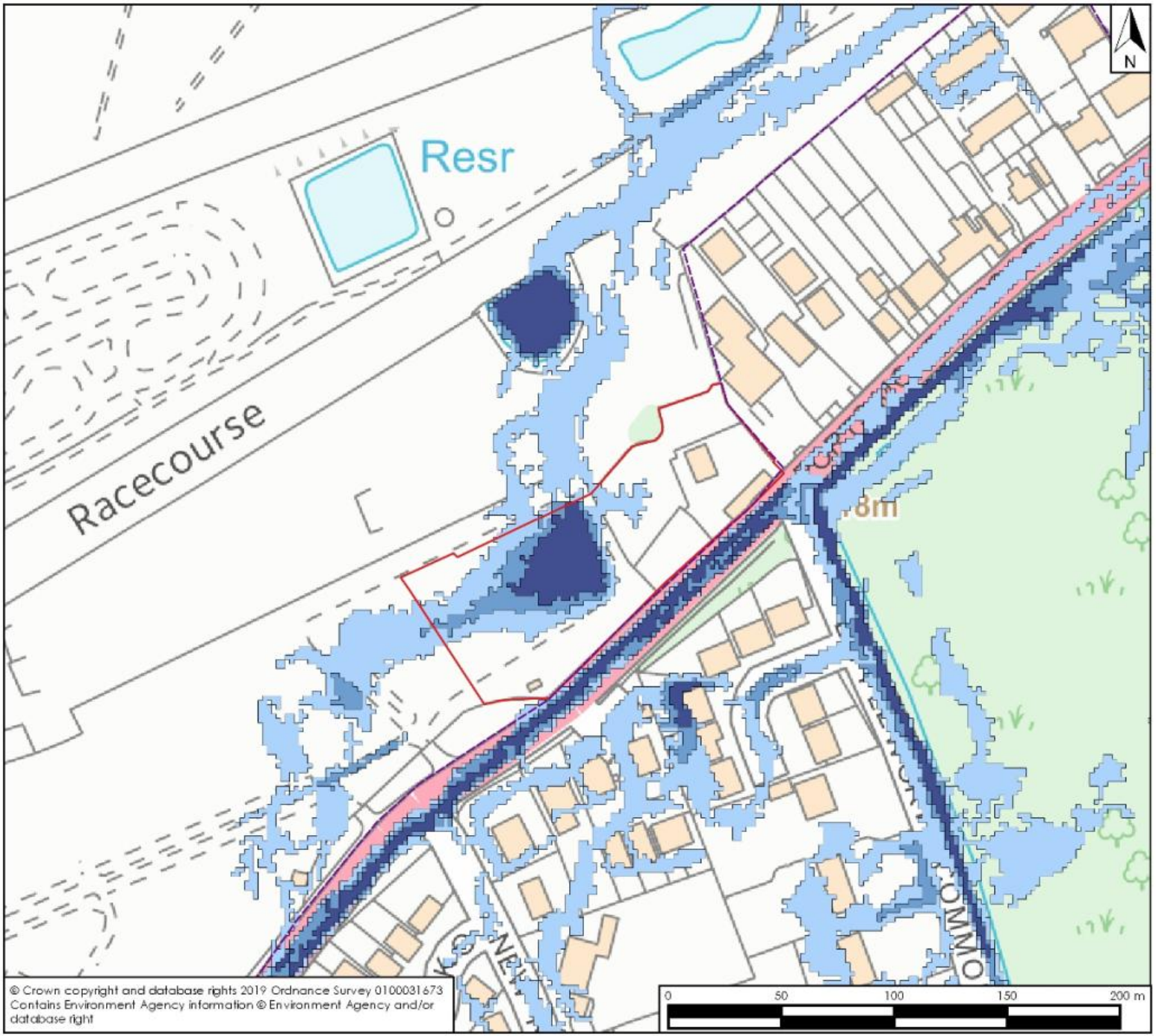

Legend

Landholding

Site 5 Application Area

Surface water flood risk

- High Risk
- Medium Risk
- Low Risk
- Very Low Risk

Scale correct at A4

Client	Rapleys LLP
Title	Surface water flood risk
Project	Sandown Park
Drawing	2661/OPA-S5/04
Version	2
Date	Jan 19
Scale	1:2,500

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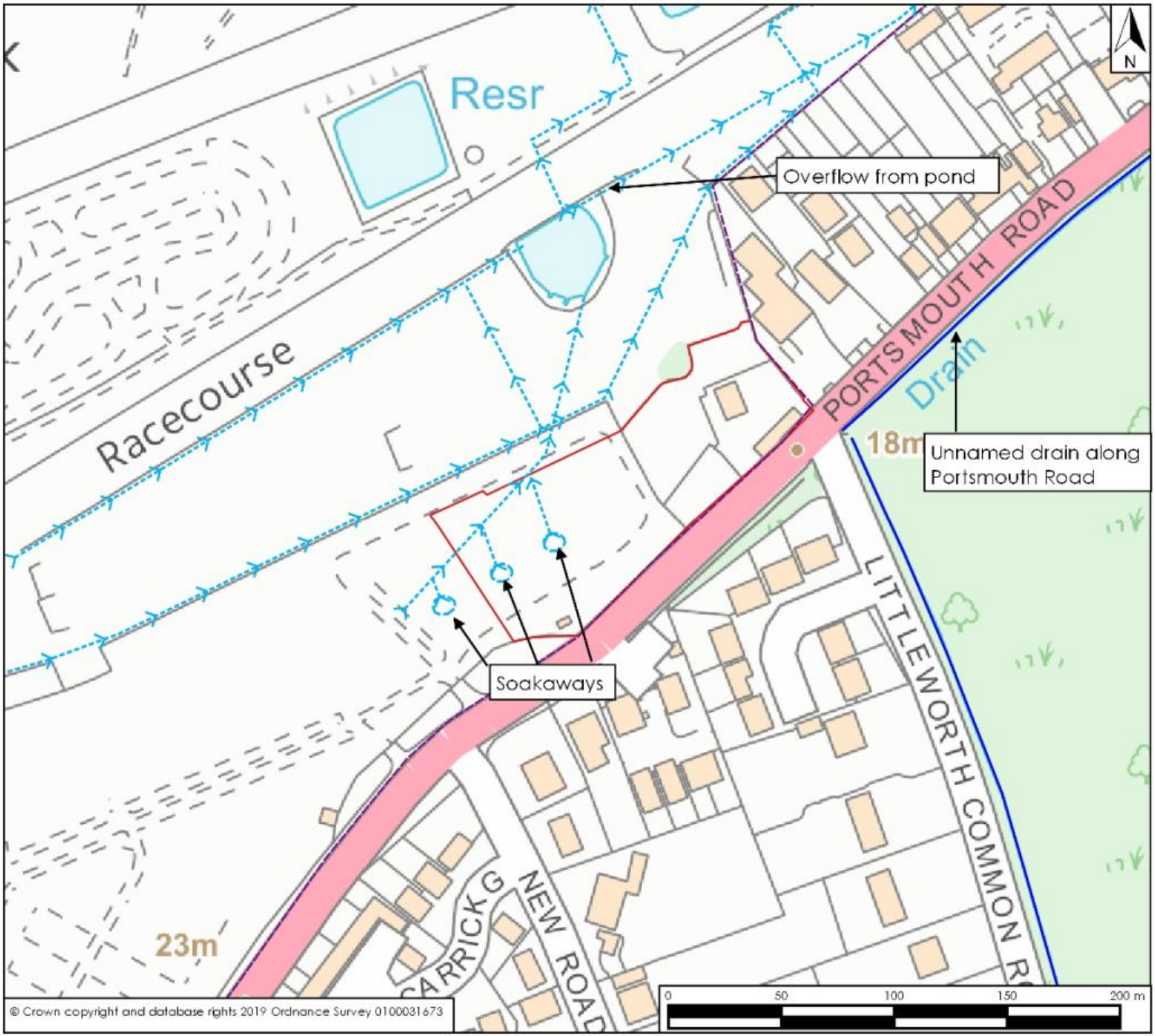

Legend

- Landholding
- Site 5 Application Area
- Watercourse
- Approximate location of existing surface water drains

Scale correct at A4

Client	Rapleys LLP
Title	Existing drainage
Project	Sandown Park
Drawing	2661/OPA-S5/05
Version	2
Date	Jan 19
Scale	1:2,500

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Surface Water Drainage Summary Pro-forma (2017)

Introduction (with links)

Surrey County Council recommends that this pro-forma should be completed in full and accompany the submitted drainage statement and sufficient additional evidence to confirm the information supplied. This information should be submitted with any planning application which seeks permission for 'major' development. This information contained in this form will be used by Surrey County Council in its role as Lead Local Flood Authority and 'statutory consultee' on SuDs for all 'major' planning applications. The pro-forma follows the national non-statutory technical SuDS standards (Defra 2015) is supported by the Defra/EA Guidance on Rainfall Runoff Management and can be completed using freely available tools including SuDS Tools. The pro-forma should be considered alongside other supporting SuDS Guidance (particularly the LASOO Guidance available online), but focuses on NPPF paragraphs 103 and 109: ensuring flood risk is not increased on or off-site and using SuDS as the primary drainage option. The SuDS solution must operate effectively for as long as the development exists and consideration of maintenance and management must be clearly demonstrated throughout its lifetime.

A summary of the evidential information to be provided at each stage of planning is provided in Appendix A

Pre-application advice (fees may apply) and existing flood risk information is available from Surrey County Council – SuDS@surreycc.gov.uk

1. Site Details

Site/development name	Site 5 – Villas Residential and day nursery
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 144 653
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	9,949 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.49 ha (this is the total proposed impermeable area)
REFERENCES of topographical survey plan showing existing site layout, drainage system and site levels	*Permeable and impermeable area measurements are based on Drawing 11071FE_101_E_Masterplan-A0.dwg (dated 23rd January 2019)*

***** The Greenfield runoff off rate from the development should either be calculated for the entire area or the part that forms the drainage network for the site; whatever the size of site and type of drainage technique. See section 3. Greenfield runoff rate is to be used to assess the requirements for limiting discharge flow rates and attenuation storage for the same area as chosen for greenfield rates. Please refer to the EA Rainfall Runoff Management document or CIRIA manual for further details.

2. Impermeable Area and Existing Drainage

	Existing (E)	Proposed (P)	Difference (P-E)	NOTES AND REQUIRED EVIDENCE
Impermeable area (Ha) (plan of areas and values) A 10% addition for urban creep to be included within proposed area	0.61	0.49	-0.12* * 10% urban creep not added due to reduction in impermeable area	If the proposed amount of impermeable surface is greater than existing, then runoff rates and volumes will increase and will need to be attenuated. The national standards require that runoff for previously developed sites should be as close to greenfield rates/volumes as possible. **Evidence: Plan showing impermeable areas, total area calculations +10% urban creep**
Existing Drainage Method (infiltration/watercourse/sewer)				**Evidence: Existing drainage plan showing location of drainage elements**

3. Proposed Surface Water Discharge Method according to SuDS Hierarchy (see Appendix B)

SUDS HIERARCHY (see Appendix B)	Proposed (tick all that apply)	Reference of evidence that this is possible or not practicable	NOTES AND REQUIRED EVIDENCE Evidence must be provided to demonstrate that the proposed Sustainable Drainage proposal has had regard to the SuDS hierarchy
Reduced at source			**Evidence: Details of amount of runoff reduced and storage provided**
Infiltration to ground			**Evidence: The results of infiltration tests in soakaway locations. If infiltration is deemed not viable clear site specific evidence must be provided** see Section 6 (infiltration)
Attenuated volume and discharge to watercourse	✓	Development/improvement to soakaway system currently in place	**Evidence: Details of any watercourse to which the site drains including cross-sections of any adjacent water courses for appropriate distance upstream and downstream of the discharge point (as agreed with the LLFA and/or EA)** see Section 7 (attenuated discharge)
Attenuated volume and discharge to surface water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)
Attenuated volume and discharge to combined/foul water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)

	Drawings provided	NOTES AND REQUIRED EVIDENCE
Drawings and Details (e.g. Existing and proposed drainage, Topography, Impermeable areas, cross sections of SuDS elements)	Drawings not included at outline stage of planning process.	**Evidence:** Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Calculate Peak Discharge Rates – Technical Standards S2 and S3

This is the maximum flow rate at which surface water runoff leaves the site during the critical storm event.

	Greenfield Rates (l/s)	Brownfield rates (l/s) (as appropriate)	Proposed Rates (l/s)	Difference (Proposed-Existing) (l/s)	NOTES AND REQUIRED EVIDENCE
Qbar	2.9	-	-	-	Mean annual Greenfield peak flow - QBAR is approx. 1 in 2 storm events. **Qbar**$_{rural}$ should be used for this value. If the site is currently developed, the appropriate figures should be used to calculate Qbar (and associated rates) in proportion to the amount of existing hardstanding present on the site. Use Qbar$_{rural}$ and Qbar$_{urban}$ as appropriate and prorata'd to effectively model the site.
1 in 1	1.29	6.7	2.9	-3.8	Proposed discharge rates (with mitigation) should be as close to greenfield as possible and should be no greater than existing rates for all corresponding storm events. To mitigate for climate change the proposed 1 in 100 +CC must be no greater than the existing 1 in 100 runoff rate. If not, flood risk increases under climate change. See appendix 2 for climate change allowances. **Evidence: Micro-drainage (or equivalent) calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology**
1 in 30	3.90	17.7	2.9	-14.8	
1in 100	5.49	23.3	2.9	-20.4	
1 in 100 plus 20% climate change *	N/A	N/A	2.9	-	

5. Calculate discharge volumes - Technical Standards S4 to S8

The total volume of water leaving the development site for a particular rainfall event. Introducing new impermeable surfaces increases surface water runoff and may increase flood risk outside the development.

	Greenfield Volume (m^3)	Brownfield Volume (m^3) (as appropriate)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	NOTES AND REQUIRED EVIDENCE
1 in 1	40.8	144.8	79.7	-65.1	Proposed discharge volumes (without mitigation) should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased attenuation must be provided to reduce volume outflow during the event. To mitigate for climate change the volume discharge from site must be no greater than the existing 1 in 100 storm event. **Evidence: Micro-drainage (or equivalent) calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology**
1 in 30	123.0	382.8	308.5	-74.3	
1in 100	173.0	502.7	434.1	-68.6	
1 in 100 plus 20% climate change *	N/A	N/A	543.5	-	

* Climate Change Allowance for Rainfall Intensity Increases

Designs should include 20% provision for increases in surface water runoff due to climate change during the development's lifetime – please see Appendix C

6. Infiltration

If infiltration is proposed – sufficient evidence must be provided to show that this is viable and does not increase flood risk

	SITE INFORMATION	Details	NOTES AND REQUIRED EVIDENCE
Is infiltration feasible?	**Yes/No?**	No. Site investigation required to confirm that infiltration is not possible at this location.	**Evidence: If deemed NOT FEASIBLE clear site specific evidence (site investigation, site photos, infiltration testing) must be provided to demonstrate why**
Infiltration information	**Site Geology** (bedrock and superficial)	N/A	Avoid infiltrating in made ground. **Evidence: suitable mapping/SI**
	Is ground water table less than 3m below ground?		If yes, please provide details of the site's hydrology. **Evidence : Site Investigation**
	Is the site within a known Source Protection Zones (SPZ) or above a Major Aquifer?		Refer to Environment Agency website to identify and source protection zones (SPZ). **Evidence: Adequate water treatment stages must be provided**
	Infiltration rate used in calculations		Infiltration rates should be no lower than $1x10^{-6}$ m/s. **Evidence: infiltration testing according to BRE 365 or equivalent**
	Were infiltration rates obtained by desk study or on site infiltration testing?		**Evidence: Infiltration rates solely estimated from desk studies are only suitable at outline planning applications unless clear site specific evidence can be provided and a back-up attenuation scheme is provided**
	Is the site contaminated? If yes, consider advice from EA on whether infiltration is acceptable.		Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered

Design details	**Infiltration type** (soakaway, deep bore, blanket etc)	N/A	**Evidence: Suitable designs must be provided**
	Storage volume provided within infiltration feature (m^3)		Infiltration must be designed to ensure that at a minimum no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event **Evidence:. Calculations showing available volume of proposed infiltration device and storage. Plan and Cross sectional drawings of proposed infiltration.**
	State the vertical distance between any proposed infiltration device base and the normal ground water (GW) level		1m (min) is required between the base of the infiltration device & the water table to protect groundwater quality & ensure groundwater doesn't enter infiltration devices.
	Half drain times of infiltration features (hr)		**Evidence: Suitable calculations**
	Factor of safety used in infiltration calculations		**Evidence: Suitable calculations**
	Minimum distance of infiltration from buildings		**Evidence: Minimum distance should be >5m unless designed specifically to reduce impact on adjacent buildings.**

7. Attenuated storage

In order to minimise the negative impact on flood risk resulting from any increase in runoff rate or volume from the proposed development, attenuation storage must be provided. Installed flow restriction and stored the attenuation volumes should ensure final discharge from the site at the rates and volumes set out in sections 4 and 5. If some of the stored volume of water can be infiltrated back into the ground, the remainder can be discharged at a rate at or below greenfield rates. A combined storage calculation using the partial infiltration rate and the attenuation rate used to slow the runoff from site.

ATTENUATION DETAILS	Details	NOTES AND REQUIRED EVIDENCE
How are flow rates being restricted?	Water will be attenuated and stored, to be released to the adjacent drainage ditch at no greater than the QBAR greenfield rate. Further design details are required for design of SuDS scheme for this site. However it is possible that features such as swales, pervious pavements and underground storage tanks may be used to retain water on site prior to release at the greenfield rate.	Hydrobrakes can be used where rates are >2l/s. Orifice plates with an opening <75mm in open systems may require pre-screening.

Storage volume provided (m^3) (excluding non-void spaces)	Attenuation storage will be provided for the 1 in 100 year plus climate change event, which is taken as 543.5 m^3	Volume provided to attenuate on site to discharging at existing rates. See section 5. **Evidence: Attenuation must be designed to ensure that at no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event. A 10% additional allowance should be included for underground attenuation systems which cannot be fully accessed/cleansed as well as the provision of u/s siltation protection and access/jetting points. Calculations showing available volume of proposed attenuation storage. Plan and Cross sectional drawings of proposed storage**
How will the storage be provided on site?	Swales, pervious pavements and underground storage tanks may be used.	
Half drain times of attenuation feature (hr)	TBC	**Evidence: suitable calculations to show feature**

8. Construction and Exceedance Planning - Technical Standards S9 and S14

CONSIDERATION	Details	NOTES AND REQUIRED EVIDENCE
How will exceedance/infrastructure failure events be catered on site without significantly increasing flood risks (both on site and outside the development)? Technical Standard S9	No flooding will occur in a 1 in 100-year (+CC) event. Should a flood occur that exceeds this, water will discharge downslope. Further information to be provided at detailed design stage.	**Evidence: Topographic plan showing flow routes for events above those designed – routing of water away from existing properties and critical infrastructure**. Retained water should not cause property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths and not preventing safe access/egress
Drainage during construction period: temporary drainage, pollution prevention and protection of existing/part built drainage systems. Technical Standard S14	Details to be provided at detailed reserved matters stage. Drainage works and pollution prevention measures adopted during construction will conform to current required standards and industry best practice.	Provide details of how drainage will be managed during the construction period including any necessary connections, impacts, diversions and erosion control. How pollution prevention for any local watercourses will be considered – especially siltation from runoff **Evidence: Construction phasing plan, construction environmental management plan (CEMP) or other statements**

9. Management and Maintenance of SuDs - Technical Standards S10 to S12

Details are required to be provided of the management and maintenance plan for the SuDS, including for the individual plots, in perpetuity.

How is the entire drainage system to be maintained in perpetuity?

Further information to be provided at detailed design stage, however the following information is included as guidance.

Drainage Feature	Schedule	Required Action	Frequency
Swales	Regular Maintenance	Remove litter and debris	Monthly, or as required
		Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
		Manage other vegetation and remove nuisance plants	Monthly at start, then as required
		Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
		Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly, or when required
		Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
		Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
	Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
	Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
		Re-level uneven surfaces and reinstate design levels	As required
		Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required

Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided to show that all parts of SuDs are effective and robust. It should consider how the SuDs will perform and develop over time anticipating any additional maintenance tasks to ensure the system continues to perform as designed. Responsibility for the management and maintenance of each element of the SUDS scheme will also need to be detailed within the Management Plan. Where open water is involved please provide a health and safety plan within the management plan.

Evidence: A maintenance schedule describes what work is to be done and when it is to be done using frequency and performance requirements as appropriate.

		Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
		Remove and dispose of oils or petrol residues using safe standard practices	As required

Drainage Feature	Schedule	Required Action	Frequency
Pervious Pavements	Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturers recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
	Occasional Maintenance	Stabilise and mow contributing and adjacent areas	As required
		Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
	Remedial Actions	Remediate any landscape which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
		Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a	As required

		hazard to users, and replace lost jointing material	
		Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
	Monitoring	Initial inspection	Monthly for three months after installation
		Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
		Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
		Monitor inspection chambers	Annually

Drainage Feature	Schedule	Required Action	Frequency
Attenuation Storage Tanks	Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
		Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
		For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually
		Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
	Remedial Actions	Repair/rehabilitate inlets, outlets, overflows and vents	As required
	Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that	Annually

			they are in good condition and operating as designed		
			Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required	
Please confirm the owners/adopters of the entire drainage system throughout the development. Please list all the owners.	Jockey Club Racecourses Ltd				If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit should be submitted **Evidence: statement of ownership or plan on complex sites**
Please demonstrate that any third party agreements required for adoption or using land outside the application site have been secured.	N/A				**Evidence: proof of agreements (at least in principle at planning approval stage) with adopters or external landowners**

10. Additional Considerations to comply with the Technical Standards and other legislation

Water Quality – Appropriate level and stages of water treatment must be used to prevent pollution of the environment (SuDS manual CIRIA C753)

S10 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

S11 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use. (e.g. BS or kitemarked)

S12 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

S13 The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.

The above form should be completed using evidence from information which should be appended to this form/within the planning submission. The information being submitted should be proportionate to the site conditions, flood risks and magnitude of development. It should serve as a summary of the drainage proposals and should clearly show that the proposed discharge rate and volume as a result of development will not be increasing. Where there is an increase in discharge rate or volume due to development, then the relevant section of this form must be completed with clear evidence demonstrating how the greenfield rates (or as close to them as possible if a brownfield site) will be met.

This form is completed using factual information and can be used as a summary of the surface water drainage strategy on this site.

Form completed by:……Rebecca John…….(Checked by Richard Laker)…….....

Contact details: Tel.....01743 355770.....Email.....chris@hafrenwater.com.....

Qualification of person responsible for signing off this pro-forma: .....Environmental Consultant……(BSc FGS)…….....

Company:…….Hafren Water……..……,.....

On behalf of (Client's details): .....Rapleys LLP.....

Date:…….January 2019…….....

