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environmental water management

ASSESSMENT OF DRAINAGE AND FLOOD RISK FOR OUTLINE PLANNING APPLICATIONS

SANDOWN PARK

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Report prepared for:

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GENERAL NOTES

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1 REGIONAL SETTING AND LOCAL POLICIES

1.1 Background

A Masterplan-led hybrid application has been prepared for proposed developments within the curtilage of Sandown Park Racecourse, Esher. The application is for mixed-use development comprising:

Outline planning permission (with all matters reserved except for access to the development) is sought for:

- Enhancement and rationalisation of existing racecourse facilities/infrastructure and car parking;
- Re-location of an upgraded children's nursery (Use Class D1);
- Development of a hotel of approximately 150 rooms (Use Class C1), and
- Demolition of existing buildings/structures and residential development of approximately 318 dwellings (Use Class C3).

Full planning permission is sought for:

- Racetrack widening to the southwest and east sections of the existing racecourse track, including associated ground levelling/earthworks to the southwest section, and re-positioning of fencing, and improvements to a section of the existing internal access road from More Lane, and
- New bell mouth accesses serving the development.

Flood risk and drainage have been assessed as part of the development of the proposed schemes. Consultants Hafren Water were commissioned to undertake the assessments, building on their initial assessment of water issues, reported in May 2017.

Chapter 1 outlines the (geological and hydrological) regional setting of the whole of Sandown Park and local policies relating to water issues. Flood risk and drainage aspects of individual sites are considered, in turn, in subsequent sections.

1.2 Location and setting

Sandown Park Racecourse occupies a large, approximately triangular, area of land to the northeast of the centre of Esher, Surrey. The racecourse is bounded to the north by Lower Green Road and the Waterloo–Portsmouth railway line, to the east by Station Road, to the south by Portsmouth Road (A307) and to the west by More Lane and Esher Green Road.

The site setting and application areas are shown on *Drawing 2661/OPA-RS/01*.

1.3 Fluvial flood risk

Flood risk mapping for the area covered by Elmbridge Borough Council was undertaken as a Level 1 Strategic Flood Risk Assessment by URS in May 2015. For the purposes of development planning, areas at risk of flooding means land in Flood Zones 2 and 3.

1.4 Data sources

The following data sources have been used in all of the assessments discussed herein:

Rapleys LLP and Jockey Club Racecourses

- Proposed site locations and boundaries

Environment Agency (EA)

- Flood map for planning: as Web Map Service (WMS) layers
- Risk of flooding from surface water: as WMS layers
- Historical Flooding: as WMS layer
- Product 4

National Policy and Guidance

- Department for Communities and Local Government (DCLG)
- Planning Practice Guidance: technical guidance on flood risk management

[NB: This report has been undertaken with due regard to the statutory requirements of the Nation Planning Policy Framework (NPPF) and with reference to Planning Policy Guidance (PPG) with regard to development and flood risk. This ensures that flood risk is taken into account at all stages of the planning process and avoids inappropriate development in areas potentially at risk of flooding]

Elmbridge Borough Council

- Elmbridge Core Strategy, June 2011
- Elmbridge Development Management Plan (April 2015)
- Strategic Flood Risk Assessment, URS, June 2015
- Flood Risk Supplementary Planning Document (SPD), May 2016

Hafren Water

- Site walkover 8th October 2018

1.5 Scope of work

The following input has been undertaken:

- Collation and review of data
- Site walkover
- Assessment with reference to all pertinent national and local guidance
- Identification of potential impacts and mitigation measures, including options for disposal of site drainage
- Completion of Surface Water Drainage Pro-forma (2017) for each site, Surrey County Council
- Practice Guidance and Planning Policy

1.5.1 National Planning Practice Guidance

National Planning Practice Guidance (NPPG) provides guidance to Local Authorities to ensure effective implementation of planning policy relating to development in areas at risk of flooding. The guidance sets out the risk vulnerability of types of development and the acceptability of each vulnerability class within each flood zone.

The proposed development for Sites 1-5 is for residential housing. Residential housing (termed dwellings used for residential use in guidance) is classified as 'More Vulnerable' development. Site B is also classed as 'More Vulnerable' as it comprises a hotel. The proposed developments for Sites A, C and D are classified as 'Less Vulnerable'.

1.5.2 Elmbridge Borough Council Flood Risk Information and Planning Policy

Planning policy for the Borough Council is described in their Core Strategy, issued in July 2011. Specifically this outlines planning policies for Esher (CS9) and Flooding (CS26). Policy for Esher (CS9) does not provide specific constraints from flooding other than noting that The Rythe has a medium risk of flooding. Policy for flooding (CS26) requires that Planning Permission for development will only be granted where specific conditions are fulfilled, particularly that it is in the lowest appropriate flood risk zone, does not constrain the natural function of the floodplain and that flood mitigation measures are incorporated.

Flood risk for the Borough Council area was assessed and reported in a Level 1 Strategic Flood Risk Assessment (SFRA) prepared for the Council by consultants URS in May 2015. Flood risk planning guidance for the Council is provided in the Flood Risk Supplementary Planning Document (SPD) dated May 2016.

The SFRA repeats the national policy requirement that schemes should not increase the vulnerability classification of a site. All development schemes must result in a net reduction in flood risk to ensure that floodplain storage and flow routes are not affected (para 2.3.15). This can be achieved by a combination of on-site and off-site measures including:

- Reducing the land use vulnerability
- No increase in the number of number of people at risk
- Maintaining or reducing the building footprint
- Raising finished floor levels to above flood level (typically specified as 600 mm above the 1% AEP flood level with climate change)
- Reducing surface water run-off rates and volumes from the site including use of sustainable drainage (SuDS) elements to manage surface water drainage
- Incorporating flood resilient and/or resistance measures
- Ensuring the development remains safe for users in time of flood. This may include timely evacuation of properties prior to the onset of flooding and therefore this may include the availability of access routes to and from the property at times of flooding
- Basements, basement extensions or conversions of basements to a higher vulnerability classification are not permitted
- Development should not obstruct floodwater flow routes through the site

With regards to water quality Elmbridge Borough Council's adopted Development Management Plan (2015) document and Policy DM5 (d) states:

d. *Development proposals should be designed and/or located to prevent or limit the input of pollutants into water bodies and the groundwater. Sustainable Drainage Systems (SuDS) should be incorporated wherever practical to reduce the discharge of surface water to the sewer network.*

1.5.3 Surrey County Council – Local Lead Flood Authority

Surrey County Council, in its role as Local Lead Flood Authority, are statutory consultees on drainage issues (specifically SuDs) for all major planning applications. In order to be able to assess Planning Applications to the required level of detail, the Council has prepared a Surface Water Drainage Pro-forma (2017). This requires the applicant to provide information about the proposed development and the means of water management. The requisite forms have been completed for each site and are included within this report.

