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

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	0.730	1.271	0.185

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	18.7	65.2	11.3	0.0	0	95.3	85.7
0.5	7.3	14.6	11.9	41.3	7.2	0.0	0	60.3	108.6
1	9.0	9.0	7.3	25.4	4.4	0.0	0	37.1	133.7
2	14.1	7.0	5.7	19.9	3.4	0.0	0	29.1	209.4
4	19.4	4.8	3.9	13.7	2.4	0.0	0	20.0	288.0
6	22.4	3.7	3.0	10.5	1.8	0.0	0	15.4	332.6
8	24.4	3.0	2.5	8.6	1.5	0.0	0	12.6	362.0
12	27.0	2.3	1.8	6.4	1.1	0.0	0	9.3	401.5
16	28.9	1.8	1.5	5.1	0.9	0.0	0	7.4	428.7
20	30.3	1.5	1.2	4.3	0.7	0.0	0	6.3	450.3
24	31.6	1.3	1.1	3.7	0.6	0.0	0	5.4	469.0
28	32.7	1.2	0.9	3.3	0.6	0.0	0	4.8	485.3
32	33.7	1.1	0.9	3.0	0.5	0.0	0	4.3	500.5
36	34.6	1.0	0.8	2.7	0.5	0.0	0	4.0	514.6
40	35.5	0.9	0.7	2.5	0.4	0.0	0	3.7	528.0
44	36.4	0.8	0.7	2.3	0.4	0.0	0	3.4	540.8
48	37.2	0.8	0.6	2.2	0.4	0.0	0	3.2	553.2

*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 A - EXISTING		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SA/A3.1	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.730	1.271	0.185

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	70.7	246.1	42.6	0.0	0	359.4	323.5
0.5	28.2	56.4	45.7	159.4	27.6	0.0	0	232.7	418.9
1	34.7	34.7	28.2	98.2	17.0	0.0	0	143.4	516.1
2	44.1	22.1	17.9	62.3	10.8	0.0	0	91.0	655.3
4	53.8	13.5	10.9	38.0	6.6	0.0	0	55.5	799.8
6	59.2	9.9	8.0	27.9	4.8	0.0	0	40.7	879.0
8	62.6	7.8	6.3	22.1	3.8	0.0	0	32.3	929.6
12	67.0	5.6	4.5	15.8	2.7	0.0	0	23.1	995.9
16	70.0	4.4	3.6	12.4	2.1	0.0	0	18.1	1040.5
20	72.3	3.6	2.9	10.2	1.8	0.0	0	14.9	1073.9
24	74.1	3.1	2.5	8.7	1.5	0.0	0	12.7	1101.0
28	75.7	2.7	2.2	7.6	1.3	0.0	0	11.2	1124.2
32	77.1	2.4	2.0	6.8	1.2	0.0	0	9.9	1145.0
36	78.3	2.2	1.8	6.2	1.1	0.0	0	9.0	1164.0
40	79.5	2.0	1.6	5.6	1.0	0.0	0	8.2	1182.0
44	80.7	1.8	1.5	5.2	0.9	0.0	0	7.6	1198.8
48	81.7	1.7	1.4	4.8	0.8	0.0	0	7.0	1214.7

*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 A - EXISTING

Project: Sandown Park

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

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.730	1.271	0.185

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	91.9	320.1	55.4	0.0	0	467.4	420.7
0.5	36.9	73.8	59.9	208.6	36.1	0.0	0	304.6	548.3
1	45.8	45.8	37.2	129.5	22.4	0.0	0	189.1	680.7
2	57.4	28.7	23.3	81.1	14.1	0.0	0	118.5	853.0
4	70.4	17.6	14.3	49.7	8.6	0.0	0	72.6	1045.4
6	77.7	12.9	10.5	36.6	6.3	0.0	0	53.4	1154.2
8	82.6	10.3	8.4	29.2	5.1	0.0	0	42.6	1227.3
12	88.9	7.4	6.0	20.9	3.6	0.0	0	30.6	1321.5
16	92.9	5.8	4.7	16.4	2.8	0.0	0	24.0	1380.8
20	95.8	4.8	3.9	13.5	2.3	0.0	0	19.8	1423.0
24	97.9	4.1	3.3	11.5	2.0	0.0	0	16.8	1455.4
28	99.6	3.6	2.9	10.1	1.7	0.0	0	14.7	1480.5
32	101.1	3.2	2.6	8.9	1.5	0.0	0	13.0	1502.0
36	102.4	2.8	2.3	8.0	1.4	0.0	0	11.7	1521.1
40	103.5	2.6	2.1	7.3	1.3	0.0	0	10.7	1538.3
44	104.6	2.4	1.9	6.7	1.2	0.0	0	9.8	1554.1
48	105.6	2.2	1.8	6.2	1.1	0.0	0	9.1	1568.8

*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 A - EXISTING

Project: Sandown Park

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

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.712	0.902	0.572

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 %

Area of Soakaway 50 m^2

Infiltration Rate 3.00E-04 m/s

Infiltration loss through soakaway 15.0 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 Soakaway *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
Duration	**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	18.3	46.3	34.9	0.0	-15	84.4	76.0
0.5	7.3	14.6	11.6	29.3	22.1	0.0	-15	48.0	86.4
1	9.0	9.0	7.1	18.1	13.6	0.0	-15	23.8	85.6
2	14.1	7.0	5.6	14.1	10.6	0.0	-15	15.4	110.5
4	19.4	4.8	3.8	9.7	7.3	0.0	-15	5.9	84.6
6	22.4	3.7	3.0	7.5	5.6	0.0	-15	1.1	23.1
8	24.4	3.0	2.4	6.1	4.6	0.0	-15	-1.9	-54.2
12	27.0	2.3	1.8	4.5	3.4	0.0	-15	-5.3	-228.9
16	28.9	1.8	1.4	3.6	2.7	0.0	-15	-7.2	-416.5
20	30.3	1.5	1.2	3.0	2.3	0.0	-15	-8.5	-610.0
24	31.6	1.3	1.0	2.6	2.0	0.0	-15	-9.3	-806.5
28	32.7	1.2	0.9	2.3	1.8	0.0	-15	-10.0	-1005.4
32	33.7	1.1	0.8	2.1	1.6	0.0	-15	-10.5	-1205.6
36	34.6	1.0	0.8	1.9	1.5	0.0	-15	-10.9	-1406.9
40	35.5	0.9	0.7	1.8	1.3	0.0	-15	-11.2	-1608.9
44	36.4	0.8	0.7	1.7	1.2	0.0	-15	-11.4	-1811.6
48	37.2	0.8	0.6	1.6	1.2	0.0	-15	-11.7	-2014.5

*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 A - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/SA/A4.1

Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.712	0.902	0.572

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 15.0 l/s

Area of Soakaway 50 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 Soakaway *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	68.9	174.7	131.5	0.0	-15	360.2	324.2
0.5	28.2	56.4	44.6	113.1	85.2	0.0	-15	227.9	410.2
1	34.7	34.7	27.5	69.7	52.5	0.0	-15	134.6	484.7
2	44.1	22.1	17.5	44.2	33.3	0.0	-15	80.0	576.0
4	53.8	13.5	10.7	27.0	20.3	0.0	-15	43.0	618.8
6	59.2	9.9	7.8	19.8	14.9	0.0	-15	27.5	593.4
8	62.6	7.8	6.2	15.7	11.8	0.0	-15	18.7	538.3
12	67.0	5.6	4.4	11.2	8.4	0.0	-15	9.1	391.5
16	70.0	4.4	3.5	8.8	6.6	0.0	-15	3.9	222.0
20	72.3	3.6	2.9	7.2	5.5	0.0	-15	0.6	40.9
24	74.1	3.1	2.4	6.2	4.7	0.0	-15	-1.7	-146.8
28	75.7	2.7	2.1	5.4	4.1	0.0	-15	-3.4	-338.6
32	77.1	2.4	1.9	4.8	3.6	0.0	-15	-4.6	-532.9
36	78.3	2.2	1.7	4.4	3.3	0.0	-15	-5.6	-729.1
40	79.5	2.0	1.6	4.0	3.0	0.0	-15	-6.4	-926.3
44	80.7	1.8	1.5	3.7	2.8	0.0	-15	-7.1	-1124.8
48	81.7	1.7	1.3	3.4	2.6	0.0	-15	-7.7	-1324.2

*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 A - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/SA/A4.2 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.712	0.902	0.572

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 %

Area of Soakaway 50 m^2
Infiltration Rate 3.00E-04 m/s

Infiltration loss through soakaway 15.0 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 Soakaway *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	89.7	227.2	171.1	0.0	-15	472.9	425.6
0.5	36.9	73.8	58.4	148.0	111.5	0.0	-15	303.0	545.3
1	45.8	45.8	36.3	91.9	69.2	0.0	-15	182.4	656.5
2	57.4	28.7	22.7	57.6	43.4	0.0	-15	108.7	782.3
4	70.4	17.6	13.9	35.3	26.6	0.0	-15	60.8	875.2
6	77.7	12.9	10.2	26.0	19.6	0.0	-15	40.8	880.7
8	82.6	10.3	8.2	20.7	15.6	0.0	-15	29.5	849.0
12	88.9	7.4	5.9	14.9	11.2	0.0	-15	16.9	731.3
16	92.9	5.8	4.6	11.7	8.8	0.0	-15	10.0	577.2
20	95.8	4.8	3.8	9.6	7.2	0.0	-15	5.6	405.3
24	97.9	4.1	3.2	8.2	6.2	0.0	-15	2.6	223.1
28	99.6	3.6	2.8	7.1	5.4	0.0	-15	0.3	33.3
32	101.1	3.2	2.5	6.3	4.8	0.0	-15	-1.4	-160.2
36	102.4	2.8	2.3	5.7	4.3	0.0	-15	-2.7	-356.4
40	103.5	2.6	2.0	5.2	3.9	0.0	-15	-3.8	-554.4
44	104.6	2.4	1.9	4.8	3.6	0.0	-15	-4.8	-753.9
48	105.6	2.2	1.7	4.4	3.3	0.0	-15	-5.5	-954.6

*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 A - PROPOSED
Project: Sandown Park
Calc Sheet: 2661_OPA/SA/A4.3
Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.712	0.902	0.572

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 %

Area of Soakaway 50 m^2

Infiltration Rate 3.00E-04 m/s

Infiltration loss through soakaway 15.0 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 Soakaway *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	107.6	272.6	205.3	0.0	-15	570.5	513.4
0.5	36.9	73.8	70.1	177.7	133.8	0.0	-15	366.6	659.8
1	45.8	45.8	43.5	110.3	83.0	0.0	-15	221.8	798.6
2	57.4	28.7	27.3	69.1	52.0	0.0	-15	133.4	960.4
4	70.4	17.6	16.7	42.3	31.9	0.0	-15	75.9	1093.4
6	77.7	12.9	12.3	31.2	23.5	0.0	-15	51.9	1121.6
8	82.6	10.3	9.8	24.9	18.7	0.0	-15	38.4	1105.2
12	88.9	7.4	7.0	17.8	13.4	0.0	-15	23.3	1007.2
16	92.9	5.8	5.5	14.0	10.5	0.0	-15	15.0	865.5
20	95.8	4.8	4.5	11.5	8.7	0.0	-15	9.8	702.3
24	97.9	4.1	3.9	9.8	7.4	0.0	-15	6.1	526.9
28	99.6	3.6	3.4	8.6	6.5	0.0	-15	3.4	342.4
32	101.1	3.2	3.0	7.6	5.7	0.0	-15	1.3	153.3
36	102.4	2.8	2.7	6.8	5.2	0.0	-15	-0.3	-38.8
40	103.5	2.6	2.5	6.2	4.7	0.0	-15	-1.6	-233.2
44	104.6	2.4	2.3	5.7	4.3	0.0	-15	-2.7	-429.5
48	105.6	2.2	2.1	5.3	4.0	0.0	-15	-3.6	-627.1

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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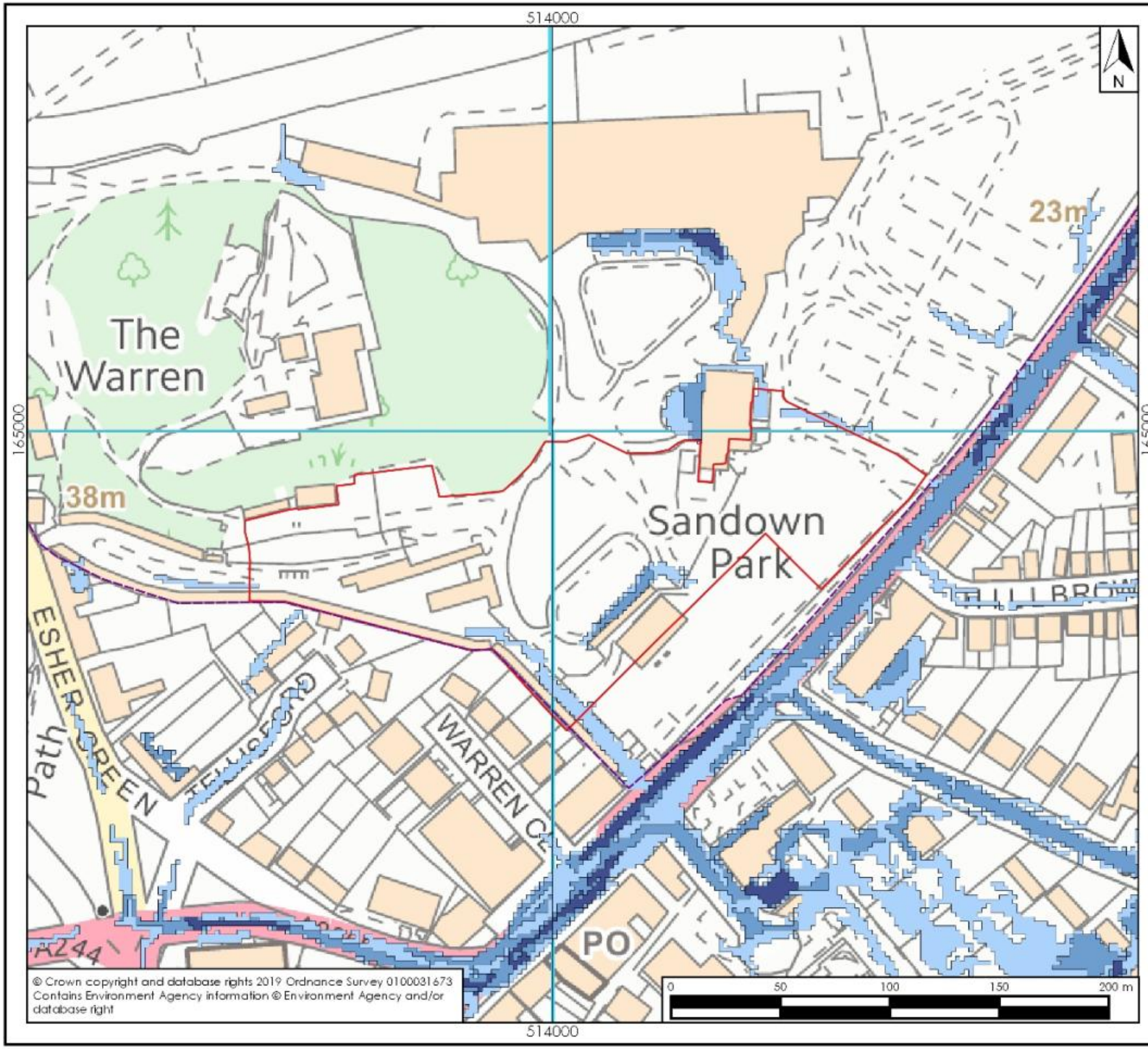
Title: Runoff rates and retention volumes for Site A - PROPOSED

Project: Sandown Park

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



Legend

- Landholding
- Site A 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-SA/04
Version	2
Date	Jan 19
Scale	1:2,500

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8 SANDOWN PARK – SITE B

8.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site B (Hotel), shown on *Drawing 2661/OPA-SB/01*.

8.2 Location and setting

The Application Area is located in the west extent of the landholding and comprises a rectangular area of land immediately east of the existing grandstand. It extends to approximately 0.3 ha.

8.3 The proposed development

The area of the proposed development currently comprises an area of hardstanding overlooking the racetrack. It is proposed to develop the area into a circa 150 room hotel (Use Class C1). The current land uses are shown on *Drawing 2661/OPA-SB/01*.

8.4 Baseline conditions

8.4.1 Landform

The elevation of the ground surface within the Application Area declines northeastwards from approximately 25 mAOD to 21 mAOD.

8.5 Hydrology

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

8.6 Geology

The southwest of Site B is underlain directly by the Bagshot Formation. The northeastern extent of site is underlain directly by the Claygate Member, with no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-SB/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 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. The boundary is drawn at

the base of the lowest sand bed, conformable on silty clay with common sandy clayey silt interbeds. Its average thickness is 16 m in the London area.

8.7 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-SB/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 0.3 ha in size, therefore a Flood Risk Assessment is not required.

8.8 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 Application Area.

The entire site is noted as being at a very low risk of surface water flooding, with a likelihood of flooding less than 0.1%, the extent of which are shown on *Drawing 2661/OPA-SB/04*.

The majority of the site is overlain by hardstanding which slopes gently northeastwards. Under current conditions surface water run-off across the Application Area follows the local topography and exits the site towards the northeast. There are currently no issues with standing water within the site boundary.

Approximately 50% of the site is located on the Bagshot Formation, which comprises predominately sand. The northwestern extent of the site is located on Claygate Member and London Clay. The natural drainability of the sub-surface is therefore considered to be good if the surface run-off can be directed to the southwestern extent where the site overlies sands of the Bagshot Formation.

8.9 Assessment of flood risk and drainage

8.9.1 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.

The entire site is at very low risk from surface water (pluvial) flooding and 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.

8.9.2 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. However, any off-site discharge will be controlled at the pre-existing greenfield run-off rate.

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

8.9.3 Drainage requirements

Infiltration to ground via soakaway would appear to be feasible at this site. 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 utilised in the drainage 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 the proposed hardstanding parking area north of the hotel, an area comprising approximately 1,400 m^2. The geo-cellular storage will provide 184.1 m^3 for the 1 in 100-year plus 20% climate change event, assuming discharge to a 10 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 surface water drainage within the proposed development will be designed to manage off-site discharge at 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.

8.9.4 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'.

8.10 Summary and conclusions

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%). 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.

The entire site is noted as being at very low risk of surface water flooding, with a likelihood of flooding less than 0.1.

The proposed development provides an opportunity for betterment of the existing drainage and water management. The natural drainability of the sub-surface beneath the western extent of the site is good so infiltration to ground via a soakaway would appear to be feasible. 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 small.

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

2661/OPA-SB/01: Proposed development

Please note drawings are illustrative

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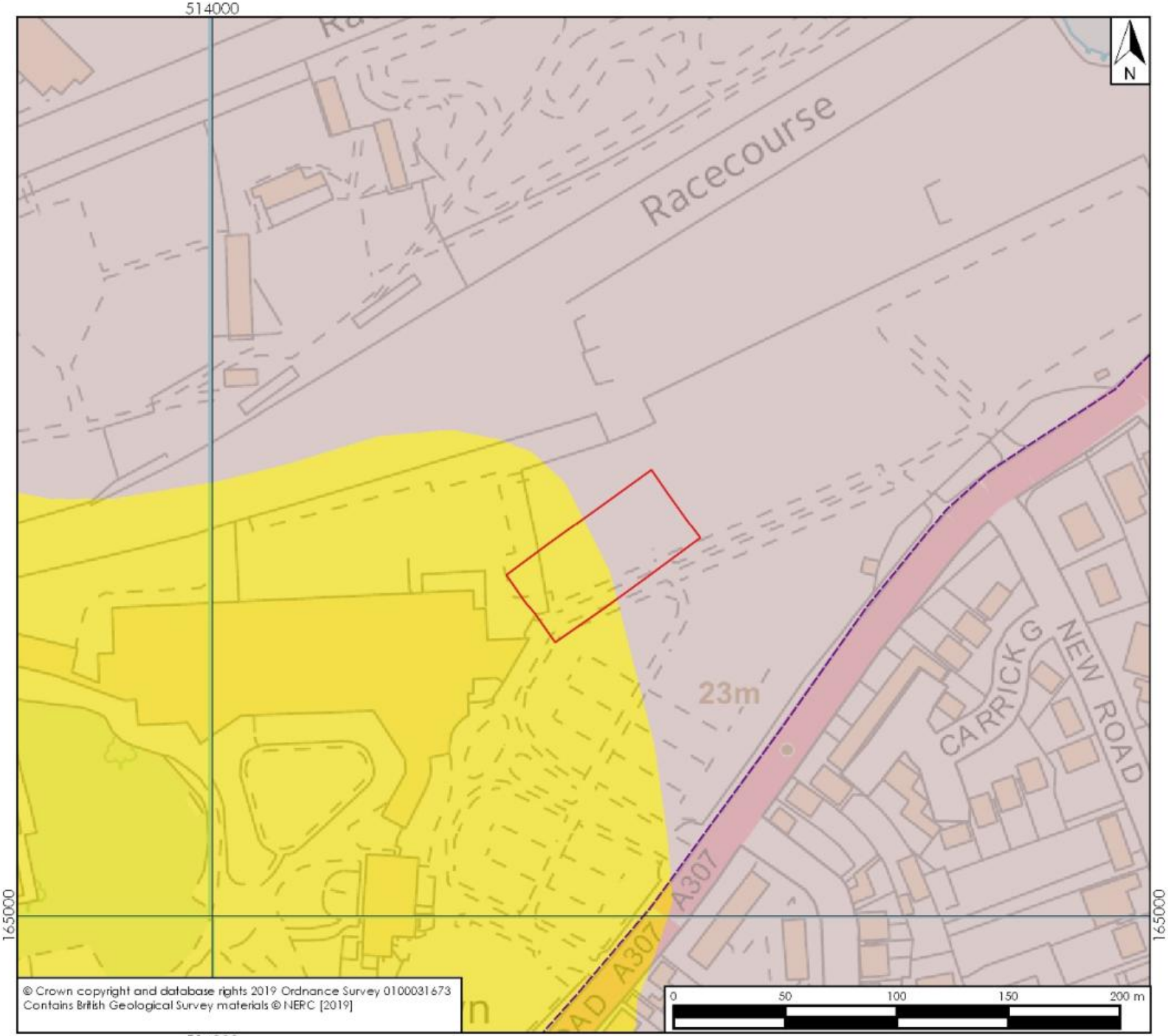
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-SB/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Landholding
- Site B 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-SB/02
Version	2
Date	Jan 19
Scale	1:2,500