Appendix A

Evidence to be submitted at each stage of planning

Pre-app	Outline	Full	Reserved	Discharge	Document submitted
✓	✓	✓			Flood Risk Assessment/Statement
✓	✓	✓			Drainage Strategy/Statement & sketch layout plan
	✓				Preliminary layout drawings
	✓				Preliminary "Outline" hydraulic calculations
	✓				Preliminary landscape proposals
	✓				Ground investigation report (for infiltration)
	✓	✓			Evidence of third party agreement for discharge to their system (in principle/ consent to discharge)
		✓		✓	Maintenance program and on-going maintenance responsibilities
		✓	✓		Detailed development layout
		✓	✓	✓	Detailed flood & drainage design drawings
		✓	✓	✓	Full Structural, hydraulic & ground investigations
		✓	✓	✓	Geotechnical factual and interpretive reports, including infiltration results
		✓	✓	✓	Detailed landscaping details
		✓	✓	✓	Discharge agreements (temporary and permanent)
		✓	✓	✓	Development Management & Construction Phasing Plan

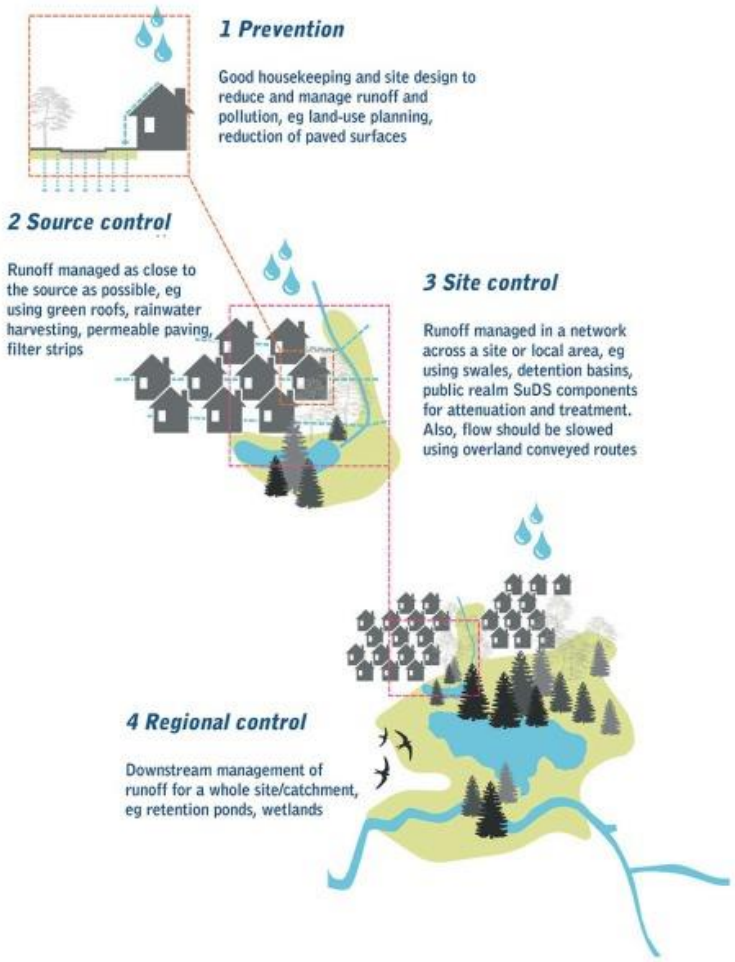
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

At Outline Planning stage enough evidence must be provided to prove that a viable method of draining the site has been provided which does not increase local flood risk

At Full Application, Discharge of Conditions or Reserved Matters stage suitable evidence must be provided to show that all the requirements of the national standards have been met

Appendix B

SuDS Treatment Train



Dickie, S, McKay, G, Ions, L, Shaffer, P (2010) Planning for SuDS – making it happen, C687, CIRIA, London (ISBN: 978-0-86017-687-9).

Discharge Hierarchy

Sustainability Hierarchy

DISCHARGE CHOICE		SUSTAINABILITY CHOICE				
Discharge Hierarchy	**SuDS Type**	**Sustainability Level**	**SuDS Technique**	Flood Reduction	Pollution Reduction	Wildlife & Landscape Benefit
MUST BE CONSIDERED FIRST	**Source Control**	MOST SUSTAINABLE (PREFERRED)	**Green/Living Roofs & Walls**	✓	✓	✓
	OPTION 1 Infiltration To Ground		**Infiltration:** • Infiltration trenches & basins • Soakaways: (standard or crate system)	✓	✓	✓
	OPTION 2 Attenuation and Discharge: **To Pond, Ordinary Watercourse or Main River**		**Filter strips and Swales**	✓	✓	✓
			Basins and ponds: • Wetlands • Balancing Ponds • Detention Basins • Retention Basins • Conveyance swales	✓	✓	✓
	OPTION 3 Attenuation and Discharge **a) To Surface Water Sewer** **b) To Combined Sewer**		**Permeable Surfaces & filter drains:** • Gravelled areas • Porous paving	✓	✓	
ONLY IF ALL OTHER OPTIONS ARE UNVIABLE	**OPTION 4 Attenuation and Discharge** **To Foul or Highways sewer (only in exceptional circumstances)**	LEAST SUSTAINABLE	**Tanks & Piped Systems:** • Crated Attenuation • Tanks • Oversize pipes	✓		

Appendix C

Climate change allowances

In February 2016 there was a change to the EA climate change advice to modify the allowance levels for rainfall when designing surface water drainage: to 20% CC allowance for 1 in 100 year events but with a 40% sensitivity test. (please note the advice for river flow levels also changed – please contact the Environment Agency for more details)

Applicants should design the discharge rates and attenuation on site to accommodate the 1:100 year +20% CC event and understand the flooding implications for the +40% CC event.

If the implications are significant i.e. the site contains "highly vulnerable" or "critical infrastructure" receptors, could flood another development or put people at risk then a view should be taken to provide more attenuation to meet the 40% CC event. This will tie into designing for exceedance principles.

An example: Attenuation basin designed to accommodate the 1:100 year + 20% climate change event, during the modelling of the 40% cc event the water level of the basin rises by 340mm, which equates to 40mm over the 300mm already freeboard provided. Therefore a suitable mitigation would be to provide freeboard of 350mm instead of 300mm, in order to ensure the development doesn't flood third parties downstream for the extreme 40% cc scenario.

Extract taken from Environment Agency publication; *Adapting to Climate Change: Advice for Flood and Coastal Risk Management Authorities:*

What are the climate change allowances?

To assess the potential impacts that climate change may have on extreme rainfall, river flood flows, sea level rise and storm surges, climate change allowances are provided in Annex 1. The climate change allowances quantify the potential change (as either mm or percentage increase, depending on the variable) to the baseline. The climate change allowances are based on the best available, credible, peer-reviewed scientific evidence from UKCP09, but given the complexity of the science around climatic projections, there are significant uncertainties attributed to the climate change allowances. This is why the climate change allowances are presented as a range of possibilities (Lower, Central, Higher Central and Upper), to reflect the potential variation in climate change impacts over three epochs from the present day to 2115. It is recommended that the performance of flood risk management options are assessed against all of the change allowances covering the whole of the decision lifetime.

Change to extreme rainfall intensity compared to a 1961-90 baseline Applies across all of England			
Climate Change scenario	**Total potential change anticipated for '2020s' (2015-39)**	**Total potential change anticipated for '2050s' (2040-2069)**	**Total potential change anticipated for '2080s' (2070-2115)**
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

Greenfield Runoff Estimate for SITE 5

Institute of hydrology report no. 124 (IH124)

$$Q_{BAR(rural)} = 0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}$$

Where:

$Q_{BAR(rural)}$	mean annual flood (return period 2.3 years) (m^3/s)
AREA	catchment area (km^2)
SAAR(4170)	standard average rainfall for the period 1941 to 1970 (mm)
SOIL	soil index

$Q_{BAR(rural)}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

Parameters	
Area	0.0099 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	2.9 l/s
Q (1in1yr)*	2.4 l/s
QBAR	2.9 l/s/ha
Q (1in1yr)	2.5 l/s/ha
Q (1in100yr)	9.2 l/s/ha

NB: calculation based on 0.5 km2 and then scaled down to actual catchment size. The IH124 methodology is designed for sites > 0.5 km2 but can be linearly interpolated to represent smaller catchments.

Q (1in1yr)*: 1 year return period growth curve factors are taken from NERC (1977). 30 year (and 1 year for Ireland) return period growth curve factors are interpolated estimates (Source: *CIRIA SuDS Manual C753*)

Return period (yr)	**1**	**2**	**5**	**10**	**25**	**30**	**50**	**100**	**200**
Q (l/s/ha)	2.5	2.5	3.7	4.7	6.2	7.0	7.6	9.2	11.2
Q (l/s)	2.4	2.5	3.7	4.7	6.2	6.9	7.5	9.2	11.1

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www.hafrenwater.com

Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE 5, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:20:20 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 564B-BE6D

Site name: Sandown Park - Site 5

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.01 [0.01]*

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.01
Total Rainfall (mm):	15.02	Total flow (ML):	0.04
Peak Rainfall (mm):	1.07	Peak flow (m^3/s):	0.00

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:42:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:06:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	1	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	40.7	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.0809	0.0000	0.0071	0.0000	0	0
00:10:00	0.0944	0.0000	0.0083	0.0000	4.11E-09	1.07E-06
00:20:00	0.1101	0.0000	0.0097	0.0000	2.53E-08	4.47E-06
00:30:00	0.1284	0.0000	0.0114	0.0000	8.29E-08	1.06E-05
00:40:00	0.1496	0.0000	0.0133	0.0000	1.99E-07	2E-05
00:50:00	0.1743	0.0000	0.0155	0.0000	4.01E-07	3.31E-05
01:00:00	0.2030	0.0000	0.0181	0.0000	7.17E-07	5.06E-05
01:10:00	0.2363	0.0000	0.0211	0.0001	1.18E-06	7.17E-05
01:20:00	0.2749	0.0000	0.0246	0.0001	1.8E-06	9.5E-05
01:30:00	0.3196	0.0000	0.0288	0.0001	2.61E-06	0.000121
01:40:00	0.3712	0.0000	0.0336	0.0001	3.62E-06	0.000151
01:50:00	0.4309	0.0000	0.0392	0.0002	4.86E-06	0.000184
02:00:00	0.4995	0.0000	0.0457	0.0002	6.36E-06	0.000221
02:10:00	0.5782	0.0000	0.0532	0.0003	8.14E-06	0.000264
02:20:00	0.6682	0.0000	0.0620	0.0003	1.03E-05	0.000313
02:30:00	0.7700	0.0000	0.0721	0.0004	1.28E-05	0.00037
02:40:00	0.8833	0.0000	0.0836	0.0004	1.57E-05	0.000436
02:50:00	1.0028	0.0000	0.0961	0.0005	1.92E-05	0.000512
03:00:00	1.0687	0.0000	0.1037	0.0006	2.32E-05	0.0006
03:10:00	1.0028	0.0000	0.0986	0.0007	2.79E-05	0.0007
03:20:00	0.8833	0.0000	0.0878	0.0008	3.34E-05	0.000809
03:30:00	0.7700	0.0000	0.0773	0.0009	3.96E-05	0.000922
03:40:00	0.6682	0.0000	0.0677	0.0010	4.66E-05	0.00103
03:50:00	0.5782	0.0000	0.0590	0.0011	5.44E-05	0.00113
04:00:00	0.4995	0.0000	0.0513	0.0011	6.27E-05	0.00121
04:10:00	0.4309	0.0000	0.0445	0.0012	7.14E-05	0.00126
04:20:00	0.3712	0.0000	0.0385	0.0012	8.04E-05	0.00129
04:30:00	0.3196	0.0000	0.0333	0.0012	8.93E-05	0.00129
04:40:00	0.2749	0.0000	0.0287	0.0012	9.81E-05	0.00127
04:50:00	0.2363	0.0000	0.0248	0.0011	0.000107	0.00123
05:00:00	0.2030	0.0000	0.0213	0.0011	0.000115	0.00118
05:10:00	0.1743	0.0000	0.0184	0.0010	0.000122	0.00113
05:20:00	0.1496	0.0000	0.0158	0.0009	0.000129	0.00106
05:30:00	0.1284	0.0000	0.0136	0.0009	0.000135	0.000998
05:40:00	0.1101	0.0000	0.0116	0.0008	0.000141	0.00093

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.0944	0.0000	0.0100	0.0007	0.000146	0.000861
06:00:00	0.0809	0.0000	0.0086	0.0006	0.000151	0.000792
06:10:00	0.0000	0.0000	0.0000	0.0006	0.000155	0.000725
06:20:00	0.0000	0.0000	0.0000	0.0005	0.000159	0.00066
06:30:00	0.0000	0.0000	0.0000	0.0004	0.000162	0.000596
06:40:00	0.0000	0.0000	0.0000	0.0004	0.000164	0.000536
06:50:00	0.0000	0.0000	0.0000	0.0003	0.000166	0.00048
07:00:00	0.0000	0.0000	0.0000	0.0003	0.000167	0.000428
07:10:00	0.0000	0.0000	0.0000	0.0002	0.000169	0.000382
07:20:00	0.0000	0.0000	0.0000	0.0002	0.000169	0.00034
07:30:00	0.0000	0.0000	0.0000	0.0001	0.00017	0.000306
07:40:00	0.0000	0.0000	0.0000	0.0001	0.00017	0.000277
07:50:00	0.0000	0.0000	0.0000	0.0001	0.00017	0.000254
08:00:00	0.0000	0.0000	0.0000	0.0001	0.00017	0.000234
08:10:00	0.0000	0.0000	0.0000	0.0000	0.00017	0.000219
08:20:00	0.0000	0.0000	0.0000	0.0000	0.000169	0.000206
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000169	0.000196
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000168	0.000188
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000168	0.000181
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000167	0.000176
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000167	0.000171
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000166	0.000168
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000165	0.000166
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000165	0.000165
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000164	0.000164
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000163	0.000163
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000163	0.000163
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000162	0.000162
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000161	0.000161
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000161	0.000161
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00016	0.00016
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000159	0.000159
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000159	0.000159
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000158	0.000158
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000157	0.000157
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000157	0.000157

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:21:03 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 564B-BE6D

Site name: Sandown Park - Site 5

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.01 [0.01]*

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.04
Total Rainfall (mm):	39.47	Total flow (ML):	0.12
Peak Rainfall (mm):	2.81	Peak flow (m^3/s):	0.00

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:42:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:06:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	1	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	40.7	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2126	0.0000	0.0187	0.0000	0	0
00:10:00	0.2480	0.0000	0.0219	0.0000	1.08E-08	2.82E-06
00:20:00	0.2893	0.0000	0.0257	0.0000	6.67E-08	1.18E-05
00:30:00	0.3374	0.0000	0.0301	0.0000	2.18E-07	2.79E-05
00:40:00	0.3932	0.0000	0.0352	0.0001	5.25E-07	5.26E-05
00:50:00	0.4582	0.0000	0.0413	0.0001	1.06E-06	8.73E-05
01:00:00	0.5336	0.0000	0.0484	0.0001	1.89E-06	0.000134
01:10:00	0.6211	0.0000	0.0568	0.0002	3.11E-06	0.00019
01:20:00	0.7225	0.0000	0.0666	0.0002	4.77E-06	0.000252
01:30:00	0.8399	0.0000	0.0782	0.0003	6.91E-06	0.000322
01:40:00	0.9757	0.0000	0.0919	0.0004	9.6E-06	0.000401
01:50:00	1.1323	0.0000	0.1081	0.0005	1.29E-05	0.00049
02:00:00	1.3127	0.0000	0.1273	0.0006	1.69E-05	0.000592
02:10:00	1.5197	0.0000	0.1499	0.0007	2.17E-05	0.00071
02:20:00	1.7560	0.0000	0.1767	0.0008	2.74E-05	0.000847
02:30:00	2.0235	0.0000	0.2082	0.0010	3.42E-05	0.00101
02:40:00	2.3213	0.0000	0.2448	0.0012	4.23E-05	0.00119
02:50:00	2.6354	0.0000	0.2858	0.0014	5.18E-05	0.00141
03:00:00	2.8086	0.0000	0.3137	0.0016	6.3E-05	0.00167
03:10:00	2.6354	0.0000	0.3030	0.0019	7.62E-05	0.00197
03:20:00	2.3213	0.0000	0.2738	0.0022	9.17E-05	0.0023
03:30:00	2.0235	0.0000	0.2439	0.0025	0.00011	0.00265
03:40:00	1.7560	0.0000	0.2157	0.0029	0.00013	0.00299
03:50:00	1.5197	0.0000	0.1896	0.0032	0.000153	0.00331
04:00:00	1.3127	0.0000	0.1660	0.0034	0.000177	0.00357
04:10:00	1.1323	0.0000	0.1449	0.0036	0.000203	0.00377
04:20:00	0.9757	0.0000	0.1261	0.0036	0.00023	0.00387
04:30:00	0.8399	0.0000	0.1094	0.0036	0.000257	0.0039
04:40:00	0.7225	0.0000	0.0948	0.0036	0.000284	0.00387
04:50:00	0.6211	0.0000	0.0820	0.0035	0.00031	0.00378
05:00:00	0.5336	0.0000	0.0708	0.0033	0.000335	0.00365
05:10:00	0.4582	0.0000	0.0611	0.0031	0.000359	0.00349
05:20:00	0.3932	0.0000	0.0526	0.0029	0.00038	0.00332
05:30:00	0.3374	0.0000	0.0453	0.0027	0.000401	0.00312
05:40:00	0.2893	0.0000	0.0390	0.0025	0.000419	0.00292

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.2480	0.0000	0.0335	0.0023	0.000436	0.00272
06:00:00	0.2126	0.0000	0.0287	0.0021	0.000451	0.00251
06:10:00	0.0000	0.0000	0.0000	0.0018	0.000464	0.0023
06:20:00	0.0000	0.0000	0.0000	0.0016	0.000475	0.0021
06:30:00	0.0000	0.0000	0.0000	0.0014	0.000485	0.0019
06:40:00	0.0000	0.0000	0.0000	0.0012	0.000493	0.00171
06:50:00	0.0000	0.0000	0.0000	0.0010	0.0005	0.00153
07:00:00	0.0000	0.0000	0.0000	0.0009	0.000505	0.00137
07:10:00	0.0000	0.0000	0.0000	0.0007	0.000509	0.00121
07:20:00	0.0000	0.0000	0.0000	0.0006	0.000512	0.00108
07:30:00	0.0000	0.0000	0.0000	0.0005	0.000514	0.000965
07:40:00	0.0000	0.0000	0.0000	0.0004	0.000515	0.000871
07:50:00	0.0000	0.0000	0.0000	0.0003	0.000515	0.000793
08:00:00	0.0000	0.0000	0.0000	0.0002	0.000515	0.000729
08:10:00	0.0000	0.0000	0.0000	0.0002	0.000514	0.000678
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000513	0.000637
08:30:00	0.0000	0.0000	0.0000	0.0001	0.000512	0.000603
08:40:00	0.0000	0.0000	0.0000	0.0001	0.000511	0.000575
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000509	0.000553
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000507	0.000535
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000505	0.000521
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000503	0.000511
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000501	0.000504
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000499	0.0005
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000497	0.000497
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000495	0.000495
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000493	0.000493
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000491	0.000491
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000489	0.000489
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000487	0.000487
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000485	0.000485
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000483	0.000483
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000481	0.000481
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000479	0.000479
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000477	0.000477
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000475	0.000475

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:21:35 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 564B-BE6D

Site name: Sandown Park - Site 5

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.01 [0.01]*

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.06
Total Rainfall (mm):	51.99	Total flow (ML):	0.17
Peak Rainfall (mm):	3.70	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:42:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:06:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	1	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	40.7	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2800	0.0000	0.0247	0.0000	0	0
00:10:00	0.3267	0.0000	0.0289	0.0000	1.43E-08	3.71E-06
00:20:00	0.3811	0.0000	0.0339	0.0000	8.79E-08	1.55E-05
00:30:00	0.4444	0.0000	0.0398	0.0000	2.88E-07	3.69E-05
00:40:00	0.5180	0.0000	0.0467	0.0001	6.92E-07	6.94E-05
00:50:00	0.6035	0.0000	0.0548	0.0001	1.39E-06	0.000115
01:00:00	0.7028	0.0000	0.0643	0.0002	2.5E-06	0.000177
01:10:00	0.8181	0.0000	0.0756	0.0002	4.11E-06	0.000251
01:20:00	0.9517	0.0000	0.0890	0.0003	6.3E-06	0.000333
01:30:00	1.1063	0.0000	0.1048	0.0004	9.14E-06	0.000426
01:40:00	1.2852	0.0000	0.1236	0.0005	1.27E-05	0.000532
01:50:00	1.4915	0.0000	0.1459	0.0006	1.71E-05	0.000651
02:00:00	1.7291	0.0000	0.1725	0.0008	2.24E-05	0.000788
02:10:00	2.0017	0.0000	0.2042	0.0009	2.88E-05	0.000947
02:20:00	2.3130	0.0000	0.2419	0.0011	3.65E-05	0.00113
02:30:00	2.6654	0.0000	0.2867	0.0013	4.56E-05	0.00135
02:40:00	3.0577	0.0000	0.3394	0.0016	5.64E-05	0.00161
02:50:00	3.4714	0.0000	0.3989	0.0018	6.92E-05	0.00191
03:00:00	3.6995	0.0000	0.4410	0.0022	8.44E-05	0.00227
03:10:00	3.4714	0.0000	0.4288	0.0026	0.000102	0.00268
03:20:00	3.0577	0.0000	0.3896	0.0030	0.000124	0.00315
03:30:00	2.6654	0.0000	0.3488	0.0035	0.000148	0.00364
03:40:00	2.3130	0.0000	0.3096	0.0040	0.000176	0.00413
03:50:00	2.0017	0.0000	0.2731	0.0044	0.000208	0.00459
04:00:00	1.7291	0.0000	0.2398	0.0047	0.000242	0.00498
04:10:00	1.4915	0.0000	0.2097	0.0050	0.000278	0.00526
04:20:00	1.2852	0.0000	0.1828	0.0051	0.000316	0.00543
04:30:00	1.1063	0.0000	0.1590	0.0051	0.000354	0.00549
04:40:00	0.9517	0.0000	0.1379	0.0051	0.000392	0.00546
04:50:00	0.8181	0.0000	0.1194	0.0049	0.000429	0.00535
05:00:00	0.7028	0.0000	0.1032	0.0047	0.000464	0.00518
05:10:00	0.6035	0.0000	0.0891	0.0045	0.000498	0.00496
05:20:00	0.5180	0.0000	0.0768	0.0042	0.000529	0.00472
05:30:00	0.4444	0.0000	0.0662	0.0039	0.000558	0.00445
05:40:00	0.3811	0.0000	0.0569	0.0036	0.000585	0.00417