1.5.4 Development considerations with reference to flooding and drainage

Water-related considerations of the proposals are influenced predominantly by the extant drainage network (natural and man-made) and the drainage characteristics of the sub-surface. Restrictions occur on the allowable discharge rate from developments, to ensure that they do not exacerbate downstream flooding. This is generally achieved by providing passive attenuation to regulate discharge to pre-development (ie 'greenfield') rates. The hierarchy of disposal methods for site drainage is:

1. Infiltration
2. Discharge to watercourse
3. Discharge to surface water sewers
4. Discharge to combined sewers

Therefore opportunities will be sought to discharge to ground in the first instance. This will require soakaway testing at the appropriate stage of the development cycle.

1.6 Dialogue with the LLFA

The draft flood risk and drainage report was submitted to the LLFA of Surrey County Council in December 2018 and initial discussions held. Additional input to the report was undertaken in January 2019, specifically involving completion of a Surface Water Drainage Summary Pro-forma (2017) for each site (1-5 and A-D). The report was re-submitted in January 2019 and arrangements made to obtain feedback from the LLFA. Pre-application information was received from Surrey County Council on 13th February 2019 and their queries have been addressed in this report.

1.7 Baseline conditions

1.7.1 Landform

Land within the majority of the curtilage of Sandown Park declines broadly northwards, towards the watercourse which parallels its northern boundary. Elevations decrease northwards from 45 m Above Ordnance Datum (mAOD), to a minimum of 12 mAOD along the northern boundary. The exception to the landform of the majority of the site occurs in the southwest, in an area known as the Warren. This forms a localised area of higher ground with relatively steep gradients declining from its summit.

1.7.2 Hydrology

Sandown Park is located within the surface water Operational Catchment of the Lower River Mole (also referred to as the River Ember or Dead River) and The Rythe. The River Mole is the

larger of the two watercourses, and both converge with the River Thames to the northeast of the site. The hydrology is shown on *Drawing 2661/OPA-RS/02*.

Sandown Park is located across two surface water catchments; the northern part of the site is located within that of the River Mole, along the reach from Hersham to its confluence with the River Thames (ID GB106039017622). The southern edge of the landholding is within the catchment of The Rythe (GB106039017650).

Two minor watercourses are present within the northwest of the site, and drainage ditches are also installed around some sections of the racetrack itself. Three lined waterbodies are located within the curtilage of the racecourse, providing surface water storage for the drainage network and a water source for irrigation. The irrigation water is sourced from mains supply.

1.7.3 Flood risk

The majority of Sandown Park is located in Flood Zone 1 as defined by the Environment Agency. This has a low flood risk with less than a 1 in 1000 annual probability of river flooding.

Areas in the north of the site, and to a smaller extent in the east, are defined as Flood Zone 2, medium risk. This is land which has between a 1 in 100 and 1 in 1000 annual probability of river flooding.

An area of historical flooding is identified by the Environment Agency, it extends north to south in the eastern central section of the site. The extents of flood zones and historical flooding are shown on *Drawing 2661/OPA-RS/03*.

Surface water flood risk is shown on *Drawing 2661/OPA-RS/04*. The majority of the site is 'very low risk'. Limited areas of low risk and a small area of medium and high risk occur in the northwest, with a smaller area in the southeast of the site.

1.7.4 Geology

An understanding of the near-surface geology is required due to its influence on surface water run-off and natural drainage characteristics. The regional geology can be broadly sub-divided into the bedrock geology and the overlying superficial deposits.

Bedrock geology

The bedrock geology comprises two principal units; the Bagshot Beds and the London Clay. The London Clay is subdivided vertically into different units, based upon their composition and physical characteristics. The uppermost unit of the London Clay, which occurs over the

majority of the curtilage of Sandown Park, is the Claygate Member. The distribution of the Bagshot Beds, Claygate Member and undifferentiated London Clay is shown on *Drawing 2661/OPA-RS/05*.

Superficial geology

The bedrock geology is overlain in parts of the curtilage of Sandown Park by superficial deposits. These predominantly comprise the Kempton Park Gravel Member which occupies the northeast of the site. Another area of laterally restricted superficial deposits, termed River Terrace Deposits (undifferentiated) occurs close to the eastern boundary and the northwestern corner of Sandown Park.

1.7.5 Drainage characteristics

Natural drainage

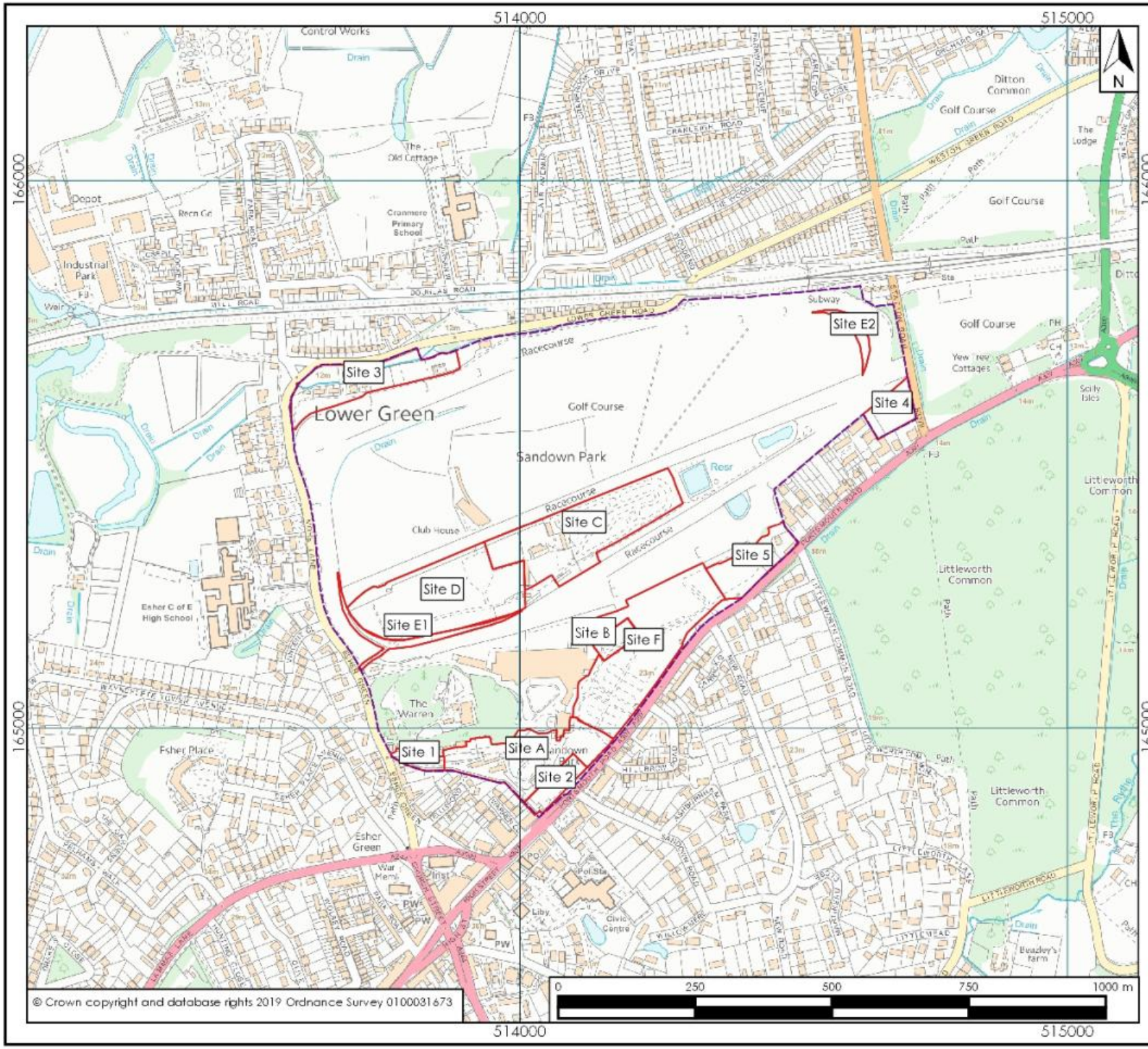
The drainage characteristics of Sandown Park are dictated by topography, the nature of the sub-surface and the existing drainage provision, both natural and man-made.