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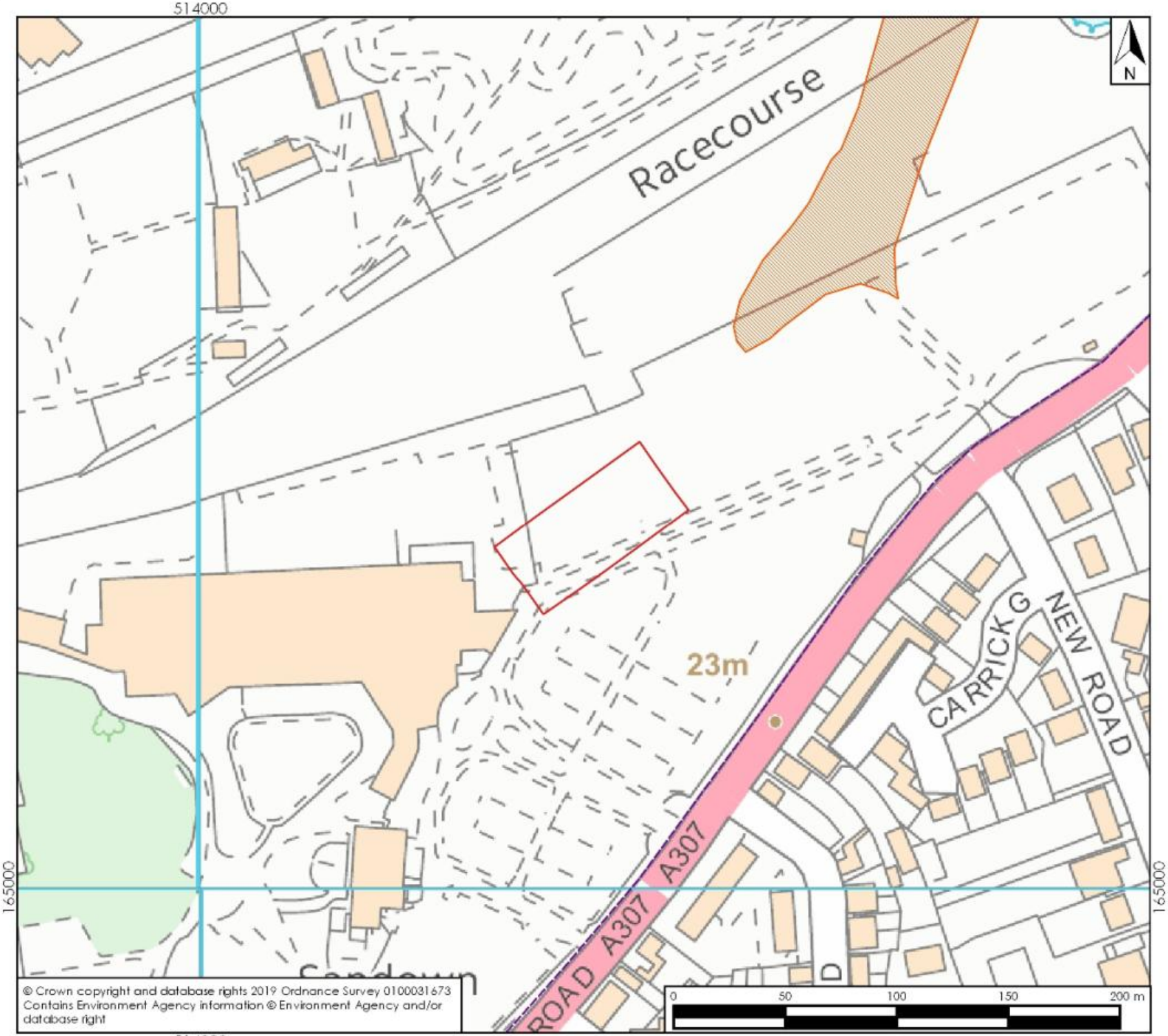

Legend

- Landholding
- Site B 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-SB/03
Version	2
Date	Jan 19
Scale	1:2,500

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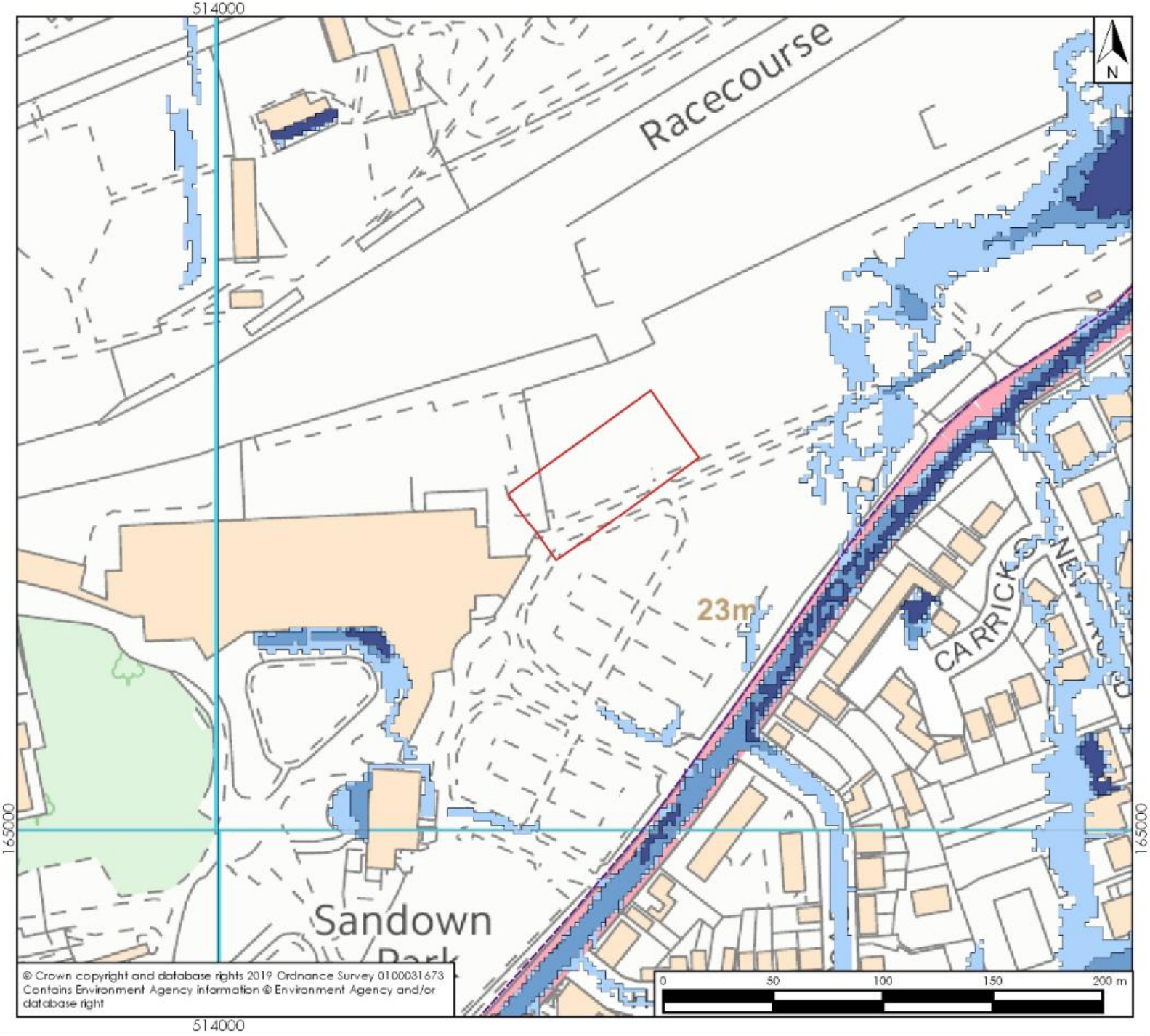

Legend

- Landholding
- Site B 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-SB/04
Version	1
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 B - Hotel
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 141 651
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	3,028 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.3 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	0.26	0.30	0.05 (derived from 0.04 + 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)				**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)	Ground investigation is required to inform location of potential soakaways. 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	0.9	-	-	-	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	0.39	2.4	0.0	-2.4	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	1.19	6.3	0.0	-6.3	
1in 100	1.67	8.2	0.0	-8.2	
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	12.4	51.3	16	-35.3	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	37.6	135.5	100.5	-35	
1in 100	52.9	177.9	144.7	-33.2	
1 in 100 plus 20% climate change *	N/A	N/A	184.1	-	

* 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)	Southwest extent of site underlain by Bagshot Formation. Northeast extent is underlain by Claygate Member	Avoid infiltrating in made ground. **Evidence: suitable mapping/SI**
	Is ground water table less than 3m below ground?	Would require further 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. Soakaways would provide attenuation storage for the 1 in 100 year event plus climate change, which is taken as 184.1 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**
How will the storage be provided on site?		

		showing available volume of proposed attenuation storage. Plan and Cross sectional drawings of proposed storage
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

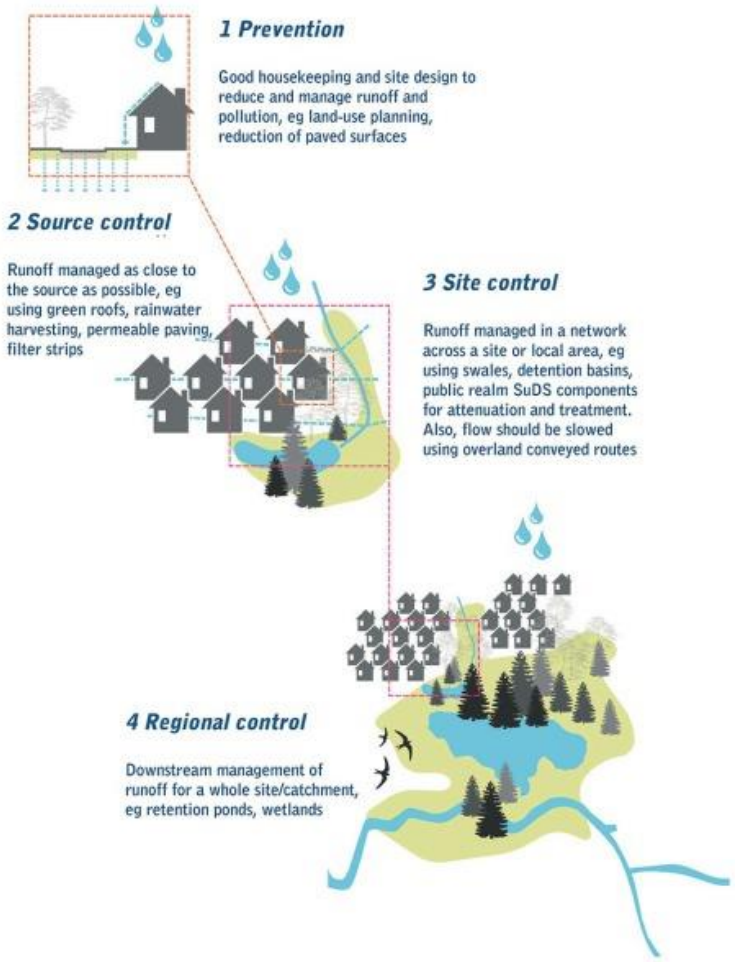
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 B

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	0.0030 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	0.9 l/s
Q (1in1yr)*	0.7 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)	0.7	0.8	1.1	1.4	1.9	2.1	2.3	2.8	3.4

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www.hafrenwater.com

Client: **Rapleys LLP**

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

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:41:02 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: 96DB-EE2B

Site name: Sandown Park - Site B

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0 [0]*

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.00
Total Rainfall (mm):	15.04	Total flow (ML):	0.01
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)	37.17	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	0.0810	0.0000	0.0071	0.0000	0	0
00:10:00	0.0945	0.0000	0.0083	0.0000	1.36E-09	3.24E-07
00:20:00	0.1102	0.0000	0.0097	0.0000	8.4E-09	1.36E-06
00:30:00	0.1285	0.0000	0.0114	0.0000	2.75E-08	3.22E-06
00:40:00	0.1498	0.0000	0.0133	0.0000	6.61E-08	6.05E-06
00:50:00	0.1746	0.0000	0.0155	0.0000	1.33E-07	1E-05
01:00:00	0.2033	0.0000	0.0181	0.0000	2.38E-07	1.54E-05
01:10:00	0.2366	0.0000	0.0211	0.0000	3.9E-07	2.17E-05
01:20:00	0.2753	0.0000	0.0247	0.0000	5.98E-07	2.88E-05
01:30:00	0.3200	0.0000	0.0288	0.0000	8.66E-07	3.68E-05
01:40:00	0.3717	0.0000	0.0336	0.0000	1.2E-06	4.57E-05
01:50:00	0.4314	0.0000	0.0392	0.0001	1.61E-06	5.57E-05
02:00:00	0.5001	0.0000	0.0457	0.0001	2.11E-06	6.71E-05
02:10:00	0.5790	0.0000	0.0533	0.0001	2.7E-06	8.01E-05
02:20:00	0.6690	0.0000	0.0621	0.0001	3.4E-06	9.51E-05
02:30:00	0.7709	0.0000	0.0722	0.0001	4.23E-06	0.000112
02:40:00	0.8844	0.0000	0.0837	0.0001	5.2E-06	0.000132
02:50:00	1.0041	0.0000	0.0962	0.0001	6.34E-06	0.000156
03:00:00	1.0700	0.0000	0.1039	0.0002	7.68E-06	0.000182
03:10:00	1.0041	0.0000	0.0987	0.0002	9.24E-06	0.000213
03:20:00	0.8844	0.0000	0.0879	0.0002	1.1E-05	0.000246
03:30:00	0.7709	0.0000	0.0774	0.0003	1.31E-05	0.00028
03:40:00	0.6690	0.0000	0.0678	0.0003	1.54E-05	0.000314
03:50:00	0.5790	0.0000	0.0591	0.0003	1.8E-05	0.000344
04:00:00	0.5001	0.0000	0.0514	0.0003	2.08E-05	0.000368
04:10:00	0.4314	0.0000	0.0445	0.0004	2.36E-05	0.000384
04:20:00	0.3717	0.0000	0.0386	0.0004	2.66E-05	0.000392
04:30:00	0.3200	0.0000	0.0333	0.0004	2.96E-05	0.000393
04:40:00	0.2753	0.0000	0.0288	0.0004	3.25E-05	0.000387
04:50:00	0.2366	0.0000	0.0248	0.0003	3.52E-05	0.000376
05:00:00	0.2033	0.0000	0.0214	0.0003	3.79E-05	0.000361
05:10:00	0.1746	0.0000	0.0184	0.0003	4.04E-05	0.000344
05:20:00	0.1498	0.0000	0.0158	0.0003	4.27E-05	0.000326
05:30:00	0.1285	0.0000	0.0136	0.0003	4.48E-05	0.000306
05:40:00	0.1102	0.0000	0.0117	0.0002	4.67E-05	0.000286

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	0.0945	0.0000	0.0100	0.0002	4.84E-05	0.000265
06:00:00	0.0810	0.0000	0.0086	0.0002	4.99E-05	0.000244
06:10:00	0.0000	0.0000	0.0000	0.0002	5.12E-05	0.000224
06:20:00	0.0000	0.0000	0.0000	0.0002	5.24E-05	0.000204
06:30:00	0.0000	0.0000	0.0000	0.0001	5.33E-05	0.000185
06:40:00	0.0000	0.0000	0.0000	0.0001	5.41E-05	0.000167
06:50:00	0.0000	0.0000	0.0000	0.0001	5.47E-05	0.00015
07:00:00	0.0000	0.0000	0.0000	0.0001	5.52E-05	0.000134
07:10:00	0.0000	0.0000	0.0000	0.0001	5.56E-05	0.00012
07:20:00	0.0000	0.0000	0.0000	0.0001	5.58E-05	0.000108
07:30:00	0.0000	0.0000	0.0000	0.0000	5.6E-05	9.72E-05
07:40:00	0.0000	0.0000	0.0000	0.0000	5.6E-05	8.85E-05
07:50:00	0.0000	0.0000	0.0000	0.0000	5.6E-05	8.13E-05
08:00:00	0.0000	0.0000	0.0000	0.0000	5.6E-05	7.54E-05
08:10:00	0.0000	0.0000	0.0000	0.0000	5.59E-05	7.08E-05
08:20:00	0.0000	0.0000	0.0000	0.0000	5.57E-05	6.69E-05
08:30:00	0.0000	0.0000	0.0000	0.0000	5.56E-05	6.38E-05
08:40:00	0.0000	0.0000	0.0000	0.0000	5.54E-05	6.12E-05
08:50:00	0.0000	0.0000	0.0000	0.0000	5.52E-05	5.91E-05
09:00:00	0.0000	0.0000	0.0000	0.0000	5.49E-05	5.75E-05
09:10:00	0.0000	0.0000	0.0000	0.0000	5.47E-05	5.62E-05
09:20:00	0.0000	0.0000	0.0000	0.0000	5.45E-05	5.52E-05
09:30:00	0.0000	0.0000	0.0000	0.0000	5.42E-05	5.45E-05
09:40:00	0.0000	0.0000	0.0000	0.0000	5.4E-05	5.4E-05
09:50:00	0.0000	0.0000	0.0000	0.0000	5.37E-05	5.37E-05
10:00:00	0.0000	0.0000	0.0000	0.0000	5.35E-05	5.35E-05
10:10:00	0.0000	0.0000	0.0000	0.0000	5.33E-05	5.33E-05
10:20:00	0.0000	0.0000	0.0000	0.0000	5.3E-05	5.3E-05
10:30:00	0.0000	0.0000	0.0000	0.0000	5.28E-05	5.28E-05
10:40:00	0.0000	0.0000	0.0000	0.0000	5.26E-05	5.26E-05
10:50:00	0.0000	0.0000	0.0000	0.0000	5.23E-05	5.23E-05
11:00:00	0.0000	0.0000	0.0000	0.0000	5.21E-05	5.21E-05
11:10:00	0.0000	0.0000	0.0000	0.0000	5.19E-05	5.19E-05
11:20:00	0.0000	0.0000	0.0000	0.0000	5.16E-05	5.16E-05
11:30:00	0.0000	0.0000	0.0000	0.0000	5.14E-05	5.14E-05
11:40:00	0.0000	0.0000	0.0000	0.0000	5.12E-05	5.12E-05

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 2:42:11 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: 96DB-EE2B

Site name: Sandown Park - Site B

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0 [0]*

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.01
Total Rainfall (mm):	39.52	Total flow (ML):	0.04
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)	37.17	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	0.2128	0.0000	0.0188	0.0000	0	0
00:10:00	0.2483	0.0000	0.0220	0.0000	3.59E-09	8.54E-07
00:20:00	0.2897	0.0000	0.0257	0.0000	2.21E-08	3.57E-06
00:30:00	0.3378	0.0000	0.0301	0.0000	7.24E-08	8.47E-06
00:40:00	0.3937	0.0000	0.0353	0.0000	1.74E-07	1.6E-05
00:50:00	0.4587	0.0000	0.0413	0.0000	3.5E-07	2.65E-05
01:00:00	0.5342	0.0000	0.0485	0.0000	6.27E-07	4.06E-05
01:10:00	0.6219	0.0000	0.0568	0.0001	1.03E-06	5.75E-05
01:20:00	0.7234	0.0000	0.0667	0.0001	1.58E-06	7.64E-05
01:30:00	0.8410	0.0000	0.0783	0.0001	2.29E-06	9.77E-05
01:40:00	0.9769	0.0000	0.0920	0.0001	3.18E-06	0.000122
01:50:00	1.1338	0.0000	0.1083	0.0001	4.28E-06	0.000149
02:00:00	1.3144	0.0000	0.1274	0.0002	5.6E-06	0.00018
02:10:00	1.5216	0.0000	0.1501	0.0002	7.19E-06	0.000216
02:20:00	1.7582	0.0000	0.1769	0.0002	9.09E-06	0.000257
02:30:00	2.0261	0.0000	0.2085	0.0003	1.13E-05	0.000306
02:40:00	2.3243	0.0000	0.2452	0.0003	1.4E-05	0.000363
02:50:00	2.6388	0.0000	0.2862	0.0004	1.72E-05	0.00043
03:00:00	2.8121	0.0000	0.3142	0.0005	2.09E-05	0.000508
03:10:00	2.6388	0.0000	0.3035	0.0006	2.52E-05	0.000598
03:20:00	2.3243	0.0000	0.2742	0.0007	3.04E-05	0.000699
03:30:00	2.0261	0.0000	0.2443	0.0008	3.63E-05	0.000805
03:40:00	1.7582	0.0000	0.2160	0.0009	4.3E-05	0.00091
03:50:00	1.5216	0.0000	0.1899	0.0010	5.05E-05	0.00101
04:00:00	1.3144	0.0000	0.1663	0.0010	5.87E-05	0.00109
04:10:00	1.1338	0.0000	0.1451	0.0011	6.73E-05	0.00115
04:20:00	0.9769	0.0000	0.1263	0.0011	7.62E-05	0.00118
04:30:00	0.8410	0.0000	0.1096	0.0011	8.52E-05	0.00119
04:40:00	0.7234	0.0000	0.0950	0.0011	9.4E-05	0.00118
04:50:00	0.6219	0.0000	0.0821	0.0011	0.000103	0.00115
05:00:00	0.5342	0.0000	0.0709	0.0010	0.000111	0.00112
05:10:00	0.4587	0.0000	0.0612	0.0009	0.000119	0.00107
05:20:00	0.3937	0.0000	0.0527	0.0009	0.000126	0.00102
05:30:00	0.3378	0.0000	0.0454	0.0008	0.000132	0.000958
05:40:00	0.2897	0.0000	0.0390	0.0008	0.000139	0.000897

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	0.2483	0.0000	0.0335	0.0007	0.000144	0.000835
06:00:00	0.2128	0.0000	0.0288	0.0006	0.000149	0.000773
06:10:00	0.0000	0.0000	0.0000	0.0006	0.000153	0.000711
06:20:00	0.0000	0.0000	0.0000	0.0005	0.000157	0.000649
06:30:00	0.0000	0.0000	0.0000	0.0004	0.00016	0.000589
06:40:00	0.0000	0.0000	0.0000	0.0004	0.000163	0.000531
06:50:00	0.0000	0.0000	0.0000	0.0003	0.000165	0.000477
07:00:00	0.0000	0.0000	0.0000	0.0003	0.000167	0.000427
07:10:00	0.0000	0.0000	0.0000	0.0002	0.000168	0.000381
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	0.000169	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	0.000169	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	0.000168	0.000196
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000168	0.000187
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000167	0.00018
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000167	0.000175
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000166	0.000171
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000165	0.000168
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000164	0.000165
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000164	0.000164
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000163	0.000163
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000162	0.000162
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000162	0.000162
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000161	0.000161
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00016	0.00016
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000159	0.000159
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000159	0.000159
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000158	0.000158
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000157	0.000157
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000157	0.000157
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000156	0.000156
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000155	0.000155