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.3267	0.0000	0.0490	0.0033	0.000609	0.00389
06:00:00	0.2800	0.0000	0.0421	0.0030	0.00063	0.00359
06:10:00	0.0000	0.0000	0.0000	0.0027	0.000649	0.0033
06:20:00	0.0000	0.0000	0.0000	0.0023	0.000666	0.00301
06:30:00	0.0000	0.0000	0.0000	0.0020	0.00068	0.00273
06:40:00	0.0000	0.0000	0.0000	0.0018	0.000692	0.00246
06:50:00	0.0000	0.0000	0.0000	0.0015	0.000702	0.0022
07:00:00	0.0000	0.0000	0.0000	0.0013	0.000709	0.00196
07:10:00	0.0000	0.0000	0.0000	0.0010	0.000715	0.00174
07:20:00	0.0000	0.0000	0.0000	0.0008	0.000719	0.00154
07:30:00	0.0000	0.0000	0.0000	0.0007	0.000722	0.00138
07:40:00	0.0000	0.0000	0.0000	0.0005	0.000724	0.00124
07:50:00	0.0000	0.0000	0.0000	0.0004	0.000724	0.00113
08:00:00	0.0000	0.0000	0.0000	0.0003	0.000724	0.00104
08:10:00	0.0000	0.0000	0.0000	0.0002	0.000723	0.000963
08:20:00	0.0000	0.0000	0.0000	0.0002	0.000722	0.000903
08:30:00	0.0000	0.0000	0.0000	0.0001	0.00072	0.000853
08:40:00	0.0000	0.0000	0.0000	0.0001	0.000718	0.000813
08:50:00	0.0000	0.0000	0.0000	0.0001	0.000716	0.00078
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000713	0.000754
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000711	0.000734
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000708	0.00072
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000705	0.000709
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000702	0.000703
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000699	0.000699
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000696	0.000696
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000694	0.000694
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000691	0.000691
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000688	0.000688
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000685	0.000685
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000682	0.000682
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00068	0.00068
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000677	0.000677
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000674	0.000674
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000671	0.000671
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000669	0.000669

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

Storage Volumes vs Storm Duration (1-in-1-year storm) for Site 5 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.385	0.579	0.031

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roof *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	1 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	5.8	23.1	9.9	29.7	1.9	0.0	0	41.5	37.3
0.5	7.3	14.6	6.3	18.8	1.2	0.0	0	26.3	47.3
1	9.0	9.0	3.9	11.6	0.7	0.0	0	16.2	58.2
2	14.1	7.0	3.0	9.1	0.6	0.0	0	12.7	91.2
4	19.4	4.8	2.1	6.2	0.4	0.0	0	8.7	125.4
6	22.4	3.7	1.6	4.8	0.3	0.0	0	6.7	144.8
8	24.4	3.0	1.3	3.9	0.3	0.0	0	5.5	157.7
12	27.0	2.3	1.0	2.9	0.2	0.0	0	4.0	174.9
16	28.9	1.8	0.8	2.3	0.1	0.0	0	3.2	186.7
20	30.3	1.5	0.6	2.0	0.1	0.0	0	2.7	196.1
24	31.6	1.3	0.6	1.7	0.1	0.0	0	2.4	204.3
28	32.7	1.2	0.5	1.5	0.1	0.0	0	2.1	211.4
32	33.7	1.1	0.5	1.4	0.1	0.0	0	1.9	218.0
36	34.6	1.0	0.4	1.2	0.1	0.0	0	1.7	224.1
40	35.5	0.9	0.4	1.1	0.1	0.0	0	1.6	230.0
44	36.4	0.8	0.4	1.1	0.1	0.0	0	1.5	235.5
48	37.2	0.8	0.3	1.0	0.1	0.0	0	1.4	241.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Client: **Rapleys LLP**

Title: Runoff rates and retention volumes for Site 5 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S5/A3.1 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 5 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.385	0.579	0.031

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roof *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	30 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	37.3	112.1	7.2	0.0	0	156.6	140.9
0.5	28.2	56.4	24.1	72.6	4.7	0.0	0	101.4	182.4
1	34.7	34.7	14.9	44.7	2.9	0.0	0	62.4	224.8
2	44.1	22.1	9.4	28.4	1.8	0.0	0	39.6	285.4
4	53.8	13.5	5.8	17.3	1.1	0.0	0	24.2	348.3
6	59.2	9.9	4.2	12.7	0.8	0.0	0	17.7	382.8
8	62.6	7.8	3.3	10.1	0.6	0.0	0	14.1	404.9
12	67.0	5.6	2.4	7.2	0.5	0.0	0	10.0	433.8
16	70.0	4.4	1.9	5.6	0.4	0.0	0	7.9	453.2
20	72.3	3.6	1.5	4.7	0.3	0.0	0	6.5	467.7
24	74.1	3.1	1.3	4.0	0.3	0.0	0	5.5	479.5
28	75.7	2.7	1.2	3.5	0.2	0.0	0	4.9	489.6
32	77.1	2.4	1.0	3.1	0.2	0.0	0	4.3	498.7
36	78.3	2.2	0.9	2.8	0.2	0.0	0	3.9	507.0
40	79.5	2.0	0.9	2.6	0.2	0.0	0	3.6	514.8
44	80.7	1.8	0.8	2.4	0.2	0.0	0	3.3	522.1
48	81.7	1.7	0.7	2.2	0.1	0.0	0	3.1	529.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Client: **Rapleys LLP**

Title: Runoff rates and retention volumes for Site 5 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S5/A3.2

Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 5 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.385	0.579	0.031

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roof *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	48.5	145.8	9.4	0.0	0	203.6	183.2
0.5	36.9	73.8	31.6	95.0	6.1	0.0	0	132.7	238.8
1	45.8	45.8	19.6	59.0	3.8	0.0	0	82.4	296.5
2	57.4	28.7	12.3	36.9	2.4	0.0	0	51.6	371.5
4	70.4	17.6	7.5	22.6	1.5	0.0	0	31.6	455.3
6	77.7	12.9	5.5	16.7	1.1	0.0	0	23.3	502.7
8	82.6	10.3	4.4	13.3	0.9	0.0	0	18.6	534.5
12	88.9	7.4	3.2	9.5	0.6	0.0	0	13.3	575.6
16	92.9	5.8	2.5	7.5	0.5	0.0	0	10.4	601.4
20	95.8	4.8	2.0	6.2	0.4	0.0	0	8.6	619.8
24	97.9	4.1	1.7	5.3	0.3	0.0	0	7.3	633.9
28	99.6	3.6	1.5	4.6	0.3	0.0	0	6.4	644.8
32	101.1	3.2	1.4	4.1	0.3	0.0	0	5.7	654.2
36	102.4	2.8	1.2	3.7	0.2	0.0	0	5.1	662.5
40	103.5	2.6	1.1	3.3	0.2	0.0	0	4.7	670.0
44	104.6	2.4	1.0	3.1	0.2	0.0	0	4.3	676.9
48	105.6	2.2	0.9	2.8	0.2	0.0	0	4.0	683.3

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Client: **Rapleys LLP**

Title: Runoff rates and retention volumes for Site 5 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S5/A3.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-1-year storm) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	1 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	5.8	23.1	13.1	13.2	13.9	0.0	-3	37.3	33.6
0.5	7.3	14.6	8.3	8.4	8.8	0.0	-3	22.6	40.6
1	9.0	9.0	5.1	5.1	5.4	0.0	-3	12.8	46.0
2	14.1	7.0	4.0	4.0	4.2	0.0	-3	9.4	67.4
4	19.4	4.8	2.7	2.8	2.9	0.0	-3	5.5	79.7
6	22.4	3.7	2.1	2.1	2.2	0.0	-3	3.6	77.6
8	24.4	3.0	1.7	1.7	1.8	0.0	-3	2.4	69.1
12	27.0	2.3	1.3	1.3	1.4	0.0	-3	1.0	44.1
16	28.9	1.8	1.0	1.0	1.1	0.0	-3	0.2	13.8
20	30.3	1.5	0.9	0.9	0.9	0.0	-3	-0.3	-18.9
24	31.6	1.3	0.7	0.8	0.8	0.0	-3	-0.6	-52.8
28	32.7	1.2	0.7	0.7	0.7	0.0	-3	-0.9	-87.6
32	33.7	1.1	0.6	0.6	0.6	0.0	-3	-1.1	-123.0
36	34.6	1.0	0.5	0.5	0.6	0.0	-3	-1.2	-158.8
40	35.5	0.9	0.5	0.5	0.5	0.0	-3	-1.4	-194.9
44	36.4	0.8	0.5	0.5	0.5	0.0	-3	-1.5	-231.3
48	37.2	0.8	0.4	0.4	0.5	0.0	-3	-1.5	-267.8

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Client: **Rapleys LLP**

Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.1	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
Duration	**30 year event**								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	49.4	49.8	52.4	0.0	-3	148.7	133.8
0.5	28.2	56.4	32.0	32.2	33.9	0.0	-3	95.2	171.4
1	34.7	34.7	19.7	19.9	20.9	0.0	-3	57.6	207.2
2	44.1	22.1	12.5	12.6	13.3	0.0	-3	35.5	255.5
4	53.8	13.5	7.6	7.7	8.1	0.0	-3	20.5	295.5
6	59.2	9.9	5.6	5.6	5.9	0.0	-3	14.3	308.1
8	62.6	7.8	4.4	4.5	4.7	0.0	-3	10.7	308.5
12	67.0	5.6	3.2	3.2	3.4	0.0	-3	6.8	294.7
16	70.0	4.4	2.5	2.5	2.6	0.0	-3	4.7	271.8
20	72.3	3.6	2.0	2.1	2.2	0.0	-3	3.4	244.1
24	74.1	3.1	1.8	1.8	1.9	0.0	-3	2.5	213.8
28	75.7	2.7	1.5	1.5	1.6	0.0	-3	1.8	181.8
32	77.1	2.4	1.4	1.4	1.4	0.0	-3	1.3	148.8
36	78.3	2.2	1.2	1.2	1.3	0.0	-3	0.9	115.1
40	79.5	2.0	1.1	1.1	1.2	0.0	-3	0.6	80.9
44	80.7	1.8	1.0	1.0	1.1	0.0	-3	0.3	46.2
48	81.7	1.7	1.0	1.0	1.0	0.0	-3	0.1	11.1

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.2	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	64.2	64.7	68.2	0.0	-3	194.2	174.8
0.5	36.9	73.8	41.9	42.2	44.4	0.0	-3	125.6	226.0
1	45.8	45.8	26.0	26.2	27.6	0.0	-3	76.8	276.7
2	57.4	28.7	16.3	16.4	17.3	0.0	-3	47.1	338.8
4	70.4	17.6	10.0	10.1	10.6	0.0	-3	27.7	399.1
6	77.7	12.9	7.3	7.4	7.8	0.0	-3	19.6	424.1
8	82.6	10.3	5.9	5.9	6.2	0.0	-3	15.1	434.1
12	88.9	7.4	4.2	4.2	4.5	0.0	-3	10.0	432.0
16	92.9	5.8	3.3	3.3	3.5	0.0	-3	7.2	415.3
20	95.8	4.8	2.7	2.7	2.9	0.0	-3	5.4	391.3
24	97.9	4.1	2.3	2.3	2.5	0.0	-3	4.2	363.2
28	99.6	3.6	2.0	2.0	2.1	0.0	-3	3.3	332.1
32	101.1	3.2	1.8	1.8	1.9	0.0	-3	2.6	299.4
36	102.4	2.8	1.6	1.6	1.7	0.0	-3	2.0	265.7
40	103.5	2.6	1.5	1.5	1.6	0.0	-3	1.6	231.2
44	104.6	2.4	1.3	1.4	1.4	0.0	-3	1.2	196.0
48	105.6	2.2	1.2	1.3	1.3	0.0	-3	0.9	160.5

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.3	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm+CC) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	20	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	77.1	77.7	81.8	0.0	-3	233.7	210.3
0.5	36.9	73.8	50.2	50.6	53.3	0.0	-3	151.3	272.3
1	45.8	45.8	31.2	31.4	33.1	0.0	-3	92.8	334.1
2	57.4	28.7	19.5	19.7	20.7	0.0	-3	57.1	410.8
4	70.4	17.6	12.0	12.1	12.7	0.0	-3	33.8	487.3
6	77.7	12.9	8.8	8.9	9.4	0.0	-3	24.1	521.5
8	82.6	10.3	7.0	7.1	7.5	0.0	-3	18.7	537.6
12	88.9	7.4	5.0	5.1	5.4	0.0	-3	12.6	543.5
16	92.9	5.8	4.0	4.0	4.2	0.0	-3	9.2	531.8
20	95.8	4.8	3.3	3.3	3.5	0.0	-3	7.1	511.4
24	97.9	4.1	2.8	2.8	2.9	0.0	-3	5.6	486.0
28	99.6	3.6	2.4	2.4	2.6	0.0	-3	4.5	456.9
32	101.1	3.2	2.1	2.2	2.3	0.0	-3	3.7	426.1
36	102.4	2.8	1.9	2.0	2.1	0.0	-3	3.0	393.9
40	103.5	2.6	1.8	1.8	1.9	0.0	-3	2.5	360.9
44	104.6	2.4	1.6	1.6	1.7	0.0	-3	2.1	327.1
48	105.6	2.2	1.5	1.5	1.6	0.0	-3	1.7	292.8

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.4	Date:	Jan-19

7 SANDOWN PARK – SITE A

7.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site A (Racecourse Operational Facilities), as shown on *Drawing 2661/OPA-SA/01*.

7.2 Location and setting

The Application Area is located at the southwestern corner of the Sandown Park landholding and comprises a roughly triangular area of land which is bounded by Site 1 to the northwest and Site 2 to the southeast. It extends to approximately 2.2 ha.

7.3 The proposed development

The area of the proposed development currently comprises the main operational area and facilities for the racecourse. This includes Sandown Park Lodge, the pre-parade ring, stable blocks, saddling enclosures and a hardstanding area for horsebox unloading. It is proposed to re-develop the lodge to provide accommodation for racecourse staff and improve the existing operational area and associated facilities. The current land uses are shown on *Drawing 2661/OPA-SA/01*.

7.4 Baseline conditions

7.4.1 Landform

The elevation of the ground surface within the Application Area declines towards the east and northeast from approximately 42 mAOD to 28 mAOD.

7.5 Hydrology

There are no watercourses, drainage ditches, or waterbodies within or immediately adjacent to the Application Area.

7.6 Geology

This area of the site is underlain directly by the Bagshot Formation, with no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-SA/02*.

The Bagshot Formation forms the locally elevated area of The Warren and its immediate surrounds. Most of the Bagshot Formation is composed of pale yellow-brown to pale grey or white, locally orange or crimson, fine- to coarse-grained sand.

The base of the Bagshot Formation is marked by an erosional surface marking a change from clay, silt and fine-grained sand of the Claygate Member (London Clay Formation) to thick-bedded, pale-coloured, fine-grained sands, with a basal fine gravelly sand developed in places.

7.7 Fluvial flood mapping

The Application Area is located within the Environment Agency's indicative Flood Zone 1, where the probability of fluvial flooding in any one year is less than 1 in 1,000 (Annual Exceedance Probability, AEP <0.1%) (*Drawing 2661/OPA-SA/03)*. There are generally few restrictions to development in terms of flood risk within Flood Zone 1. The exception being for development over 1 ha in extent, for which Flood Risk Assessment must be undertaken.

The Application Area is 2.2 ha in size. This document outlines the flood risk to and from the proposed development and highlights the suitable mitigation measures, if required, for consideration at the detailed reserved matters stage.

7.8 Drainage characteristics

The Application Area is located within Flood Zone 1 and therefore not deemed to be at risk of fluvial flooding. There is no history of flooding within the Application Area.

Minimal areas of the site are noted as being at low and medium risk of surface water flooding, with a likelihood of flooding up to 1%, the extent of which are shown on *Drawing 2661/OPA-SA/04*. These areas are considered likely to be associated with topographical lows within the existing ground surface which will be re-profiled during the development, if necessary.

The majority of the Application Area is overlain by hardstanding, with some areas of grass surrounding the pre-parade ring. Under current conditions surface water run-off across the Application Area follows the local topography and exits the site eastwards. There are currently no issues with standing water within the site boundary.

The site is located above the Bagshot Formation, which comprises predominantly sand. The natural drainability of the sub-surface is therefore considered to be good.

7.9 Assessment of flood risk and drainage

7.9.1 Flood risk to the development

The situation of the Application Area within Flood Zone 1 and the absence of potential for fluvial flooding is such that flood risk to the proposed development is not anticipated and mitigation measures are not required.

Small areas are designated as being of low and medium risk of surface water (pluvial) flooding, however the existing surface water drainage across the site will be improved upon by the development. Therefore surface water flooding to the proposed development is not anticipated and mitigation measures are not required.

7.9.2 Flood risk from the development

The surrounds of the Application Area are also located within Flood Zone 1, which is classified as having a 'very low' fluvial flood risk.

The proposed development will modify the run-off characteristics of the site due to the change in the ground profile and surface cover. The surface water management system will be improved upon as part of the development and will ensure that volumes of surface water run-off can be retained, attenuated or infiltrated within the site boundary.

The proposed development is not anticipated to increase fluvial or pluvial flood risk to the external receptors.

7.9.3 Drainage requirements

Infiltration to ground via soakaway would appear to be feasible at this site, however a potentially high watertable will need to be considered. Intrusive soakaway testing could not be completed at this outline stage due to access restrictions on site (the site is actively in-use). Subject to appropriate soakaway testing, SuDS methods to retain and attenuate water (swales, French drains, etc) would be incorporated into the development design, and would conform to best practice.

It is anticipated that below ground attenuation in the form of geo-cellular storage will be used and located beneath proposed hardstanding parking and stables areas in the south and the west, an area comprising approximately 9,000 m^2. The geo-cellular storage will provide 1121.6 m^3 for the 1 in 100-year plus 20% climate change event, assuming discharge to a 50 m^2 soakaway.

In the event that soakaway testing proves to be unviable on site (and in the absence of a surface watercourse), discussions will commence with the local utility provider on the availability to discharge into the surface water sewer along Portsmouth Road to the east. In this scenario, the proposed outfall would be located along the eastern boundary of the site.

The Surrey County Council Surface Water Drainage Summary Pro-forma (2017) has been completed for the site, which provides data and details of the proposed drainage provision.

7.9.4 Betterment

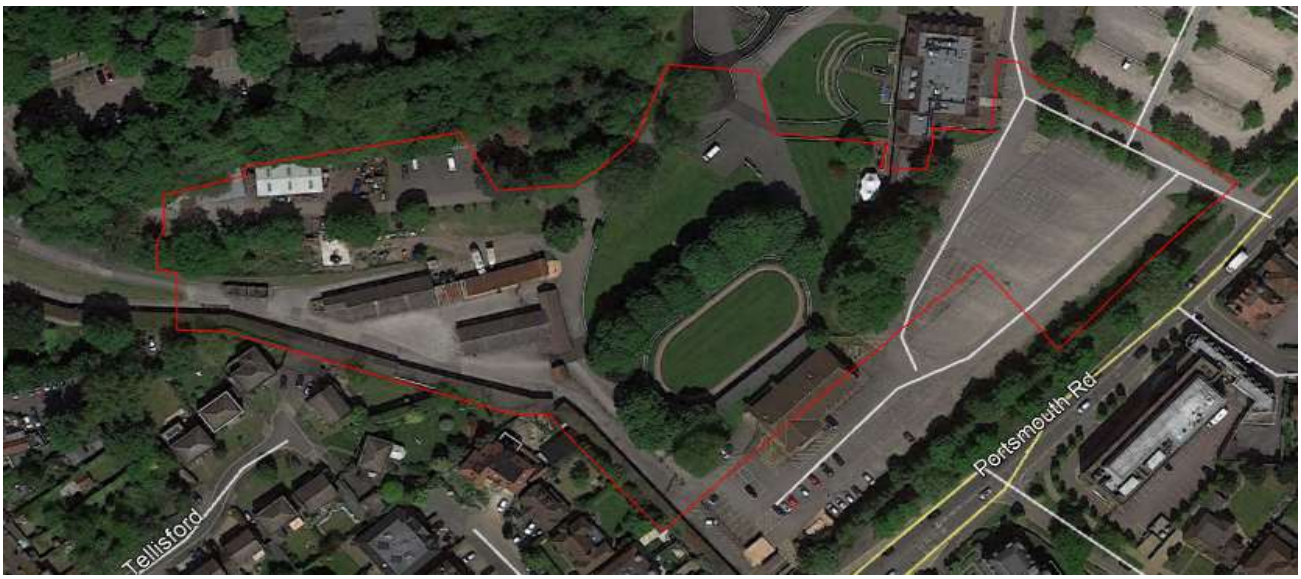
The proposed development is an opportunity for betterment of the existing drainage and water management across the Application Area. If SuDS methods to retain and attenuate water are incorporated into the development design, it is considered that the risk of increasing flood risk to or from the development is small.

7.10 Summary and conclusions

The Application Area is located at the southwestern corner of Sandown Park and is 2.2 ha in size. It is located within the Environment Agency's indicative Flood Zone 1, where the probability of fluvial flooding in any one year is less than 1 in 1,000 (Annual Exceedance Probability, AEP <0.1%). There is no history of flooding within the site. Therefore, the site is not deemed to be at risk of fluvial flooding.

Minimal areas of the site are noted as being at low and medium risk of surface water flooding, with a likelihood of flooding of up to 1%, however these are likely associated with topographical lows within the current land cover.

The proposed development provides an opportunity for betterment of the existing drainage and water management. The natural drainability of the sub-surface beneath the site is considered to be good and infiltration to ground via soakaway would appear to be feasible. However a potentially high watertable will need to be considered and soakaway testing is advised.