In general, areas overlying the Claygate Member and London Clay are poorly drained whereas those overlying Sand and Gravel, in the northeast of the site, and the Bagshot Formation in the southwest, are free-draining. Localised areas of waterlogging and mapped areas of surface water flooding occur in areas underlain by clays and are shown on *Drawing 2661/OPA-RS/04*.

Logs of boreholes held by the British Geological Survey (BGS) record depths to groundwater of between approximately 1 – 8.7 metres below ground level (mbgl) across the site.

Installed drainage

Details of the installed drainage were obtained from the Jockey Club. The configuration of drainage is shown on six detailed drawings (see *Appendices 2661/OPA/A1-A6*). A comprehensive system of drainage exists, which essentially conveys water to sumps that act to collect water and provide flow balancing capacity. Water is transferred from the sumps northwards, where it discharges to the east-west oriented watercourse.



Legend

Landholding

Application Areas

Scale correct at A4

Client	Rapleys LLP
Title	Site location
Project	Sandown Park
Drawing	2661/OPA-RS/01
Version	3
Date	Feb 19
Scale	1:10,000

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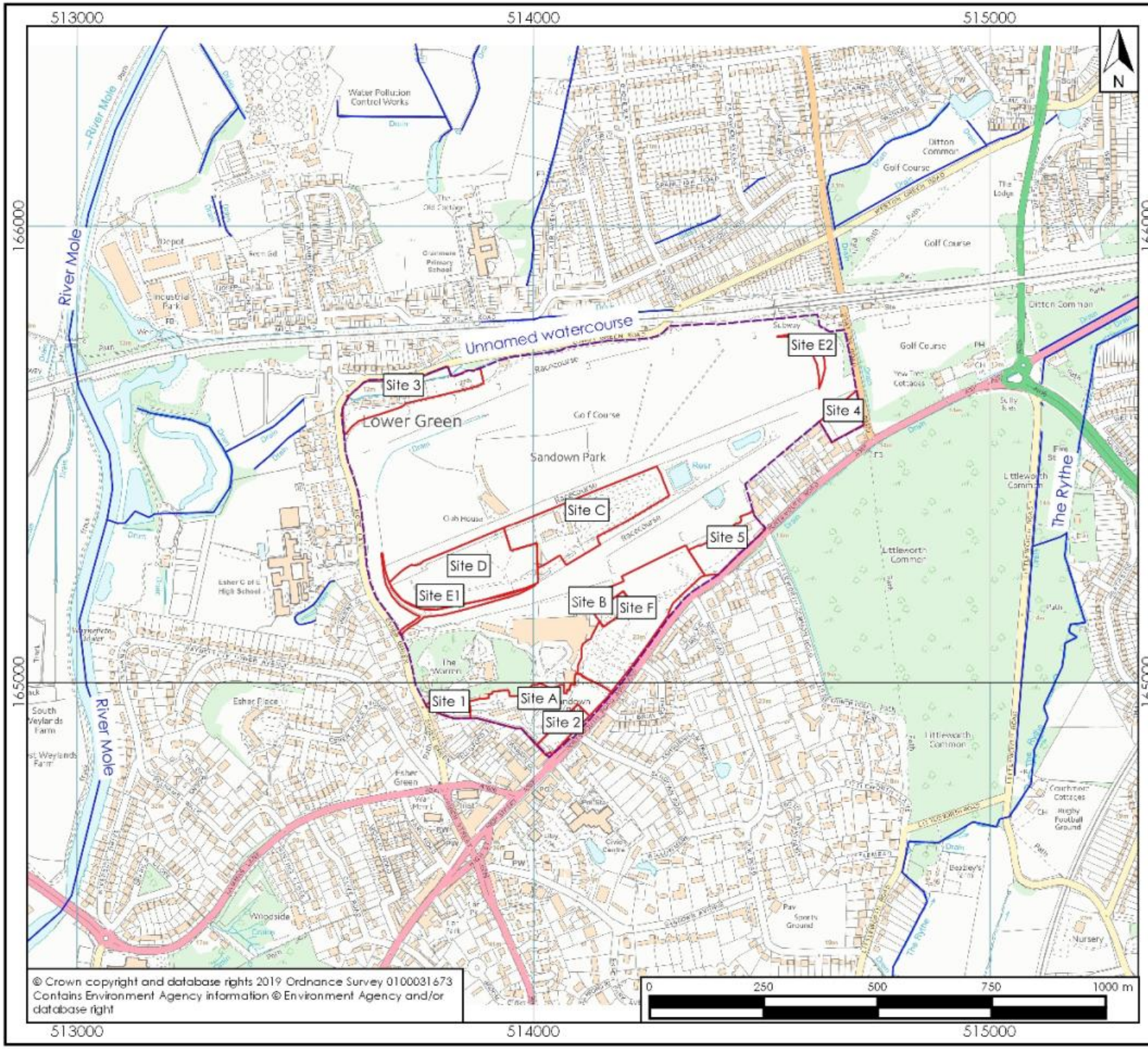