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 2:42:48 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: 96DB-EE2B

Site name: Sandown Park - Site B

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0 [0]*

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.02
Total Rainfall (mm):	52.06	Total flow (ML):	0.05
Peak Rainfall (mm):	3.70	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)	37.17	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	0.2803	0.0000	0.0247	0.0000	0	0
00:10:00	0.3271	0.0000	0.0290	0.0000	4.73E-09	1.12E-06
00:20:00	0.3816	0.0000	0.0340	0.0000	2.91E-08	4.7E-06
00:30:00	0.4449	0.0000	0.0398	0.0000	9.54E-08	1.12E-05
00:40:00	0.5186	0.0000	0.0467	0.0000	2.3E-07	2.1E-05
00:50:00	0.6043	0.0000	0.0548	0.0000	4.62E-07	3.49E-05
01:00:00	0.7037	0.0000	0.0644	0.0001	8.28E-07	5.36E-05
01:10:00	0.8191	0.0000	0.0757	0.0001	1.36E-06	7.6E-05
01:20:00	0.9529	0.0000	0.0891	0.0001	2.09E-06	0.000101
01:30:00	1.1077	0.0000	0.1050	0.0001	3.03E-06	0.000129
01:40:00	1.2868	0.0000	0.1238	0.0002	4.21E-06	0.000161
01:50:00	1.4934	0.0000	0.1461	0.0002	5.66E-06	0.000198
02:00:00	1.7313	0.0000	0.1727	0.0002	7.43E-06	0.000239
02:10:00	2.0042	0.0000	0.2045	0.0003	9.55E-06	0.000288
02:20:00	2.3159	0.0000	0.2423	0.0003	1.21E-05	0.000344
02:30:00	2.6688	0.0000	0.2871	0.0004	1.51E-05	0.00041
02:40:00	3.0615	0.0000	0.3399	0.0005	1.87E-05	0.000488
02:50:00	3.4758	0.0000	0.3995	0.0006	2.29E-05	0.00058
03:00:00	3.7042	0.0000	0.4417	0.0007	2.8E-05	0.000689
03:10:00	3.4758	0.0000	0.4295	0.0008	3.39E-05	0.000815
03:20:00	3.0615	0.0000	0.3903	0.0009	4.09E-05	0.000957
03:30:00	2.6688	0.0000	0.3494	0.0011	4.9E-05	0.00111
03:40:00	2.3159	0.0000	0.3101	0.0012	5.83E-05	0.00126
03:50:00	2.0042	0.0000	0.2735	0.0013	6.87E-05	0.0014
04:00:00	1.7313	0.0000	0.2402	0.0014	8.01E-05	0.00152
04:10:00	1.4934	0.0000	0.2101	0.0015	9.21E-05	0.0016
04:20:00	1.2868	0.0000	0.1831	0.0016	0.000105	0.00166
04:30:00	1.1077	0.0000	0.1592	0.0016	0.000117	0.00167
04:40:00	0.9529	0.0000	0.1382	0.0015	0.00013	0.00166
04:50:00	0.8191	0.0000	0.1196	0.0015	0.000142	0.00163
05:00:00	0.7037	0.0000	0.1034	0.0014	0.000154	0.00158
05:10:00	0.6043	0.0000	0.0893	0.0014	0.000165	0.00152
05:20:00	0.5186	0.0000	0.0770	0.0013	0.000175	0.00144
05:30:00	0.4449	0.0000	0.0663	0.0012	0.000185	0.00136
05:40:00	0.3816	0.0000	0.0570	0.0011	0.000193	0.00128

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	0.3271	0.0000	0.0490	0.0010	0.000201	0.00119
06:00:00	0.2803	0.0000	0.0421	0.0009	0.000208	0.00111
06:10:00	0.0000	0.0000	0.0000	0.0008	0.000214	0.00102
06:20:00	0.0000	0.0000	0.0000	0.0007	0.00022	0.000931
06:30:00	0.0000	0.0000	0.0000	0.0006	0.000225	0.000846
06:40:00	0.0000	0.0000	0.0000	0.0005	0.000228	0.000763
06:50:00	0.0000	0.0000	0.0000	0.0005	0.000232	0.000685
07:00:00	0.0000	0.0000	0.0000	0.0004	0.000234	0.000613
07:10:00	0.0000	0.0000	0.0000	0.0003	0.000236	0.000546
07:20:00	0.0000	0.0000	0.0000	0.0002	0.000237	0.000487
07:30:00	0.0000	0.0000	0.0000	0.0002	0.000238	0.000437
07:40:00	0.0000	0.0000	0.0000	0.0002	0.000238	0.000396
07:50:00	0.0000	0.0000	0.0000	0.0001	0.000239	0.000361
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000238	0.000333
08:10:00	0.0000	0.0000	0.0000	0.0001	0.000238	0.000311
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000238	0.000292
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000237	0.000277
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000236	0.000265
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000235	0.000255
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000234	0.000247
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000233	0.000241
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000232	0.000236
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000231	0.000233
09:40:00	0.0000	0.0000	0.0000	0.0000	0.00023	0.00023
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000229	0.000229
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000228	0.000228
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000227	0.000227
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000226	0.000226
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000225	0.000225
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000224	0.000224
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000223	0.000223
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000222	0.000222
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000221	0.000221
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00022	0.00022
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000219	0.000219
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000218	0.000218

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 B - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.045	0.228	0.030

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	1.1	11.7	1.8	0.0	0	14.7	13.2
0.5	7.3	14.6	0.7	7.4	1.2	0.0	0	9.3	16.7
1	9.0	9.0	0.4	4.6	0.7	0.0	0	5.7	20.6
2	14.1	7.0	0.3	3.6	0.6	0.0	0	4.5	32.3
4	19.4	4.8	0.2	2.5	0.4	0.0	0	3.1	44.4
6	22.4	3.7	0.2	1.9	0.3	0.0	0	2.4	51.3
8	24.4	3.0	0.2	1.5	0.2	0.0	0	1.9	55.8
12	27.0	2.3	0.1	1.1	0.2	0.0	0	1.4	61.9
16	28.9	1.8	0.1	0.9	0.1	0.0	0	1.1	66.1
20	30.3	1.5	0.1	0.8	0.1	0.0	0	1.0	69.4
24	31.6	1.3	0.1	0.7	0.1	0.0	0	0.8	72.3
28	32.7	1.2	0.1	0.6	0.1	0.0	0	0.7	74.8
32	33.7	1.1	0.1	0.5	0.1	0.0	0	0.7	77.2
36	34.6	1.0	0.0	0.5	0.1	0.0	0	0.6	79.3
40	35.5	0.9	0.0	0.5	0.1	0.0	0	0.6	81.4
44	36.4	0.8	0.0	0.4	0.1	0.0	0	0.5	83.4
48	37.2	0.8	0.0	0.4	0.1	0.0	0	0.5	85.3

*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 B - EXISTING

Project: Sandown Park

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

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.045	0.228	0.030

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	4.3	44.2	6.9	0.0	0	55.4	49.9
0.5	28.2	56.4	2.8	28.6	4.5	0.0	0	35.9	64.6
1	34.7	34.7	1.7	17.6	2.8	0.0	0	22.1	79.6
2	44.1	22.1	1.1	11.2	1.7	0.0	0	14.0	101.0
4	53.8	13.5	0.7	6.8	1.1	0.0	0	8.6	123.3
6	59.2	9.9	0.5	5.0	0.8	0.0	0	6.3	135.5
8	62.6	7.8	0.4	4.0	0.6	0.0	0	5.0	143.3
12	67.0	5.6	0.3	2.8	0.4	0.0	0	3.6	153.5
16	70.0	4.4	0.2	2.2	0.3	0.0	0	2.8	160.4
20	72.3	3.6	0.2	1.8	0.3	0.0	0	2.3	165.6
24	74.1	3.1	0.2	1.6	0.2	0.0	0	2.0	169.7
28	75.7	2.7	0.1	1.4	0.2	0.0	0	1.7	173.3
32	77.1	2.4	0.1	1.2	0.2	0.0	0	1.5	176.5
36	78.3	2.2	0.1	1.1	0.2	0.0	0	1.4	179.4
40	79.5	2.0	0.1	1.0	0.2	0.0	0	1.3	182.2
44	80.7	1.8	0.1	0.9	0.1	0.0	0	1.2	184.8
48	81.7	1.7	0.1	0.9	0.1	0.0	0	1.1	187.3

*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 B - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/SB/A3.2

Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.045	0.228	0.030

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	5.6	57.5	9.0	0.0	0	72.1	64.9
0.5	36.9	73.8	3.7	37.5	5.8	0.0	0	47.0	84.5
1	45.8	45.8	2.3	23.2	3.6	0.0	0	29.2	104.9
2	57.4	28.7	1.4	14.6	2.3	0.0	0	18.3	131.5
4	70.4	17.6	0.9	8.9	1.4	0.0	0	11.2	161.2
6	77.7	12.9	0.6	6.6	1.0	0.0	0	8.2	177.9
8	82.6	10.3	0.5	5.2	0.8	0.0	0	6.6	189.2
12	88.9	7.4	0.4	3.8	0.6	0.0	0	4.7	203.7
16	92.9	5.8	0.3	2.9	0.5	0.0	0	3.7	212.9
20	95.8	4.8	0.2	2.4	0.4	0.0	0	3.0	219.4
24	97.9	4.1	0.2	2.1	0.3	0.0	0	2.6	224.4
28	99.6	3.6	0.2	1.8	0.3	0.0	0	2.3	228.2
32	101.1	3.2	0.2	1.6	0.3	0.0	0	2.0	231.6
36	102.4	2.8	0.1	1.4	0.2	0.0	0	1.8	234.5
40	103.5	2.6	0.1	1.3	0.2	0.0	0	1.6	237.1
44	104.6	2.4	0.1	1.2	0.2	0.0	0	1.5	239.6
48	105.6	2.2	0.1	1.1	0.2	0.0	0	1.4	241.8

*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 B - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/SB/A3.3

Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.000	0.140	0.163

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 Soakaway*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	0.0	7.2	9.9	0.0	-3	14.1	12.7
0.5	7.3	14.6	0.0	4.6	6.3	0.0	-3	7.8	14.1
1	9.0	9.0	0.0	2.8	3.9	0.0	-3	3.7	13.2
2	14.1	7.0	0.0	2.2	3.0	0.0	-3	2.2	16.0
4	19.4	4.8	0.0	1.5	2.1	0.0	-3	0.6	8.6
6	22.4	3.7	0.0	1.2	1.6	0.0	-3	-0.2	-5.0
8	24.4	3.0	0.0	0.9	1.3	0.0	-3	-0.7	-21.3
12	27.0	2.3	0.0	0.7	1.0	0.0	-3	-1.3	-57.4
16	28.9	1.8	0.0	0.6	0.8	0.0	-3	-1.7	-95.8
20	30.3	1.5	0.0	0.5	0.7	0.0	-3	-1.9	-135.1
24	31.6	1.3	0.0	0.4	0.6	0.0	-3	-2.0	-174.9
28	32.7	1.2	0.0	0.4	0.5	0.0	-3	-2.1	-215.2
32	33.7	1.1	0.0	0.3	0.5	0.0	-3	-2.2	-255.7
36	34.6	1.0	0.0	0.3	0.4	0.0	-3	-2.3	-296.3
40	35.5	0.9	0.0	0.3	0.4	0.0	-3	-2.3	-337.1
44	36.4	0.8	0.0	0.3	0.4	0.0	-3	-2.4	-378.0
48	37.2	0.8	0.0	0.2	0.3	0.0	-3	-2.4	-419.0

*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 B - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SB/A4.1	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.000	0.140	0.163

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 Soakaway*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	0.0	27.1	37.5	0.0	-3	61.6	55.4
0.5	28.2	56.4	0.0	17.6	24.3	0.0	-3	38.8	69.9
1	34.7	34.7	0.0	10.8	15.0	0.0	-3	22.8	82.0
2	44.1	22.1	0.0	6.9	9.5	0.0	-3	13.4	96.2
4	53.8	13.5	0.0	4.2	5.8	0.0	-3	7.0	100.5
6	59.2	9.9	0.0	3.1	4.2	0.0	-3	4.3	93.2
8	62.6	7.8	0.0	2.4	3.4	0.0	-3	2.8	80.7
12	67.0	5.6	0.0	1.7	2.4	0.0	-3	1.1	49.4
16	70.0	4.4	0.0	1.4	1.9	0.0	-3	0.2	14.2
20	72.3	3.6	0.0	1.1	1.6	0.0	-3	-0.3	-23.0
24	74.1	3.1	0.0	1.0	1.3	0.0	-3	-0.7	-61.3
28	75.7	2.7	0.0	0.8	1.2	0.0	-3	-1.0	-100.4
32	77.1	2.4	0.0	0.7	1.0	0.0	-3	-1.2	-139.8
36	78.3	2.2	0.0	0.7	0.9	0.0	-3	-1.4	-179.6
40	79.5	2.0	0.0	0.6	0.9	0.0	-3	-1.5	-219.6
44	80.7	1.8	0.0	0.6	0.8	0.0	-3	-1.6	-259.8
48	81.7	1.7	0.0	0.5	0.7	0.0	-3	-1.7	-300.1

*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 B - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/SB/A4.2 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.000	0.140	0.163

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 Soakaway*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	0.0	35.3	48.7	0.0	-3	81.0	72.9
0.5	36.9	73.8	0.0	23.0	31.8	0.0	-3	51.7	93.1
1	45.8	45.8	0.0	14.3	19.7	0.0	-3	31.0	111.5
2	57.4	28.7	0.0	8.9	12.4	0.0	-3	18.3	131.7
4	70.4	17.6	0.0	5.5	7.6	0.0	-3	10.0	144.7
6	77.7	12.9	0.0	4.0	5.6	0.0	-3	6.6	142.6
8	82.6	10.3	0.0	3.2	4.4	0.0	-3	4.7	134.2
12	88.9	7.4	0.0	2.3	3.2	0.0	-3	2.5	107.9
16	92.9	5.8	0.0	1.8	2.5	0.0	-3	1.3	75.4
20	95.8	4.8	0.0	1.5	2.1	0.0	-3	0.6	39.7
24	97.9	4.1	0.0	1.3	1.8	0.0	-3	0.0	2.4
28	99.6	3.6	0.0	1.1	1.5	0.0	-3	-0.4	-36.3
32	101.1	3.2	0.0	1.0	1.4	0.0	-3	-0.7	-75.7
36	102.4	2.8	0.0	0.9	1.2	0.0	-3	-0.9	-115.4
40	103.5	2.6	0.0	0.8	1.1	0.0	-3	-1.1	-155.5
44	104.6	2.4	0.0	0.7	1.0	0.0	-3	-1.2	-195.9
48	105.6	2.2	0.0	0.7	0.9	0.0	-3	-1.4	-236.5

*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 B - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/SB/A4.3 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.000	0.140	0.163

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

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 Soakaway*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	0.0	42.3	58.5	0.0	-3	97.8	88.0
0.5	36.9	73.8	0.0	27.6	38.1	0.0	-3	62.7	112.9
1	45.8	45.8	0.0	17.1	23.7	0.0	-3	37.8	136.0
2	57.4	28.7	0.0	10.7	14.8	0.0	-3	22.5	162.4
4	70.4	17.6	0.0	6.6	9.1	0.0	-3	12.7	182.3
6	77.7	12.9	0.0	4.8	6.7	0.0	-3	8.5	184.1
8	82.6	10.3	0.0	3.9	5.3	0.0	-3	6.2	178.3
12	88.9	7.4	0.0	2.8	3.8	0.0	-3	3.6	155.4
16	92.9	5.8	0.0	2.2	3.0	0.0	-3	2.2	125.0
20	95.8	4.8	0.0	1.8	2.5	0.0	-3	1.3	90.9
24	97.9	4.1	0.0	1.5	2.1	0.0	-3	0.6	54.7
28	99.6	3.6	0.0	1.3	1.8	0.0	-3	0.2	16.9
32	101.1	3.2	0.0	1.2	1.6	0.0	-3	-0.2	-21.7
36	102.4	2.8	0.0	1.1	1.5	0.0	-3	-0.5	-60.8
40	103.5	2.6	0.0	1.0	1.3	0.0	-3	-0.7	-100.2
44	104.6	2.4	0.0	0.9	1.2	0.0	-3	-0.9	-140.0
48	105.6	2.2	0.0	0.8	1.1	0.0	-3	-1.0	-180.1

*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 B - PROPOSED

Project: Sandown Park

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

9 SANDOWN PARK – SITE C

9.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site C (Leisure and Recreational Area), shown on *Drawing 2661/OPA-SC/01*.

9.2 Location and setting

The Application Area is located close to the centre of the Sandown Park landholding and comprises a roughly rectangular area of land which is bounded by Site D to the west. It extends to approximately 3.4 ha.

9.3 The proposed development

The area of the proposed development currently comprises a kart track and car park area. It is proposed to remodel the kart track for cycling and demolish existing buildings to accommodate outdoor recreational areas, indoor soft play areas and ancillary café buildings. The current land uses are shown on *Drawing 2661/OPA-SC/01*.

9.4 Baseline conditions

9.4.1 Landform

The elevation of the ground surface within the Application Area declines generally northwards from approximately 25 mAOD to 18 mAOD.

9.5 Hydrology

There are no watercourses or drainage ditches within or immediately adjacent to the Application Area. A small waterbody is located immediately to the east of the site.

9.6 Geology

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-SC/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.

9.7 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-SC/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 3.4 ha in size.

9.8 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 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-SC/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.

Much of the site is overlain by hardstanding which slopes gently towards the north. Under current conditions surface water runs off across the Application Area following the local topography and exits the site towards the north. There are currently no issues with standing water within the site boundary.

The site is located on Claygate Member of the London Clay which comprises predominantly impermeable clay. The natural drainability of the sub-surface is therefore considered to be poor and infiltration in the vicinity of the site is not considered to be viable therefore discharge to a watercourse or sewer will have to be considered.

9.9 Assessment of flood risk and drainage

9.9.1 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.

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 upon by the development. Therefore surface water flooding to the proposed development is not anticipated and mitigation measures are not required.

9.9.2 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. Historical flooding has occurred to the northeast of the site, as indicated by the Environment Agency (*Drawing 2661/OPA-SC/03*).

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.

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

9.9.3 Drainage requirements

Infiltration to ground via soakaway would not appear to be feasible at this site. SuDS methods to retain and temporarily store water generated during storm events prior to discharge off-site (grassed swales, French drains and ephemeral ponds) would be required to limit increasing flood risk to flood receptors downstream, and would conform to best practice.

The grassed nature of the ground surface, the absence of current water management issues and the small difference in land use, with respect to the effects on drainage, is such that passive water management measures are proposed. It is anticipated that above ground attenuation in the form of swales (and/or French drains) will be used and located around the periphery of soft landscaped areas, an area comprising approximately 24,500 m^2, which will accommodate any surface water run-off. The above ground storage will provide 1416.8 m^3 for the 1 in 100-year plus 20% climate change event, assuming discharge to the existing pipe network at the Q_{BAR} greenfield rate of 9.7 l/s.

Post-development, the drainage would be diverted to the pipe network which currently exists to the west of the site (*Drawing 2661/OPA-SC/05*). The outfall from the site into the existing pipe network would be located along the western boundary. 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.

In the event that discharge to the existing pipe network west of site proves to be unviable, then investigation will commence into the option of discharging southwards into the existing pipe network located off-site. In this scenario, the proposed outfall would be located along

the southern boundary of the site. Alternatively, if discharging to either pipe network is unviable, discussions will commence with the local utility provider on the availability to discharge into the nearest surface water sewer.

9.9.4 Betterment

The proposed development provides 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'.

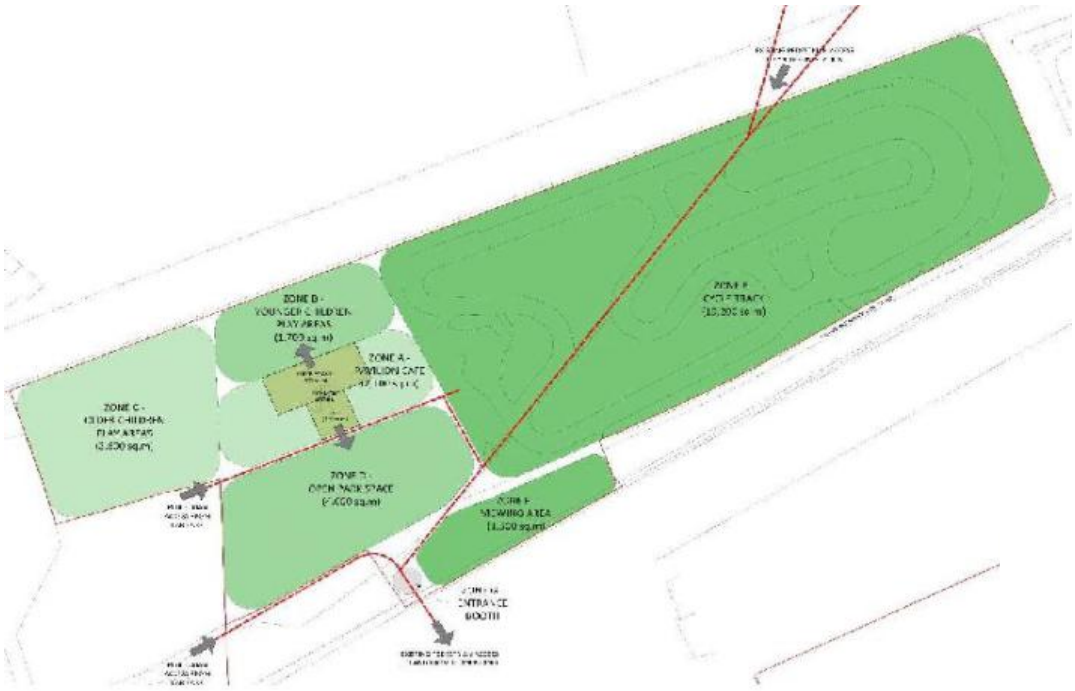
9.10 Summary and conclusions

The Application Area is located in the centre of Sandown Park and is 3.4 ha in size.

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%). There is no history of flooding within the site. Therefore, the site is not deemed to be at risk of fluvial flooding.

The proposed development which includes re-development of existing structures, provides an opportunity for betterment of the existing drainage and water management. The natural drainability of the sub-surface beneath the site is poor. The provision of SuDS features to accommodate surface water run-off will be sufficient to efficiently manage drainage. However, the proximity of existing drains to the west and south of the site is such that contingency exists in the case of future need. Due to the nature of the proposals there is considered to be no increase in flood risk potential.