2661/OPA-SA/01: Existing development
Google earth imagery (May 2018)

2661/OPA-SA/01: Proposed development

Please note drawings are illustrative

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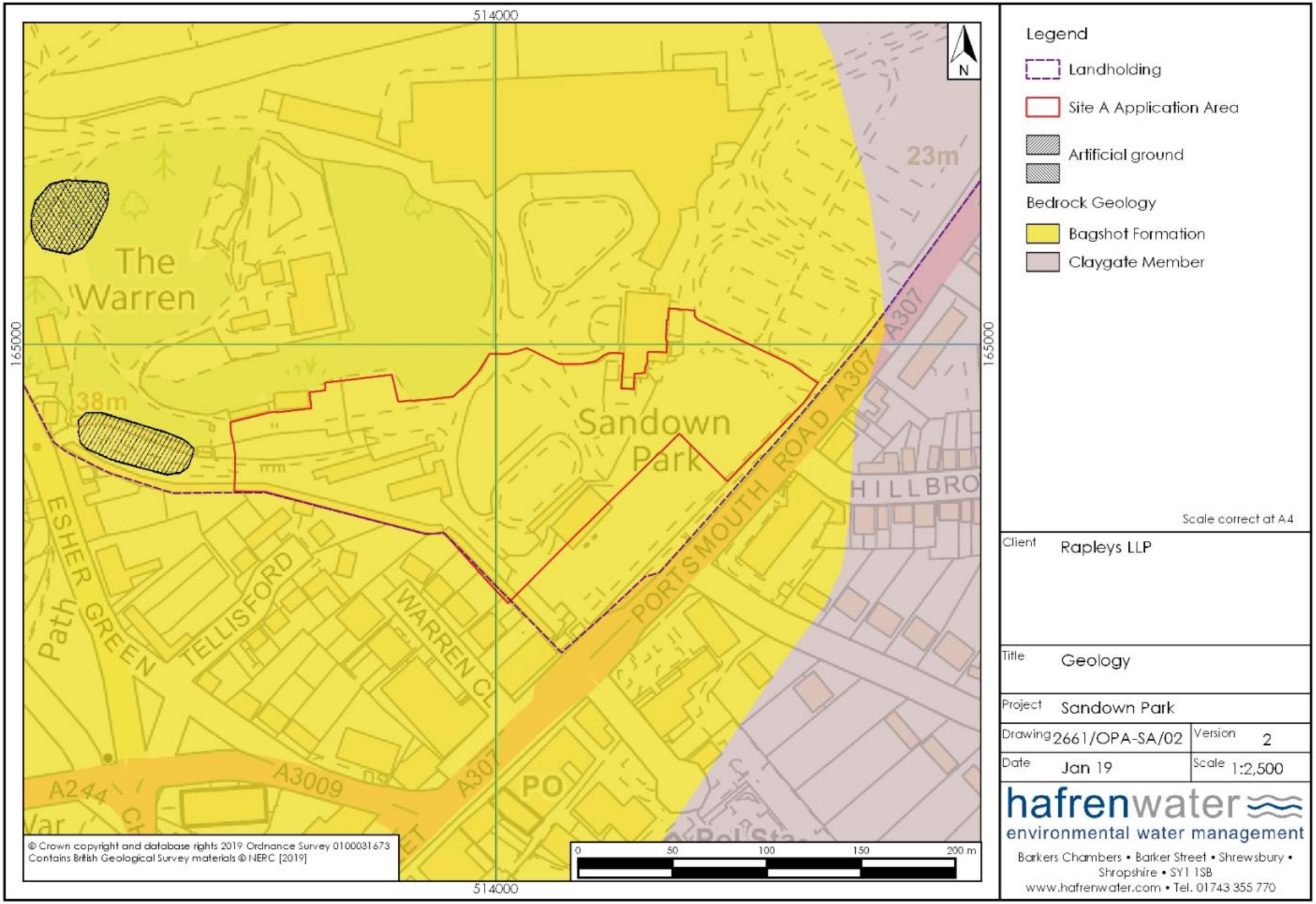
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-SA/01	Version	3
Date	Feb-19	Scale	nts


514000
165000
N
The Warren
Sandown Park
23m
38m
A307
PORTSMOUTH ROAD
HILLBRO
ESHER GREEN
TELLISFORD
WARREN CL
A3009
A244
PO
0
50
100
150
200 m
© Crown copyright and database rights 2019 Ordnance Survey 0100031673
Contains British Geological Survey materials © NERC [2019]
Legend
Landholding
Site A Application Area
Artificial ground
Bedrock Geology
Bagshot Formation
Claygate Member
Scale correct at A4
Client Rapleys LLP
Title Geology
Project Sandown Park
Drawing 2661/OPA-SA/02
Version 2
Date Jan 19
Scale 1:2,500
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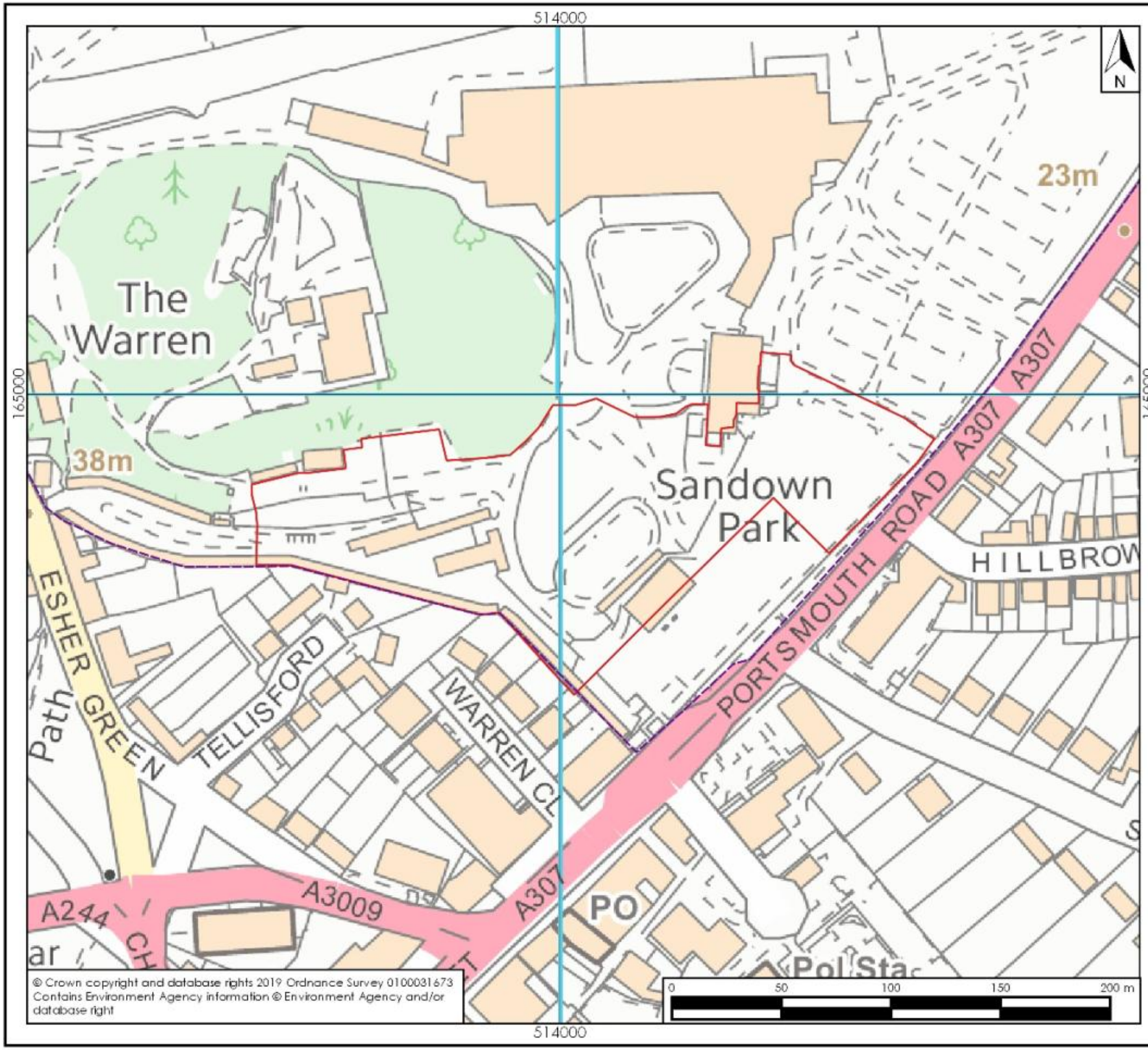

Legend

- Landholding
- Site A Application Area

Flood Risk Zones

- Flood Zone 3: High Risk
- Flood Zone 2: Medium Risk
- Flood Zone 1: Low Risk

- Historical Flooding

Scale correct at A4

Client	Rapleys LLP
Title	Fluvial flood risk and historical flooding
Project	Sandown Park
Drawing	2661/OPA-SA/03
Version	2
Date	Jan 19
Scale	1:2,500

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Surface Water Drainage Summary Pro-forma (2017)

Introduction (with links)

Surrey County Council recommends that this pro-forma should be completed in full and accompany the submitted drainage statement and sufficient additional evidence to confirm the information supplied. This information should be submitted with any planning application which seeks permission for 'major' development. This information contained in this form will be used by Surrey County Council in its role as Lead Local Flood Authority and 'statutory consultee' on SuDs for all 'major' planning applications. The pro-forma follows the national non-statutory technical SuDS standards (Defra 2015) is supported by the Defra/EA Guidance on Rainfall Runoff Management and can be completed using freely available tools including SuDS Tools. The pro-forma should be considered alongside other supporting SuDS Guidance (particularly the LASOO Guidance available online), but focuses on NPPF paragraphs 103 and 109: ensuring flood risk is not increased on or off-site and using SuDS as the primary drainage option. The SuDS solution must operate effectively for as long as the development exists and consideration of maintenance and management must be clearly demonstrated throughout its lifetime.

A summary of the evidential information to be provided at each stage of planning is provided in Appendix A

Pre-application advice (fees may apply) and existing flood risk information is available from Surrey County Council – SuDS@surreycc.gov.uk

1. Site Details

Site/development name	Site A – Racecourse Operational Facilities
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 139 649
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	21,861 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	1.47 ha (this is the total proposed impermeable area)
REFERENCES of topographical survey plan showing existing site layout, drainage system and site levels	*Permeable and impermeable area measurements are based on Drawing 11071FE_101_E_Masterplan-A0.dwg (dated 23rd January 2019)*

***** The Greenfield runoff off rate from the development should either be calculated for the entire area or the part that forms the drainage network for the site; whatever the size of site and type of drainage technique. See section 3. Greenfield runoff rate is to be used to assess the requirements for limiting discharge flow rates and attenuation storage for the same area as chosen for greenfield rates. Please refer to the EA Rainfall Runoff Management document or CIRIA manual for further details.

2. Impermeable Area and Existing Drainage

	Existing (E)	Proposed (P)	Difference (P-E)	NOTES AND REQUIRED EVIDENCE
Impermeable area (Ha) (plan of areas and values) A 10% addition for urban creep to be included within proposed area	1.46	1.47	0.02 (derived from 0.01 + 10%)	If the proposed amount of impermeable surface is greater than existing, then runoff rates and volumes will increase and will need to be attenuated. The national standards require that runoff for previously developed sites should be as close to greenfield rates/volumes as possible. **Evidence: Plan showing impermeable areas, total area calculations +10% urban creep**
Existing Drainage Method (infiltration/watercourse/sewer)	Investigation required			**Evidence: Existing drainage plan showing location of drainage elements**

3. Proposed Surface Water Discharge Method according to SuDS Hierarchy (see Appendix B)

SUDS HIERARCHY (see Appendix B)	Proposed (tick all that apply)	Reference of evidence that this is possible or not practicable	NOTES AND REQUIRED EVIDENCE Evidence must be provided to demonstrate that the proposed Sustainable Drainage proposal has had regard to the SuDS hierarchy
Reduced at source			**Evidence: Details of amount of runoff reduced and storage provided**
Infiltration to ground	✓	Ground investigation required to confirm that soakaway is viable	**Evidence: The results of infiltration tests in soakaway locations. If infiltration is deemed not viable clear site specific evidence must be provided** see Section 6 (infiltration)
Attenuated volume and discharge to watercourse			**Evidence: Details of any watercourse to which the site drains including cross-sections of any adjacent water courses for appropriate distance upstream and downstream of the discharge point (as agreed with the LLFA and/or EA)** see Section 7 (attenuated discharge)
Attenuated volume and discharge to surface water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)
Attenuated volume and discharge to combined/foul water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)

	Drawings provided	NOTES AND REQUIRED EVIDENCE
Drawings and Details (e.g. Existing and proposed drainage, Topography, Impermeable areas, cross sections of SuDS elements)	Drawings not included at outline stage of planning process.	**Evidence:** Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Calculate Peak Discharge Rates – Technical Standards S2 and S3

This is the maximum flow rate at which surface water runoff leaves the site during the critical storm event.

	Greenfield Rates (l/s)	Brownfield rates (l/s) (as appropriate)	Proposed Rates (l/s)	Difference (Proposed-Existing) (l/s)	NOTES AND REQUIRED EVIDENCE
Qbar	6.3	-	-	-	Mean annual Greenfield peak flow - QBAR is approx. 1 in 2 storm events. **Qbar**$_{rural}$ should be used for this value. If the site is currently developed, the appropriate figures should be used to calculate Qbar (and associated rates) in proportion to the amount of existing hardstanding present on the site. Use Qbar$_{rural}$ and Qbar$_{urban}$ as appropriate and prorata'd to effectively model the site.
1 in 1	2.81	15.4	0.0	-15.4	Proposed discharge rates (with mitigation) should be as close to greenfield as possible and should be no greater than existing rates for all corresponding storm events. To mitigate for climate change the proposed 1 in 100 +CC must be no greater than the existing 1 in 100 runoff rate. If not, flood risk increases under climate change. See appendix 2 for climate change allowances. **Evidence: Micro-drainage (or equivalent) calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology**
1 in 30	8.5	40.7	0.0	-40.7	
1in 100	12.0	53.4	0.0	-53.4	
1 in 100 plus 20% climate change *	N/A	N/A	0.0	-	

5. Calculate discharge volumes - Technical Standards S4 to S8

The total volume of water leaving the development site for a particular rainfall event. Introducing new impermeable surfaces increases surface water runoff and may increase flood risk outside the development.

	Greenfield Volume (m^3)	Brownfield Volume (m^3) (as appropriate)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	NOTES AND REQUIRED EVIDENCE
1 in 1	88.9	332.6	110.5	-222.1	Proposed discharge volumes (without mitigation) should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased attenuation must be provided to reduce volume outflow during the event. To mitigate for climate change the volume discharge from site must be no greater than the existing 1 in 100 storm event. **Evidence: Micro-drainage (or equivalent) calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology**
1 in 30	269.0	879.0	618.8	-260.2	
1in 100	378.0	1154.2	880.7	-273.5	
1 in 100 plus 20% climate change *	N/A	N/A	1121.6	-	

* Climate Change Allowance for Rainfall Intensity Increases

Designs should include 20% provision for increases in surface water runoff due to climate change during the development's lifetime – please see Appendix C

6. Infiltration

If infiltration is proposed – sufficient evidence must be provided to show that this is viable and does not increase flood risk

	SITE INFORMATION	Details	NOTES AND REQUIRED EVIDENCE
Is infiltration feasible?	**Yes/No?**	Yes	**Evidence: If deemed NOT FEASIBLE clear site specific evidence (site investigation, site photos, infiltration testing) must be provided to demonstrate why**
Infiltration information	**Site Geology** (bedrock and superficial)	Underlain by Bagshot Formation (no superficial deposits recorded)	Avoid infiltrating in made ground. **Evidence: suitable mapping/SI**
	Is ground water table less than 3m below ground?	Requires investigation	If yes, please provide details of the site's hydrology. **Evidence : Site Investigation**
	Is the site within a known Source Protection Zones (SPZ) or above a Major Aquifer?	No	Refer to Environment Agency website to identify and source protection zones (SPZ). **Evidence: Adequate water treatment stages must be provided**
	Infiltration rate used in calculations	3×10^{-4} m/s	Infiltration rates should be no lower than $1x10^{-6}$ m/s. **Evidence: infiltration testing according to BRE 365 or equivalent**
	Were infiltration rates obtained by desk study or on site infiltration testing?	Infiltration rates taken from CIRIA SuDS Manual 2015, Table 25.1: Typical infiltration. Coefficients based on soil texture (after Bettess, 1996)	**Evidence: Infiltration rates solely estimated from desk studies are only suitable at outline planning applications unless clear site specific evidence can be provided and a back-up attenuation scheme is provided**
	Is the site contaminated? If yes, consider advice from EA on whether infiltration is acceptable.	Unknown	Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered

Design details	**Infiltration type** (soakaway, deep bore, blanket etc)	Soakaway	**Evidence: Suitable designs must be provided**
	Storage volume provided within infiltration feature (m^3)	Further work is required (in the form of intrusive ground investigation) to allow specific rates of infiltration to be determined. These will be used in the design of soakaways at the site. Soakaway will attenuate the 1 in 100 year plus climate change event, which is taken as 1,121.6 m^3	Infiltration must be designed to ensure that at a minimum no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event **Evidence:. Calculations showing available volume of proposed infiltration device and storage. Plan and Cross sectional drawings of proposed infiltration.**
	State the vertical distance between any proposed infiltration device base and the normal ground water (GW) level		1m (min) is required between the base of the infiltration device & the water table to protect groundwater quality & ensure groundwater doesn't enter infiltration devices.
	Half drain times of infiltration features (hr)		**Evidence: Suitable calculations**
	Factor of safety used in infiltration calculations		**Evidence: Suitable calculations**
	Minimum distance of infiltration from buildings		**Evidence: Minimum distance should be >5m unless designed specifically to reduce impact on adjacent buildings.**

7. Attenuated storage

In order to minimise the negative impact on flood risk resulting from any increase in runoff rate or volume from the proposed development, attenuation storage must be provided. Installed flow restriction and stored the attenuation volumes should ensure final discharge from the site at the rates and volumes set out in sections 4 and 5. If some of the stored volume of water can be infiltrated back into the ground, the remainder can be discharged at a rate at or below greenfield rates. A combined storage calculation using the partial infiltration rate and the attenuation rate used to slow the runoff from site.

ATTENUATION DETAILS	Details	NOTES AND REQUIRED EVIDENCE
How are flow rates being restricted?	Infiltration (See Section 6 above)	Hydrobrakes can be used where rates are >2l/s. Orifice plates with an opening <75mm in open systems may require pre-screening.
Storage volume provided (m^3) (excluding non-void spaces)	Below ground soakaway will be sized to accommodate a 1 in 100 year (+CC) event. Further information to be provided at Detailed Design stage. This will be required for the Full Planning Application.	Volume provided to attenuate on site to discharging at existing rates. See section 5. **Evidence: Attenuation must be designed to ensure that at no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event. A 10% additional allowance should be included for underground attenuation systems which cannot be fully accessed/cleansed as well as the provision of u/s siltation protection and access/jetting points. Calculations showing available volume of proposed attenuation storage. Plan and Cross sectional drawings of proposed storage**
How will the storage be provided on site?		

Half drain times of attenuation feature (hr)		**Evidence: suitable calculations to show feature**

8. Construction and Exceedance Planning - Technical Standards S9 and S14

CONSIDERATION	Details	NOTES AND REQUIRED EVIDENCE
How will exceedance/infrastructure failure events be catered on site without significantly increasing flood risks (both on site and outside the development)? Technical Standard S9	No flooding will occur in a 1 in 100-year (+CC) event. Should a flood occur that exceeds this, water will discharge downslope. Further information to be provided at detailed design stage.	**Evidence: Topographic plan showing flow routes for events above those designed – routing of water away from existing properties and critical infrastructure**. Retained water should not cause property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths and not preventing safe access/egress
Drainage during construction period: temporary drainage, pollution prevention and protection of existing/part built drainage systems. Technical Standard S14	Details to be provided at detailed reserved matters stage. Drainage works and pollution prevention measures adopted during construction will conform to current required standards and industry best practice.	Provide details of how drainage will be managed during the construction period including any necessary connections, impacts, diversions and erosion control. How pollution prevention for any local watercourses will be considered – especially siltation from runoff **Evidence: Construction phasing plan, construction environmental management plan (CEMP) or other statements**

9. Management and Maintenance of SuDs - Technical Standards S10 to S12

Details are required to be provided of the management and maintenance plan for the SuDS, including for the individual plots, in perpetuity.

How is the entire drainage system to be maintained in perpetuity?

Further information to be provided at detailed design stage, however the following information is included as guidance.

Drainage Feature	Schedule	Required Action	Frequency
Infiltration Systems (Soakaways and trenches)	Regular Maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
		Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
		Trimming any roots that may be causing blockages	Annually (or as required)
	Occasional Maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
	Remedial Actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
		Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
	Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
		Check soakaway to ensure emptying is occurring	Annually

Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided to show that all parts of SuDs are effective and robust. It should consider how the SuDs will perform and develop over time anticipating any additional maintenance tasks to ensure the system continues to perform as designed. Responsibility for the management and maintenance of each element of the SUDS scheme will also need to be detailed within the Management Plan. Where open water is involved please provide a health and safety plan within the management plan.

Evidence: A maintenance schedule describes what work is to be done and when it is to be done using frequency and performance requirements as appropriate.

Please confirm the owners/adopters of the entire drainage system throughout the development. Please list all the owners.	Jockey Club Racecourses Ltd	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit should be submitted **Evidence: statement of ownership or plan on complex sites**
Please demonstrate that any third party agreements required for adoption or using land outside the application site have been secured.	N/A	**Evidence: proof of agreements (at least in principle at planning approval stage) with adopters or external landowners**

10. Additional Considerations to comply with the Technical Standards and other legislation

Water Quality – Appropriate level and stages of water treatment must be used to prevent pollution of the environment (SuDS manual CIRIA C753)

S10 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

S11 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use. (e.g. BS or kitemarked)

S12 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

S13 The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.

The above form should be completed using evidence from information which should be appended to this form/within the planning submission. The information being submitted should be proportionate to the site conditions, flood risks and magnitude of development. It should serve as a summary of the drainage proposals and should clearly show that the proposed discharge rate and volume as a result of development will not be increasing. Where there is an increase in discharge rate or volume due to development, then the relevant section of this form must be completed with clear evidence demonstrating how the greenfield rates (or as close to them as possible if a brownfield site) will be met.

This form is completed using factual information and can be used as a summary of the surface water drainage strategy on this site.

Form completed by:……Rebecca John…….(Checked by Richard Laker)…….....

Contact details: Tel.....01743 355770.....Email.....chris@hafrenwater.com.....

Qualification of person responsible for signing off this pro-forma: .....Environmental Consultant……(BSc FGS)…….....

Company:…….Hafren Water……..……,.....

On behalf of (Client's details): .....Rapleys LLP.....

Date:…….January 2019…….....

Appendix A

Evidence to be submitted at each stage of planning

Pre-app	Outline	Full	Reserved	Discharge	Document submitted
✓	✓	✓			Flood Risk Assessment/Statement
✓	✓	✓			Drainage Strategy/Statement & sketch layout plan
	✓				Preliminary layout drawings
	✓				Preliminary "Outline" hydraulic calculations
	✓				Preliminary landscape proposals
	✓				Ground investigation report (for infiltration)
	✓	✓			Evidence of third party agreement for discharge to their system (in principle/ consent to discharge)
		✓		✓	Maintenance program and on-going maintenance responsibilities
		✓	✓		Detailed development layout
		✓	✓	✓	Detailed flood & drainage design drawings
		✓	✓	✓	Full Structural, hydraulic & ground investigations
		✓	✓	✓	Geotechnical factual and interpretive reports, including infiltration results
		✓	✓	✓	Detailed landscaping details
		✓	✓	✓	Discharge agreements (temporary and permanent)
		✓	✓	✓	Development Management & Construction Phasing Plan

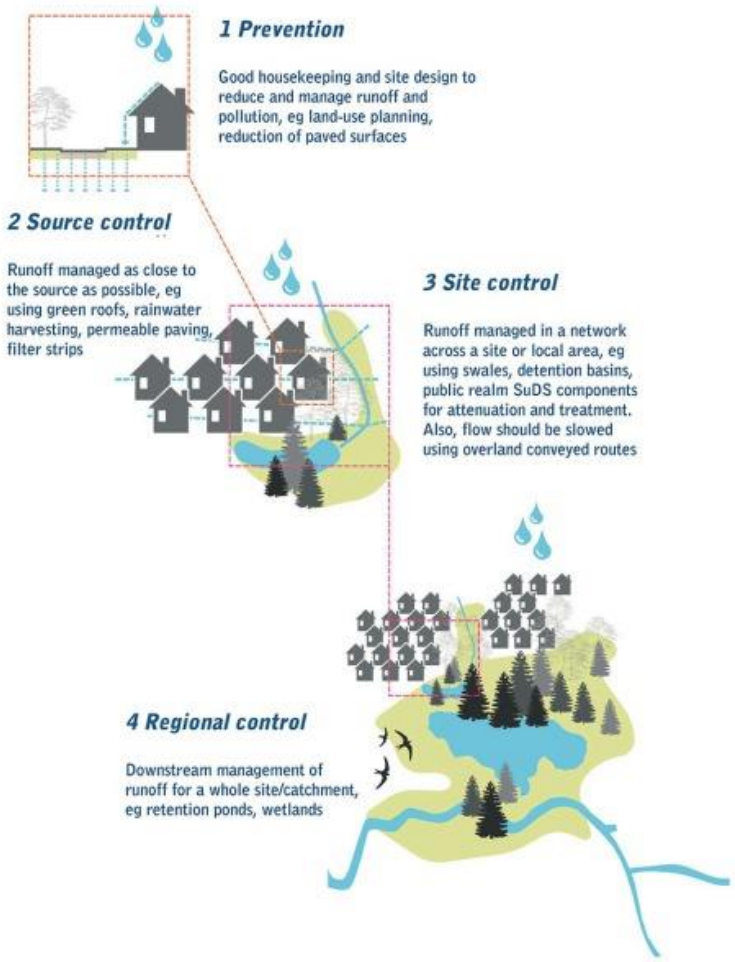
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

At Outline Planning stage enough evidence must be provided to prove that a viable method of draining the site has been provided which does not increase local flood risk

At Full Application, Discharge of Conditions or Reserved Matters stage suitable evidence must be provided to show that all the requirements of the national standards have been met

Appendix B

SuDS Treatment Train



Dickie, S, McKay, G, Ions, L, Shaffer, P (2010) Planning for SuDS – making it happen, C687, CIRIA, London (ISBN: 978-0-86017-687-9).