Legend

- Landholding
- Application Areas
- Watercourses
- Waterbodies

Scale correct at A4

Client	Rapleys LLP
Title	Regional Hydrology
Project	Sandown Park
Drawing	2661/OPA-RS/02
Version	3
Date	Feb 19
Scale	1:12,000

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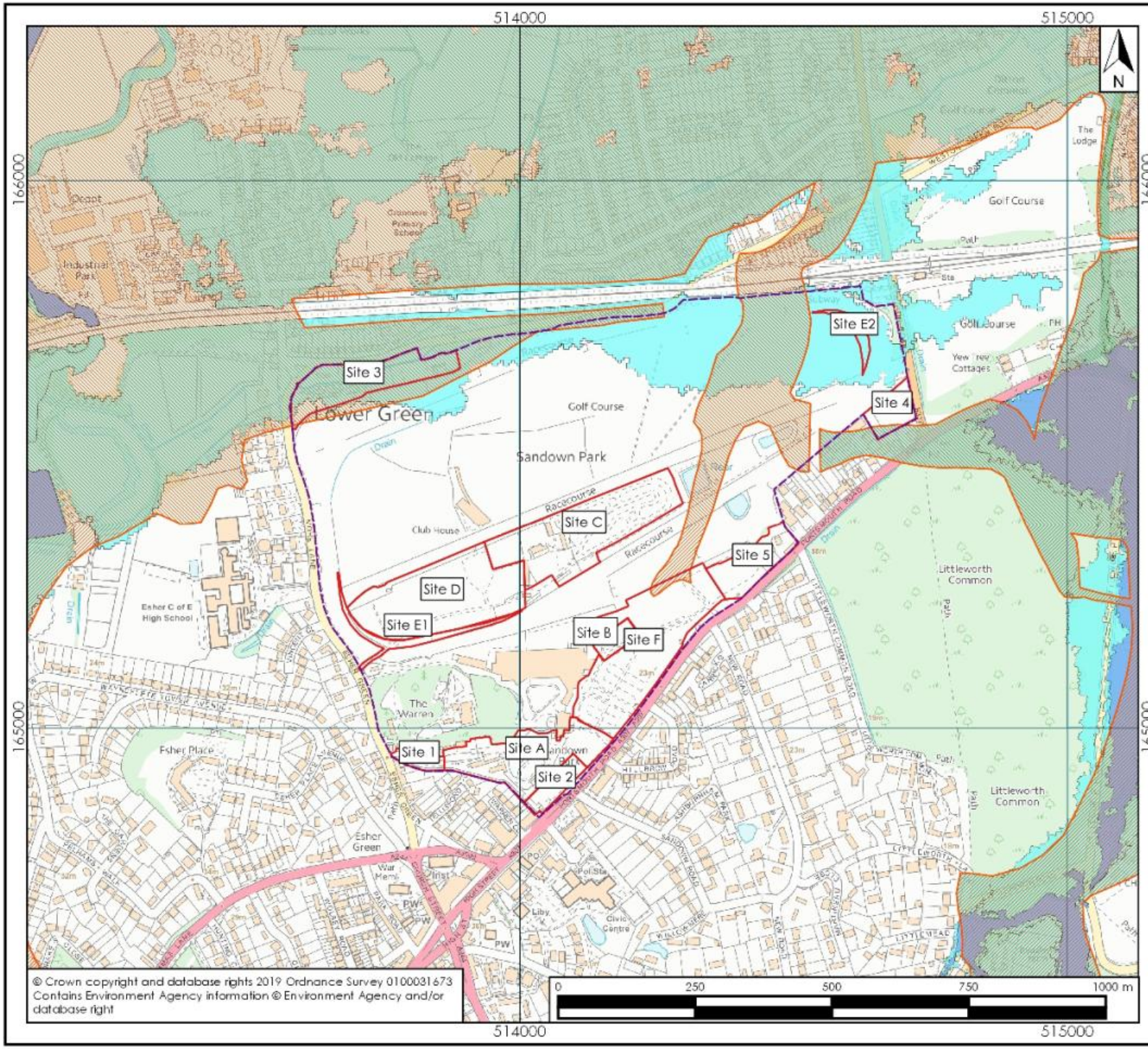

Legend

- Landholding
- Application Areas
- 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-RS/03
Version	3
Date	Feb 19
Scale	1:10,000

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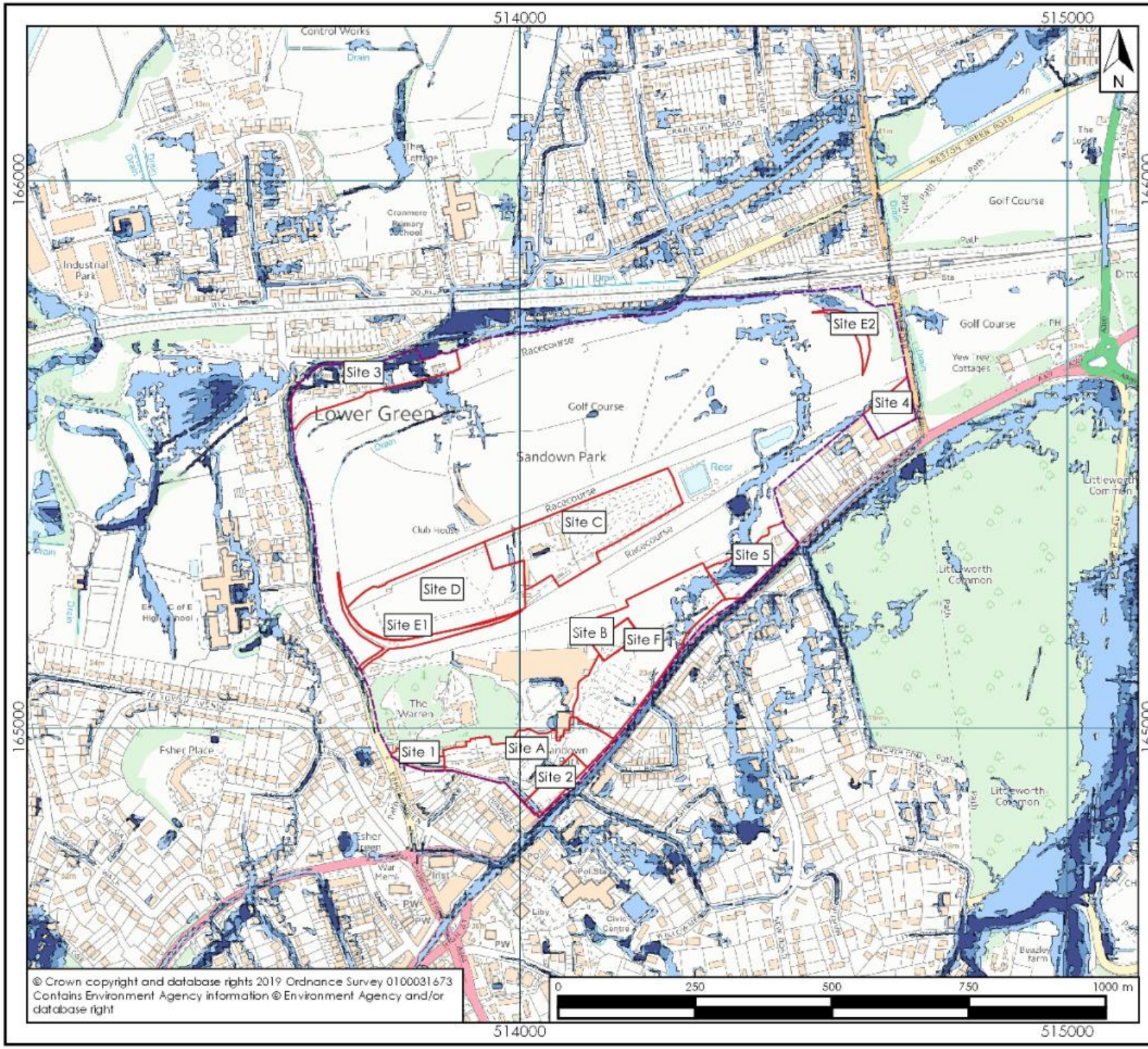