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



2661/OPA-SC/01: Proposed development

Please note drawings are illustrative

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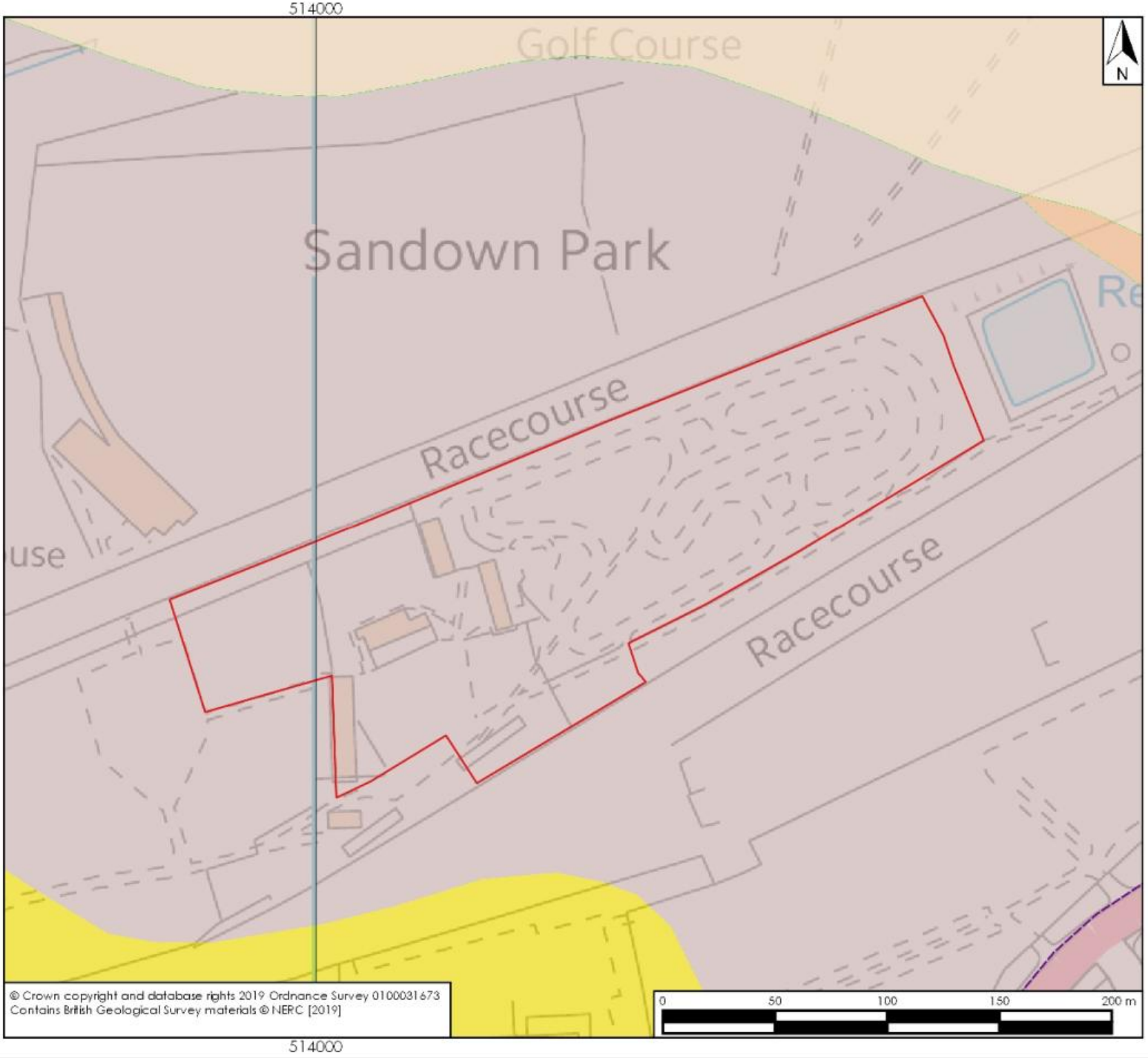
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-SC/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Landholding
- Site C Application Area
- Artificial ground

Bedrock Geology

- Claygate Member

Scale correct at A4

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

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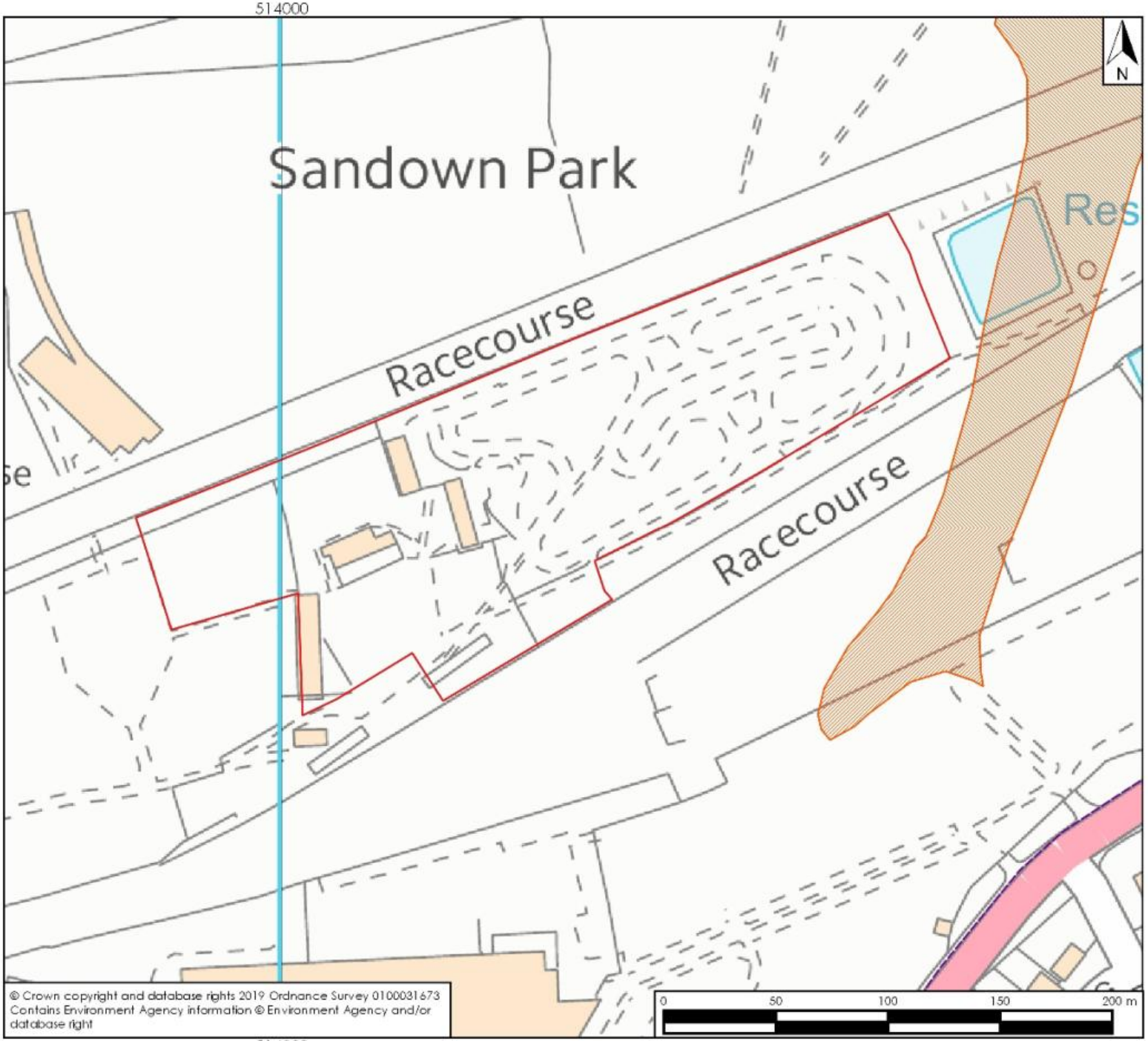

Legend

- Landholding
- Site C 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-SC/03
Version	2
Date	Jan 19
Scale	1:2,500

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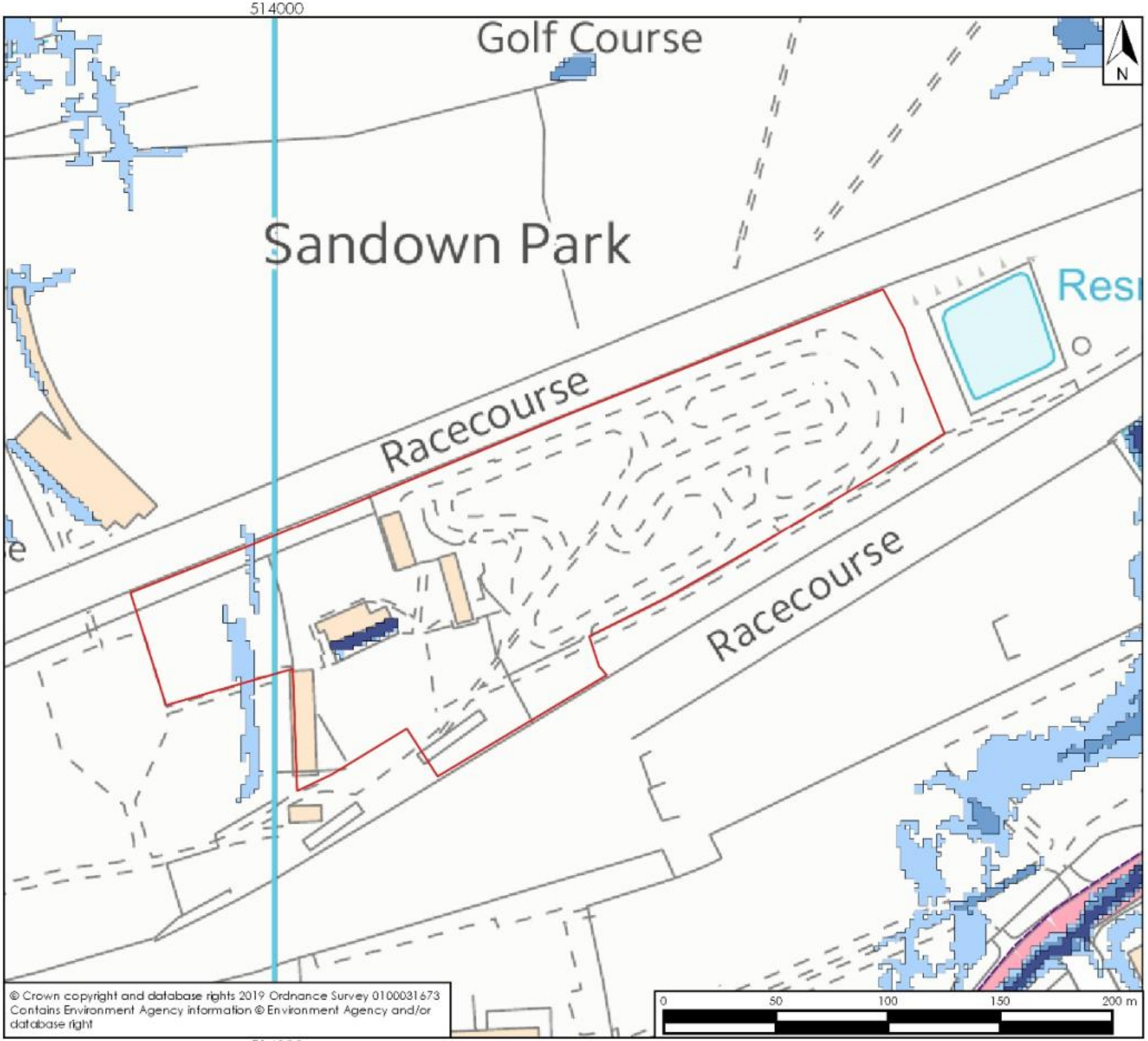

Legend

- Landholding
- Site C 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-SC/04
Version	2
Date	Jan 19
Scale	1:2,500

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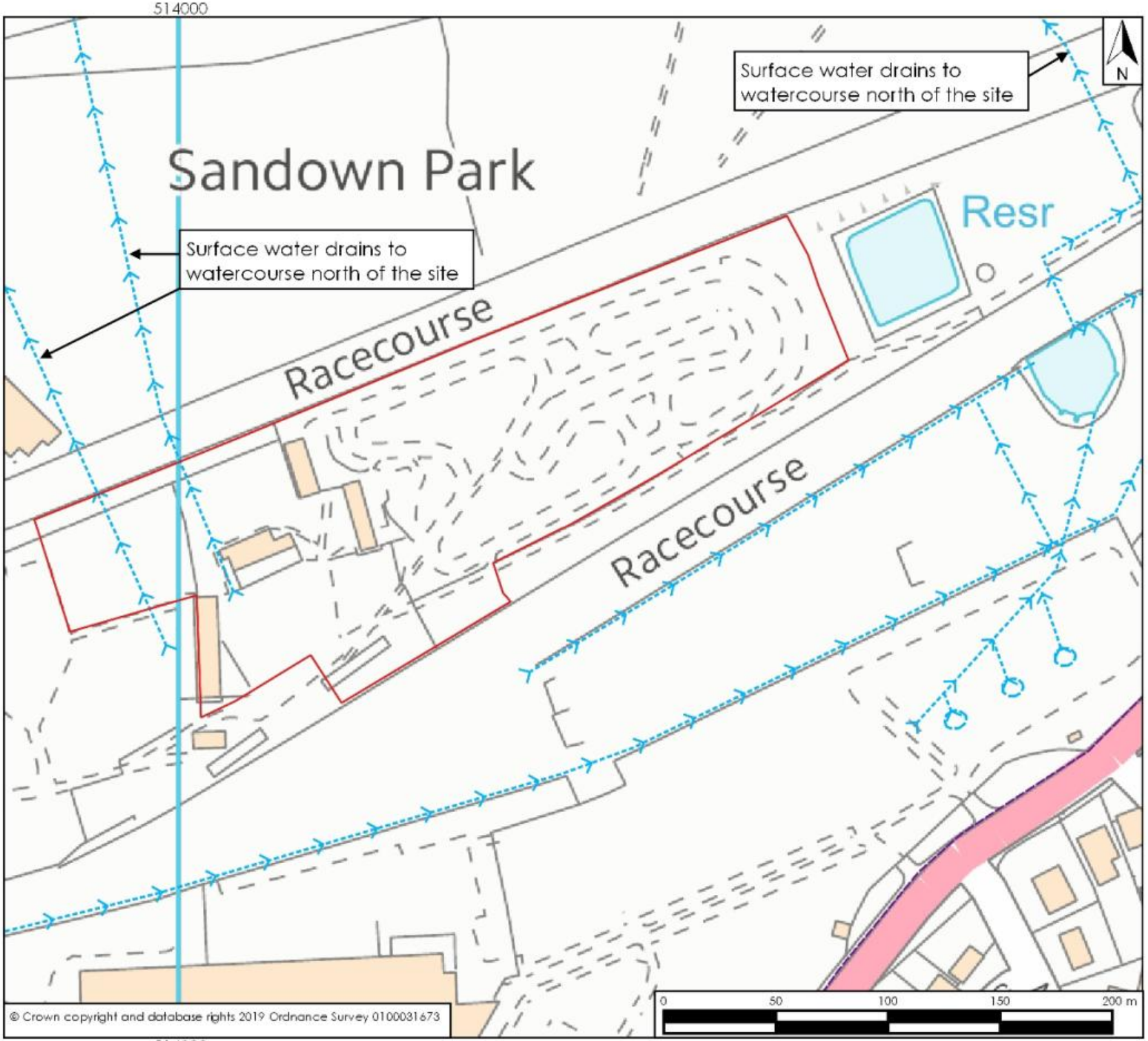

Legend

- Landholding
- Site C 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-SC/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 C – Leisure and recreational area
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 141 653
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	33,579 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.89 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	1.73	0.89	-0.84* * 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	✓	To be confirmed with a ground investigation	**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	✓	Discharge via existing surface water drains to the watercourse north of the site	**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)	Ground investigation is required to inform location of potential soakaways. 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	9.7	-	-	-	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	4.1	21.2	9.7	-11.5	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	12.5	55.9	9.7	-46.2	
1in 100	17.5	73.4	9.7	-63.7	
1 in 100 plus 20% climate change *	N/A	N/A	9.7	-	

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	138.0	456.9	192	-264.9	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	416.0	1207.5	802.8	-404.7	
1in 100	585.0	1585.6	1134.1	-451.5	
1 in 100 plus 20% climate change *	N/A	N/A	1416.8	-	

* 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)		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)		**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 watercourse 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 1,416.8 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**

How will the storage be provided on site?	It is anticipated that swales, pervious pavements and underground storage tanks may be used.	**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**
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 as per the pre-development site. 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,	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.

		break up silt deposits and prevent compaction of the soil surface	
		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

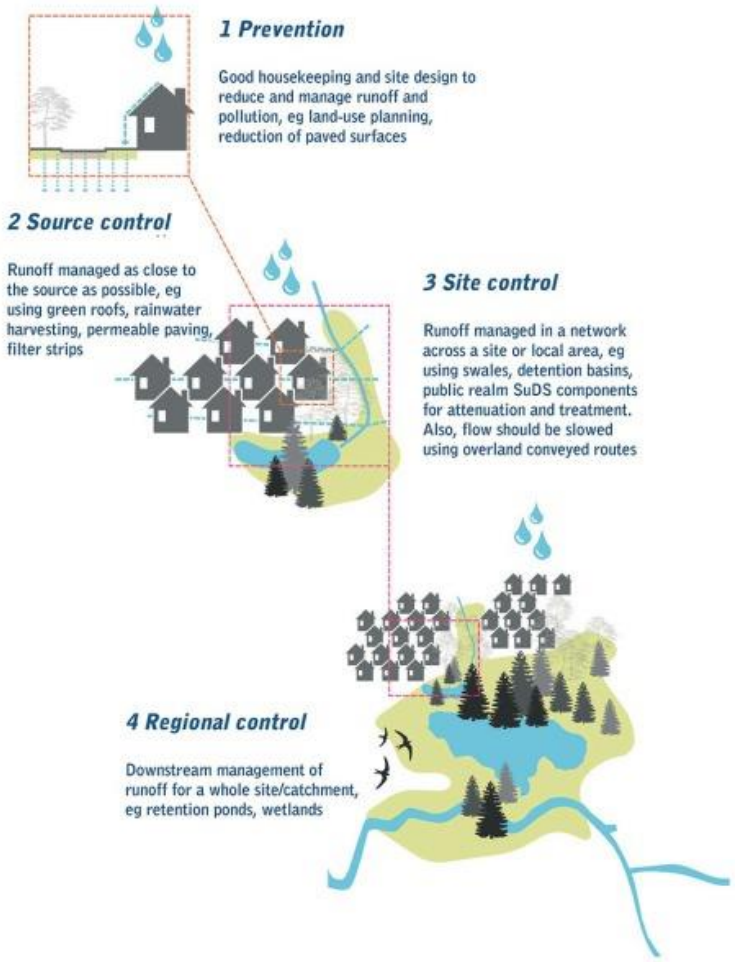
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 C

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	0.0336 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	9.7 l/s
Q (1in1yr)*	8.3 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)	8.3	8.6	12.4	15.8	20.8	23.3	25.5	31.0	37.5

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Client: **Rapleys LLP**

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

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:45:04 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: 10F5-C707

Site name: Sandown Park - Site C

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.03 [0.04]*

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.05
Total Rainfall (mm):	14.98	Total flow (ML):	0.14
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)	1.14	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	44.64	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	0.0807	0.0000	0.0071	0.0000	0	0
00:10:00	0.0941	0.0000	0.0083	0.0000	9.71E-09	2.77E-06
00:20:00	0.1098	0.0000	0.0097	0.0000	5.99E-08	1.16E-05
00:30:00	0.1281	0.0000	0.0113	0.0000	1.96E-07	2.75E-05
00:40:00	0.1493	0.0000	0.0132	0.0001	4.71E-07	5.17E-05
00:50:00	0.1739	0.0000	0.0154	0.0001	9.47E-07	8.56E-05
01:00:00	0.2025	0.0000	0.0180	0.0001	1.69E-06	0.000131
01:10:00	0.2357	0.0000	0.0211	0.0002	2.8E-06	0.00019
01:20:00	0.2742	0.0000	0.0246	0.0003	4.34E-06	0.000258
01:30:00	0.3188	0.0000	0.0287	0.0003	6.37E-06	0.000335
01:40:00	0.3703	0.0000	0.0335	0.0004	8.95E-06	0.000422
01:50:00	0.4298	0.0000	0.0391	0.0005	1.22E-05	0.000521
02:00:00	0.4983	0.0000	0.0456	0.0006	1.61E-05	0.000633
02:10:00	0.5768	0.0000	0.0531	0.0007	2.08E-05	0.00076
02:20:00	0.6665	0.0000	0.0619	0.0009	2.64E-05	0.000906
02:30:00	0.7681	0.0000	0.0720	0.0010	3.3E-05	0.00107
02:40:00	0.8811	0.0000	0.0834	0.0012	4.09E-05	0.00127
02:50:00	1.0004	0.0000	0.0958	0.0014	5.01E-05	0.00149
03:00:00	1.0661	0.0000	0.1034	0.0017	6.09E-05	0.00175
03:10:00	1.0004	0.0000	0.0983	0.0020	7.36E-05	0.00205
03:20:00	0.8811	0.0000	0.0876	0.0023	8.83E-05	0.00238
03:30:00	0.7681	0.0000	0.0771	0.0026	0.000105	0.00272
03:40:00	0.6665	0.0000	0.0675	0.0029	0.000124	0.00306
03:50:00	0.5768	0.0000	0.0588	0.0032	0.000146	0.00339
04:00:00	0.4983	0.0000	0.0511	0.0035	0.000169	0.00367
04:10:00	0.4298	0.0000	0.0444	0.0037	0.000193	0.00389
04:20:00	0.3703	0.0000	0.0384	0.0038	0.000219	0.00404
04:30:00	0.3188	0.0000	0.0332	0.0039	0.000245	0.00411
04:40:00	0.2742	0.0000	0.0286	0.0038	0.000271	0.00411
04:50:00	0.2357	0.0000	0.0247	0.0038	0.000297	0.00405
05:00:00	0.2025	0.0000	0.0213	0.0036	0.000322	0.00395
05:10:00	0.1739	0.0000	0.0183	0.0035	0.000345	0.00381
05:20:00	0.1493	0.0000	0.0157	0.0033	0.000368	0.00364
05:30:00	0.1281	0.0000	0.0135	0.0031	0.000389	0.00346
05:40:00	0.1098	0.0000	0.0116	0.0029	0.000408	0.00327