Discharge Hierarchy

Sustainability Hierarchy

DISCHARGE CHOICE		SUSTAINABILITY CHOICE				
Discharge Hierarchy	**SuDS Type**	**Sustainability Level**	**SuDS Technique**	Flood Reduction	Pollution Reduction	Wildlife & Landscape Benefit
MUST BE CONSIDERED FIRST	**Source Control**	MOST SUSTAINABLE (PREFERRED)	**Green/Living Roofs & Walls**	✓	✓	✓
	OPTION 1 Infiltration To Ground		**Infiltration:** • Infiltration trenches & basins • Soakaways: (standard or crate system)	✓	✓	✓
	OPTION 2 Attenuation and Discharge: **To Pond, Ordinary Watercourse or Main River**		**Filter strips and Swales**	✓	✓	✓
			Basins and ponds: • Wetlands • Balancing Ponds • Detention Basins • Retention Basins • Conveyance swales	✓	✓	✓
	OPTION 3 Attenuation and Discharge **a) To Surface Water Sewer** **b) To Combined Sewer**		**Permeable Surfaces & filter drains:** • Gravelled areas • Porous paving	✓	✓	
ONLY IF ALL OTHER OPTIONS ARE UNVIABLE	**OPTION 4 Attenuation and Discharge** **To Foul or Highways sewer (only in exceptional circumstances)**	LEAST SUSTAINABLE	**Tanks & Piped Systems:** • Crated Attenuation • Tanks • Oversize pipes	✓		

Appendix C

Climate change allowances

In February 2016 there was a change to the EA climate change advice to modify the allowance levels for rainfall when designing surface water drainage: to 20% CC allowance for 1 in 100 year events but with a 40% sensitivity test. (please note the advice for river flow levels also changed – please contact the Environment Agency for more details)

Applicants should design the discharge rates and attenuation on site to accommodate the 1:100 year +20% CC event and understand the flooding implications for the +40% CC event.

If the implications are significant i.e. the site contains "highly vulnerable" or "critical infrastructure" receptors, could flood another development or put people at risk then a view should be taken to provide more attenuation to meet the 40% CC event. This will tie into designing for exceedance principles.

An example: Attenuation basin designed to accommodate the 1:100 year + 20% climate change event, during the modelling of the 40% cc event the water level of the basin rises by 340mm, which equates to 40mm over the 300mm already freeboard provided. Therefore a suitable mitigation would be to provide freeboard of 350mm instead of 300mm, in order to ensure the development doesn't flood third parties downstream for the extreme 40% cc scenario.

Extract taken from Environment Agency publication; *Adapting to Climate Change: Advice for Flood and Coastal Risk Management Authorities:*

What are the climate change allowances?

To assess the potential impacts that climate change may have on extreme rainfall, river flood flows, sea level rise and storm surges, climate change allowances are provided in Annex 1. The climate change allowances quantify the potential change (as either mm or percentage increase, depending on the variable) to the baseline. The climate change allowances are based on the best available, credible, peer-reviewed scientific evidence from UKCP09, but given the complexity of the science around climatic projections, there are significant uncertainties attributed to the climate change allowances. This is why the climate change allowances are presented as a range of possibilities (Lower, Central, Higher Central and Upper), to reflect the potential variation in climate change impacts over three epochs from the present day to 2115. It is recommended that the performance of flood risk management options are assessed against all of the change allowances covering the whole of the decision lifetime.

Change to extreme rainfall intensity compared to a 1961-90 baseline Applies across all of England			
Climate Change scenario	**Total potential change anticipated for '2020s' (2015-39)**	**Total potential change anticipated for '2050s' (2040-2069)**	**Total potential change anticipated for '2080s' (2070-2115)**
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

Greenfield Runoff Estimate for SITE A

Institute of hydrology report no. 124 (IH124)

$$Q_{BAR(rural)} = 0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}$$

Where:

$Q_{BAR(rural)}$	mean annual flood (return period 2.3 years) (m^3/s)
AREA	catchment area (km^2)
SAAR(4170)	standard average rainfall for the period 1941 to 1970 (mm)
SOIL	soil index

$Q_{BAR(rural)}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

Parameters	
Area	0.0219 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	6.3 l/s
Q (1in1yr)*	5.4 l/s
QBAR	2.9 l/s/ha
Q (1in1yr)	2.5 l/s/ha
Q (1in100yr)	9.2 l/s/ha

NB: calculation based on 0.5 km2 and then scaled down to actual catchment size. The IH124 methodology is designed for sites > 0.5 km2 but can be linearly interpolated to represent smaller catchments.

Q (1in1yr)*: 1 year return period growth curve factors are taken from NERC (1977). 30 year (and 1 year for Ireland) return period growth curve factors are interpolated estimates (Source: *CIRIA SuDS Manual C753*)

Return period (yr)	**1**	**2**	**5**	**10**	**25**	**30**	**50**	**100**	**200**
Q (l/s/ha)	2.5	2.5	3.7	4.7	6.2	7.0	7.6	9.2	11.2
Q (l/s)	5.4	5.6	8.1	10.3	13.5	15.2	16.6	20.2	24.4

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www.hafrenwater.com

Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE A, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SA/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:26:34 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: AB8F-A43D

Site name: Sandown Park - Site A

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.02 [0.02]*

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.03
Total Rainfall (mm):	15.00	Total flow (ML):	0.09
Peak Rainfall (mm):	1.07	Peak flow (m^3/s):	0.00

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:45:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:15:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.01	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	43.21	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.0808	0.0000	0.0071	0.0000	0	0
00:10:00	0.0942	0.0000	0.0083	0.0000	8.32E-09	2.3E-06
00:20:00	0.1099	0.0000	0.0097	0.0000	5.13E-08	9.61E-06
00:30:00	0.1282	0.0000	0.0113	0.0000	1.68E-07	2.28E-05
00:40:00	0.1494	0.0000	0.0132	0.0000	4.03E-07	4.29E-05
00:50:00	0.1741	0.0000	0.0155	0.0001	8.11E-07	7.11E-05
01:00:00	0.2027	0.0000	0.0181	0.0001	1.45E-06	0.000109
01:10:00	0.2360	0.0000	0.0211	0.0002	2.39E-06	0.000154
01:20:00	0.2745	0.0000	0.0246	0.0002	3.66E-06	0.000205
01:30:00	0.3191	0.0000	0.0287	0.0003	5.31E-06	0.000262
01:40:00	0.3707	0.0000	0.0335	0.0003	7.37E-06	0.000325
01:50:00	0.4302	0.0000	0.0391	0.0004	9.9E-06	0.000397
02:00:00	0.4988	0.0000	0.0456	0.0005	1.3E-05	0.000478
02:10:00	0.5774	0.0000	0.0532	0.0006	1.66E-05	0.000571
02:20:00	0.6672	0.0000	0.0619	0.0007	2.09E-05	0.000678
02:30:00	0.7688	0.0000	0.0720	0.0008	2.6E-05	0.000801
02:40:00	0.8820	0.0000	0.0835	0.0009	3.21E-05	0.000944
02:50:00	1.0013	0.0000	0.0959	0.0011	3.91E-05	0.00111
03:00:00	1.0671	0.0000	0.1036	0.0013	4.74E-05	0.0013
03:10:00	1.0013	0.0000	0.0984	0.0015	5.71E-05	0.00152
03:20:00	0.8820	0.0000	0.0877	0.0017	6.82E-05	0.00175
03:30:00	0.7688	0.0000	0.0772	0.0019	8.1E-05	0.002
03:40:00	0.6672	0.0000	0.0676	0.0021	9.54E-05	0.00224
03:50:00	0.5774	0.0000	0.0589	0.0023	0.000111	0.00245
04:00:00	0.4988	0.0000	0.0512	0.0025	0.000128	0.00262
04:10:00	0.4302	0.0000	0.0444	0.0026	0.000146	0.00274
04:20:00	0.3707	0.0000	0.0384	0.0026	0.000165	0.0028
04:30:00	0.3191	0.0000	0.0332	0.0026	0.000183	0.00281
04:40:00	0.2745	0.0000	0.0287	0.0026	0.000201	0.00276
04:50:00	0.2360	0.0000	0.0247	0.0025	0.000219	0.00269
05:00:00	0.2027	0.0000	0.0213	0.0023	0.000236	0.00258
05:10:00	0.1741	0.0000	0.0183	0.0022	0.000251	0.00246
05:20:00	0.1494	0.0000	0.0158	0.0021	0.000266	0.00232
05:30:00	0.1282	0.0000	0.0135	0.0019	0.000279	0.00218
05:40:00	0.1099	0.0000	0.0116	0.0017	0.000291	0.00203

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.0942	0.0000	0.0100	0.0016	0.000302	0.00188
06:00:00	0.0808	0.0000	0.0086	0.0014	0.000312	0.00173
06:10:00	0.0000	0.0000	0.0000	0.0013	0.00032	0.00159
06:20:00	0.0000	0.0000	0.0000	0.0011	0.000328	0.00144
06:30:00	0.0000	0.0000	0.0000	0.0010	0.000334	0.0013
06:40:00	0.0000	0.0000	0.0000	0.0008	0.000339	0.00117
06:50:00	0.0000	0.0000	0.0000	0.0007	0.000344	0.00105
07:00:00	0.0000	0.0000	0.0000	0.0006	0.000347	0.000932
07:10:00	0.0000	0.0000	0.0000	0.0005	0.000349	0.000828
07:20:00	0.0000	0.0000	0.0000	0.0004	0.000351	0.000736
07:30:00	0.0000	0.0000	0.0000	0.0003	0.000352	0.000659
07:40:00	0.0000	0.0000	0.0000	0.0002	0.000353	0.000595
07:50:00	0.0000	0.0000	0.0000	0.0002	0.000353	0.000542
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000353	0.000499
08:10:00	0.0000	0.0000	0.0000	0.0001	0.000353	0.000465
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000352	0.000437
08:30:00	0.0000	0.0000	0.0000	0.0001	0.000351	0.000414
08:40:00	0.0000	0.0000	0.0000	0.0000	0.00035	0.000395
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000349	0.00038
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000348	0.000368
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000347	0.000359
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000345	0.000352
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000344	0.000347
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000343	0.000343
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000342	0.000342
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00034	0.00034
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000339	0.000339
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000338	0.000338
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000336	0.000336
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000335	0.000335
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000334	0.000334
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000332	0.000332
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000331	0.000331
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00033	0.00033
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000329	0.000329
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000327	0.000327

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:27:23 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: AB8F-A43D

Site name: Sandown Park - Site A

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.02 [0.02]*

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.10
Total Rainfall (mm):	39.42	Total flow (ML):	0.27
Peak Rainfall (mm):	2.80	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:45:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:15:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.01	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	43.21	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2123	0.0000	0.0187	0.0000	0	0
00:10:00	0.2477	0.0000	0.0219	0.0000	2.19E-08	6.05E-06
00:20:00	0.2889	0.0000	0.0256	0.0000	1.35E-07	2.53E-05
00:30:00	0.3369	0.0000	0.0300	0.0001	4.42E-07	6E-05
00:40:00	0.3927	0.0000	0.0352	0.0001	1.06E-06	0.000113
00:50:00	0.4575	0.0000	0.0412	0.0002	2.14E-06	0.000187
01:00:00	0.5328	0.0000	0.0483	0.0003	3.83E-06	0.000287
01:10:00	0.6202	0.0000	0.0567	0.0004	6.3E-06	0.000408
01:20:00	0.7214	0.0000	0.0665	0.0005	9.67E-06	0.000543
01:30:00	0.8387	0.0000	0.0781	0.0007	1.4E-05	0.000695
01:40:00	0.9742	0.0000	0.0918	0.0008	1.95E-05	0.000866
01:50:00	1.1307	0.0000	0.1079	0.0010	2.63E-05	0.00106
02:00:00	1.3108	0.0000	0.1271	0.0012	3.45E-05	0.00128
02:10:00	1.5174	0.0000	0.1497	0.0015	4.43E-05	0.00154
02:20:00	1.7534	0.0000	0.1764	0.0018	5.6E-05	0.00183
02:30:00	2.0206	0.0000	0.2078	0.0021	6.99E-05	0.00218
02:40:00	2.3179	0.0000	0.2444	0.0025	8.63E-05	0.00259
02:50:00	2.6316	0.0000	0.2853	0.0030	0.000106	0.00306
03:00:00	2.8045	0.0000	0.3132	0.0035	0.000129	0.00362
03:10:00	2.6316	0.0000	0.3025	0.0041	0.000156	0.00426
03:20:00	2.3179	0.0000	0.2733	0.0048	0.000188	0.00498
03:30:00	2.0206	0.0000	0.2435	0.0055	0.000224	0.00574
03:40:00	1.7534	0.0000	0.2152	0.0062	0.000266	0.00648
03:50:00	1.5174	0.0000	0.1893	0.0069	0.000312	0.00718
04:00:00	1.3108	0.0000	0.1657	0.0074	0.000363	0.00776
04:10:00	1.1307	0.0000	0.1446	0.0078	0.000416	0.00818
04:20:00	0.9742	0.0000	0.1258	0.0080	0.000472	0.00843
04:30:00	0.8387	0.0000	0.1092	0.0080	0.000528	0.0085
04:40:00	0.7214	0.0000	0.0946	0.0078	0.000583	0.00843
04:50:00	0.6202	0.0000	0.0818	0.0076	0.000637	0.00824
05:00:00	0.5328	0.0000	0.0707	0.0073	0.000689	0.00797
05:10:00	0.4575	0.0000	0.0610	0.0069	0.000737	0.00763
05:20:00	0.3927	0.0000	0.0525	0.0065	0.000783	0.00724
05:30:00	0.3369	0.0000	0.0452	0.0060	0.000825	0.00683
05:40:00	0.2889	0.0000	0.0389	0.0055	0.000864	0.00639

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.2477	0.0000	0.0334	0.0050	0.000899	0.00594
06:00:00	0.2123	0.0000	0.0287	0.0046	0.00093	0.00549
06:10:00	0.0000	0.0000	0.0000	0.0041	0.000958	0.00504
06:20:00	0.0000	0.0000	0.0000	0.0036	0.000982	0.00459
06:30:00	0.0000	0.0000	0.0000	0.0032	0.001	0.00415
06:40:00	0.0000	0.0000	0.0000	0.0027	0.00102	0.00373
06:50:00	0.0000	0.0000	0.0000	0.0023	0.00103	0.00334
07:00:00	0.0000	0.0000	0.0000	0.0019	0.00105	0.00297
07:10:00	0.0000	0.0000	0.0000	0.0016	0.00105	0.00263
07:20:00	0.0000	0.0000	0.0000	0.0013	0.00106	0.00233
07:30:00	0.0000	0.0000	0.0000	0.0010	0.00107	0.00208
07:40:00	0.0000	0.0000	0.0000	0.0008	0.00107	0.00187
07:50:00	0.0000	0.0000	0.0000	0.0006	0.00107	0.0017
08:00:00	0.0000	0.0000	0.0000	0.0005	0.00107	0.00156
08:10:00	0.0000	0.0000	0.0000	0.0004	0.00107	0.00144
08:20:00	0.0000	0.0000	0.0000	0.0003	0.00107	0.00135
08:30:00	0.0000	0.0000	0.0000	0.0002	0.00106	0.00127
08:40:00	0.0000	0.0000	0.0000	0.0002	0.00106	0.00121
08:50:00	0.0000	0.0000	0.0000	0.0001	0.00106	0.00116
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00105	0.00112
09:10:00	0.0000	0.0000	0.0000	0.0000	0.00105	0.00109
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00105	0.00107
09:30:00	0.0000	0.0000	0.0000	0.0000	0.00104	0.00105
09:40:00	0.0000	0.0000	0.0000	0.0000	0.00104	0.00104
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00103	0.00103
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00103	0.00103
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00103	0.00103
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00101	0.00101
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00101	0.00101
11:10:00	0.0000	0.0000	0.0000	0.0000	0.001	0.001
11:20:00	0.0000	0.0000	0.0000	0.0000	0.001	0.001
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000996	0.000996
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000992	0.000992

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:27:57 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: AB8F-A43D

Site name: Sandown Park - Site A

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.02 [0.02]*

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.14
Total Rainfall (mm):	51.92	Total flow (ML):	0.38
Peak Rainfall (mm):	3.69	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:45:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:15:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.01	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	43.21	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2796	0.0000	0.0247	0.0000	0	0
00:10:00	0.3262	0.0000	0.0289	0.0000	2.88E-08	7.97E-06
00:20:00	0.3805	0.0000	0.0339	0.0000	1.78E-07	3.33E-05
00:30:00	0.4437	0.0000	0.0397	0.0001	5.83E-07	7.92E-05
00:40:00	0.5172	0.0000	0.0466	0.0001	1.4E-06	0.000149
00:50:00	0.6026	0.0000	0.0547	0.0002	2.82E-06	0.000247
01:00:00	0.7018	0.0000	0.0642	0.0004	5.05E-06	0.000379
01:10:00	0.8169	0.0000	0.0755	0.0005	8.32E-06	0.000539
01:20:00	0.9503	0.0000	0.0888	0.0007	1.28E-05	0.000719
01:30:00	1.1047	0.0000	0.1046	0.0009	1.86E-05	0.00092
01:40:00	1.2833	0.0000	0.1234	0.0011	2.58E-05	0.00115
01:50:00	1.4893	0.0000	0.1457	0.0014	3.48E-05	0.00141
02:00:00	1.7266	0.0000	0.1722	0.0017	4.57E-05	0.00171
02:10:00	1.9988	0.0000	0.2038	0.0020	5.87E-05	0.00205
02:20:00	2.3096	0.0000	0.2415	0.0024	7.44E-05	0.00245
02:30:00	2.6615	0.0000	0.2862	0.0028	9.3E-05	0.00292
02:40:00	3.0532	0.0000	0.3388	0.0034	0.000115	0.00348
02:50:00	3.4664	0.0000	0.3982	0.0040	0.000141	0.00413
03:00:00	3.6941	0.0000	0.4402	0.0047	0.000172	0.00491
03:10:00	3.4664	0.0000	0.4279	0.0056	0.000209	0.0058
03:20:00	3.0532	0.0000	0.3889	0.0066	0.000253	0.00681
03:30:00	2.6615	0.0000	0.3481	0.0076	0.000303	0.00788
03:40:00	2.3096	0.0000	0.3090	0.0086	0.00036	0.00895
03:50:00	1.9988	0.0000	0.2725	0.0095	0.000425	0.00995
04:00:00	1.7266	0.0000	0.2393	0.0103	0.000495	0.0108
04:10:00	1.4893	0.0000	0.2093	0.0109	0.00057	0.0114
04:20:00	1.2833	0.0000	0.1824	0.0112	0.000648	0.0118
04:30:00	1.1047	0.0000	0.1586	0.0112	0.000727	0.012
04:40:00	0.9503	0.0000	0.1376	0.0111	0.000805	0.0119
04:50:00	0.8169	0.0000	0.1192	0.0108	0.000881	0.0117
05:00:00	0.7018	0.0000	0.1030	0.0103	0.000954	0.0113
05:10:00	0.6026	0.0000	0.0889	0.0098	0.00102	0.0108
05:20:00	0.5172	0.0000	0.0767	0.0092	0.00109	0.0103
05:30:00	0.4437	0.0000	0.0660	0.0086	0.00115	0.00973
05:40:00	0.3805	0.0000	0.0568	0.0079	0.0012	0.00912

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.3262	0.0000	0.0489	0.0072	0.00125	0.00849
06:00:00	0.2796	0.0000	0.0420	0.0066	0.0013	0.00786
06:10:00	0.0000	0.0000	0.0000	0.0059	0.00134	0.00722
06:20:00	0.0000	0.0000	0.0000	0.0052	0.00138	0.00659
06:30:00	0.0000	0.0000	0.0000	0.0046	0.00141	0.00597
06:40:00	0.0000	0.0000	0.0000	0.0039	0.00143	0.00536
06:50:00	0.0000	0.0000	0.0000	0.0033	0.00145	0.00479
07:00:00	0.0000	0.0000	0.0000	0.0028	0.00147	0.00427
07:10:00	0.0000	0.0000	0.0000	0.0023	0.00148	0.00378
07:20:00	0.0000	0.0000	0.0000	0.0019	0.00149	0.00334
07:30:00	0.0000	0.0000	0.0000	0.0015	0.0015	0.00298
07:40:00	0.0000	0.0000	0.0000	0.0012	0.0015	0.00267
07:50:00	0.0000	0.0000	0.0000	0.0009	0.0015	0.00242
08:00:00	0.0000	0.0000	0.0000	0.0007	0.0015	0.00221
08:10:00	0.0000	0.0000	0.0000	0.0005	0.0015	0.00205
08:20:00	0.0000	0.0000	0.0000	0.0004	0.0015	0.00191
08:30:00	0.0000	0.0000	0.0000	0.0003	0.0015	0.0018
08:40:00	0.0000	0.0000	0.0000	0.0002	0.00149	0.00171
08:50:00	0.0000	0.0000	0.0000	0.0002	0.00149	0.00164
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00148	0.00158
09:10:00	0.0000	0.0000	0.0000	0.0001	0.00148	0.00154
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00147	0.0015
09:30:00	0.0000	0.0000	0.0000	0.0000	0.00147	0.00148
09:40:00	0.0000	0.0000	0.0000	0.0000	0.00146	0.00146
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00146	0.00146
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00145	0.00145
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00144	0.00144
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00144	0.00144
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00143	0.00143
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00143	0.00143
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00142	0.00142
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00142	0.00142
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00141	0.00141
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00141	0.00141
11:30:00	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014
11:40:00	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

Storage Volumes vs Storm Duration (1-in-1-year storm) for Site 5 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.385	0.579	0.031