Legend

- Landholding
- Application Areas

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-RS/04
Version	3
Date	Feb 19
Scale	1:10,000

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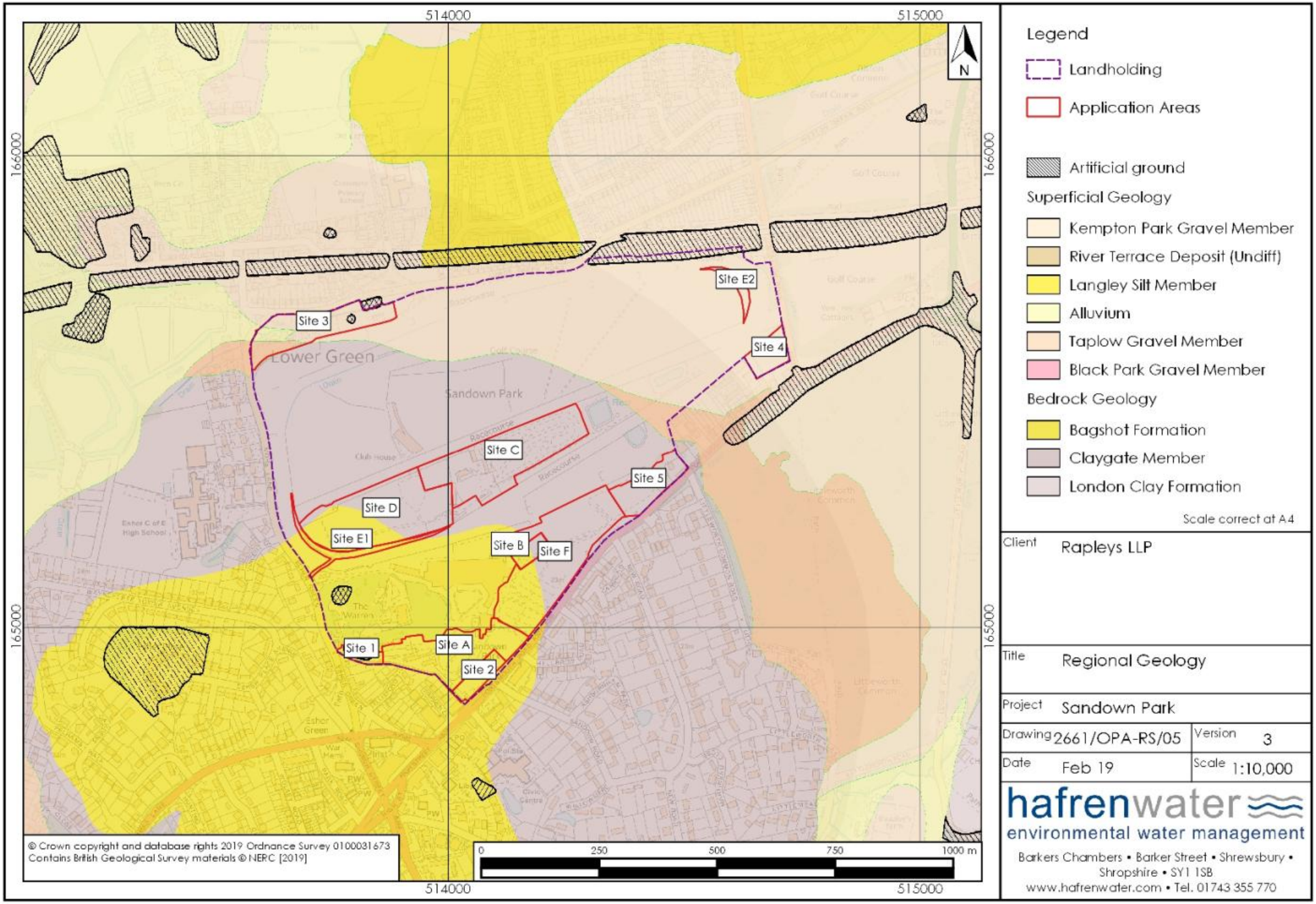

Legend

- Landholding
- Application Areas
- Artificial ground

Superficial Geology

- Kempton Park Gravel Member
- River Terrace Deposit (Undiff)
- Langley Silt Member
- Alluvium
- Taplow Gravel Member
- Black Park Gravel Member

Bedrock Geology

- Bagshot Formation
- Claygate Member
- London Clay Formation

Scale correct at A4

Client	Rapleys LLP
Title	Regional Geology
Project	Sandown Park
Drawing	2661/OPA-RS/05
Version	3
Date	Feb 19
Scale	1:10,000

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2 SANDOWN PARK – SITE 1

2.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site 1 (Mews Residential), as shown on *Drawing 2661/OPA-S1/01*.

2.2 Location and setting

The Application Area is located at the southwestern corner of the Jockey Club landholding and comprises a narrow, elongate area of land which is bounded by Esher Green Road to the west. It extends to approximately 0.25 hectares (ha).

2.3 The proposed development

The area of the proposed development currently comprises rows of stabling and hardstanding (*see Photographs 2661/OPA-S1/P1, P2 and P3*). It is proposed to demolish the current stabling, remove the hardstanding and construct up to 15 one and two bedroom apartments. The current and proposed land uses are shown on *Drawing 2661/OPA-S1/01*.