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	0.0941	0.0000	0.0100	0.0026	0.000426	0.00307
06:00:00	0.0807	0.0000	0.0085	0.0024	0.000442	0.00287
06:10:00	0.0000	0.0000	0.0000	0.0022	0.000457	0.00266
06:20:00	0.0000	0.0000	0.0000	0.0020	0.00047	0.00246
06:30:00	0.0000	0.0000	0.0000	0.0018	0.000481	0.00225
06:40:00	0.0000	0.0000	0.0000	0.0016	0.000491	0.00205
06:50:00	0.0000	0.0000	0.0000	0.0013	0.000499	0.00185
07:00:00	0.0000	0.0000	0.0000	0.0012	0.000506	0.00166
07:10:00	0.0000	0.0000	0.0000	0.0010	0.000512	0.00148
07:20:00	0.0000	0.0000	0.0000	0.0008	0.000516	0.00132
07:30:00	0.0000	0.0000	0.0000	0.0007	0.000519	0.00117
07:40:00	0.0000	0.0000	0.0000	0.0005	0.000522	0.00105
07:50:00	0.0000	0.0000	0.0000	0.0004	0.000523	0.000951
08:00:00	0.0000	0.0000	0.0000	0.0003	0.000524	0.000866
08:10:00	0.0000	0.0000	0.0000	0.0003	0.000524	0.000795
08:20:00	0.0000	0.0000	0.0000	0.0002	0.000524	0.000737
08:30:00	0.0000	0.0000	0.0000	0.0002	0.000523	0.000689
08:40:00	0.0000	0.0000	0.0000	0.0001	0.000522	0.00065
08:50:00	0.0000	0.0000	0.0000	0.0001	0.000521	0.000617
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00052	0.000591
09:10:00	0.0000	0.0000	0.0000	0.0001	0.000518	0.000568
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000517	0.000551
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000515	0.000537
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000513	0.000526
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000511	0.000517
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000509	0.000512
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000507	0.000508
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000506	0.000506
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000504	0.000504
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000502	0.000502
10:50:00	0.0000	0.0000	0.0000	0.0000	0.0005	0.0005
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000498	0.000498
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000496	0.000496
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000494	0.000494
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000492	0.000492
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000491	0.000491

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 2:45:49 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: 10F5-C707

Site name: Sandown Park - Site C

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.03 [0.04]*

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.15
Total Rainfall (mm):	39.38	Total flow (ML):	0.42
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)	1.14	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	44.64	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	0.2121	0.0000	0.0187	0.0000	0	0
00:10:00	0.2474	0.0000	0.0219	0.0000	2.55E-08	7.3E-06
00:20:00	0.2886	0.0000	0.0256	0.0000	1.58E-07	3.05E-05
00:30:00	0.3366	0.0000	0.0300	0.0001	5.16E-07	7.24E-05
00:40:00	0.3923	0.0000	0.0351	0.0001	1.24E-06	0.000136
00:50:00	0.4571	0.0000	0.0412	0.0002	2.5E-06	0.000226
01:00:00	0.5323	0.0000	0.0483	0.0003	4.47E-06	0.000346
01:10:00	0.6196	0.0000	0.0566	0.0005	7.39E-06	0.000502
01:20:00	0.7207	0.0000	0.0664	0.0007	1.15E-05	0.000684
01:30:00	0.8379	0.0000	0.0780	0.0009	1.68E-05	0.00089
01:40:00	0.9733	0.0000	0.0917	0.0011	2.37E-05	0.00112
01:50:00	1.1296	0.0000	0.1078	0.0014	3.23E-05	0.00139
02:00:00	1.3095	0.0000	0.1269	0.0017	4.27E-05	0.00169
02:10:00	1.5160	0.0000	0.1495	0.0020	5.53E-05	0.00204
02:20:00	1.7517	0.0000	0.1762	0.0024	7.05E-05	0.00245
02:30:00	2.0186	0.0000	0.2076	0.0028	8.85E-05	0.00292
02:40:00	2.3157	0.0000	0.2441	0.0034	0.00011	0.00347
02:50:00	2.6291	0.0000	0.2850	0.0040	0.000135	0.00411
03:00:00	2.8018	0.0000	0.3128	0.0047	0.000165	0.00487
03:10:00	2.6291	0.0000	0.3021	0.0055	0.000201	0.00574
03:20:00	2.3157	0.0000	0.2729	0.0065	0.000242	0.00673
03:30:00	2.0186	0.0000	0.2432	0.0075	0.00029	0.00778
03:40:00	1.7517	0.0000	0.2150	0.0085	0.000345	0.00884
03:50:00	1.5160	0.0000	0.1890	0.0095	0.000407	0.00986
04:00:00	1.3095	0.0000	0.1655	0.0103	0.000475	0.0108
04:10:00	1.1296	0.0000	0.1444	0.0110	0.000548	0.0115
04:20:00	0.9733	0.0000	0.1257	0.0114	0.000625	0.0121
04:30:00	0.8379	0.0000	0.1091	0.0117	0.000704	0.0124
04:40:00	0.7207	0.0000	0.0945	0.0117	0.000783	0.0125
04:50:00	0.6196	0.0000	0.0817	0.0115	0.000861	0.0123
05:00:00	0.5323	0.0000	0.0706	0.0112	0.000938	0.0121
05:10:00	0.4571	0.0000	0.0609	0.0107	0.00101	0.0117
05:20:00	0.3923	0.0000	0.0525	0.0102	0.00108	0.0113
05:30:00	0.3366	0.0000	0.0451	0.0096	0.00115	0.0107
05:40:00	0.2886	0.0000	0.0388	0.0090	0.00121	0.0102

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	0.2474	0.0000	0.0334	0.0083	0.00126	0.00961
06:00:00	0.2121	0.0000	0.0287	0.0077	0.00131	0.00901
06:10:00	0.0000	0.0000	0.0000	0.0070	0.00136	0.00839
06:20:00	0.0000	0.0000	0.0000	0.0064	0.0014	0.00777
06:30:00	0.0000	0.0000	0.0000	0.0057	0.00144	0.00714
06:40:00	0.0000	0.0000	0.0000	0.0050	0.00147	0.0065
06:50:00	0.0000	0.0000	0.0000	0.0044	0.0015	0.00588
07:00:00	0.0000	0.0000	0.0000	0.0038	0.00152	0.00528
07:10:00	0.0000	0.0000	0.0000	0.0032	0.00154	0.00471
07:20:00	0.0000	0.0000	0.0000	0.0026	0.00156	0.00419
07:30:00	0.0000	0.0000	0.0000	0.0022	0.00157	0.00372
07:40:00	0.0000	0.0000	0.0000	0.0018	0.00158	0.00333
07:50:00	0.0000	0.0000	0.0000	0.0014	0.00158	0.003
08:00:00	0.0000	0.0000	0.0000	0.0011	0.00158	0.00272
08:10:00	0.0000	0.0000	0.0000	0.0009	0.00159	0.00248
08:20:00	0.0000	0.0000	0.0000	0.0007	0.00159	0.00229
08:30:00	0.0000	0.0000	0.0000	0.0006	0.00158	0.00214
08:40:00	0.0000	0.0000	0.0000	0.0004	0.00158	0.00201
08:50:00	0.0000	0.0000	0.0000	0.0003	0.00158	0.0019
09:00:00	0.0000	0.0000	0.0000	0.0002	0.00157	0.00181
09:10:00	0.0000	0.0000	0.0000	0.0002	0.00157	0.00174
09:20:00	0.0000	0.0000	0.0000	0.0001	0.00156	0.00168
09:30:00	0.0000	0.0000	0.0000	0.0001	0.00156	0.00163
09:40:00	0.0000	0.0000	0.0000	0.0000	0.00155	0.0016
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00155	0.00157
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00154	0.00155
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00154	0.00154
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00153	0.00153
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00153	0.00153
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00152	0.00152
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00151	0.00151
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00151	0.00151
11:10:00	0.0000	0.0000	0.0000	0.0000	0.0015	0.0015
11:20:00	0.0000	0.0000	0.0000	0.0000	0.0015	0.0015
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00149	0.00149
11:40:00	0.0000	0.0000	0.0000	0.0000	0.00149	0.00149

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 2:46:31 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: 10F5-C707

Site name: Sandown Park - Site C

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.03 [0.04]*

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.21
Total Rainfall (mm):	51.87	Total flow (ML):	0.58
Peak Rainfall (mm):	3.69	Peak flow (m^3/s):	0.02

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)	1.14	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	44.64	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	0.2793	0.0000	0.0246	0.0000	0	0
00:10:00	0.3259	0.0000	0.0289	0.0000	3.37E-08	9.61E-06
00:20:00	0.3802	0.0000	0.0338	0.0000	2.08E-07	4.02E-05
00:30:00	0.4433	0.0000	0.0397	0.0001	6.8E-07	9.54E-05
00:40:00	0.5167	0.0000	0.0465	0.0002	1.64E-06	0.00018
00:50:00	0.6020	0.0000	0.0546	0.0003	3.29E-06	0.000298
01:00:00	0.7011	0.0000	0.0642	0.0005	5.9E-06	0.000457
01:10:00	0.8161	0.0000	0.0754	0.0007	9.76E-06	0.000663
01:20:00	0.9494	0.0000	0.0888	0.0009	1.51E-05	0.000905
01:30:00	1.1037	0.0000	0.1045	0.0012	2.23E-05	0.00118
01:40:00	1.2820	0.0000	0.1233	0.0015	3.14E-05	0.00149
01:50:00	1.4879	0.0000	0.1455	0.0018	4.27E-05	0.00185
02:00:00	1.7249	0.0000	0.1720	0.0022	5.66E-05	0.00225
02:10:00	1.9969	0.0000	0.2036	0.0027	7.34E-05	0.00272
02:20:00	2.3074	0.0000	0.2412	0.0032	9.36E-05	0.00327
02:30:00	2.6590	0.0000	0.2859	0.0038	0.000118	0.00391
02:40:00	3.0503	0.0000	0.3384	0.0045	0.000146	0.00466
02:50:00	3.4630	0.0000	0.3977	0.0054	0.000181	0.00554
03:00:00	3.6906	0.0000	0.4397	0.0064	0.000221	0.00659
03:10:00	3.4630	0.0000	0.4274	0.0075	0.000269	0.00781
03:20:00	3.0503	0.0000	0.3884	0.0089	0.000326	0.00918
03:30:00	2.6590	0.0000	0.3477	0.0103	0.000392	0.0107
03:40:00	2.3074	0.0000	0.3086	0.0117	0.000467	0.0122
03:50:00	1.9969	0.0000	0.2722	0.0131	0.000553	0.0136
04:00:00	1.7249	0.0000	0.2390	0.0143	0.000647	0.015
04:10:00	1.4879	0.0000	0.2090	0.0153	0.000749	0.0161
04:20:00	1.2820	0.0000	0.1822	0.0160	0.000856	0.0169
04:30:00	1.1037	0.0000	0.1584	0.0164	0.000967	0.0173
04:40:00	0.9494	0.0000	0.1375	0.0164	0.00108	0.0175
04:50:00	0.8161	0.0000	0.1190	0.0162	0.00119	0.0174
05:00:00	0.7011	0.0000	0.1029	0.0158	0.0013	0.0171
05:10:00	0.6020	0.0000	0.0888	0.0152	0.0014	0.0166
05:20:00	0.5167	0.0000	0.0766	0.0145	0.0015	0.016
05:30:00	0.4433	0.0000	0.0660	0.0137	0.00159	0.0153
05:40:00	0.3802	0.0000	0.0567	0.0128	0.00168	0.0145

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	0.3259	0.0000	0.0488	0.0119	0.00176	0.0137
06:00:00	0.2793	0.0000	0.0419	0.0110	0.00184	0.0129
06:10:00	0.0000	0.0000	0.0000	0.0101	0.0019	0.012
06:20:00	0.0000	0.0000	0.0000	0.0092	0.00196	0.0111
06:30:00	0.0000	0.0000	0.0000	0.0082	0.00202	0.0102
06:40:00	0.0000	0.0000	0.0000	0.0073	0.00206	0.00933
06:50:00	0.0000	0.0000	0.0000	0.0063	0.0021	0.00844
07:00:00	0.0000	0.0000	0.0000	0.0054	0.00214	0.00758
07:10:00	0.0000	0.0000	0.0000	0.0046	0.00216	0.00676
07:20:00	0.0000	0.0000	0.0000	0.0038	0.00219	0.006
07:30:00	0.0000	0.0000	0.0000	0.0031	0.0022	0.00533
07:40:00	0.0000	0.0000	0.0000	0.0026	0.00221	0.00477
07:50:00	0.0000	0.0000	0.0000	0.0021	0.00222	0.00428
08:00:00	0.0000	0.0000	0.0000	0.0016	0.00223	0.00388
08:10:00	0.0000	0.0000	0.0000	0.0013	0.00223	0.00354
08:20:00	0.0000	0.0000	0.0000	0.0010	0.00223	0.00326
08:30:00	0.0000	0.0000	0.0000	0.0008	0.00223	0.00303
08:40:00	0.0000	0.0000	0.0000	0.0006	0.00222	0.00285
08:50:00	0.0000	0.0000	0.0000	0.0005	0.00222	0.00269
09:00:00	0.0000	0.0000	0.0000	0.0003	0.00221	0.00256
09:10:00	0.0000	0.0000	0.0000	0.0002	0.00221	0.00245
09:20:00	0.0000	0.0000	0.0000	0.0002	0.0022	0.00237
09:30:00	0.0000	0.0000	0.0000	0.0001	0.00219	0.0023
09:40:00	0.0000	0.0000	0.0000	0.0001	0.00219	0.00225
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00218	0.00221
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00217	0.00218
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00216	0.00216
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00215	0.00215
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00215	0.00215
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00214	0.00214
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00213	0.00213
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00212	0.00212
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00211	0.00211
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00211	0.00211
11:30:00	0.0000	0.0000	0.0000	0.0000	0.0021	0.0021
11:40:00	0.0000	0.0000	0.0000	0.0000	0.00209	0.00209

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 C - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	1.628	1.697	0.032

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	41.8	87.1	2.0	0.0	0	130.9	117.8
0.5	7.3	14.6	26.5	55.2	1.3	0.0	0	82.9	149.2
1	9.0	9.0	16.3	34.0	0.8	0.0	0	51.0	183.7
2	14.1	7.0	12.8	26.6	0.6	0.0	0	40.0	287.6
4	19.4	4.8	8.8	18.3	0.4	0.0	0	27.5	395.6
6	22.4	3.7	6.8	14.1	0.3	0.0	0	21.2	456.9
8	24.4	3.0	5.5	11.5	0.3	0.0	0	17.3	497.3
12	27.0	2.3	4.1	8.5	0.2	0.0	0	12.8	551.6
16	28.9	1.8	3.3	6.8	0.2	0.0	0	10.2	589.0
20	30.3	1.5	2.7	5.7	0.1	0.0	0	8.6	618.6
24	31.6	1.3	2.4	5.0	0.1	0.0	0	7.5	644.3
28	32.7	1.2	2.1	4.4	0.1	0.0	0	6.6	666.7
32	33.7	1.1	1.9	4.0	0.1	0.0	0	6.0	687.6
36	34.6	1.0	1.7	3.6	0.1	0.0	0	5.5	707.0
40	35.5	0.9	1.6	3.4	0.1	0.0	0	5.0	725.3
44	36.4	0.8	1.5	3.1	0.1	0.0	0	4.7	742.9
48	37.2	0.8	1.4	2.9	0.1	0.0	0	4.4	760.0

*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 C - EXISTING

Project: Sandown Park

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

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	1.628	1.697	0.032

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	157.7	328.7	7.5	0.0	0	493.8	444.4
0.5	28.2	56.4	102.1	212.8	4.8	0.0	0	319.7	575.5
1	34.7	34.7	62.9	131.1	3.0	0.0	0	196.9	709.0
2	44.1	22.1	39.9	83.2	1.9	0.0	0	125.0	900.3
4	53.8	13.5	24.4	50.8	1.2	0.0	0	76.3	1098.7
6	59.2	9.9	17.9	37.2	0.8	0.0	0	55.9	1207.5
8	62.6	7.8	14.2	29.5	0.7	0.0	0	44.3	1277.1
12	67.0	5.6	10.1	21.1	0.5	0.0	0	31.7	1368.2
16	70.0	4.4	7.9	16.5	0.4	0.0	0	24.8	1429.4
20	72.3	3.6	6.5	13.6	0.3	0.0	0	20.5	1475.4
24	74.1	3.1	5.6	11.7	0.3	0.0	0	17.5	1512.5
28	75.7	2.7	4.9	10.2	0.2	0.0	0	15.3	1544.4
32	77.1	2.4	4.4	9.1	0.2	0.0	0	13.7	1572.9
36	78.3	2.2	3.9	8.2	0.2	0.0	0	12.3	1599.1
40	79.5	2.0	3.6	7.5	0.2	0.0	0	11.3	1623.8
44	80.7	1.8	3.3	6.9	0.2	0.0	0	10.4	1646.8
48	81.7	1.7	3.1	6.4	0.1	0.0	0	9.7	1668.7

*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 C - EXISTING

Project: Sandown Park

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

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	1.628	1.697	0.032

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	205.1	427.4	9.7	0.0	0	642.2	577.9
0.5	36.9	73.8	133.6	278.5	6.3	0.0	0	418.5	753.3
1	45.8	45.8	83.0	172.9	3.9	0.0	0	259.8	935.2
2	57.4	28.7	52.0	108.3	2.5	0.0	0	162.7	1171.8
4	70.4	17.6	31.8	66.4	1.5	0.0	0	99.7	1436.2
6	77.7	12.9	23.4	48.9	1.1	0.0	0	73.4	1585.6
8	82.6	10.3	18.7	39.0	0.9	0.0	0	58.5	1686.0
12	88.9	7.4	13.4	28.0	0.6	0.0	0	42.0	1815.5
16	92.9	5.8	10.5	21.9	0.5	0.0	0	32.9	1896.9
20	95.8	4.8	8.7	18.1	0.4	0.0	0	27.2	1954.9
24	97.9	4.1	7.4	15.4	0.3	0.0	0	23.1	1999.4
28	99.6	3.6	6.4	13.4	0.3	0.0	0	20.2	2033.9
32	101.1	3.2	5.7	11.9	0.3	0.0	0	17.9	2063.5
36	102.4	2.8	5.1	10.7	0.2	0.0	0	16.1	2089.6
40	103.5	2.6	4.7	9.8	0.2	0.0	0	14.7	2113.3
44	104.6	2.4	4.3	9.0	0.2	0.0	0	13.5	2135.0
48	105.6	2.2	4.0	8.3	0.2	0.0	0	12.5	2155.2

*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 C - EXISTING		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SC/A3.3	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.467	0.821	0.070

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 9.7 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	63.3	42.1	4.3	0.0	-10	100.0	90.0
0.5	7.3	14.6	40.1	26.7	2.7	0.0	-10	59.8	107.6
1	9.0	9.0	24.7	16.4	1.7	0.0	-10	33.1	119.1
2	14.1	7.0	19.3	12.9	1.3	0.0	-10	23.8	171.3
4	19.4	4.8	13.3	8.8	0.9	0.0	-10	13.3	192.0
6	22.4	3.7	10.2	6.8	0.7	0.0	-10	8.0	173.5
8	24.4	3.0	8.4	5.6	0.6	0.0	-10	4.8	137.6
12	27.0	2.3	6.2	4.1	0.4	0.0	-10	1.0	43.4
16	28.9	1.8	4.9	3.3	0.3	0.0	-10	-1.1	-65.0
20	30.3	1.5	4.2	2.8	0.3	0.0	-10	-2.5	-179.8
24	31.6	1.3	3.6	2.4	0.2	0.0	-10	-3.4	-297.9
28	32.7	1.2	3.2	2.1	0.2	0.0	-10	-4.2	-418.8
32	33.7	1.1	2.9	1.9	0.2	0.0	-10	-4.7	-541.0
36	34.6	1.0	2.6	1.8	0.2	0.0	-10	-5.1	-664.4
40	35.5	0.9	2.4	1.6	0.2	0.0	-10	-5.5	-788.7
44	36.4	0.8	2.3	1.5	0.2	0.0	-10	-5.8	-913.7
48	37.2	0.8	2.1	1.4	0.1	0.0	-10	-6.0	-1039.0

*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 C - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/SC/A4.1 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.467	0.821	0.070

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	9.7	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	238.9	159.0	16.1	0.0	-10	404.3	363.9
0.5	28.2	56.4	154.7	102.9	10.4	0.0	-10	258.3	465.0
1	34.7	34.7	95.3	63.4	6.4	0.0	-10	155.4	559.5
2	44.1	22.1	60.5	40.3	4.1	0.0	-10	95.1	684.9
4	53.8	13.5	36.9	24.6	2.5	0.0	-10	54.3	781.4
6	59.2	9.9	27.0	18.0	1.8	0.0	-10	37.2	802.8
8	62.6	7.8	21.5	14.3	1.4	0.0	-10	27.5	791.3
12	67.0	5.6	15.3	10.2	1.0	0.0	-10	16.9	728.0
16	70.0	4.4	12.0	8.0	0.8	0.0	-10	11.1	639.6
20	72.3	3.6	9.9	6.6	0.7	0.0	-10	7.5	538.5
24	74.1	3.1	8.5	5.6	0.6	0.0	-10	5.0	429.9
28	75.7	2.7	7.4	4.9	0.5	0.0	-10	3.1	317.0
32	77.1	2.4	6.6	4.4	0.4	0.0	-10	1.7	201.2
36	78.3	2.2	6.0	4.0	0.4	0.0	-10	0.6	83.5
40	79.5	2.0	5.5	3.6	0.4	0.0	-10	-0.2	-35.5
44	80.7	1.8	5.0	3.3	0.3	0.0	-10	-1.0	-155.8
48	81.7	1.7	4.7	3.1	0.3	0.0	-10	-1.6	-277.2

*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 C - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SC/A4.2	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.467	0.821	0.070

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	9.7	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	**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	310.7	206.8	20.9	0.0	-10	528.7	475.8
0.5	36.9	73.8	202.5	134.8	13.6	0.0	-10	341.2	614.1
1	45.8	45.8	125.7	83.6	8.5	0.0	-10	208.1	749.1
2	57.4	28.7	78.7	52.4	5.3	0.0	-10	126.7	912.5
4	70.4	17.6	48.2	32.1	3.3	0.0	-10	73.9	1064.3
6	77.7	12.9	35.5	23.6	2.4	0.0	-10	51.8	1119.8
8	82.6	10.3	28.3	18.9	1.9	0.0	-10	39.4	1134.1
12	88.9	7.4	20.3	13.5	1.4	0.0	-10	25.5	1103.0
16	92.9	5.8	15.9	10.6	1.1	0.0	-10	17.9	1031.6
20	95.8	4.8	13.1	8.7	0.9	0.0	-10	13.1	940.5
24	97.9	4.1	11.2	7.5	0.8	0.0	-10	9.7	838.1
28	99.6	3.6	9.8	6.5	0.7	0.0	-10	7.2	727.4
32	101.1	3.2	8.7	5.8	0.6	0.0	-10	5.3	612.5
36	102.4	2.8	7.8	5.2	0.5	0.0	-10	3.8	494.7
40	103.5	2.6	7.1	4.7	0.5	0.0	-10	2.6	374.9
44	104.6	2.4	6.5	4.3	0.4	0.0	-10	1.6	253.4
48	105.6	2.2	6.0	4.0	0.4	0.0	-10	0.8	130.6

*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 C - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SC/A4.3	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.467	0.821	0.070

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	9.7	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	372.8	248.1	25.1	0.0	-10	636.3	572.7
0.5	36.9	73.8	242.9	161.7	16.4	0.0	-10	411.3	740.4
1	45.8	45.8	150.8	100.4	10.2	0.0	-10	251.6	905.9
2	57.4	28.7	94.5	62.9	6.4	0.0	-10	154.0	1109.0
4	70.4	17.6	57.9	38.5	3.9	0.0	-10	90.6	1305.1
6	77.7	12.9	42.6	28.4	2.9	0.0	-10	64.1	1385.6
8	82.6	10.3	34.0	22.6	2.3	0.0	-10	49.2	1416.8
12	88.9	7.4	24.4	16.2	1.6	0.0	-10	32.6	1407.4
16	92.9	5.8	19.1	12.7	1.3	0.0	-10	23.4	1349.6
20	95.8	4.8	15.8	10.5	1.1	0.0	-10	17.6	1268.3
24	97.9	4.1	13.4	8.9	0.9	0.0	-10	13.6	1173.4
28	99.6	3.6	11.7	7.8	0.8	0.0	-10	10.6	1068.4
32	101.1	3.2	10.4	6.9	0.7	0.0	-10	8.3	958.5
36	102.4	2.8	9.4	6.2	0.6	0.0	-10	6.5	845.1
40	103.5	2.6	8.5	5.7	0.6	0.0	-10	5.1	729.3
44	104.6	2.4	7.8	5.2	0.5	0.0	-10	3.9	611.3
48	105.6	2.2	7.2	4.8	0.5	0.0	-10	2.8	492.0

*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 C - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SC/A4.4	Date:	Jan-19

10 SANDOWN PARK – SITE D

10.1 Background

This section discusses the issues relating to flooding and drainage specifically at the Application Area known as Site D (Rationalisation of the Car Park), shown on *Drawing 2661/OPA-SD/01*.