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roof *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	1 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	5.8	23.1	9.9	29.7	1.9	0.0	0	41.5	37.3
0.5	7.3	14.6	6.3	18.8	1.2	0.0	0	26.3	47.3
1	9.0	9.0	3.9	11.6	0.7	0.0	0	16.2	58.2
2	14.1	7.0	3.0	9.1	0.6	0.0	0	12.7	91.2
4	19.4	4.8	2.1	6.2	0.4	0.0	0	8.7	125.4
6	22.4	3.7	1.6	4.8	0.3	0.0	0	6.7	144.8
8	24.4	3.0	1.3	3.9	0.3	0.0	0	5.5	157.7
12	27.0	2.3	1.0	2.9	0.2	0.0	0	4.0	174.9
16	28.9	1.8	0.8	2.3	0.1	0.0	0	3.2	186.7
20	30.3	1.5	0.6	2.0	0.1	0.0	0	2.7	196.1
24	31.6	1.3	0.6	1.7	0.1	0.0	0	2.4	204.3
28	32.7	1.2	0.5	1.5	0.1	0.0	0	2.1	211.4
32	33.7	1.1	0.5	1.4	0.1	0.0	0	1.9	218.0
36	34.6	1.0	0.4	1.2	0.1	0.0	0	1.7	224.1
40	35.5	0.9	0.4	1.1	0.1	0.0	0	1.6	230.0
44	36.4	0.8	0.4	1.1	0.1	0.0	0	1.5	235.5
48	37.2	0.8	0.3	1.0	0.1	0.0	0	1.4	241.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 5 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S5/A3.1 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 5 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.385	0.579	0.031

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roof *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	30 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	37.3	112.1	7.2	0.0	0	156.6	140.9
0.5	28.2	56.4	24.1	72.6	4.7	0.0	0	101.4	182.4
1	34.7	34.7	14.9	44.7	2.9	0.0	0	62.4	224.8
2	44.1	22.1	9.4	28.4	1.8	0.0	0	39.6	285.4
4	53.8	13.5	5.8	17.3	1.1	0.0	0	24.2	348.3
6	59.2	9.9	4.2	12.7	0.8	0.0	0	17.7	382.8
8	62.6	7.8	3.3	10.1	0.6	0.0	0	14.1	404.9
12	67.0	5.6	2.4	7.2	0.5	0.0	0	10.0	433.8
16	70.0	4.4	1.9	5.6	0.4	0.0	0	7.9	453.2
20	72.3	3.6	1.5	4.7	0.3	0.0	0	6.5	467.7
24	74.1	3.1	1.3	4.0	0.3	0.0	0	5.5	479.5
28	75.7	2.7	1.2	3.5	0.2	0.0	0	4.9	489.6
32	77.1	2.4	1.0	3.1	0.2	0.0	0	4.3	498.7
36	78.3	2.2	0.9	2.8	0.2	0.0	0	3.9	507.0
40	79.5	2.0	0.9	2.6	0.2	0.0	0	3.6	514.8
44	80.7	1.8	0.8	2.4	0.2	0.0	0	3.3	522.1
48	81.7	1.7	0.7	2.2	0.1	0.0	0	3.1	529.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 5 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S5/A3.2

Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 5 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.385	0.579	0.031

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase) 0 %

IH124 Estimate of 50% AEP Greenfield Discharge 0.0 l/s

Groundwater Inflow Rate (-ve for Outflow) 0.0 l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from grassed areas *3	Accretion Rate from hardstanding *3	Accretion Rate from roof *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	48.5	145.8	9.4	0.0	0	203.6	183.2
0.5	36.9	73.8	31.6	95.0	6.1	0.0	0	132.7	238.8
1	45.8	45.8	19.6	59.0	3.8	0.0	0	82.4	296.5
2	57.4	28.7	12.3	36.9	2.4	0.0	0	51.6	371.5
4	70.4	17.6	7.5	22.6	1.5	0.0	0	31.6	455.3
6	77.7	12.9	5.5	16.7	1.1	0.0	0	23.3	502.7
8	82.6	10.3	4.4	13.3	0.9	0.0	0	18.6	534.5
12	88.9	7.4	3.2	9.5	0.6	0.0	0	13.3	575.6
16	92.9	5.8	2.5	7.5	0.5	0.0	0	10.4	601.4
20	95.8	4.8	2.0	6.2	0.4	0.0	0	8.6	619.8
24	97.9	4.1	1.7	5.3	0.3	0.0	0	7.3	633.9
28	99.6	3.6	1.5	4.6	0.3	0.0	0	6.4	644.8
32	101.1	3.2	1.4	4.1	0.3	0.0	0	5.7	654.2
36	102.4	2.8	1.2	3.7	0.2	0.0	0	5.1	662.5
40	103.5	2.6	1.1	3.3	0.2	0.0	0	4.7	670.0
44	104.6	2.4	1.0	3.1	0.2	0.0	0	4.3	676.9
48	105.6	2.2	0.9	2.8	0.2	0.0	0	4.0	683.3

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title: Runoff rates and retention volumes for Site 5 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S5/A3.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-1-year storm) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	1 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	5.8	23.1	13.1	13.2	13.9	0.0	-3	37.3	33.6
0.5	7.3	14.6	8.3	8.4	8.8	0.0	-3	22.6	40.6
1	9.0	9.0	5.1	5.1	5.4	0.0	-3	12.8	46.0
2	14.1	7.0	4.0	4.0	4.2	0.0	-3	9.4	67.4
4	19.4	4.8	2.7	2.8	2.9	0.0	-3	5.5	79.7
6	22.4	3.7	2.1	2.1	2.2	0.0	-3	3.6	77.6
8	24.4	3.0	1.7	1.7	1.8	0.0	-3	2.4	69.1
12	27.0	2.3	1.3	1.3	1.4	0.0	-3	1.0	44.1
16	28.9	1.8	1.0	1.0	1.1	0.0	-3	0.2	13.8
20	30.3	1.5	0.9	0.9	0.9	0.0	-3	-0.3	-18.9
24	31.6	1.3	0.7	0.8	0.8	0.0	-3	-0.6	-52.8
28	32.7	1.2	0.7	0.7	0.7	0.0	-3	-0.9	-87.6
32	33.7	1.1	0.6	0.6	0.6	0.0	-3	-1.1	-123.0
36	34.6	1.0	0.5	0.5	0.6	0.0	-3	-1.2	-158.8
40	35.5	0.9	0.5	0.5	0.5	0.0	-3	-1.4	-194.9
44	36.4	0.8	0.5	0.5	0.5	0.0	-3	-1.5	-231.3
48	37.2	0.8	0.4	0.4	0.5	0.0	-3	-1.5	-267.8

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.1	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C	co-efficient of run-off (dimensionless)
i	rainfall intensity (mm/hr)
A	catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
Duration	**30 year event**								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	49.4	49.8	52.4	0.0	-3	148.7	133.8
0.5	28.2	56.4	32.0	32.2	33.9	0.0	-3	95.2	171.4
1	34.7	34.7	19.7	19.9	20.9	0.0	-3	57.6	207.2
2	44.1	22.1	12.5	12.6	13.3	0.0	-3	35.5	255.5
4	53.8	13.5	7.6	7.7	8.1	0.0	-3	20.5	295.5
6	59.2	9.9	5.6	5.6	5.9	0.0	-3	14.3	308.1
8	62.6	7.8	4.4	4.5	4.7	0.0	-3	10.7	308.5
12	67.0	5.6	3.2	3.2	3.4	0.0	-3	6.8	294.7
16	70.0	4.4	2.5	2.5	2.6	0.0	-3	4.7	271.8
20	72.3	3.6	2.0	2.1	2.2	0.0	-3	3.4	244.1
24	74.1	3.1	1.8	1.8	1.9	0.0	-3	2.5	213.8
28	75.7	2.7	1.5	1.5	1.6	0.0	-3	1.8	181.8
32	77.1	2.4	1.4	1.4	1.4	0.0	-3	1.3	148.8
36	78.3	2.2	1.2	1.2	1.3	0.0	-3	0.9	115.1
40	79.5	2.0	1.1	1.1	1.2	0.0	-3	0.6	80.9
44	80.7	1.8	1.0	1.0	1.1	0.0	-3	0.3	46.2
48	81.7	1.7	1.0	1.0	1.0	0.0	-3	0.1	11.1

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.2	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\ CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	0	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	64.2	64.7	68.2	0.0	-3	194.2	174.8
0.5	36.9	73.8	41.9	42.2	44.4	0.0	-3	125.6	226.0
1	45.8	45.8	26.0	26.2	27.6	0.0	-3	76.8	276.7
2	57.4	28.7	16.3	16.4	17.3	0.0	-3	47.1	338.8
4	70.4	17.6	10.0	10.1	10.6	0.0	-3	27.7	399.1
6	77.7	12.9	7.3	7.4	7.8	0.0	-3	19.6	424.1
8	82.6	10.3	5.9	5.9	6.2	0.0	-3	15.1	434.1
12	88.9	7.4	4.2	4.2	4.5	0.0	-3	10.0	432.0
16	92.9	5.8	3.3	3.3	3.5	0.0	-3	7.2	415.3
20	95.8	4.8	2.7	2.7	2.9	0.0	-3	5.4	391.3
24	97.9	4.1	2.3	2.3	2.5	0.0	-3	4.2	363.2
28	99.6	3.6	2.0	2.0	2.1	0.0	-3	3.3	332.1
32	101.1	3.2	1.8	1.8	1.9	0.0	-3	2.6	299.4
36	102.4	2.8	1.6	1.6	1.7	0.0	-3	2.0	265.7
40	103.5	2.6	1.5	1.5	1.6	0.0	-3	1.6	231.2
44	104.6	2.4	1.3	1.4	1.4	0.0	-3	1.2	196.0
48	105.6	2.2	1.2	1.3	1.3	0.0	-3	0.9	160.5

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.3	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm+CC) for Site 5 - PROPOSED

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.510	0.257	0.228

The Rational Method to give peak flow Q_p is in the form:

$$Q_p = 2.78\,CiA$$

Where:

C co-efficient of run-off (dimensionless)
i rainfall intensity (mm/hr)
A catchment area (Ha)

Climate change (% rainfall increase)	20	%

IH124 Estimate of 50% AEP Greenfield Discharge	2.9	l/s

Groundwater Inflow Rate (-ve for Outflow)	0.0	l/s

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	77.1	77.7	81.8	0.0	-3	233.7	210.3
0.5	36.9	73.8	50.2	50.6	53.3	0.0	-3	151.3	272.3
1	45.8	45.8	31.2	31.4	33.1	0.0	-3	92.8	334.1
2	57.4	28.7	19.5	19.7	20.7	0.0	-3	57.1	410.8
4	70.4	17.6	12.0	12.1	12.7	0.0	-3	33.8	487.3
6	77.7	12.9	8.8	8.9	9.4	0.0	-3	24.1	521.5
8	82.6	10.3	7.0	7.1	7.5	0.0	-3	18.7	537.6
12	88.9	7.4	5.0	5.1	5.4	0.0	-3	12.6	543.5
16	92.9	5.8	4.0	4.0	4.2	0.0	-3	9.2	531.8
20	95.8	4.8	3.3	3.3	3.5	0.0	-3	7.1	511.4
24	97.9	4.1	2.8	2.8	2.9	0.0	-3	5.6	486.0
28	99.6	3.6	2.4	2.4	2.6	0.0	-3	4.5	456.9
32	101.1	3.2	2.1	2.2	2.3	0.0	-3	3.7	426.1
36	102.4	2.8	1.9	2.0	2.1	0.0	-3	3.0	393.9
40	103.5	2.6	1.8	1.8	1.9	0.0	-3	2.5	360.9
44	104.6	2.4	1.6	1.6	1.7	0.0	-3	2.1	327.1
48	105.6	2.2	1.5	1.5	1.6	0.0	-3	1.7	292.8

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for Site 5 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S5/A4.4	Date:	Jan-19

7 SANDOWN PARK – SITE A

7.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site A (Racecourse Operational Facilities), as shown on *Drawing 2661/OPA-SA/01*.

7.2 Location and setting

The Application Area is located at the southwestern corner of the Sandown Park landholding and comprises a roughly triangular area of land which is bounded by Site 1 to the northwest and Site 2 to the southeast. It extends to approximately 2.2 ha.

7.3 The proposed development

The area of the proposed development currently comprises the main operational area and facilities for the racecourse. This includes Sandown Park Lodge, the pre-parade ring, stable blocks, saddling enclosures and a hardstanding area for horsebox unloading. It is proposed to re-develop the lodge to provide accommodation for racecourse staff and improve the existing operational area and associated facilities. The current land uses are shown on *Drawing 2661/OPA-SA/01*.

7.4 Baseline conditions

7.4.1 Landform

The elevation of the ground surface within the Application Area declines towards the east and northeast from approximately 42 mAOD to 28 mAOD.

7.5 Hydrology

There are no watercourses, drainage ditches, or waterbodies within or immediately adjacent to the Application Area.

7.6 Geology

This area of the site is underlain directly by the Bagshot Formation, with no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-SA/02*.

The Bagshot Formation forms the locally elevated area of The Warren and its immediate surrounds. Most of the Bagshot Formation is composed of pale yellow-brown to pale grey or white, locally orange or crimson, fine- to coarse-grained sand.

The base of the Bagshot Formation is marked by an erosional surface marking a change from clay, silt and fine-grained sand of the Claygate Member (London Clay Formation) to thick-bedded, pale-coloured, fine-grained sands, with a basal fine gravelly sand developed in places.

7.7 Fluvial flood mapping

The Application Area is located within the Environment Agency's indicative Flood Zone 1, where the probability of fluvial flooding in any one year is less than 1 in 1,000 (Annual Exceedance Probability, AEP <0.1%) (*Drawing 2661/OPA-SA/03)*. There are generally few restrictions to development in terms of flood risk within Flood Zone 1. The exception being for development over 1 ha in extent, for which Flood Risk Assessment must be undertaken.

The Application Area is 2.2 ha in size. This document outlines the flood risk to and from the proposed development and highlights the suitable mitigation measures, if required, for consideration at the detailed reserved matters stage.

7.8 Drainage characteristics

The Application Area is located within Flood Zone 1 and therefore not deemed to be at risk of fluvial flooding. There is no history of flooding within the Application Area.

Minimal areas of the site are noted as being at low and medium risk of surface water flooding, with a likelihood of flooding up to 1%, the extent of which are shown on *Drawing 2661/OPA-SA/04*. These areas are considered likely to be associated with topographical lows within the existing ground surface which will be re-profiled during the development, if necessary.

The majority of the Application Area is overlain by hardstanding, with some areas of grass surrounding the pre-parade ring. Under current conditions surface water run-off across the Application Area follows the local topography and exits the site eastwards. There are currently no issues with standing water within the site boundary.

The site is located above the Bagshot Formation, which comprises predominantly sand. The natural drainability of the sub-surface is therefore considered to be good.

7.9 Assessment of flood risk and drainage

7.9.1 Flood risk to the development

The situation of the Application Area within Flood Zone 1 and the absence of potential for fluvial flooding is such that flood risk to the proposed development is not anticipated and mitigation measures are not required.

Small areas are designated as being of low and medium risk of surface water (pluvial) flooding, however the existing surface water drainage across the site will be improved upon by the development. Therefore surface water flooding to the proposed development is not anticipated and mitigation measures are not required.

7.9.2 Flood risk from the development

The surrounds of the Application Area are also located within Flood Zone 1, which is classified as having a 'very low' fluvial flood risk.

The proposed development will modify the run-off characteristics of the site due to the change in the ground profile and surface cover. The surface water management system will be improved upon as part of the development and will ensure that volumes of surface water run-off can be retained, attenuated or infiltrated within the site boundary.

The proposed development is not anticipated to increase fluvial or pluvial flood risk to the external receptors.

7.9.3 Drainage requirements

Infiltration to ground via soakaway would appear to be feasible at this site, however a potentially high watertable will need to be considered. Intrusive soakaway testing could not be completed at this outline stage due to access restrictions on site (the site is actively in-use). Subject to appropriate soakaway testing, SuDS methods to retain and attenuate water (swales, French drains, etc) would be incorporated into the development design, and would conform to best practice.

It is anticipated that below ground attenuation in the form of geo-cellular storage will be used and located beneath proposed hardstanding parking and stables areas in the south and the west, an area comprising approximately 9,000 m^2. The geo-cellular storage will provide 1121.6 m^3 for the 1 in 100-year plus 20% climate change event, assuming discharge to a 50 m^2 soakaway.

In the event that soakaway testing proves to be unviable on site (and in the absence of a surface watercourse), discussions will commence with the local utility provider on the availability to discharge into the surface water sewer along Portsmouth Road to the east. In this scenario, the proposed outfall would be located along the eastern boundary of the site.

The Surrey County Council Surface Water Drainage Summary Pro-forma (2017) has been completed for the site, which provides data and details of the proposed drainage provision.

7.9.4 Betterment

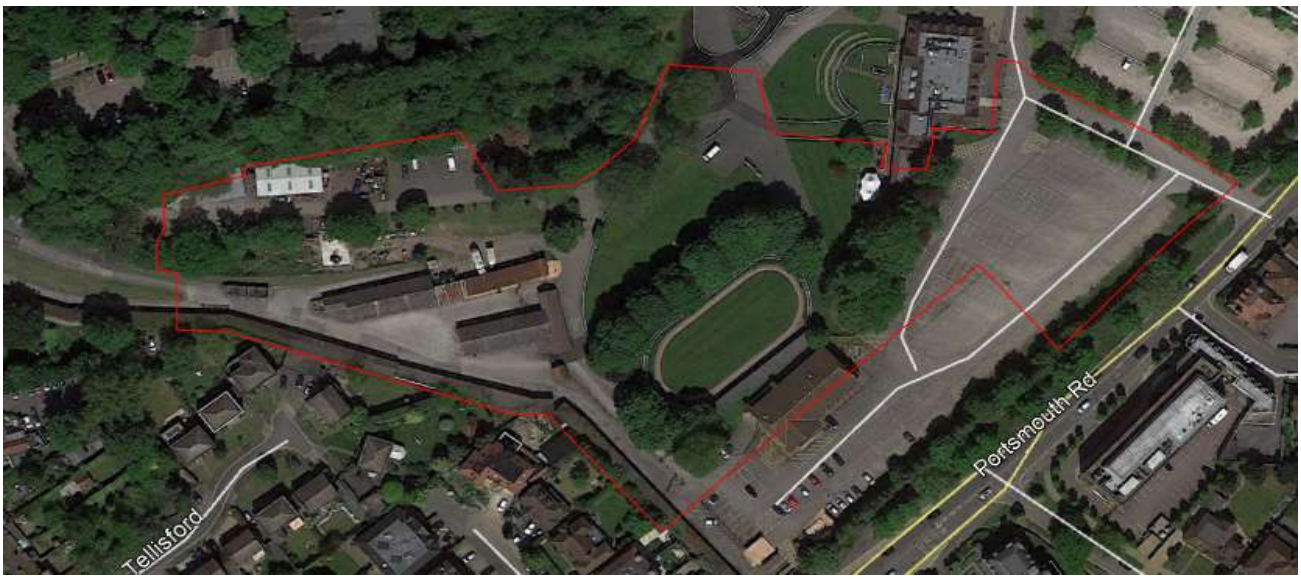
The proposed development is an opportunity for betterment of the existing drainage and water management across the Application Area. If SuDS methods to retain and attenuate water are incorporated into the development design, it is considered that the risk of increasing flood risk to or from the development is small.

7.10 Summary and conclusions

The Application Area is located at the southwestern corner of Sandown Park and is 2.2 ha in size. It is located within the Environment Agency's indicative Flood Zone 1, where the probability of fluvial flooding in any one year is less than 1 in 1,000 (Annual Exceedance Probability, AEP <0.1%). There is no history of flooding within the site. Therefore, the site is not deemed to be at risk of fluvial flooding.

Minimal areas of the site are noted as being at low and medium risk of surface water flooding, with a likelihood of flooding of up to 1%, however these are likely associated with topographical lows within the current land cover.

The proposed development provides an opportunity for betterment of the existing drainage and water management. The natural drainability of the sub-surface beneath the site is considered to be good and infiltration to ground via soakaway would appear to be feasible. However a potentially high watertable will need to be considered and soakaway testing is advised.