2.4 Baseline conditions

2.4.1 Landform

A topographic survey was undertaken in November 2018. The elevation of the ground surface within the Application Area declines south and southwestwards from approximately 42 mAOD to 39 mAOD.

2.5 Hydrology

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

2.6 Geology

The Application Area is overlain predominantly by Made Ground, beneath which is the Bagshot Formation. There are no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-S1/02*.

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. A thick clay bed, the Swinley Clay Member, is included at the top of the sequence. In places, there is a basal bed of gravelly coarse-grained sand.

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

2.7 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-S1/03)*. There are generally few restrictions to development in terms of flood risk within Flood Zone 1. The exception being for development over 1 ha in extent, for which Flood Risk Assessment must be undertaken. The Application Area is 0.25 ha in size, therefore a Flood Risk Assessment is not required.

The surface water flood risk is minimal, with a small strip bordering the southern boundary shown as low risk (see *Drawing 2661/OPA-S1/04*).

2.8 Drainage characteristics

There is no history of flooding within the Application Area.

Minimal areas of the site are noted as being at low risk of surface water flooding, with a likelihood of flooding between 0.1-1%, the extent of which is shown on *Drawing 2661/OPA-S1/04*. 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 75% of the Application Area is overlain by hardstanding, with some small steeply sloped embankments. Some pre-existing drainage infrastructure exists, however it is reported to be non-functional. Rainfall-derived surface water follows the local topography and exits the site towards the south and southwest. There are currently no issues with standing water within the site boundary.

The site is located above the Bagshot Formation, which comprises predominantly sand. The natural drainability of the sub-surface is therefore considered to be good. However, a high watertable and potentially large volumes of near surface groundwater, see below, will need to be considered.

Ground conditions were discussed with the Facilities Manager following the site meeting on 8th October. During construction of the Owners and Trainers Offices, sand was reportedly encountered to depth and water ingress was prolific. Difficulty was found in disposing of the

water and piles were subsequently used for the foundations. The similarity of the geology beneath the Application Area and the Owners and Trainers offices is such that similar conditions may pertain.

2.9 Assessment of flood risk and drainage

2.9.1 Flood risk to the development

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

There are small areas designated as at low 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.

2.9.2 Flood risk from the development

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

The proposed development will modify the run-off characteristics of the site due to the change in the ground profile and surface cover. The surface water management system will be improved upon as part of the development and will ensure that volumes of surface water run-off can be retained, attenuated or infiltrated within the site boundary. The surface water drainage within the proposed development will be designed to manage volumes equivalent to the greenfield run-off rate, as discussed in Section 2.9.3 below.

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

2.9.3 Drainage requirements

Infiltration to ground via soakaway would appear to be feasible at this site, however a potentially high water table will need to be considered. Intrusive soakaway testing could not be completed at this outline stage due to access restrictions on site (the site is actively in-use). Subject to appropriate soakaway testing, SuDS methods to retain and attenuate water (swales, French drains, etc) should be incorporated into the 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 eastern and western hardstanding parking areas, an area comprising approximately 975 m^2. The geo-cellular storage will

provide 102.7 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 Esher Green Road. In this scenario, the proposed outfall would be located along the western extent of the site.

The surface water drainage within the proposed development will be designed to manage volumes discharging off-site at a rate 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.

2.9.4 Betterment

The proposed development is an opportunity for betterment of the existing drainage and water management within 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'.

2.10 Summary and conclusions

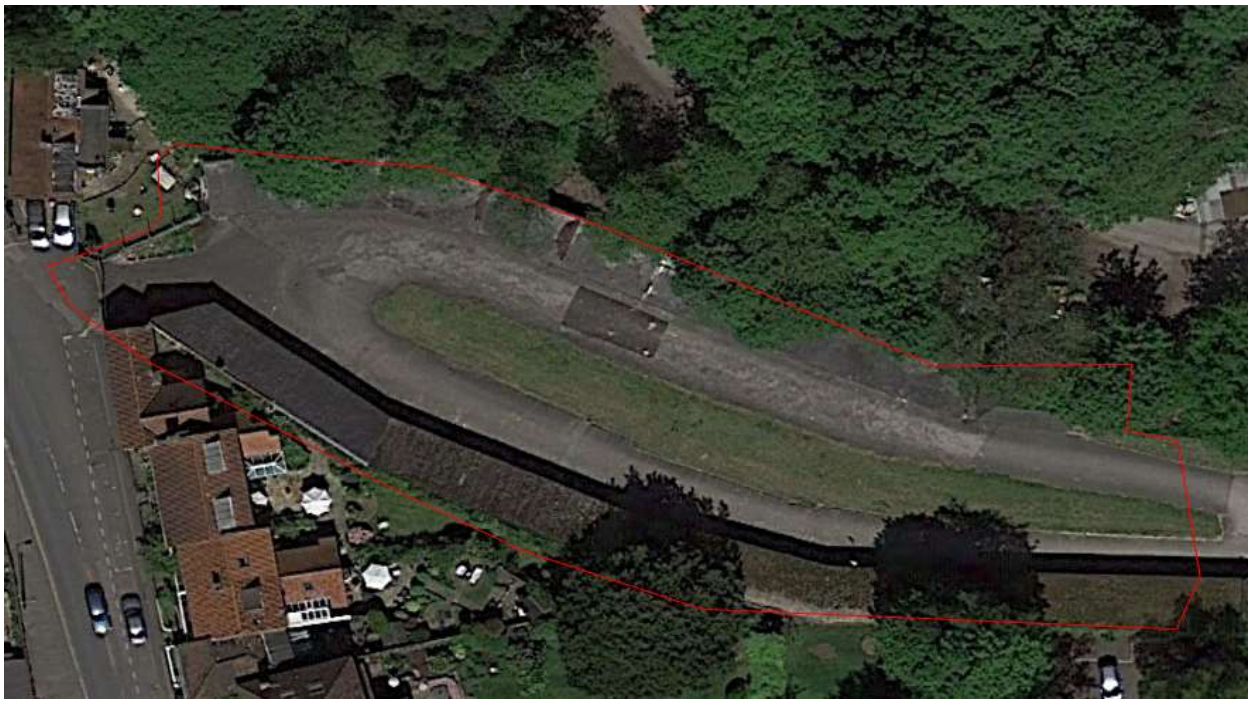
The Application Area is located at the southwestern corner of Sandown Park and is 0.25 ha in extent.

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

Small areas of the site are noted as being at low risk of surface water flooding, with a likelihood of flooding of between 0.1-1%. However these are considered likely to be associated with topographical lows within the current land cover which will be improved upon as a result of the development.