10.2 Location and setting

The Application Area is located in the western central area of the Sandown Park landholding and comprises a roughly rectangular area of land which is bounded by Site C to the east and Esher Green Road and Moor Lane to the west. It extends to approximately 3.5 ha.

10.3 The proposed development

The proposed development currently comprises areas of hardstanding and grass used for car parking. It is proposed to upgrade the car park by two methods: one area will comprise bonded gravel hardstanding and the other grasscrete type material. The current land uses are shown on *Drawing 2661/OPA-SD/01*.

10.4 Baseline conditions

10.4.1 Landform

The elevation of the ground surface within the Application Area declines towards the north and northeast, from approximately 31 mAOD to 18 mAOD.

10.5 Hydrology

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

10.6 Geology

The southwestern extent of the site is underlain by the Bagshot Formation. The northeastern extent of site is underlain directly by the Claygate Member, with no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-SD/02*.

The majority of the Bagshot Formation is composed of pale yellow-brown to pale grey or white, locally orange or crimson, fine- to coarse-grained sand. A thick clay bed, the Swinley Clay Member, is included at the top. In places, there is a basal bed of gravelly coarse-grained sand.

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.

10.7 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-SD/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.

10.8 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 Application Area.

Minimal areas of the site are noted as being at a low risk of surface water flooding, with a likelihood of flooding between 0.1-1%, the extent of which are shown on *Drawing 2661/OPA-SD/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.

Approximately 38% of the site is located on Bagshot Formation, which comprises predominately sand. The northeastern extent of the site is located on Claygate Member and London Clay which comprises predominantly impermeable clay. The natural drainability of the sub-surface is therefore considered to be good if the surface run-off can be directed to the west/southwest extent of the site.

10.9 Assessment of flood risk and drainage

10.9.1 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 is a very small area designated as at low 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.

10.9.2 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 surface cover.

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

10.9.3 Drainage requirements

Infiltration to ground via soakaway would appear to be feasible at this site; and is proposed. 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 areas to the northeast and east, an area comprising approximately 7,240 m^2. The geo-cellular storage will provide 1,258.4 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 Esher Green Road to the west. In this scenario, the proposed outfall would be located along the western 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.

10.9.4 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'.

10.10 Summary and conclusions

The Application Area is located in the western central section of Sandown Park and is 3.5 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%). There is no history of flooding within the site, thus it is not deemed to be at risk of fluvial flooding.

Areas of the site are noted as being at low risk of surface water flooding, with a likelihood of flooding between 0.1-1%, however these are likely to be improved upon as a result of the development.

The proposed development provides an opportunity for betterment of the existing drainage and water management. The natural drainability of the sub-surface beneath the southwestern extent of the site is good and infiltration to ground via a soakaway/SuDS is proposed. 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 negligible.

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

2661/OPA-SD/01: Proposed development

Please note drawings are illustrative

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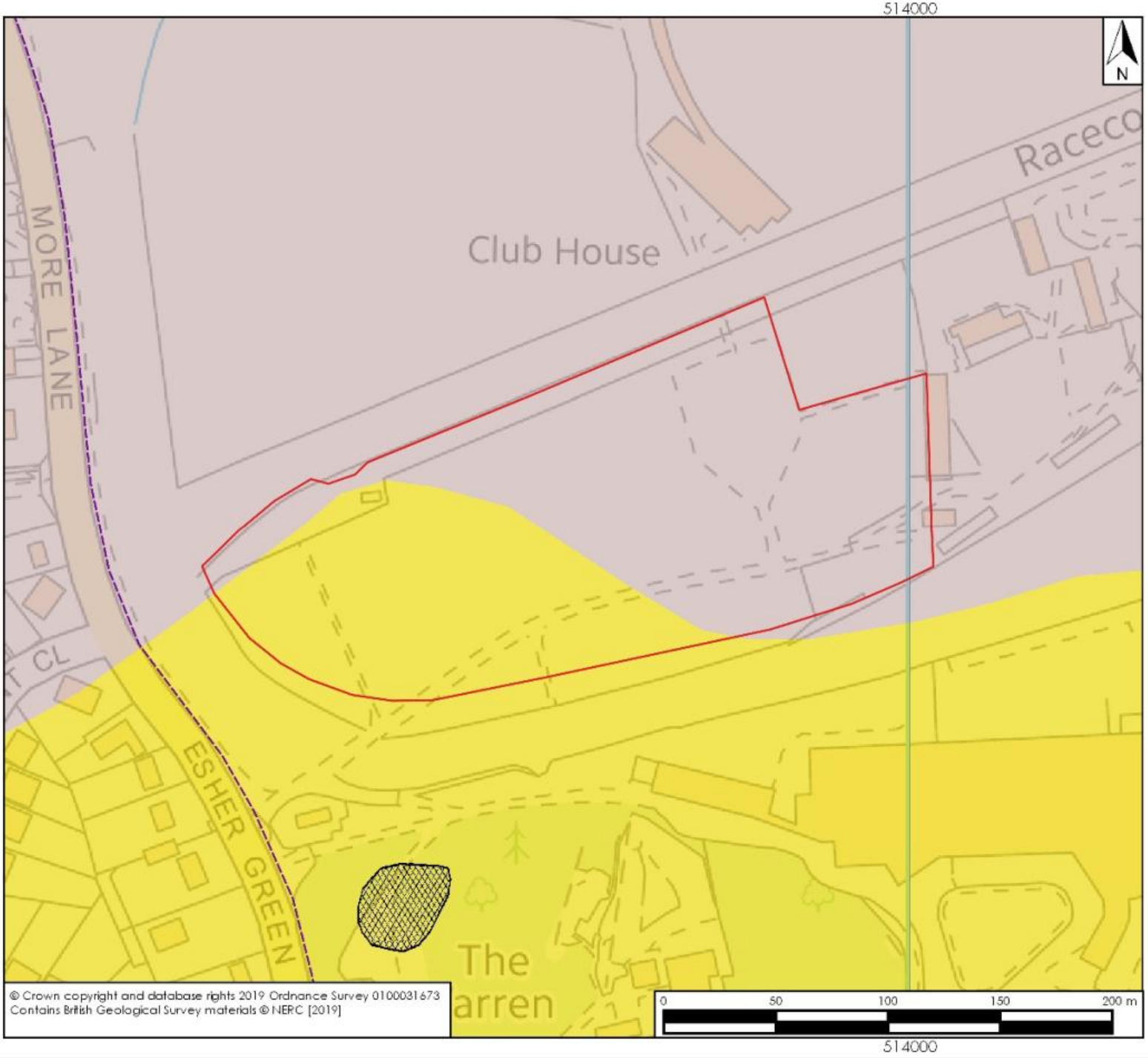
Client	Rapleys	Title	Existing and proposed development
		Project	Sandown Park
		Drawing	2661/OPA-SD/01
		Version	3
		Date	Feb-19
		Scale	nts



Legend

- Landholding
- Site D 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-SD/02
Version	2
Date	Jan 19
Scale	1:2,500

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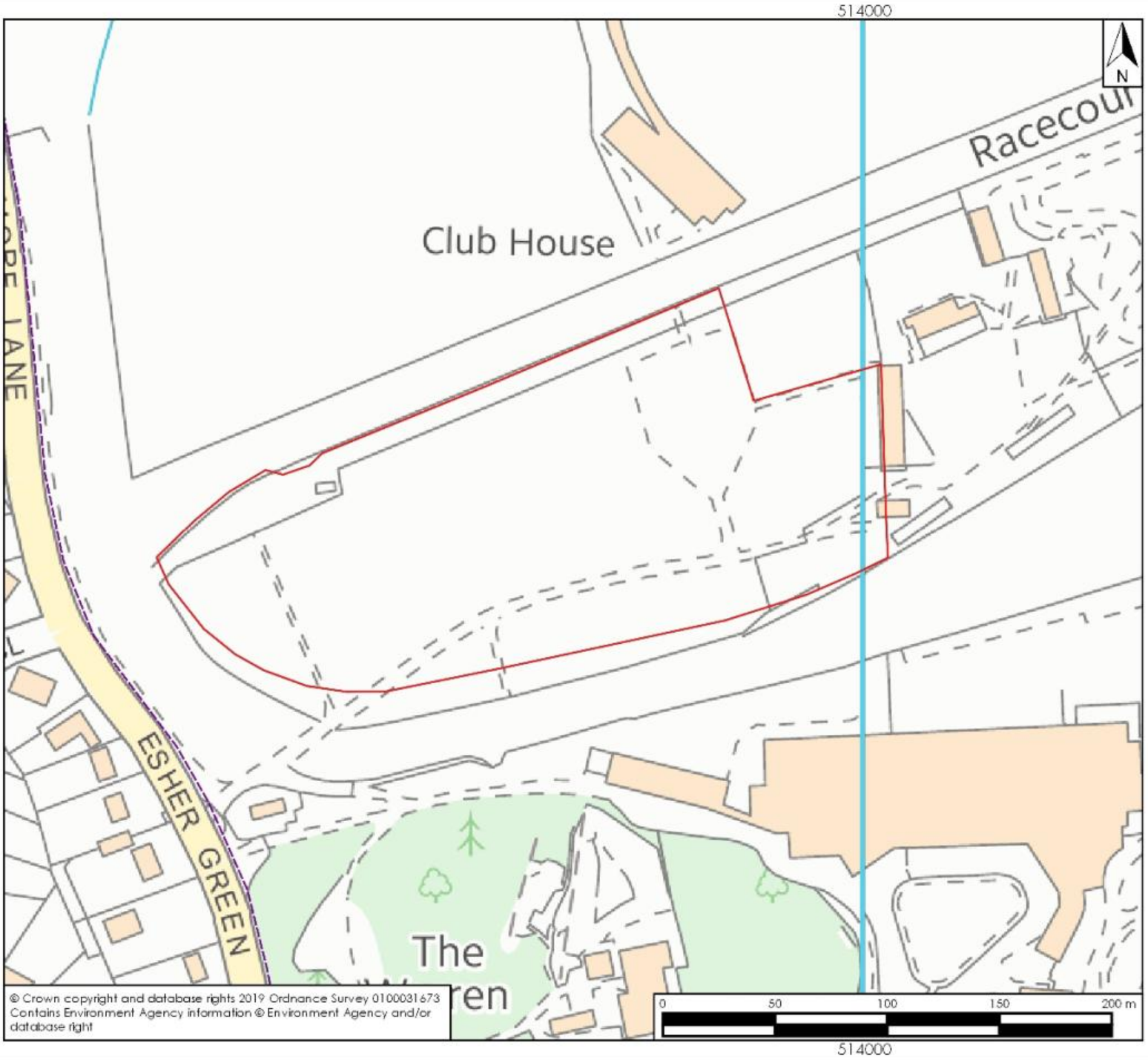

Legend

- Landholding
- Site D 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-SD/03
Version	2
Date	Jan 19
Scale	1:2,500

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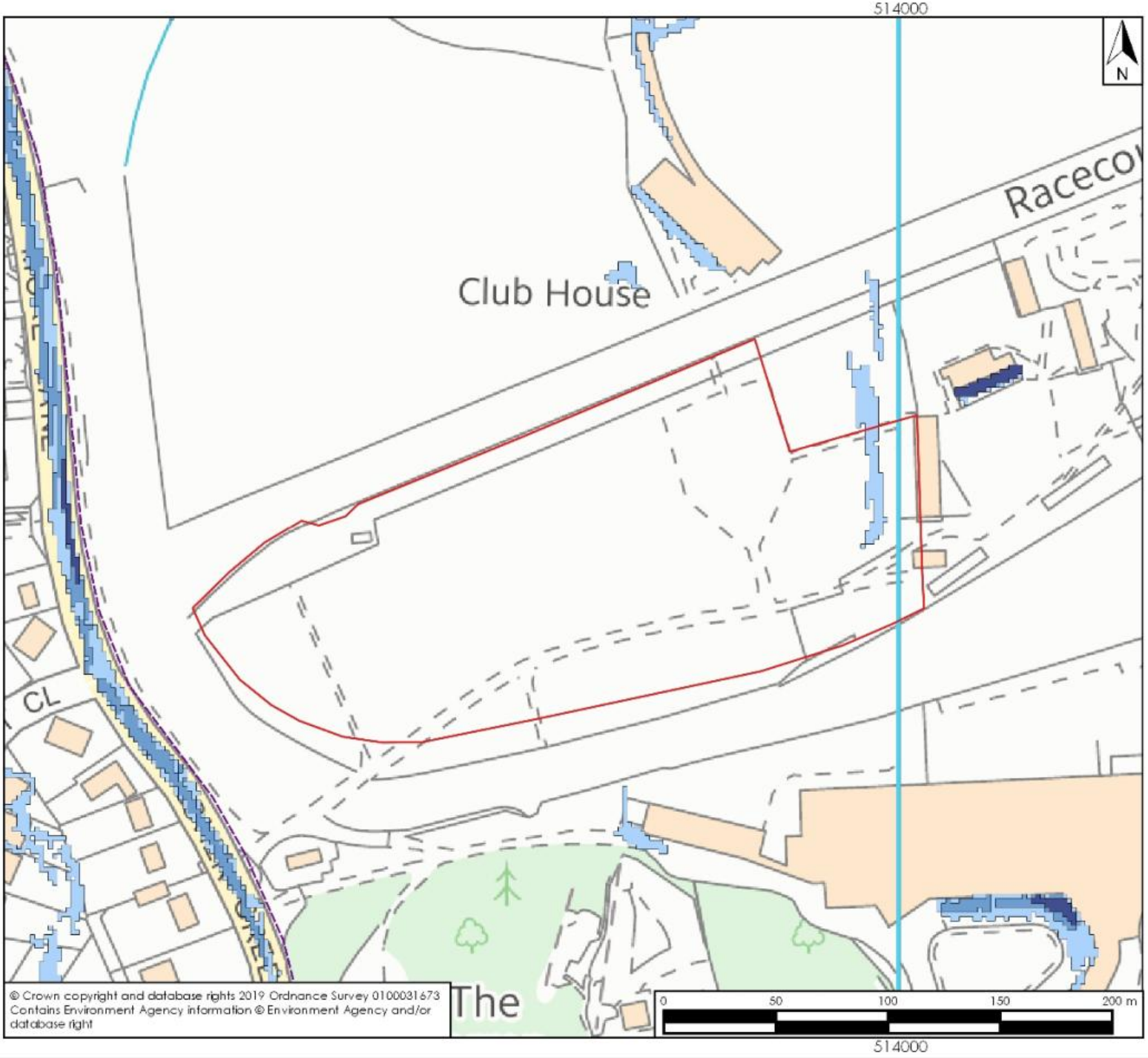

Legend

- Landholding
- Site D 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-SD/04
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 D – Rationalisation of car park
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 138 652
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	35,169 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.72 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	0.50	0.72	0.25 (derived from 0.23 + 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)				**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)	Ground investigation is required to inform location of potential soakaways. 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	10.2	-	-	-	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	4.3	16.7	0.0	-16.7	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	13.0	44.0	0.0	-44.0	
1in 100	18.2	57.8	0.0	-57.8	
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	144.0	359.7	131.2	-228.5	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	436.0	950.8	697.7	-253.1	
1in 100	612.0	1248.4	994.6	-253.8	
1 in 100 plus 20% climate change *	N/A	N/A	1258.4	-	

* 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)	Bagshot Formation	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. Soakaways will attenuate the 1 in 100 year plus climate change event, which is taken as 1,258.4 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 soakaways will be sized to accommodate a 1 in 100 year (+CC) event, which is taken as 1,258.4 m^3 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 as per the pre-development site. 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

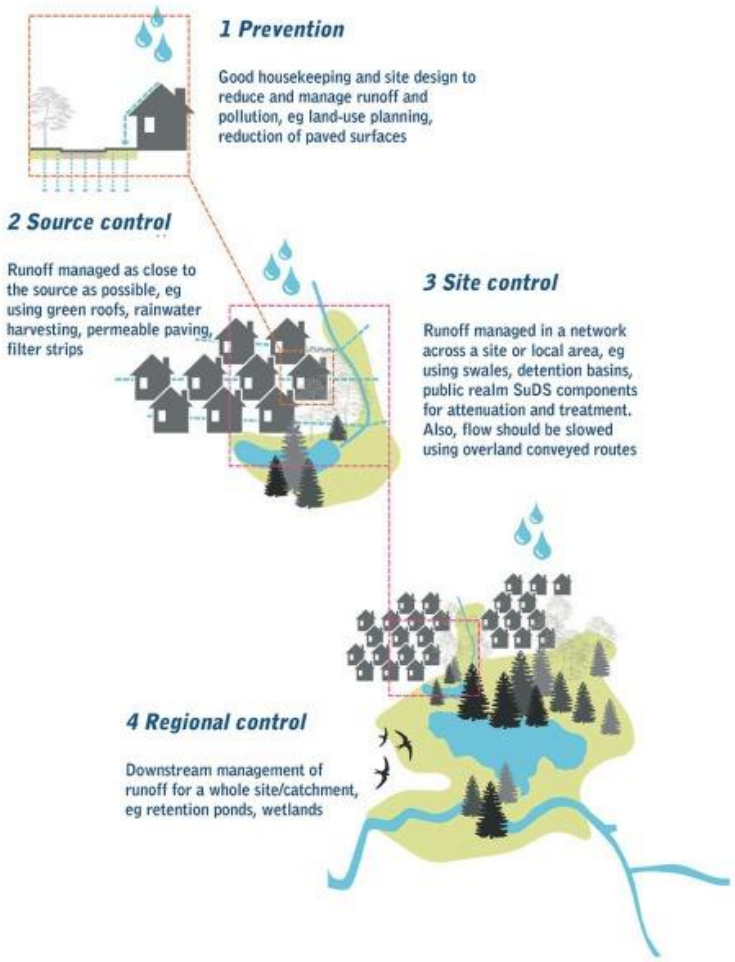
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 D

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	0.0352 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	10.2 l/s
Q (1in1yr)*	8.7 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)	8.7	9.0	13.0	16.5	21.8	24.4	26.7	32.5	39.3

hafrenwater
environmental water management

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Tel: 01743 355770
www.hafrenwater.com

Client: **Rapleys LLP**

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

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 2:48:36 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: 63A2-80D3

Site name: Sandown Park - Site D

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.04 [0.04]*

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.05
Total Rainfall (mm):	14.98	Total flow (ML):	0.14
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)	1.15	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	44.8	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	0.0807	0.0000	0.0071	0.0000	0	0
00:10:00	0.0942	0.0000	0.0083	0.0000	9.88E-09	2.83E-06
00:20:00	0.1098	0.0000	0.0097	0.0000	6.09E-08	1.18E-05
00:30:00	0.1281	0.0000	0.0113	0.0000	1.99E-07	2.8E-05
00:40:00	0.1493	0.0000	0.0132	0.0001	4.79E-07	5.27E-05
00:50:00	0.1739	0.0000	0.0154	0.0001	9.63E-07	8.74E-05
01:00:00	0.2025	0.0000	0.0180	0.0001	1.72E-06	0.000134
01:10:00	0.2358	0.0000	0.0211	0.0002	2.85E-06	0.000194
01:20:00	0.2743	0.0000	0.0246	0.0003	4.41E-06	0.000264
01:30:00	0.3188	0.0000	0.0287	0.0003	6.49E-06	0.000344
01:40:00	0.3704	0.0000	0.0335	0.0004	9.13E-06	0.000434
01:50:00	0.4298	0.0000	0.0391	0.0005	1.24E-05	0.000536
02:00:00	0.4983	0.0000	0.0456	0.0006	1.64E-05	0.000652
02:10:00	0.5769	0.0000	0.0531	0.0008	2.13E-05	0.000783
02:20:00	0.6666	0.0000	0.0619	0.0009	2.7E-05	0.000934
02:30:00	0.7681	0.0000	0.0720	0.0011	3.39E-05	0.00111
02:40:00	0.8812	0.0000	0.0834	0.0013	4.19E-05	0.00131
02:50:00	1.0004	0.0000	0.0958	0.0015	5.14E-05	0.00154
03:00:00	1.0662	0.0000	0.1034	0.0017	6.26E-05	0.00181
03:10:00	1.0004	0.0000	0.0983	0.0020	7.56E-05	0.00212
03:20:00	0.8812	0.0000	0.0876	0.0024	9.07E-05	0.00246
03:30:00	0.7681	0.0000	0.0771	0.0027	0.000108	0.00281
03:40:00	0.6666	0.0000	0.0675	0.0030	0.000128	0.00317
03:50:00	0.5769	0.0000	0.0588	0.0034	0.00015	0.00351
04:00:00	0.4983	0.0000	0.0511	0.0036	0.000174	0.0038
04:10:00	0.4298	0.0000	0.0444	0.0038	0.000199	0.00404
04:20:00	0.3704	0.0000	0.0384	0.0040	0.000226	0.0042
04:30:00	0.3188	0.0000	0.0332	0.0040	0.000253	0.00428
04:40:00	0.2743	0.0000	0.0286	0.0040	0.00028	0.00429
04:50:00	0.2358	0.0000	0.0247	0.0039	0.000307	0.00423
05:00:00	0.2025	0.0000	0.0213	0.0038	0.000333	0.00413
05:10:00	0.1739	0.0000	0.0183	0.0036	0.000357	0.00399
05:20:00	0.1493	0.0000	0.0157	0.0034	0.000381	0.00382
05:30:00	0.1281	0.0000	0.0135	0.0032	0.000403	0.00363
05:40:00	0.1098	0.0000	0.0116	0.0030	0.000423	0.00344