2661/OPA-SA/01: Existing development
Google earth imagery (May 2018)

2661/OPA-SA/01: Proposed development

Please note drawings are illustrative

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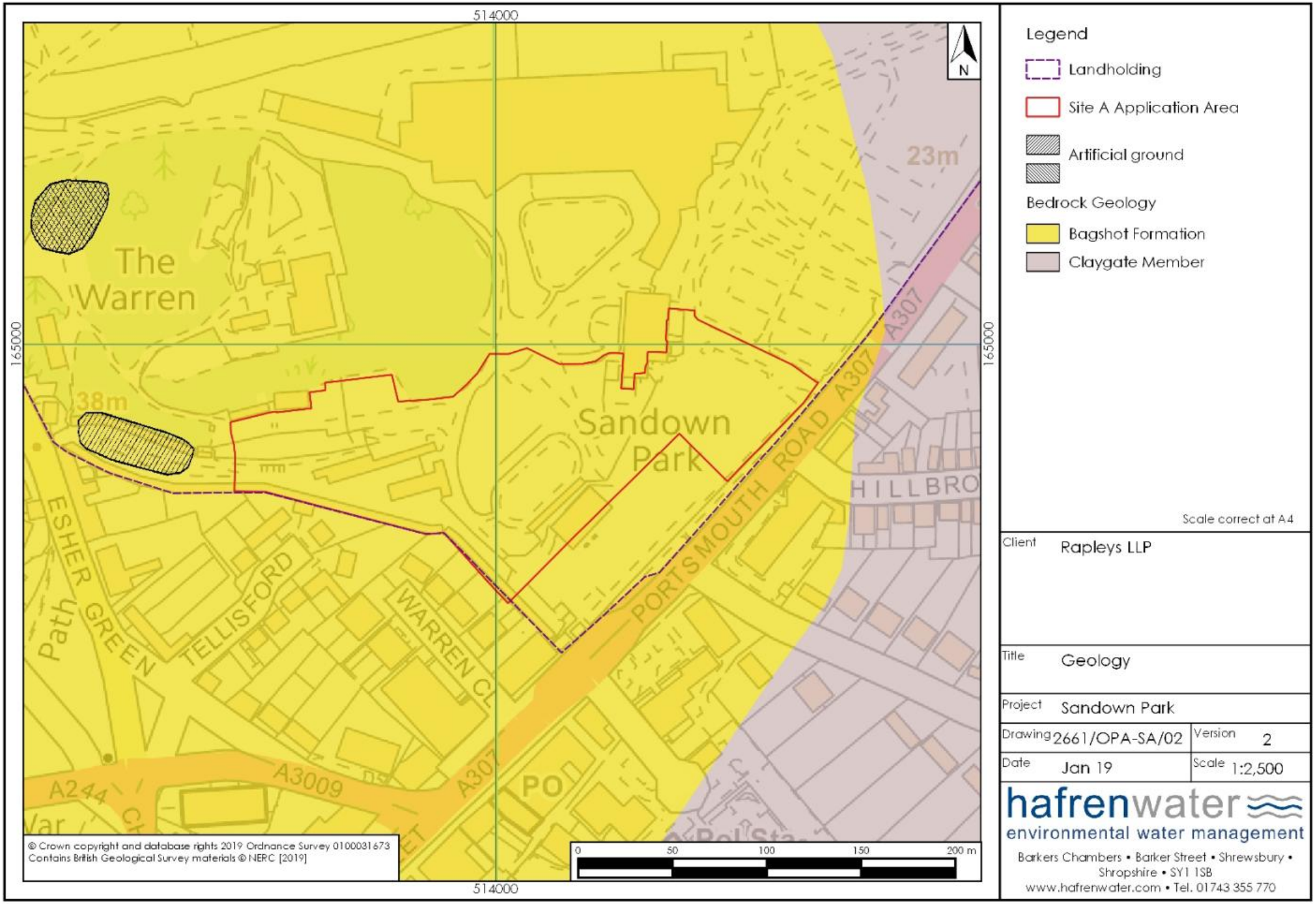
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-SA/01	Version	3
Date	Feb-19	Scale	nts


514000
165000
N
The Warren
Sandown Park
23m
38m
A307
PORTSMOUTH ROAD
HILLBRO
ESHER GREEN
TELLISFORD
WARREN CL
A3009
A244
PO
0
50
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150
200 m
© Crown copyright and database rights 2019 Ordnance Survey 0100031673
Contains British Geological Survey materials © NERC [2019]
Legend
Landholding
Site A Application Area
Artificial ground
Bedrock Geology
Bagshot Formation
Claygate Member
Scale correct at A4
Client Rapleys LLP
Title Geology
Project Sandown Park
Drawing 2661/OPA-SA/02
Version 2
Date Jan 19
Scale 1:2,500
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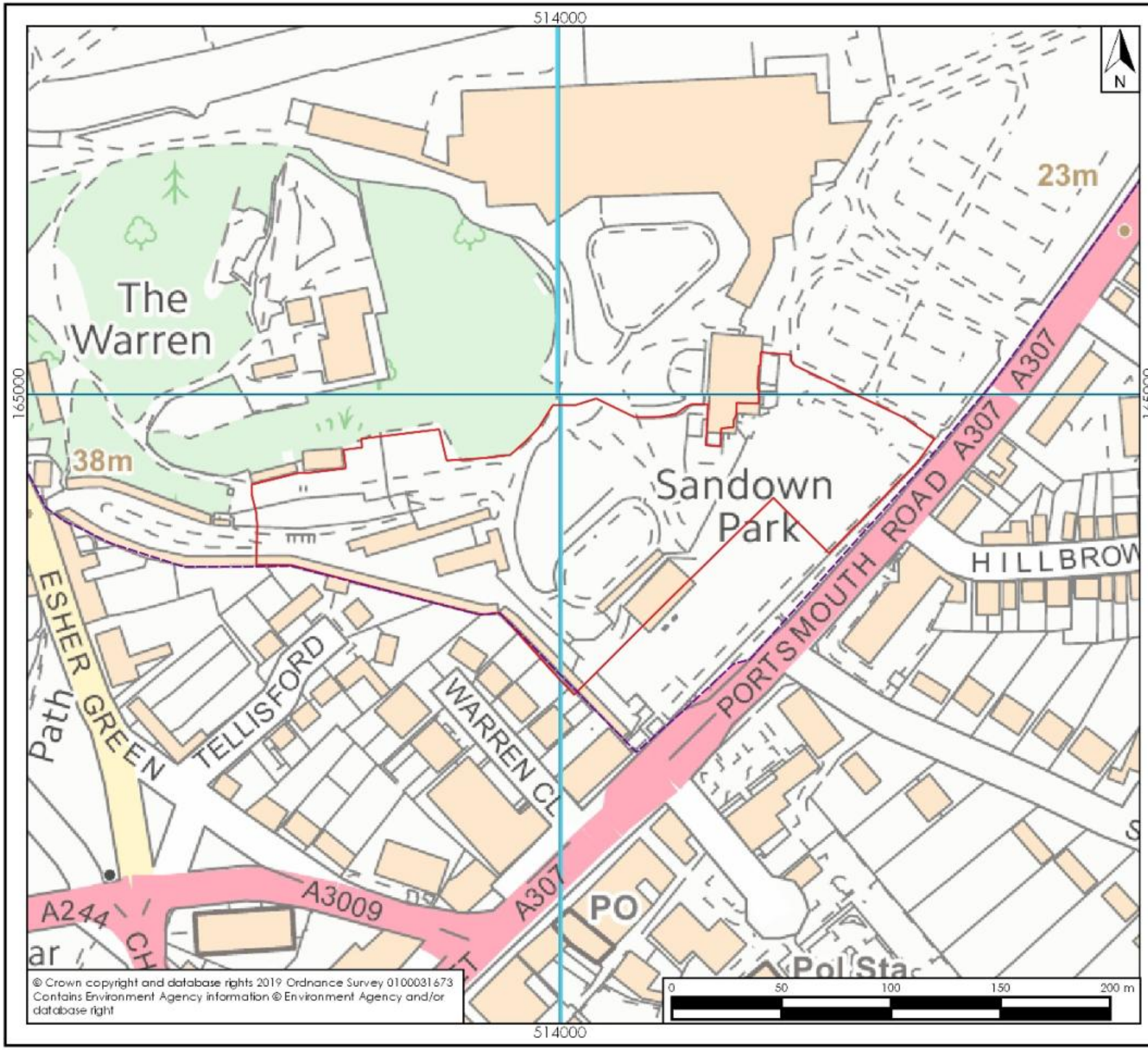

Legend

- Landholding
- Site A Application Area

Flood Risk Zones

- Flood Zone 3: High Risk
- Flood Zone 2: Medium Risk
- Flood Zone 1: Low Risk

- Historical Flooding

Scale correct at A4

Client	Rapleys LLP
Title	Fluvial flood risk and historical flooding
Project	Sandown Park
Drawing	2661/OPA-SA/03
Version	2
Date	Jan 19
Scale	1:2,500

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Surface Water Drainage Summary Pro-forma (2017)

Introduction (with links)

Surrey County Council recommends that this pro-forma should be completed in full and accompany the submitted drainage statement and sufficient additional evidence to confirm the information supplied. This information should be submitted with any planning application which seeks permission for 'major' development. This information contained in this form will be used by Surrey County Council in its role as Lead Local Flood Authority and 'statutory consultee' on SuDs for all 'major' planning applications. The pro-forma follows the national non-statutory technical SuDS standards (Defra 2015) is supported by the Defra/EA Guidance on Rainfall Runoff Management and can be completed using freely available tools including SuDS Tools. The pro-forma should be considered alongside other supporting SuDS Guidance (particularly the LASOO Guidance available online), but focuses on NPPF paragraphs 103 and 109: ensuring flood risk is not increased on or off-site and using SuDS as the primary drainage option. The SuDS solution must operate effectively for as long as the development exists and consideration of maintenance and management must be clearly demonstrated throughout its lifetime.

A summary of the evidential information to be provided at each stage of planning is provided in Appendix A

Pre-application advice (fees may apply) and existing flood risk information is available from Surrey County Council – SuDS@surreycc.gov.uk

1. Site Details

Site/development name	Site A – Racecourse Operational Facilities
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 139 649
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	21,861 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	1.47 ha (this is the total proposed impermeable area)
REFERENCES of topographical survey plan showing existing site layout, drainage system and site levels	*Permeable and impermeable area measurements are based on Drawing 11071FE_101_E_Masterplan-A0.dwg (dated 23rd January 2019)*

***** The Greenfield runoff off rate from the development should either be calculated for the entire area or the part that forms the drainage network for the site; whatever the size of site and type of drainage technique. See section 3. Greenfield runoff rate is to be used to assess the requirements for limiting discharge flow rates and attenuation storage for the same area as chosen for greenfield rates. Please refer to the EA Rainfall Runoff Management document or CIRIA manual for further details.

2. Impermeable Area and Existing Drainage

	Existing (E)	Proposed (P)	Difference (P-E)	NOTES AND REQUIRED EVIDENCE
Impermeable area (Ha) (plan of areas and values) A 10% addition for urban creep to be included within proposed area	1.46	1.47	0.02 (derived from 0.01 + 10%)	If the proposed amount of impermeable surface is greater than existing, then runoff rates and volumes will increase and will need to be attenuated. The national standards require that runoff for previously developed sites should be as close to greenfield rates/volumes as possible. **Evidence: Plan showing impermeable areas, total area calculations +10% urban creep**
Existing Drainage Method (infiltration/watercourse/sewer)	Investigation required			**Evidence: Existing drainage plan showing location of drainage elements**

3. Proposed Surface Water Discharge Method according to SuDS Hierarchy (see Appendix B)

SUDS HIERARCHY (see Appendix B)	Proposed (tick all that apply)	Reference of evidence that this is possible or not practicable	NOTES AND REQUIRED EVIDENCE Evidence must be provided to demonstrate that the proposed Sustainable Drainage proposal has had regard to the SuDS hierarchy
Reduced at source			**Evidence: Details of amount of runoff reduced and storage provided**
Infiltration to ground	✓	Ground investigation required to confirm that soakaway is viable	**Evidence: The results of infiltration tests in soakaway locations. If infiltration is deemed not viable clear site specific evidence must be provided** see Section 6 (infiltration)
Attenuated volume and discharge to watercourse			**Evidence: Details of any watercourse to which the site drains including cross-sections of any adjacent water courses for appropriate distance upstream and downstream of the discharge point (as agreed with the LLFA and/or EA)** see Section 7 (attenuated discharge)
Attenuated volume and discharge to surface water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)
Attenuated volume and discharge to combined/foul water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)

	Drawings provided	NOTES AND REQUIRED EVIDENCE
Drawings and Details (e.g. Existing and proposed drainage, Topography, Impermeable areas, cross sections of SuDS elements)	Drawings not included at outline stage of planning process.	**Evidence:** Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Calculate Peak Discharge Rates – Technical Standards S2 and S3

This is the maximum flow rate at which surface water runoff leaves the site during the critical storm event.

	Greenfield Rates (l/s)	Brownfield rates (l/s) (as appropriate)	Proposed Rates (l/s)	Difference (Proposed-Existing) (l/s)	NOTES AND REQUIRED EVIDENCE
Qbar	6.3	-	-	-	Mean annual Greenfield peak flow - QBAR is approx. 1 in 2 storm events. **Qbar**$_{rural}$ should be used for this value. If the site is currently developed, the appropriate figures should be used to calculate Qbar (and associated rates) in proportion to the amount of existing hardstanding present on the site. Use Qbar$_{rural}$ and Qbar$_{urban}$ as appropriate and prorata'd to effectively model the site.
1 in 1	2.81	15.4	0.0	-15.4	Proposed discharge rates (with mitigation) should be as close to greenfield as possible and should be no greater than existing rates for all corresponding storm events. To mitigate for climate change the proposed 1 in 100 +CC must be no greater than the existing 1 in 100 runoff rate. If not, flood risk increases under climate change. See appendix 2 for climate change allowances. **Evidence: Micro-drainage (or equivalent) calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology**
1 in 30	8.5	40.7	0.0	-40.7	
1in 100	12.0	53.4	0.0	-53.4	
1 in 100 plus 20% climate change *	N/A	N/A	0.0	-	

5. Calculate discharge volumes - Technical Standards S4 to S8

The total volume of water leaving the development site for a particular rainfall event. Introducing new impermeable surfaces increases surface water runoff and may increase flood risk outside the development.

	Greenfield Volume (m^3)	Brownfield Volume (m^3) (as appropriate)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	NOTES AND REQUIRED EVIDENCE
1 in 1	88.9	332.6	110.5	-222.1	Proposed discharge volumes (without mitigation) should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased attenuation must be provided to reduce volume outflow during the event. To mitigate for climate change the volume discharge from site must be no greater than the existing 1 in 100 storm event. **Evidence: Micro-drainage (or equivalent) calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology**
1 in 30	269.0	879.0	618.8	-260.2	
1in 100	378.0	1154.2	880.7	-273.5	
1 in 100 plus 20% climate change *	N/A	N/A	1121.6	-	

* Climate Change Allowance for Rainfall Intensity Increases

Designs should include 20% provision for increases in surface water runoff due to climate change during the development's lifetime – please see Appendix C

6. Infiltration

If infiltration is proposed – sufficient evidence must be provided to show that this is viable and does not increase flood risk

	SITE INFORMATION	Details	NOTES AND REQUIRED EVIDENCE
Is infiltration feasible?	**Yes/No?**	Yes	**Evidence: If deemed NOT FEASIBLE clear site specific evidence (site investigation, site photos, infiltration testing) must be provided to demonstrate why**
Infiltration information	**Site Geology** (bedrock and superficial)	Underlain by Bagshot Formation (no superficial deposits recorded)	Avoid infiltrating in made ground. **Evidence: suitable mapping/SI**
	Is ground water table less than 3m below ground?	Requires investigation	If yes, please provide details of the site's hydrology. **Evidence : Site Investigation**
	Is the site within a known Source Protection Zones (SPZ) or above a Major Aquifer?	No	Refer to Environment Agency website to identify and source protection zones (SPZ). **Evidence: Adequate water treatment stages must be provided**
	Infiltration rate used in calculations	3×10^{-4} m/s	Infiltration rates should be no lower than $1x10^{-6}$ m/s. **Evidence: infiltration testing according to BRE 365 or equivalent**
	Were infiltration rates obtained by desk study or on site infiltration testing?	Infiltration rates taken from CIRIA SuDS Manual 2015, Table 25.1: Typical infiltration. Coefficients based on soil texture (after Bettess, 1996)	**Evidence: Infiltration rates solely estimated from desk studies are only suitable at outline planning applications unless clear site specific evidence can be provided and a back-up attenuation scheme is provided**
	Is the site contaminated? If yes, consider advice from EA on whether infiltration is acceptable.	Unknown	Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered

Design details	**Infiltration type** (soakaway, deep bore, blanket etc)	Soakaway	**Evidence: Suitable designs must be provided**
	Storage volume provided within infiltration feature (m^3)	Further work is required (in the form of intrusive ground investigation) to allow specific rates of infiltration to be determined. These will be used in the design of soakaways at the site. Soakaway will attenuate the 1 in 100 year plus climate change event, which is taken as 1,121.6 m^3	Infiltration must be designed to ensure that at a minimum no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event **Evidence:. Calculations showing available volume of proposed infiltration device and storage. Plan and Cross sectional drawings of proposed infiltration.**
	State the vertical distance between any proposed infiltration device base and the normal ground water (GW) level		1m (min) is required between the base of the infiltration device & the water table to protect groundwater quality & ensure groundwater doesn't enter infiltration devices.
	Half drain times of infiltration features (hr)		**Evidence: Suitable calculations**
	Factor of safety used in infiltration calculations		**Evidence: Suitable calculations**
	Minimum distance of infiltration from buildings		**Evidence: Minimum distance should be >5m unless designed specifically to reduce impact on adjacent buildings.**

7. Attenuated storage

In order to minimise the negative impact on flood risk resulting from any increase in runoff rate or volume from the proposed development, attenuation storage must be provided. Installed flow restriction and stored the attenuation volumes should ensure final discharge from the site at the rates and volumes set out in sections 4 and 5. If some of the stored volume of water can be infiltrated back into the ground, the remainder can be discharged at a rate at or below greenfield rates. A combined storage calculation using the partial infiltration rate and the attenuation rate used to slow the runoff from site.

ATTENUATION DETAILS	Details	NOTES AND REQUIRED EVIDENCE
How are flow rates being restricted?	Infiltration (See Section 6 above)	Hydrobrakes can be used where rates are >2l/s. Orifice plates with an opening <75mm in open systems may require pre-screening.
Storage volume provided (m^3) (excluding non-void spaces)	Below ground soakaway will be sized to accommodate a 1 in 100 year (+CC) event. Further information to be provided at Detailed Design stage. This will be required for the Full Planning Application.	Volume provided to attenuate on site to discharging at existing rates. See section 5. **Evidence: Attenuation must be designed to ensure that at no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event. A 10% additional allowance should be included for underground attenuation systems which cannot be fully accessed/cleansed as well as the provision of u/s siltation protection and access/jetting points. Calculations showing available volume of proposed attenuation storage. Plan and Cross sectional drawings of proposed storage**
How will the storage be provided on site?		

Half drain times of attenuation feature (hr)		**Evidence: suitable calculations to show feature**

8. Construction and Exceedance Planning - Technical Standards S9 and S14

CONSIDERATION	Details	NOTES AND REQUIRED EVIDENCE
How will exceedance/infrastructure failure events be catered on site without significantly increasing flood risks (both on site and outside the development)? Technical Standard S9	No flooding will occur in a 1 in 100-year (+CC) event. Should a flood occur that exceeds this, water will discharge downslope. Further information to be provided at detailed design stage.	**Evidence: Topographic plan showing flow routes for events above those designed – routing of water away from existing properties and critical infrastructure**. Retained water should not cause property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths and not preventing safe access/egress
Drainage during construction period: temporary drainage, pollution prevention and protection of existing/part built drainage systems. Technical Standard S14	Details to be provided at detailed reserved matters stage. Drainage works and pollution prevention measures adopted during construction will conform to current required standards and industry best practice.	Provide details of how drainage will be managed during the construction period including any necessary connections, impacts, diversions and erosion control. How pollution prevention for any local watercourses will be considered – especially siltation from runoff **Evidence: Construction phasing plan, construction environmental management plan (CEMP) or other statements**

9. Management and Maintenance of SuDs - Technical Standards S10 to S12

Details are required to be provided of the management and maintenance plan for the SuDS, including for the individual plots, in perpetuity.

How is the entire drainage system to be maintained in perpetuity?

Further information to be provided at detailed design stage, however the following information is included as guidance.

Drainage Feature	Schedule	Required Action	Frequency
Infiltration Systems (Soakaways and trenches)	Regular Maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
		Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
		Trimming any roots that may be causing blockages	Annually (or as required)
	Occasional Maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
	Remedial Actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
		Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
	Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
		Check soakaway to ensure emptying is occurring	Annually

Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided to show that all parts of SuDs are effective and robust. It should consider how the SuDs will perform and develop over time anticipating any additional maintenance tasks to ensure the system continues to perform as designed. Responsibility for the management and maintenance of each element of the SUDS scheme will also need to be detailed within the Management Plan. Where open water is involved please provide a health and safety plan within the management plan.

Evidence: A maintenance schedule describes what work is to be done and when it is to be done using frequency and performance requirements as appropriate.

Please confirm the owners/adopters of the entire drainage system throughout the development. Please list all the owners.	Jockey Club Racecourses Ltd	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit should be submitted **Evidence: statement of ownership or plan on complex sites**
Please demonstrate that any third party agreements required for adoption or using land outside the application site have been secured.	N/A	**Evidence: proof of agreements (at least in principle at planning approval stage) with adopters or external landowners**

10. Additional Considerations to comply with the Technical Standards and other legislation

Water Quality – Appropriate level and stages of water treatment must be used to prevent pollution of the environment (SuDS manual CIRIA C753)

S10 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

S11 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use. (e.g. BS or kitemarked)

S12 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

S13 The mode of construction of any communication with an existing sewer or drainage system must be such that the making of the communication would not be prejudicial to the structural integrity and functionality of the sewerage or drainage system.

The above form should be completed using evidence from information which should be appended to this form/within the planning submission. The information being submitted should be proportionate to the site conditions, flood risks and magnitude of development. It should serve as a summary of the drainage proposals and should clearly show that the proposed discharge rate and volume as a result of development will not be increasing. Where there is an increase in discharge rate or volume due to development, then the relevant section of this form must be completed with clear evidence demonstrating how the greenfield rates (or as close to them as possible if a brownfield site) will be met.

This form is completed using factual information and can be used as a summary of the surface water drainage strategy on this site.

Form completed by:……Rebecca John…….(Checked by Richard Laker)…….....

Contact details: Tel.....01743 355770.....Email.....chris@hafrenwater.com.....

Qualification of person responsible for signing off this pro-forma: .....Environmental Consultant……(BSc FGS)…….....

Company:…….Hafren Water……..……,.....

On behalf of (Client's details): .....Rapleys LLP.....

Date:…….January 2019…….....

Appendix A

Evidence to be submitted at each stage of planning

Pre-app	Outline	Full	Reserved	Discharge	Document submitted
✓	✓	✓			Flood Risk Assessment/Statement
✓	✓	✓			Drainage Strategy/Statement & sketch layout plan
	✓				Preliminary layout drawings
	✓				Preliminary "Outline" hydraulic calculations
	✓				Preliminary landscape proposals
	✓				Ground investigation report (for infiltration)
	✓	✓			Evidence of third party agreement for discharge to their system (in principle/ consent to discharge)
		✓		✓	Maintenance program and on-going maintenance responsibilities
		✓	✓		Detailed development layout
		✓	✓	✓	Detailed flood & drainage design drawings
		✓	✓	✓	Full Structural, hydraulic & ground investigations
		✓	✓	✓	Geotechnical factual and interpretive reports, including infiltration results
		✓	✓	✓	Detailed landscaping details
		✓	✓	✓	Discharge agreements (temporary and permanent)
		✓	✓	✓	Development Management & Construction Phasing Plan

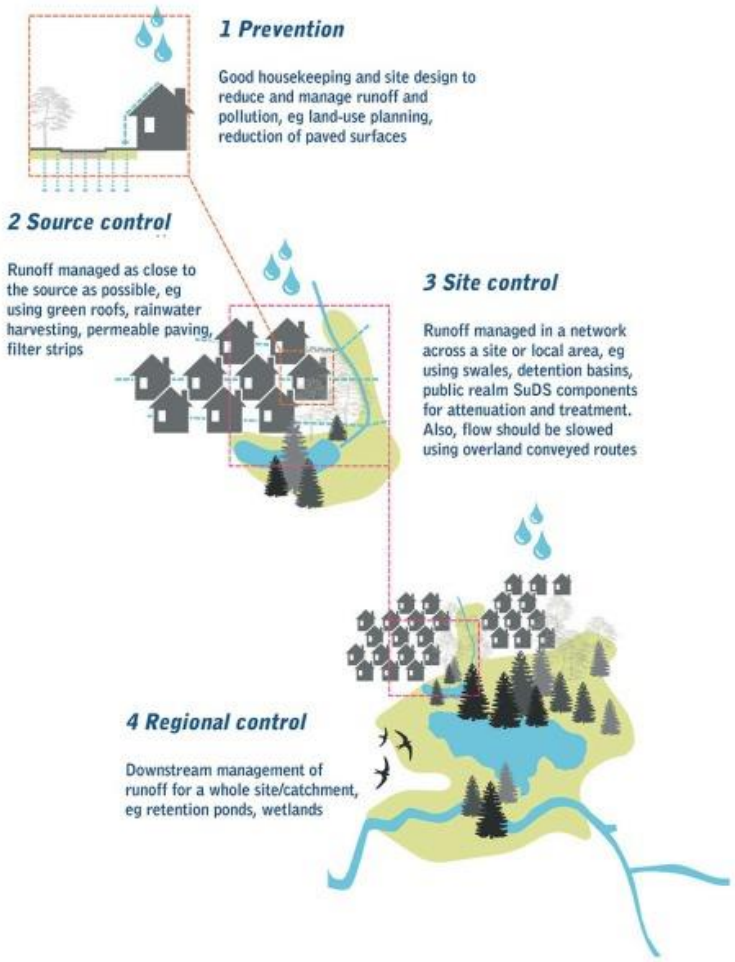
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

At Outline Planning stage enough evidence must be provided to prove that a viable method of draining the site has been provided which does not increase local flood risk

At Full Application, Discharge of Conditions or Reserved Matters stage suitable evidence must be provided to show that all the requirements of the national standards have been met

Appendix B

SuDS Treatment Train



Dickie, S, McKay, G, Ions, L, Shaffer, P (2010) Planning for SuDS – making it happen, C687, CIRIA, London (ISBN: 978-0-86017-687-9).