The natural drainability of the sub-surface beneath the site is considered to be good and infiltration to ground via soakaway would appear to be feasible although high groundwater levels may be encountered. 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-S1/01: Existing development
Google earth imagery (May 2018)

2661/OPA-S1/01: Proposed development

Please note drawings are illustrative

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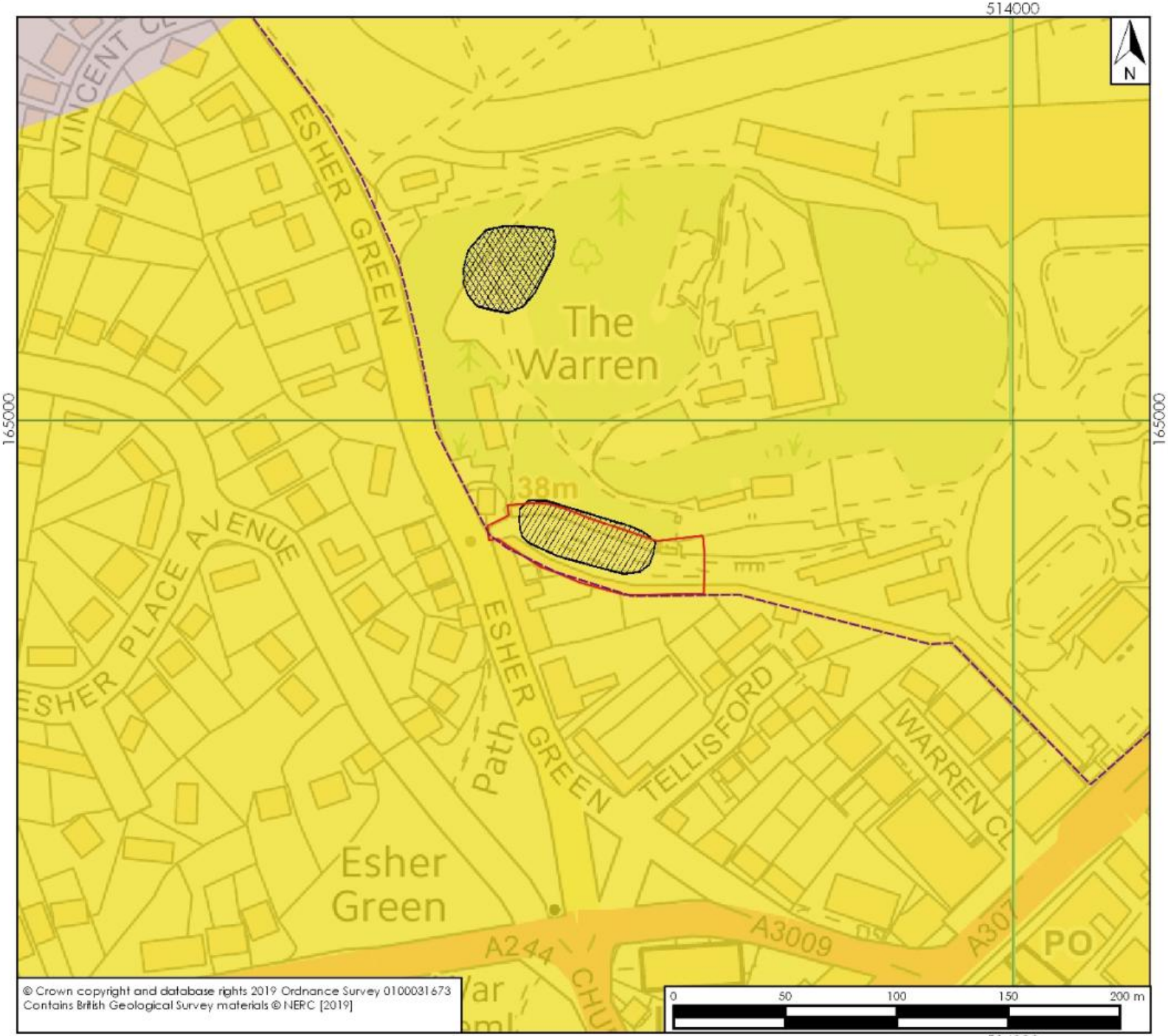
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-S1/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Landholding
- Site 1 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-S1/02
Version	2
Date	Jan 19
Scale	1:2,500

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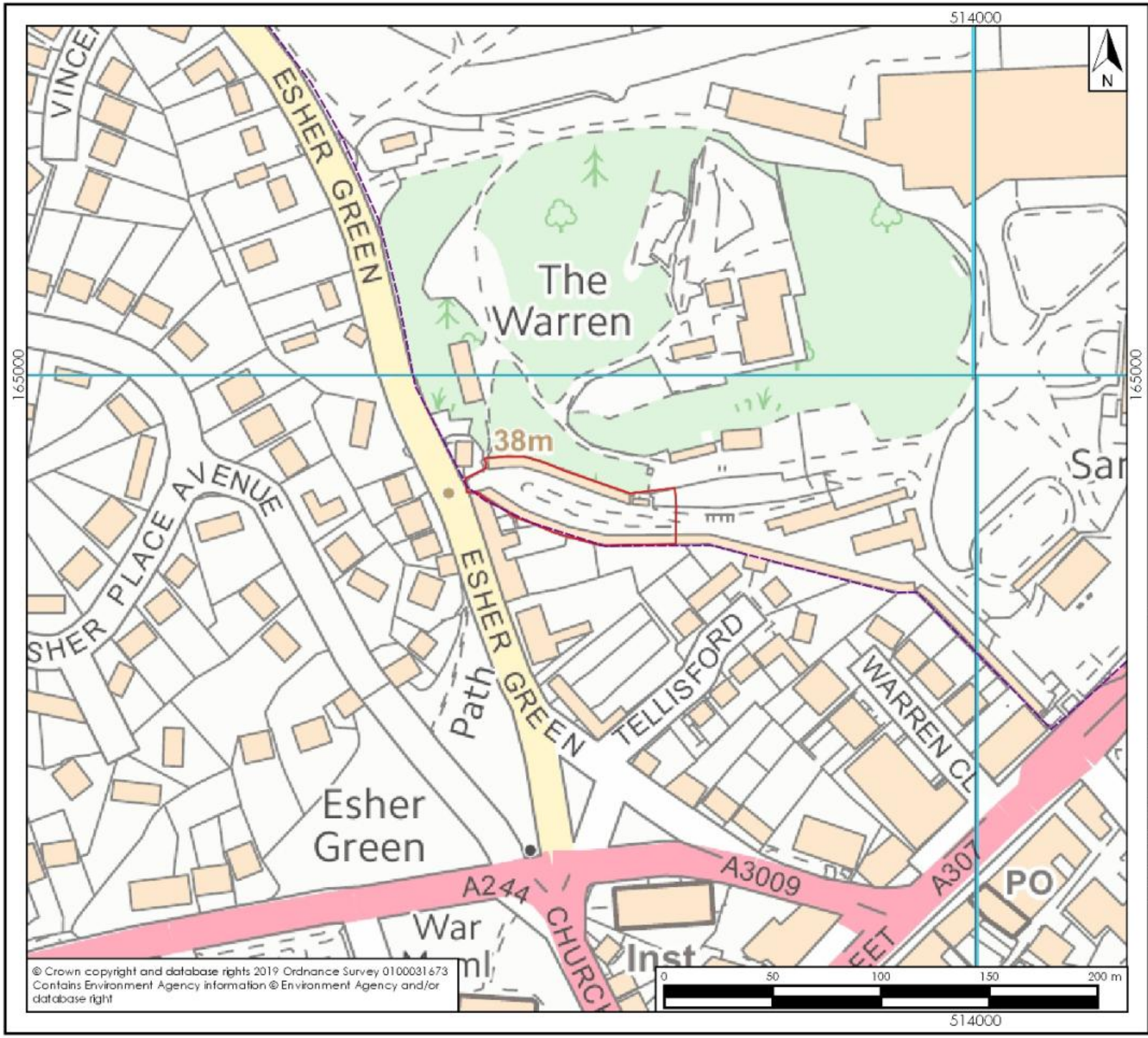