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	0.0028	0.000442	0.00323
06:00:00	0.0807	0.0000	0.0086	0.0026	0.000459	0.00302
06:10:00	0.0000	0.0000	0.0000	0.0023	0.000474	0.00281
06:20:00	0.0000	0.0000	0.0000	0.0021	0.000488	0.0026
06:30:00	0.0000	0.0000	0.0000	0.0019	0.0005	0.00239
06:40:00	0.0000	0.0000	0.0000	0.0017	0.000511	0.00217
06:50:00	0.0000	0.0000	0.0000	0.0014	0.00052	0.00197
07:00:00	0.0000	0.0000	0.0000	0.0012	0.000527	0.00177
07:10:00	0.0000	0.0000	0.0000	0.0010	0.000533	0.00158
07:20:00	0.0000	0.0000	0.0000	0.0009	0.000538	0.00141
07:30:00	0.0000	0.0000	0.0000	0.0007	0.000542	0.00125
07:40:00	0.0000	0.0000	0.0000	0.0006	0.000544	0.00112
07:50:00	0.0000	0.0000	0.0000	0.0005	0.000546	0.00101
08:00:00	0.0000	0.0000	0.0000	0.0004	0.000547	0.000921
08:10:00	0.0000	0.0000	0.0000	0.0003	0.000547	0.000845
08:20:00	0.0000	0.0000	0.0000	0.0002	0.000547	0.000782
08:30:00	0.0000	0.0000	0.0000	0.0002	0.000546	0.00073
08:40:00	0.0000	0.0000	0.0000	0.0001	0.000545	0.000688
08:50:00	0.0000	0.0000	0.0000	0.0001	0.000544	0.000652
09:00:00	0.0000	0.0000	0.0000	0.0001	0.000543	0.000623
09:10:00	0.0000	0.0000	0.0000	0.0001	0.000541	0.000599
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00054	0.000579
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000538	0.000564
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000536	0.000552
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000534	0.000542
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000532	0.000536
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00053	0.000531
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000528	0.000528
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000526	0.000526
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000524	0.000524
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000522	0.000522
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00052	0.00052
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000519	0.000519
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000517	0.000517
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000515	0.000515
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000513	0.000513

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 2:49:22 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: 63A2-80D3

Site name: Sandown Park - Site D

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.04 [0.04]*

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.15
Total Rainfall (mm):	39.38	Total flow (ML):	0.44
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)	1.15	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	44.8	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	0.2121	0.0000	0.0187	0.0000	0	0
00:10:00	0.2474	0.0000	0.0219	0.0000	2.6E-08	7.45E-06
00:20:00	0.2886	0.0000	0.0256	0.0000	1.6E-07	3.11E-05
00:30:00	0.3366	0.0000	0.0300	0.0001	5.25E-07	7.39E-05
00:40:00	0.3923	0.0000	0.0351	0.0001	1.26E-06	0.000139
00:50:00	0.4571	0.0000	0.0412	0.0002	2.54E-06	0.000231
01:00:00	0.5323	0.0000	0.0483	0.0003	4.55E-06	0.000353
01:10:00	0.6196	0.0000	0.0566	0.0005	7.52E-06	0.000512
01:20:00	0.7208	0.0000	0.0664	0.0007	1.17E-05	0.000701
01:30:00	0.8379	0.0000	0.0780	0.0009	1.72E-05	0.000913
01:40:00	0.9734	0.0000	0.0917	0.0011	2.42E-05	0.00115
01:50:00	1.1297	0.0000	0.1078	0.0014	3.3E-05	0.00143
02:00:00	1.3096	0.0000	0.1269	0.0017	4.37E-05	0.00174
02:10:00	1.5161	0.0000	0.1495	0.0020	5.66E-05	0.00211
02:20:00	1.7518	0.0000	0.1762	0.0025	7.22E-05	0.00252
02:30:00	2.0188	0.0000	0.2076	0.0029	9.07E-05	0.00301
02:40:00	2.3159	0.0000	0.2442	0.0035	0.000113	0.00358
02:50:00	2.6292	0.0000	0.2850	0.0041	0.000139	0.00424
03:00:00	2.8020	0.0000	0.3128	0.0049	0.00017	0.00502
03:10:00	2.6292	0.0000	0.3021	0.0057	0.000206	0.00593
03:20:00	2.3159	0.0000	0.2730	0.0067	0.000249	0.00694
03:30:00	2.0188	0.0000	0.2432	0.0077	0.000298	0.00803
03:40:00	1.7518	0.0000	0.2150	0.0088	0.000355	0.00914
03:50:00	1.5161	0.0000	0.1890	0.0098	0.000419	0.0102
04:00:00	1.3096	0.0000	0.1655	0.0107	0.000489	0.0112
04:10:00	1.1297	0.0000	0.1444	0.0114	0.000564	0.012
04:20:00	0.9734	0.0000	0.1257	0.0119	0.000644	0.0125
04:30:00	0.8379	0.0000	0.1091	0.0121	0.000725	0.0129
04:40:00	0.7208	0.0000	0.0945	0.0122	0.000808	0.013
04:50:00	0.6196	0.0000	0.0817	0.0120	0.000889	0.0129
05:00:00	0.5323	0.0000	0.0706	0.0117	0.000969	0.0126
05:10:00	0.4571	0.0000	0.0609	0.0112	0.00105	0.0123
05:20:00	0.3923	0.0000	0.0525	0.0107	0.00112	0.0118
05:30:00	0.3366	0.0000	0.0452	0.0101	0.00119	0.0113
05:40:00	0.2886	0.0000	0.0388	0.0095	0.00125	0.0107

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	0.2474	0.0000	0.0334	0.0088	0.00131	0.0101
06:00:00	0.2121	0.0000	0.0287	0.0081	0.00136	0.00949
06:10:00	0.0000	0.0000	0.0000	0.0074	0.00141	0.00886
06:20:00	0.0000	0.0000	0.0000	0.0068	0.00146	0.00822
06:30:00	0.0000	0.0000	0.0000	0.0061	0.0015	0.00756
06:40:00	0.0000	0.0000	0.0000	0.0054	0.00153	0.0069
06:50:00	0.0000	0.0000	0.0000	0.0047	0.00156	0.00625
07:00:00	0.0000	0.0000	0.0000	0.0040	0.00159	0.00562
07:10:00	0.0000	0.0000	0.0000	0.0034	0.00161	0.00502
07:20:00	0.0000	0.0000	0.0000	0.0028	0.00162	0.00447
07:30:00	0.0000	0.0000	0.0000	0.0023	0.00163	0.00397
07:40:00	0.0000	0.0000	0.0000	0.0019	0.00164	0.00355
07:50:00	0.0000	0.0000	0.0000	0.0015	0.00165	0.00319
08:00:00	0.0000	0.0000	0.0000	0.0012	0.00165	0.00289
08:10:00	0.0000	0.0000	0.0000	0.0010	0.00165	0.00264
08:20:00	0.0000	0.0000	0.0000	0.0008	0.00165	0.00244
08:30:00	0.0000	0.0000	0.0000	0.0006	0.00165	0.00227
08:40:00	0.0000	0.0000	0.0000	0.0005	0.00165	0.00213
08:50:00	0.0000	0.0000	0.0000	0.0004	0.00165	0.00201
09:00:00	0.0000	0.0000	0.0000	0.0003	0.00164	0.00191
09:10:00	0.0000	0.0000	0.0000	0.0002	0.00164	0.00183
09:20:00	0.0000	0.0000	0.0000	0.0001	0.00163	0.00177
09:30:00	0.0000	0.0000	0.0000	0.0001	0.00163	0.00172
09:40:00	0.0000	0.0000	0.0000	0.0001	0.00162	0.00168
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00162	0.00165
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00161	0.00162
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00161	0.00161
10:20:00	0.0000	0.0000	0.0000	0.0000	0.0016	0.0016
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00159	0.00159
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00159	0.00159
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00158	0.00158
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00158	0.00158
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00157	0.00157
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00157	0.00157
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00156	0.00156
11:40:00	0.0000	0.0000	0.0000	0.0000	0.00155	0.00155

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 2:50:01 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: 63A2-80D3

Site name: Sandown Park - Site D

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.04 [0.04]*

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.22
Total Rainfall (mm):	51.87	Total flow (ML):	0.61
Peak Rainfall (mm):	3.69	Peak flow (m^3/s):	0.02

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)	1.15	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	44.8	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	0.2793	0.0000	0.0246	0.0000	0	0
00:10:00	0.3259	0.0000	0.0289	0.0000	3.42E-08	9.81E-06
00:20:00	0.3802	0.0000	0.0338	0.0000	2.11E-07	4.1E-05
00:30:00	0.4433	0.0000	0.0397	0.0001	6.92E-07	9.74E-05
00:40:00	0.5168	0.0000	0.0465	0.0002	1.66E-06	0.000183
00:50:00	0.6021	0.0000	0.0546	0.0003	3.35E-06	0.000304
01:00:00	0.7012	0.0000	0.0642	0.0005	6E-06	0.000467
01:10:00	0.8161	0.0000	0.0754	0.0007	9.93E-06	0.000677
01:20:00	0.9494	0.0000	0.0888	0.0009	1.54E-05	0.000927
01:30:00	1.1037	0.0000	0.1045	0.0012	2.27E-05	0.00121
01:40:00	1.2821	0.0000	0.1233	0.0015	3.2E-05	0.00153
01:50:00	1.4880	0.0000	0.1455	0.0019	4.36E-05	0.0019
02:00:00	1.7250	0.0000	0.1720	0.0023	5.79E-05	0.00232
02:10:00	1.9970	0.0000	0.2036	0.0027	7.51E-05	0.00281
02:20:00	2.3075	0.0000	0.2412	0.0033	9.59E-05	0.00337
02:30:00	2.6591	0.0000	0.2859	0.0039	0.000121	0.00403
02:40:00	3.0505	0.0000	0.3384	0.0047	0.00015	0.00481
02:50:00	3.4633	0.0000	0.3978	0.0055	0.000185	0.00572
03:00:00	3.6908	0.0000	0.4397	0.0066	0.000227	0.0068
03:10:00	3.4633	0.0000	0.4275	0.0078	0.000276	0.00806
03:20:00	3.0505	0.0000	0.3884	0.0091	0.000335	0.00948
03:30:00	2.6591	0.0000	0.3477	0.0106	0.000402	0.011
03:40:00	2.3075	0.0000	0.3086	0.0121	0.00048	0.0126
03:50:00	1.9970	0.0000	0.2722	0.0135	0.000568	0.0141
04:00:00	1.7250	0.0000	0.2390	0.0148	0.000666	0.0155
04:10:00	1.4880	0.0000	0.2090	0.0159	0.000771	0.0167
04:20:00	1.2821	0.0000	0.1822	0.0166	0.000882	0.0175
04:30:00	1.1037	0.0000	0.1584	0.0170	0.000996	0.018
04:40:00	0.9494	0.0000	0.1375	0.0171	0.00111	0.0182
04:50:00	0.8161	0.0000	0.1190	0.0169	0.00123	0.0182
05:00:00	0.7012	0.0000	0.1029	0.0165	0.00134	0.0179
05:10:00	0.6021	0.0000	0.0888	0.0159	0.00145	0.0174
05:20:00	0.5168	0.0000	0.0766	0.0152	0.00155	0.0168
05:30:00	0.4433	0.0000	0.0660	0.0144	0.00165	0.016
05:40:00	0.3802	0.0000	0.0568	0.0135	0.00174	0.0152

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	0.3259	0.0000	0.0488	0.0126	0.00183	0.0144
06:00:00	0.2793	0.0000	0.0419	0.0116	0.0019	0.0135
06:10:00	0.0000	0.0000	0.0000	0.0107	0.00198	0.0127
06:20:00	0.0000	0.0000	0.0000	0.0097	0.00204	0.0118
06:30:00	0.0000	0.0000	0.0000	0.0087	0.0021	0.0108
06:40:00	0.0000	0.0000	0.0000	0.0077	0.00215	0.00989
06:50:00	0.0000	0.0000	0.0000	0.0068	0.00219	0.00897
07:00:00	0.0000	0.0000	0.0000	0.0058	0.00223	0.00807
07:10:00	0.0000	0.0000	0.0000	0.0050	0.00225	0.00721
07:20:00	0.0000	0.0000	0.0000	0.0041	0.00228	0.00641
07:30:00	0.0000	0.0000	0.0000	0.0034	0.0023	0.00569
07:40:00	0.0000	0.0000	0.0000	0.0028	0.00231	0.00508
07:50:00	0.0000	0.0000	0.0000	0.0022	0.00232	0.00457
08:00:00	0.0000	0.0000	0.0000	0.0018	0.00232	0.00413
08:10:00	0.0000	0.0000	0.0000	0.0014	0.00233	0.00377
08:20:00	0.0000	0.0000	0.0000	0.0011	0.00233	0.00346
08:30:00	0.0000	0.0000	0.0000	0.0009	0.00233	0.00322
08:40:00	0.0000	0.0000	0.0000	0.0007	0.00232	0.00301
08:50:00	0.0000	0.0000	0.0000	0.0005	0.00232	0.00284
09:00:00	0.0000	0.0000	0.0000	0.0004	0.00231	0.0027
09:10:00	0.0000	0.0000	0.0000	0.0003	0.00231	0.00259
09:20:00	0.0000	0.0000	0.0000	0.0002	0.0023	0.00249
09:30:00	0.0000	0.0000	0.0000	0.0001	0.00229	0.00242
09:40:00	0.0000	0.0000	0.0000	0.0001	0.00228	0.00236
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00228	0.00232
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00227	0.00228
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00226	0.00226
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00225	0.00225
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00224	0.00224
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00223	0.00223
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00223	0.00223
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00222	0.00222
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00221	0.00221
11:20:00	0.0000	0.0000	0.0000	0.0000	0.0022	0.0022
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00219	0.00219
11:40:00	0.0000	0.0000	0.0000	0.0000	0.00219	0.00219

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 D - EXISTING

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	3.019	0.498	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	77.5	25.6	0.0	0.0	0	103.0	92.7
0.5	7.3	14.6	49.1	16.2	0.0	0.0	0	65.3	117.5
1	9.0	9.0	30.2	10.0	0.0	0.0	0	40.2	144.7
2	14.1	7.0	23.6	7.8	0.0	0.0	0	31.5	226.5
4	19.4	4.8	16.3	5.4	0.0	0.0	0	21.6	311.5
6	22.4	3.7	12.5	4.1	0.0	0.0	0	16.7	359.7
8	24.4	3.0	10.2	3.4	0.0	0.0	0	13.6	391.6
12	27.0	2.3	7.6	2.5	0.0	0.0	0	10.1	434.3
16	28.9	1.8	6.1	2.0	0.0	0.0	0	8.1	463.7
20	30.3	1.5	5.1	1.7	0.0	0.0	0	6.8	487.0
24	31.6	1.3	4.4	1.5	0.0	0.0	0	5.9	507.3
28	32.7	1.2	3.9	1.3	0.0	0.0	0	5.2	525.0
32	33.7	1.1	3.5	1.2	0.0	0.0	0	4.7	541.4
36	34.6	1.0	3.2	1.1	0.0	0.0	0	4.3	556.6
40	35.5	0.9	3.0	1.0	0.0	0.0	0	4.0	571.1
44	36.4	0.8	2.8	0.9	0.0	0.0	0	3.7	584.9
48	37.2	0.8	2.6	0.9	0.0	0.0	0	3.5	598.4

*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 D - EXISTING		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SD/A3.1	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	3.019	0.498	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	292.3	96.5	0.0	0.0	0	388.8	349.9
0.5	28.2	56.4	189.2	62.5	0.0	0.0	0	251.7	453.1
1	34.7	34.7	116.6	38.5	0.0	0.0	0	155.1	558.2
2	44.1	22.1	74.0	24.4	0.0	0.0	0	98.5	708.8
4	53.8	13.5	45.2	14.9	0.0	0.0	0	60.1	865.1
6	59.2	9.9	33.1	10.9	0.0	0.0	0	44.0	950.8
8	62.6	7.8	26.2	8.7	0.0	0.0	0	34.9	1005.6
12	67.0	5.6	18.7	6.2	0.0	0.0	0	24.9	1077.3
16	70.0	4.4	14.7	4.8	0.0	0.0	0	19.5	1125.5
20	72.3	3.6	12.1	4.0	0.0	0.0	0	16.1	1161.6
24	74.1	3.1	10.4	3.4	0.0	0.0	0	13.8	1190.9
28	75.7	2.7	9.1	3.0	0.0	0.0	0	12.1	1216.0
32	77.1	2.4	8.1	2.7	0.0	0.0	0	10.8	1238.5
36	78.3	2.2	7.3	2.4	0.0	0.0	0	9.7	1259.0
40	79.5	2.0	6.7	2.2	0.0	0.0	0	8.9	1278.5
44	80.7	1.8	6.2	2.0	0.0	0.0	0	8.2	1296.7
48	81.7	1.7	5.7	1.9	0.0	0.0	0	7.6	1313.9

*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 D - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/SD/A3.2

Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	3.019	0.498	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	380.1	125.5	0.0	0.0	0	505.6	455.0
0.5	36.9	73.8	247.7	81.8	0.0	0.0	0	329.5	593.1
1	45.8	45.8	153.8	50.8	0.0	0.0	0	204.5	736.3
2	57.4	28.7	96.3	31.8	0.0	0.0	0	128.1	922.6
4	70.4	17.6	59.0	19.5	0.0	0.0	0	78.5	1130.8
6	77.7	12.9	43.5	14.3	0.0	0.0	0	57.8	1248.4
8	82.6	10.3	34.7	11.4	0.0	0.0	0	46.1	1327.5
12	88.9	7.4	24.9	8.2	0.0	0.0	0	33.1	1429.4
16	92.9	5.8	19.5	6.4	0.0	0.0	0	25.9	1493.6
20	95.8	4.8	16.1	5.3	0.0	0.0	0	21.4	1539.2
24	97.9	4.1	13.7	4.5	0.0	0.0	0	18.2	1574.3
28	99.6	3.6	11.9	3.9	0.0	0.0	0	15.9	1601.4
32	101.1	3.2	10.6	3.5	0.0	0.0	0	14.1	1624.7
36	102.4	2.8	9.5	3.2	0.0	0.0	0	12.7	1645.3
40	103.5	2.6	8.7	2.9	0.0	0.0	0	11.6	1663.9
44	104.6	2.4	8.0	2.6	0.0	0.0	0	10.6	1681.0
48	105.6	2.2	7.4	2.4	0.0	0.0	0	9.8	1696.9

*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 D - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/SD/A3.3

Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.793	0.724	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 %

Infiltration loss through soakaway 15.0 l/s

Area of Soakaway 50 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 Soakaway *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	71.7	37.2	0.0	0.0	-15	93.8	84.5
0.5	7.3	14.6	45.4	23.5	0.0	0.0	-15	53.9	97.1
1	9.0	9.0	28.0	14.5	0.0	0.0	-15	27.4	98.8
2	14.1	7.0	21.9	11.3	0.0	0.0	-15	18.2	131.2
4	19.4	4.8	15.0	7.8	0.0	0.0	-15	7.8	113.0
6	22.4	3.7	11.6	6.0	0.0	0.0	-15	2.6	56.0
8	24.4	3.0	9.5	4.9	0.0	0.0	-15	-0.6	-18.4
12	27.0	2.3	7.0	3.6	0.0	0.0	-15	-4.4	-189.3
16	28.9	1.8	5.6	2.9	0.0	0.0	-15	-6.5	-374.2
20	30.3	1.5	4.7	2.4	0.0	0.0	-15	-7.9	-565.6
24	31.6	1.3	4.1	2.1	0.0	0.0	-15	-8.8	-760.2
28	32.7	1.2	3.6	1.9	0.0	0.0	-15	-9.5	-957.5
32	33.7	1.1	3.3	1.7	0.0	0.0	-15	-10.0	-1156.2
36	34.6	1.0	3.0	1.5	0.0	0.0	-15	-10.5	-1356.1
40	35.5	0.9	2.8	1.4	0.0	0.0	-15	-10.8	-1556.8
44	36.4	0.8	2.6	1.3	0.0	0.0	-15	-11.1	-1758.2
48	37.2	0.8	2.4	1.2	0.0	0.0	-15	-11.3	-1959.9

*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 D - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/SD/A4.1 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.793	0.724	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	%