Discharge Hierarchy

Sustainability Hierarchy

DISCHARGE CHOICE		SUSTAINABILITY CHOICE				
Discharge Hierarchy	**SuDS Type**	**Sustainability Level**	**SuDS Technique**	Flood Reduction	Pollution Reduction	Wildlife & Landscape Benefit
MUST BE CONSIDERED FIRST	**Source Control**	MOST SUSTAINABLE (PREFERRED)	**Green/Living Roofs & Walls**	✓	✓	✓
	OPTION 1 Infiltration To Ground		**Infiltration:** • Infiltration trenches & basins • Soakaways: (standard or crate system)	✓	✓	✓
	OPTION 2 Attenuation and Discharge: **To Pond, Ordinary Watercourse or Main River**		**Filter strips and Swales**	✓	✓	✓
			Basins and ponds: • Wetlands • Balancing Ponds • Detention Basins • Retention Basins • Conveyance swales	✓	✓	✓
	OPTION 3 Attenuation and Discharge **a) To Surface Water Sewer** **b) To Combined Sewer**		**Permeable Surfaces & filter drains:** • Gravelled areas • Porous paving	✓	✓	
ONLY IF ALL OTHER OPTIONS ARE UNVIABLE	**OPTION 4 Attenuation and Discharge** **To Foul or Highways sewer (only in exceptional circumstances)**	LEAST SUSTAINABLE	**Tanks & Piped Systems:** • Crated Attenuation • Tanks • Oversize pipes	✓		

Appendix C

Climate change allowances

In February 2016 there was a change to the EA climate change advice to modify the allowance levels for rainfall when designing surface water drainage: to 20% CC allowance for 1 in 100 year events but with a 40% sensitivity test. (please note the advice for river flow levels also changed – please contact the Environment Agency for more details)

Applicants should design the discharge rates and attenuation on site to accommodate the 1:100 year +20% CC event and understand the flooding implications for the +40% CC event.

If the implications are significant i.e. the site contains "highly vulnerable" or "critical infrastructure" receptors, could flood another development or put people at risk then a view should be taken to provide more attenuation to meet the 40% CC event. This will tie into designing for exceedance principles.

An example: Attenuation basin designed to accommodate the 1:100 year + 20% climate change event, during the modelling of the 40% cc event the water level of the basin rises by 340mm, which equates to 40mm over the 300mm already freeboard provided. Therefore a suitable mitigation would be to provide freeboard of 350mm instead of 300mm, in order to ensure the development doesn't flood third parties downstream for the extreme 40% cc scenario.

Extract taken from Environment Agency publication; *Adapting to Climate Change: Advice for Flood and Coastal Risk Management Authorities:*

What are the climate change allowances?

To assess the potential impacts that climate change may have on extreme rainfall, river flood flows, sea level rise and storm surges, climate change allowances are provided in Annex 1. The climate change allowances quantify the potential change (as either mm or percentage increase, depending on the variable) to the baseline. The climate change allowances are based on the best available, credible, peer-reviewed scientific evidence from UKCP09, but given the complexity of the science around climatic projections, there are significant uncertainties attributed to the climate change allowances. This is why the climate change allowances are presented as a range of possibilities (Lower, Central, Higher Central and Upper), to reflect the potential variation in climate change impacts over three epochs from the present day to 2115. It is recommended that the performance of flood risk management options are assessed against all of the change allowances covering the whole of the decision lifetime.

Change to extreme rainfall intensity compared to a 1961-90 baseline Applies across all of England			
Climate Change scenario	**Total potential change anticipated for '2020s' (2015-39)**	**Total potential change anticipated for '2050s' (2040-2069)**	**Total potential change anticipated for '2080s' (2070-2115)**
Upper estimate	10%	20%	40%
Central estimate	5%	10%	20%

Greenfield Runoff Estimate for SITE A

Institute of hydrology report no. 124 (IH124)

$$Q_{BAR(rural)} = 0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}$$

Where:

$Q_{BAR(rural)}$	mean annual flood (return period 2.3 years) (m^3/s)
AREA	catchment area (km^2)
SAAR(4170)	standard average rainfall for the period 1941 to 1970 (mm)
SOIL	soil index

$Q_{BAR(rural)}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

Parameters	
Area	0.0219 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	6.3 l/s
Q (1in1yr)*	5.4 l/s
QBAR	2.9 l/s/ha
Q (1in1yr)	2.5 l/s/ha
Q (1in100yr)	9.2 l/s/ha

NB: calculation based on 0.5 km2 and then scaled down to actual catchment size. The IH124 methodology is designed for sites > 0.5 km2 but can be linearly interpolated to represent smaller catchments.

Q (1in1yr)*: 1 year return period growth curve factors are taken from NERC (1977). 30 year (and 1 year for Ireland) return period growth curve factors are interpolated estimates (Source: *CIRIA SuDS Manual C753*)

Return period (yr)	**1**	**2**	**5**	**10**	**25**	**30**	**50**	**100**	**200**
Q (l/s/ha)	2.5	2.5	3.7	4.7	6.2	7.0	7.6	9.2	11.2
Q (l/s)	5.4	5.6	8.1	10.3	13.5	15.2	16.6	20.2	24.4

hafrenwater
environmental water management

Barkers Chambers
Barker Street
Shrewsbury, Shropshire SY1 1SB
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Tel: 01743 355770
www.hafrenwater.com

Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE A, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SA/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:26:34 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: AB8F-A43D

Site name: Sandown Park - Site A

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.02 [0.02]*

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.03
Total Rainfall (mm):	15.00	Total flow (ML):	0.09
Peak Rainfall (mm):	1.07	Peak flow (m^3/s):	0.00

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:45:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:15:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.01	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	43.21	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.0808	0.0000	0.0071	0.0000	0	0
00:10:00	0.0942	0.0000	0.0083	0.0000	8.32E-09	2.3E-06
00:20:00	0.1099	0.0000	0.0097	0.0000	5.13E-08	9.61E-06
00:30:00	0.1282	0.0000	0.0113	0.0000	1.68E-07	2.28E-05
00:40:00	0.1494	0.0000	0.0132	0.0000	4.03E-07	4.29E-05
00:50:00	0.1741	0.0000	0.0155	0.0001	8.11E-07	7.11E-05
01:00:00	0.2027	0.0000	0.0181	0.0001	1.45E-06	0.000109
01:10:00	0.2360	0.0000	0.0211	0.0002	2.39E-06	0.000154
01:20:00	0.2745	0.0000	0.0246	0.0002	3.66E-06	0.000205
01:30:00	0.3191	0.0000	0.0287	0.0003	5.31E-06	0.000262
01:40:00	0.3707	0.0000	0.0335	0.0003	7.37E-06	0.000325
01:50:00	0.4302	0.0000	0.0391	0.0004	9.9E-06	0.000397
02:00:00	0.4988	0.0000	0.0456	0.0005	1.3E-05	0.000478
02:10:00	0.5774	0.0000	0.0532	0.0006	1.66E-05	0.000571
02:20:00	0.6672	0.0000	0.0619	0.0007	2.09E-05	0.000678
02:30:00	0.7688	0.0000	0.0720	0.0008	2.6E-05	0.000801
02:40:00	0.8820	0.0000	0.0835	0.0009	3.21E-05	0.000944
02:50:00	1.0013	0.0000	0.0959	0.0011	3.91E-05	0.00111
03:00:00	1.0671	0.0000	0.1036	0.0013	4.74E-05	0.0013
03:10:00	1.0013	0.0000	0.0984	0.0015	5.71E-05	0.00152
03:20:00	0.8820	0.0000	0.0877	0.0017	6.82E-05	0.00175
03:30:00	0.7688	0.0000	0.0772	0.0019	8.1E-05	0.002
03:40:00	0.6672	0.0000	0.0676	0.0021	9.54E-05	0.00224
03:50:00	0.5774	0.0000	0.0589	0.0023	0.000111	0.00245
04:00:00	0.4988	0.0000	0.0512	0.0025	0.000128	0.00262
04:10:00	0.4302	0.0000	0.0444	0.0026	0.000146	0.00274
04:20:00	0.3707	0.0000	0.0384	0.0026	0.000165	0.0028
04:30:00	0.3191	0.0000	0.0332	0.0026	0.000183	0.00281
04:40:00	0.2745	0.0000	0.0287	0.0026	0.000201	0.00276
04:50:00	0.2360	0.0000	0.0247	0.0025	0.000219	0.00269
05:00:00	0.2027	0.0000	0.0213	0.0023	0.000236	0.00258
05:10:00	0.1741	0.0000	0.0183	0.0022	0.000251	0.00246
05:20:00	0.1494	0.0000	0.0158	0.0021	0.000266	0.00232
05:30:00	0.1282	0.0000	0.0135	0.0019	0.000279	0.00218
05:40:00	0.1099	0.0000	0.0116	0.0017	0.000291	0.00203

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.0942	0.0000	0.0100	0.0016	0.000302	0.00188
06:00:00	0.0808	0.0000	0.0086	0.0014	0.000312	0.00173
06:10:00	0.0000	0.0000	0.0000	0.0013	0.00032	0.00159
06:20:00	0.0000	0.0000	0.0000	0.0011	0.000328	0.00144
06:30:00	0.0000	0.0000	0.0000	0.0010	0.000334	0.0013
06:40:00	0.0000	0.0000	0.0000	0.0008	0.000339	0.00117
06:50:00	0.0000	0.0000	0.0000	0.0007	0.000344	0.00105
07:00:00	0.0000	0.0000	0.0000	0.0006	0.000347	0.000932
07:10:00	0.0000	0.0000	0.0000	0.0005	0.000349	0.000828
07:20:00	0.0000	0.0000	0.0000	0.0004	0.000351	0.000736
07:30:00	0.0000	0.0000	0.0000	0.0003	0.000352	0.000659
07:40:00	0.0000	0.0000	0.0000	0.0002	0.000353	0.000595
07:50:00	0.0000	0.0000	0.0000	0.0002	0.000353	0.000542
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000353	0.000499
08:10:00	0.0000	0.0000	0.0000	0.0001	0.000353	0.000465
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000352	0.000437
08:30:00	0.0000	0.0000	0.0000	0.0001	0.000351	0.000414
08:40:00	0.0000	0.0000	0.0000	0.0000	0.00035	0.000395
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000349	0.00038
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000348	0.000368
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000347	0.000359
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000345	0.000352
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000344	0.000347
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000343	0.000343
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000342	0.000342
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00034	0.00034
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000339	0.000339
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000338	0.000338
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000336	0.000336
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000335	0.000335
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000334	0.000334
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000332	0.000332
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000331	0.000331
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00033	0.00033
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000329	0.000329
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000327	0.000327

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:27:23 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: AB8F-A43D

Site name: Sandown Park - Site A

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.02 [0.02]*

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.10
Total Rainfall (mm):	39.42	Total flow (ML):	0.27
Peak Rainfall (mm):	2.80	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:45:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:15:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.01	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	43.21	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2123	0.0000	0.0187	0.0000	0	0
00:10:00	0.2477	0.0000	0.0219	0.0000	2.19E-08	6.05E-06
00:20:00	0.2889	0.0000	0.0256	0.0000	1.35E-07	2.53E-05
00:30:00	0.3369	0.0000	0.0300	0.0001	4.42E-07	6E-05
00:40:00	0.3927	0.0000	0.0352	0.0001	1.06E-06	0.000113
00:50:00	0.4575	0.0000	0.0412	0.0002	2.14E-06	0.000187
01:00:00	0.5328	0.0000	0.0483	0.0003	3.83E-06	0.000287
01:10:00	0.6202	0.0000	0.0567	0.0004	6.3E-06	0.000408
01:20:00	0.7214	0.0000	0.0665	0.0005	9.67E-06	0.000543
01:30:00	0.8387	0.0000	0.0781	0.0007	1.4E-05	0.000695
01:40:00	0.9742	0.0000	0.0918	0.0008	1.95E-05	0.000866
01:50:00	1.1307	0.0000	0.1079	0.0010	2.63E-05	0.00106
02:00:00	1.3108	0.0000	0.1271	0.0012	3.45E-05	0.00128
02:10:00	1.5174	0.0000	0.1497	0.0015	4.43E-05	0.00154
02:20:00	1.7534	0.0000	0.1764	0.0018	5.6E-05	0.00183
02:30:00	2.0206	0.0000	0.2078	0.0021	6.99E-05	0.00218
02:40:00	2.3179	0.0000	0.2444	0.0025	8.63E-05	0.00259
02:50:00	2.6316	0.0000	0.2853	0.0030	0.000106	0.00306
03:00:00	2.8045	0.0000	0.3132	0.0035	0.000129	0.00362
03:10:00	2.6316	0.0000	0.3025	0.0041	0.000156	0.00426
03:20:00	2.3179	0.0000	0.2733	0.0048	0.000188	0.00498
03:30:00	2.0206	0.0000	0.2435	0.0055	0.000224	0.00574
03:40:00	1.7534	0.0000	0.2152	0.0062	0.000266	0.00648
03:50:00	1.5174	0.0000	0.1893	0.0069	0.000312	0.00718
04:00:00	1.3108	0.0000	0.1657	0.0074	0.000363	0.00776
04:10:00	1.1307	0.0000	0.1446	0.0078	0.000416	0.00818
04:20:00	0.9742	0.0000	0.1258	0.0080	0.000472	0.00843
04:30:00	0.8387	0.0000	0.1092	0.0080	0.000528	0.0085
04:40:00	0.7214	0.0000	0.0946	0.0078	0.000583	0.00843
04:50:00	0.6202	0.0000	0.0818	0.0076	0.000637	0.00824
05:00:00	0.5328	0.0000	0.0707	0.0073	0.000689	0.00797
05:10:00	0.4575	0.0000	0.0610	0.0069	0.000737	0.00763
05:20:00	0.3927	0.0000	0.0525	0.0065	0.000783	0.00724
05:30:00	0.3369	0.0000	0.0452	0.0060	0.000825	0.00683
05:40:00	0.2889	0.0000	0.0389	0.0055	0.000864	0.00639

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.2477	0.0000	0.0334	0.0050	0.000899	0.00594
06:00:00	0.2123	0.0000	0.0287	0.0046	0.00093	0.00549
06:10:00	0.0000	0.0000	0.0000	0.0041	0.000958	0.00504
06:20:00	0.0000	0.0000	0.0000	0.0036	0.000982	0.00459
06:30:00	0.0000	0.0000	0.0000	0.0032	0.001	0.00415
06:40:00	0.0000	0.0000	0.0000	0.0027	0.00102	0.00373
06:50:00	0.0000	0.0000	0.0000	0.0023	0.00103	0.00334
07:00:00	0.0000	0.0000	0.0000	0.0019	0.00105	0.00297
07:10:00	0.0000	0.0000	0.0000	0.0016	0.00105	0.00263
07:20:00	0.0000	0.0000	0.0000	0.0013	0.00106	0.00233
07:30:00	0.0000	0.0000	0.0000	0.0010	0.00107	0.00208
07:40:00	0.0000	0.0000	0.0000	0.0008	0.00107	0.00187
07:50:00	0.0000	0.0000	0.0000	0.0006	0.00107	0.0017
08:00:00	0.0000	0.0000	0.0000	0.0005	0.00107	0.00156
08:10:00	0.0000	0.0000	0.0000	0.0004	0.00107	0.00144
08:20:00	0.0000	0.0000	0.0000	0.0003	0.00107	0.00135
08:30:00	0.0000	0.0000	0.0000	0.0002	0.00106	0.00127
08:40:00	0.0000	0.0000	0.0000	0.0002	0.00106	0.00121
08:50:00	0.0000	0.0000	0.0000	0.0001	0.00106	0.00116
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00105	0.00112
09:10:00	0.0000	0.0000	0.0000	0.0000	0.00105	0.00109
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00105	0.00107
09:30:00	0.0000	0.0000	0.0000	0.0000	0.00104	0.00105
09:40:00	0.0000	0.0000	0.0000	0.0000	0.00104	0.00104
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00103	0.00103
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00103	0.00103
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00103	0.00103
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00102	0.00102
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00101	0.00101
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00101	0.00101
11:10:00	0.0000	0.0000	0.0000	0.0000	0.001	0.001
11:20:00	0.0000	0.0000	0.0000	0.0000	0.001	0.001
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000996	0.000996
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000992	0.000992

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:27:57 PM by richard.laker
Printed from the ReFH Flood Modelling software package, version 2.2.6589.25305

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: AB8F-A43D

Site name: Sandown Park - Site A

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.02 [0.02]*

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.14
Total Rainfall (mm):	51.92	Total flow (ML):	0.38
Peak Rainfall (mm):	3.69	Peak flow (m^3/s):	0.01

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:10:00 [01:45:00]*	Yes
Timestep (hh:mm:ss)	00:10:00 [00:15:00]*	Yes
SCF (Seasonal correction factor)	0.67	No
ARF (Areal reduction factor)	0.99	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	73.45	No
Cmax (mm)	834.23	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.01	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	43.21	No
BR	1.88	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2796	0.0000	0.0247	0.0000	0	0
00:10:00	0.3262	0.0000	0.0289	0.0000	2.88E-08	7.97E-06
00:20:00	0.3805	0.0000	0.0339	0.0000	1.78E-07	3.33E-05
00:30:00	0.4437	0.0000	0.0397	0.0001	5.83E-07	7.92E-05
00:40:00	0.5172	0.0000	0.0466	0.0001	1.4E-06	0.000149
00:50:00	0.6026	0.0000	0.0547	0.0002	2.82E-06	0.000247
01:00:00	0.7018	0.0000	0.0642	0.0004	5.05E-06	0.000379
01:10:00	0.8169	0.0000	0.0755	0.0005	8.32E-06	0.000539
01:20:00	0.9503	0.0000	0.0888	0.0007	1.28E-05	0.000719
01:30:00	1.1047	0.0000	0.1046	0.0009	1.86E-05	0.00092
01:40:00	1.2833	0.0000	0.1234	0.0011	2.58E-05	0.00115
01:50:00	1.4893	0.0000	0.1457	0.0014	3.48E-05	0.00141
02:00:00	1.7266	0.0000	0.1722	0.0017	4.57E-05	0.00171
02:10:00	1.9988	0.0000	0.2038	0.0020	5.87E-05	0.00205
02:20:00	2.3096	0.0000	0.2415	0.0024	7.44E-05	0.00245
02:30:00	2.6615	0.0000	0.2862	0.0028	9.3E-05	0.00292
02:40:00	3.0532	0.0000	0.3388	0.0034	0.000115	0.00348
02:50:00	3.4664	0.0000	0.3982	0.0040	0.000141	0.00413
03:00:00	3.6941	0.0000	0.4402	0.0047	0.000172	0.00491
03:10:00	3.4664	0.0000	0.4279	0.0056	0.000209	0.0058
03:20:00	3.0532	0.0000	0.3889	0.0066	0.000253	0.00681
03:30:00	2.6615	0.0000	0.3481	0.0076	0.000303	0.00788
03:40:00	2.3096	0.0000	0.3090	0.0086	0.00036	0.00895
03:50:00	1.9988	0.0000	0.2725	0.0095	0.000425	0.00995
04:00:00	1.7266	0.0000	0.2393	0.0103	0.000495	0.0108
04:10:00	1.4893	0.0000	0.2093	0.0109	0.00057	0.0114
04:20:00	1.2833	0.0000	0.1824	0.0112	0.000648	0.0118
04:30:00	1.1047	0.0000	0.1586	0.0112	0.000727	0.012
04:40:00	0.9503	0.0000	0.1376	0.0111	0.000805	0.0119
04:50:00	0.8169	0.0000	0.1192	0.0108	0.000881	0.0117
05:00:00	0.7018	0.0000	0.1030	0.0103	0.000954	0.0113
05:10:00	0.6026	0.0000	0.0889	0.0098	0.00102	0.0108
05:20:00	0.5172	0.0000	0.0767	0.0092	0.00109	0.0103
05:30:00	0.4437	0.0000	0.0660	0.0086	0.00115	0.00973
05:40:00	0.3805	0.0000	0.0568	0.0079	0.0012	0.00912

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
05:50:00	0.3262	0.0000	0.0489	0.0072	0.00125	0.00849
06:00:00	0.2796	0.0000	0.0420	0.0066	0.0013	0.00786
06:10:00	0.0000	0.0000	0.0000	0.0059	0.00134	0.00722
06:20:00	0.0000	0.0000	0.0000	0.0052	0.00138	0.00659
06:30:00	0.0000	0.0000	0.0000	0.0046	0.00141	0.00597
06:40:00	0.0000	0.0000	0.0000	0.0039	0.00143	0.00536
06:50:00	0.0000	0.0000	0.0000	0.0033	0.00145	0.00479
07:00:00	0.0000	0.0000	0.0000	0.0028	0.00147	0.00427
07:10:00	0.0000	0.0000	0.0000	0.0023	0.00148	0.00378
07:20:00	0.0000	0.0000	0.0000	0.0019	0.00149	0.00334
07:30:00	0.0000	0.0000	0.0000	0.0015	0.0015	0.00298
07:40:00	0.0000	0.0000	0.0000	0.0012	0.0015	0.00267
07:50:00	0.0000	0.0000	0.0000	0.0009	0.0015	0.00242
08:00:00	0.0000	0.0000	0.0000	0.0007	0.0015	0.00221
08:10:00	0.0000	0.0000	0.0000	0.0005	0.0015	0.00205
08:20:00	0.0000	0.0000	0.0000	0.0004	0.0015	0.00191
08:30:00	0.0000	0.0000	0.0000	0.0003	0.0015	0.0018
08:40:00	0.0000	0.0000	0.0000	0.0002	0.00149	0.00171
08:50:00	0.0000	0.0000	0.0000	0.0002	0.00149	0.00164
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00148	0.00158
09:10:00	0.0000	0.0000	0.0000	0.0001	0.00148	0.00154
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00147	0.0015
09:30:00	0.0000	0.0000	0.0000	0.0000	0.00147	0.00148
09:40:00	0.0000	0.0000	0.0000	0.0000	0.00146	0.00146
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00146	0.00146
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00145	0.00145
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00144	0.00144
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00144	0.00144
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00143	0.00143
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00143	0.00143
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00142	0.00142
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00142	0.00142
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00141	0.00141
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00141	0.00141
11:30:00	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014
11:40:00	0.0000	0.0000	0.0000	0.0000	0.0014	0.0014

Appendix

Catchment descriptors *

Name	Value	User-defined value used?
BFIHOST	0.76	No
PROPWET (mm)	0.29	No
SAAR (mm)	610	No

Values in square brackets are the original values loaded from the FEH Web Service or FEH CD-ROM