Infiltration loss through soakaway	15.0	l/s	

Area of Soakaway **50** 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 Soakaway *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	270.5	140.2	0.0	0.0	-15	395.7	356.1
0.5	28.2	56.4	175.1	90.8	0.0	0.0	-15	250.9	451.6
1	34.7	34.7	107.9	55.9	0.0	0.0	-15	148.8	535.6
2	44.1	22.1	68.5	35.5	0.0	0.0	-15	89.0	640.7
4	53.8	13.5	41.8	21.7	0.0	0.0	-15	48.5	697.7
6	59.2	9.9	30.6	15.9	0.0	0.0	-15	31.5	680.2
8	62.6	7.8	24.3	12.6	0.0	0.0	-15	21.9	630.1
12	67.0	5.6	17.3	9.0	0.0	0.0	-15	11.3	489.8
16	70.0	4.4	13.6	7.0	0.0	0.0	-15	5.6	324.8
20	72.3	3.6	11.2	5.8	0.0	0.0	-15	2.0	147.0
24	74.1	3.1	9.6	5.0	0.0	0.0	-15	-0.4	-38.1
28	75.7	2.7	8.4	4.4	0.0	0.0	-15	-2.3	-227.6
32	77.1	2.4	7.5	3.9	0.0	0.0	-15	-3.6	-419.9
36	78.3	2.2	6.8	3.5	0.0	0.0	-15	-4.7	-614.1
40	79.5	2.0	6.2	3.2	0.0	0.0	-15	-5.6	-809.6
44	80.7	1.8	5.7	3.0	0.0	0.0	-15	-6.4	-1006.4
48	81.7	1.7	5.3	2.7	0.0	0.0	-15	-7.0	-1204.3

*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 D - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SD/A4.2	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.793	0.724	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	%

Infiltration loss through soakaway	15.0	l/s

Area of Soakaway **50** 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 Soakaway *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	351.7	182.3	0.0	0.0	-15	519.0	467.1
0.5	36.9	73.8	229.2	118.8	0.0	0.0	-15	333.0	599.5
1	45.8	45.8	142.3	73.8	0.0	0.0	-15	201.0	723.7
2	57.4	28.7	89.1	46.2	0.0	0.0	-15	120.3	866.5
4	70.4	17.6	54.6	28.3	0.0	0.0	-15	67.9	978.4
6	77.7	12.9	40.2	20.8	0.0	0.0	-15	46.0	994.6
8	82.6	10.3	32.1	16.6	0.0	0.0	-15	33.7	970.2
12	88.9	7.4	23.0	11.9	0.0	0.0	-15	19.9	861.8
16	92.9	5.8	18.0	9.4	0.0	0.0	-15	12.4	713.6
20	95.8	4.8	14.9	7.7	0.0	0.0	-15	7.6	545.8
24	97.9	4.1	12.7	6.6	0.0	0.0	-15	4.2	366.8
28	99.6	3.6	11.1	5.7	0.0	0.0	-15	1.8	179.5
32	101.1	3.2	9.8	5.1	0.0	0.0	-15	-0.1	-11.9
36	102.4	2.8	8.8	4.6	0.0	0.0	-15	-1.6	-206.2
40	103.5	2.6	8.0	4.2	0.0	0.0	-15	-2.8	-402.5
44	104.6	2.4	7.4	3.8	0.0	0.0	-15	-3.8	-600.5
48	105.6	2.2	6.8	3.5	0.0	0.0	-15	-4.6	-799.7

*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 D - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/SD/A4.3	Date:	Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	2.793	0.724	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)	20	%

Infiltration loss through soakaway	15.0	l/s

Area of Soakaway	**50 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 Soakaway *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	422.0	218.8	0.0	0.0	-15	625.8	563.3
0.5	36.9	73.8	275.1	142.6	0.0	0.0	-15	402.6	724.8
1	45.8	45.8	170.7	88.5	0.0	0.0	-15	244.2	879.3
2	57.4	28.7	107.0	55.5	0.0	0.0	-15	147.4	1061.4
4	70.4	17.6	65.5	34.0	0.0	0.0	-15	84.5	1217.2
6	77.7	12.9	48.2	25.0	0.0	0.0	-15	58.3	1258.4
8	82.6	10.3	38.5	19.9	0.0	0.0	-15	43.4	1250.6
12	88.9	7.4	27.6	14.3	0.0	0.0	-15	26.9	1163.8
16	92.9	5.8	21.6	11.2	0.0	0.0	-15	17.9	1029.1
20	95.8	4.8	17.8	9.3	0.0	0.0	-15	12.1	870.9
24	97.9	4.1	15.2	7.9	0.0	0.0	-15	8.1	699.3
28	99.6	3.6	13.3	6.9	0.0	0.0	-15	5.1	517.8
32	101.1	3.2	11.8	6.1	0.0	0.0	-15	2.9	331.3
36	102.4	2.8	10.6	5.5	0.0	0.0	-15	1.1	141.4
40	103.5	2.6	9.6	5.0	0.0	0.0	-15	-0.4	-51.0
44	104.6	2.4	8.9	4.6	0.0	0.0	-15	-1.5	-245.4
48	105.6	2.2	8.2	4.2	0.0	0.0	-15	-2.6	-441.2

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Project:	Sandown Park		
Calc Sheet:	2661_OPA/SD/A4.4	Date:	Jan-19

11 SANDOWN PARK – SITES E1 AND E2

11.1 Comment

It is proposed to widen the racetrack at the southwest and east of the circuit. The locations of these areas are shown on *Drawing 2661/OPA-RS/01*. The areal extent and minor nature of the proposed works is such that there are not anticipated to be discernible impacts on drainage or flood risk.

12 SANDOWN PARK – SITE F

12.1 Comment

It is proposed to undertake works within Site F, the location of which is shown on *Drawing 2661/OPA-RS/01*. The proposal is to improve the existing parking area through amendments to the layout with soft and hard landscaping. The proposal also includes the relocation of the existing broadcasting compound and turnstiles/kiosk to elsewhere within Site F and installation of a new ring main unit. No effects on drainage are anticipated. An illustrative drawing of the site layout is shown on *Drawing 2661/OPA-SF/01*.

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

2661/OPA-SF/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-SF/01	Version	3
Date	Feb-19	Scale	nts

13 CONCLUSION

In summary and further to the conclusions for site 1 to 5 and A to D above, the proposed development at Sandown Park is considered, in principle, to be acceptable in both drainage and flood risk terms.

PHOTOGRAPHS

2661/OPA-S1/P1: Site 1 facing west

2661/OPA-S1/P2: Site 1 facing southwest towards Moor Lane

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Client	Rapleys
Title	Photosheet 2661/OPA-S1/PS1
Project	Sandown Park
Drawing	PS1
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S1/P3: Site 1 facing southeast

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Client	Rapleys
Title	Photosheet 2661/OPA-S1/PS2
Project	Sandown Park
Drawing	PS2
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S2/P1: Site 2 facing northeast

2661/OPA-S2/P2: Site 2 facing northeast

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Client	Rapleys
Title	Photosheet 2661/OPA-S2/PS1
Project	Sandown Park
Drawing	PS1
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S2/P3: Drain along Portsmouth Road

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Client	Rapleys
Title	Photosheet 2661/OPA-S2/PS2
Project	Sandown Park
Drawing	PS2
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S3/P1: Site 3 facing west-southwest, with area of flooding in foreground

2661/OPA-S3/P2: Facing west towards Site 3

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Client	Rapleys
Title	Photosheet 2661/OPA-S3/PS1
Project	Sandown Park
Drawing	PS1
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S3/P3: View east of watercourse at site 3

2661/OPA-S3/P2: View west of watercourse at site 3

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Client	Rapleys
Title	Photosheet 2661/OPA-S3/PS2
Project	Sandown Park
Drawing	PS2
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S3/P5: Example of pipe crossing watercourse

2661/OPA-S3/P6: Drainage ditch on racecourse near site 3

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Client	Rapleys
Title	Photosheet 2661/OPA-S3/PS3
Project	Sandown Park
Drawing	PS3
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S4/P1: Site 4 facing south

2661/OPA-S4/P2: Drainage ditch along Station Road

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Client	Rapleys
Title	Photosheet 2661/OPA-S4/PS1
Project	Sandown Park
Drawing	PS1
Version	1
Date	Oct-18
Scale	nts

2661/OPA-S5/P1: Site 5 facing northeast

2661/OPA-S5/P2: Site 5 facing east

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Client	Rapleys
Title	Photosheet 2661/OPA-S5/PS1
Project	Sandown Park
Drawing	PS1
Version	1
Date	Oct-18
Scale	nts

APPENDIX 2661/OPA/A1

Site drainage provision – Drawing 1

GAS AND ELECTRIC MAINS FROM AREA 2

ELECTRIC SUB STATION

Club House

SURFACE WATER DRAIN TO AREA 3

SOIL DRAIN TO AREA 3

CONNECTION OF GOLF CLUB SOIL DRAINAGE

DUCT UNTRACED FROM HERE

COURSE WATERING

SURFACE WATER DRAIN TO AREA 5

1

SURFACE WATER DRAIN

CATCH PIT

SOIL DRAIN

LADIES

TELEPHONES

P&S

SOIL DRAIN

CABLE DUCT

SURFACE WATER DRAIN

Black Poly to Golf club.

Disconnected.

Water main

GENTS

BAR AND BETTING OFFICE

DUCTS

GRATED GULLY

FROM AREA C

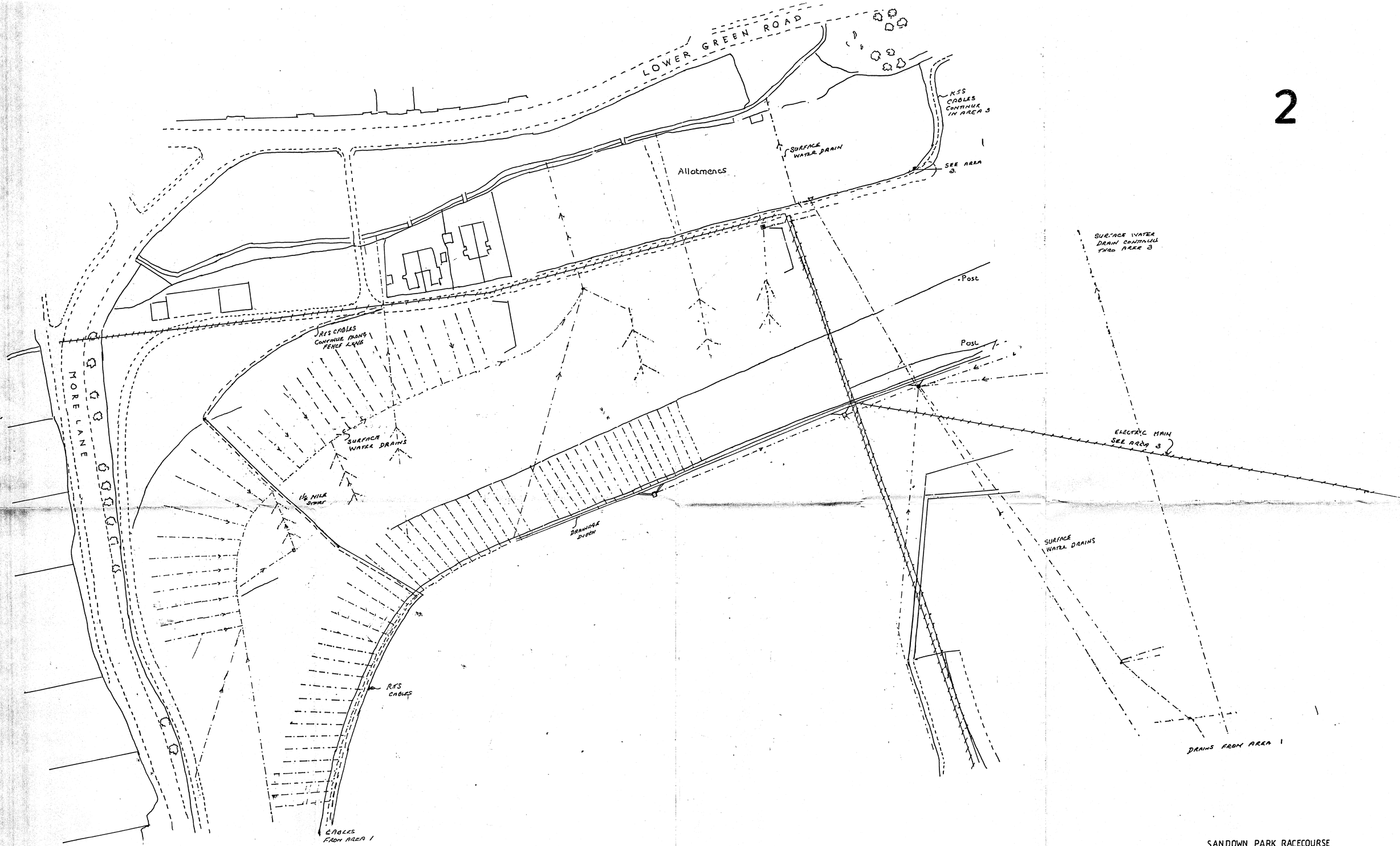
GAS MAIN FROM AREA 6

SURFACE WATER DRAIN TO AREA 6

Metal M...

APPENDIX 2661/OPA/A2

Site drainage provision – Drawing 2



SANDOWN PARK RACECOURSE
DRAINAGE AND SERVICES LAYOUT AREA 2
1993 SCALE 1-625
DRWG NO D.L.3.

APPENDIX 2661/OPA/A3

Site drainage provision – Drawing 3

3

LOWER GREEN ROAD

PO

WATER MAIN

6" VERY DEEP INSPECTION CHAMBER. UNTRACED

R.T.S CABLES

EXTENDED COURSE WATERING

WATER MAIN TO WATER JUMP

R.T.S CABLES

Race Course

7 FURLONG START

COURSE WATERING CONTINUES THRO AREA 4

R.T.S CABLES FROM AREA 2

1 MILE START

WATER JUMP

CONCEALED INSPECTION CHAMBER

SURFACE WATER DRAIN CONTINUES THRO AREA 4

SURFACE WATER DRAIN CONTINUES THRO AREA 2.

FROM AREA 2

ELECTRIC MAIN CONTINUES TO AREA 5

GOLF RANGE.

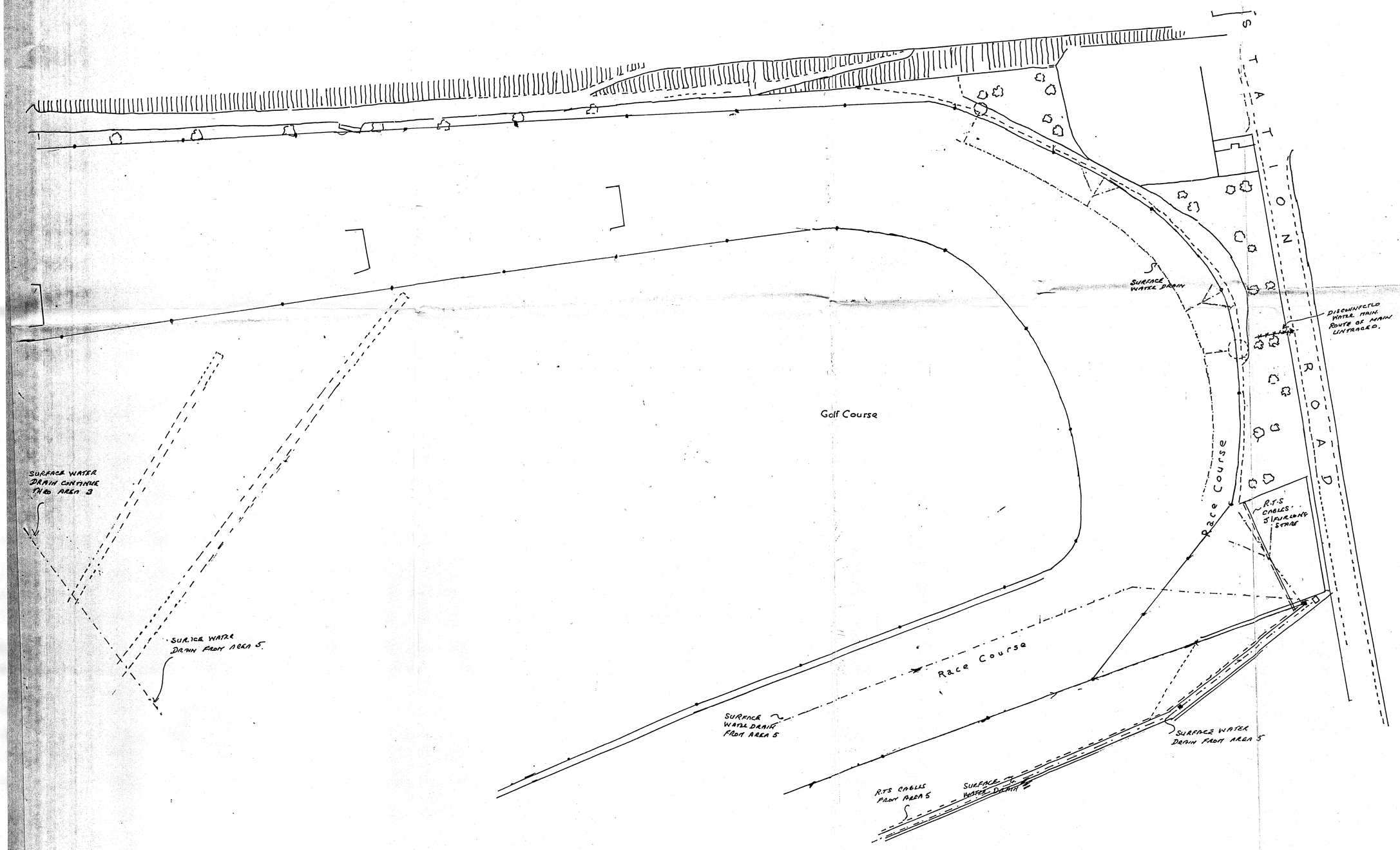
SOIL DRAIN FROM AREA 1

SANDOWN PARK RACECOURSE
DRAINAGE AND SERVICES LAYOUT - AREA 3
1993. SCALE 1-625
DRWG NO DL4

APPENDIX 2661/OPA/A4

Site drainage provision – Drawing 4

4



SANDOWN PARK RACECOURSE

DRAINAGE AND SERVICES LAYOUT- AREA 4

1993. SCALE 1 625

DRWG NO D.L.5.

APPENDIX 2661/OPA/A5

Site drainage provision – Drawing 5

5

ELECTRICITY MAIN TO AREA 3

SURFACE WATER DRAIN TO AREA 4

REDUNDANT FECO TO WATER MAIN

COURSE WATERING

TO AREA 4

R-a-c-e C-o-u-r-s-e

R.T.S CABLES TO AREA 4

SURFACE WATER DRAIN TO AREA 4

COURSE WATERING

PATHS

CABLE MARKER POSTS

SOAKAWAY

2 MILE START POST

R.T.S CABLES

R-a-Course

SURFACE WATER DRAIN

COURSE WATERING

RESERVOIR

ELECTRIC TERMINATION HOUSING

SURFACE WATER DRAIN SER AREA 1

INCOMING WATER MAIN

PUMP HOUSE

POND FENCE

POND o/FLOW

ELECTRIC SUB STATION

PATH

R.T.S CABLES

2 FURLONG

Pond

POST

PLAYGROUND

COURSE WATERING

SURFACE WATER DRAIN

R.T.S CABLES

POS

Race Course

COURSE WATERING TO AREA 6

TO AREA 6

LINE OF BEECH HEDGE

ELECTRIC MAIN TO PUMP HOUSE

SERVICES FROM HOUSE TO ROAD ROUTE UNTRACED

TOLL HOUSE

RAISED INSPECTION CHAMBER

SURFACE WATER DRAIN TO AREA 6

Race Course

o/FLOW DRAIN

SOAKAWAY PITS

WATER MAIN TO RESERVOIR

SERVICE WATER MAIN FROM AREA 7 UNTRACED BEYOND 20 RODS

SURFACE WATER DRAIN FROM AREA 6

SER AREA 7

DERAILLET TOILET

FENCE

FROM AREA 7

R.T.S CABLES FROM AREA 6

SANDOWN PARK RACECOURSE
'DRAINAGE AND SERVICES' LAYOUT - AREA 5

1993 - SCALE 1-025
DRWG DL6

APPENDIX 2661/OPA/A6

Site drainage provision – Drawing 6

6

SURFACE WATER WATER MAIN AND SOIL DRAINS TO AREA 1

DUCT TO AREA 1.

TOTE

Terraces

CABLE DUCTS TO AREA 5

SURFACE WATER AND COURSE WATERING TO AREA 5

R.T.S CABLES AND S.W TO AREA 5

NOTICE BOARD

Terraces

ELECTRIC MAIN AND R.T.S CABLES TO FIVE FURLONG TOWER - AREA 1

R.T.S CABLES

CABLE DUCTS

CABLE DUCTS

1. 5 FURLONG START

SURFACE WATER DUCT

R.T.S CABLES

GAS MAIN

R.T.S CABLE TO FIVE FURLONG TOWER

R.T.S CABLED TO 5 FURLONG START.

R.T.S CABLES TO CONTROL ROOM

DRAINAGE PITS

24 100m Coms.

GAS MAIN. ROUTE UNTRACED BEYOND THIS POINT CONNECTS TO INCOMING GAS MAIN. To Burns Road.

COURSE WATERING

SURFACE WATER

DRAINAGE PITS

CABLE DUCTS

ELECTRIC MAIN TO GRANDSTAND ROUTE UNTRACE

HV CABLE

ELECTRIC MAIN TO FIVE FURLONG TOWER FROM WARREN LODGE

Race Course

HV. CABLE

CABLE DUCTS

R.T.S CABLES

H.V. SWITCH

SOIL DRAINAGE

COURSE WATERING

CONTROL BOX

DRAINAGE PITS

Grand Stand

FIRE HYDRANT CONTINUES TO LOWER GROUND FLOOR

SURFACE WATER DRAINAGE PITS

LAWN CHAIRS

POWER AUTO WATER TO LAWN CHAIRS

CABLE AND WATER DUCTS

SOIL DRAINAGE

R.T.S UNUSED INSPECTION CHAMBER

WARREN LODGE

FIRE HYDRANT FILLER POINT

WATER MAIN TO TOTE AREA 7

WATER AND GAS MAINS TO AREA 7

FIRE HYDRANT MAIN

ENTRANCE

ELECTRIC SUB STATION

R.T.S CABLE

R.T.S DUCT

Parade Ring

H.V. INCOMING ELECTRIC MAIN - ROUTE UNTRACE

WATER MAIN FROM AREA 7

ELECTRIC MAIN FROM SUB STATION TO OFFICE

Revised 30-11-98

NOTICE BOARD

WATER MAIN TO NOTICE BOARD

FOR SOIL AND WATER SERVICES TO SKI-SLOPE SEE AREA 8

WEIGHING ROOM AND OFFICES

WATER MAIN FROM AREA 7

FIRE HYDRANT MAIN FROM AREA 7

CABLE DUCT TO MARQUEE AREA - AREA 7

SOIL DRAINAGE SEE AREA 7

SANDOWN PARK RACECOURSE.

DRAINAGE AND SERVICES LAYOUT - AREA 6

1993 SCALE 1-625

DRWG NO DL7.

APPENDIX 2661/OPA/A7

Environment Agency Product 4