Legend

- Landholding
- Site 1 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-S1/03
Version	2
Date	Jan 19
Scale	1:2,500

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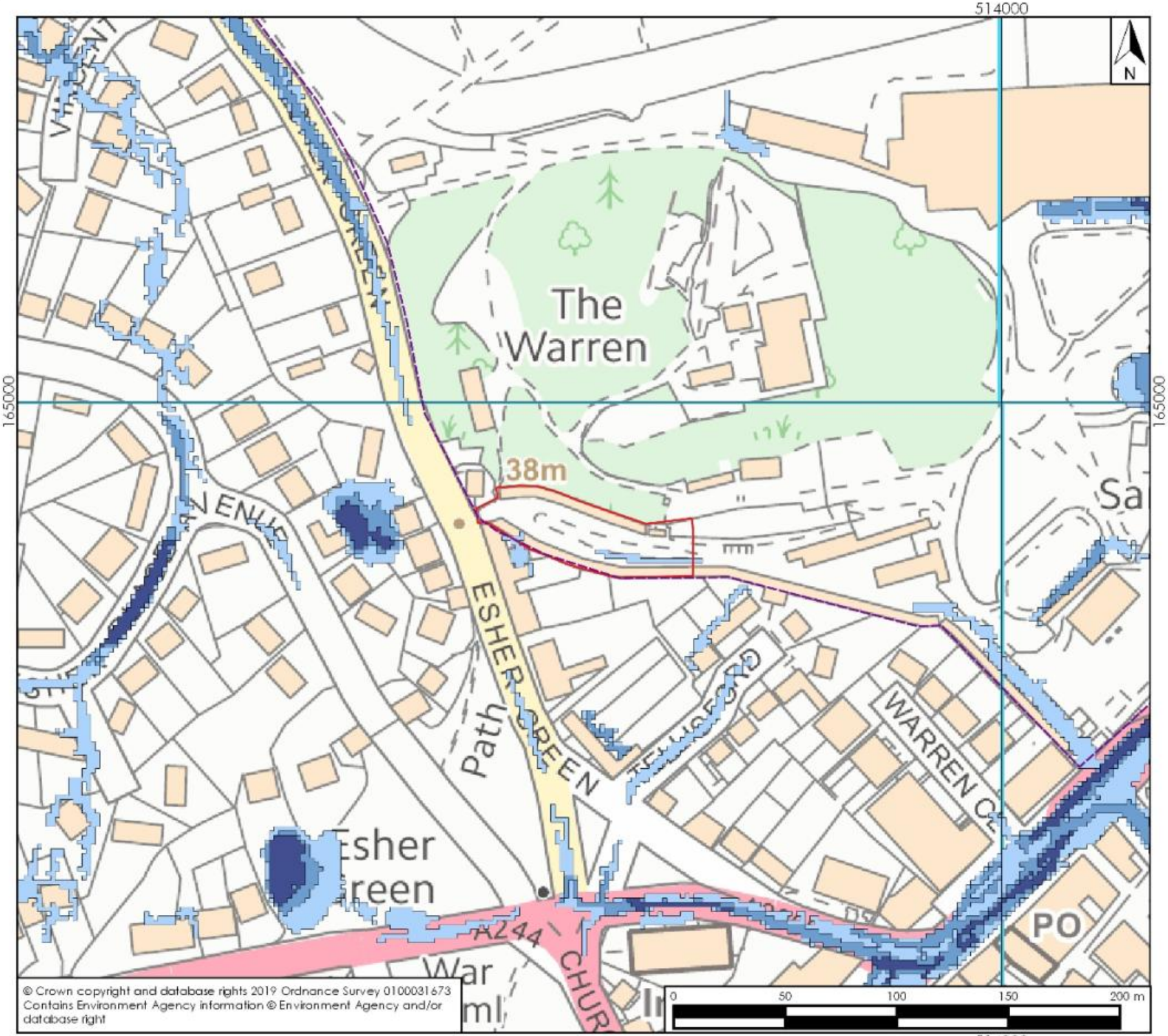

Legend

- Landholding
- Site 1 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-S1/04
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 1 – Mews Residential
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 138 649
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	2,468 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.16 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	0.19	0.16	0.04 (derived from 0.03 + 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)	Some existing drainage infrastructure exists, however it is reported to be non-functional. There are currently no issues with standing water on-site			**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	✓	See Section 6. 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	0.7	-	-	-	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	0.32	2.0	0.0	-2.0	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	0.98	5.2	0.0	-5.2	
1in 100	1.38	6.8	0.0	-6.8	
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	10.2	42.2	7.3	- 34.9	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	30.9	111.6	54.6	-57	
1in 100	43.4	146.6	78.4	-68.2	
1 in 100 plus 20% climate change *	N/A	N/A	102.7	-	

* 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?	Yes. Ground conditions have been observed on-site during previous construction works. Sand was reported 'at depth' and water ingress was described as 'prolific'. Difficulty was experienced when trying to dispose of the water. Further investigation is required of groundwater level at the site.	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 SPZ, Secondary A 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	3 x 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	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)		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?		

	Below ground soakaway will be sized to accommodate a 1 in 100 year (+CC) event, which is 102.7 m^3 Further information to be provided at Detailed Design stage. This will be required for the Full Planning Application.	**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)		**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

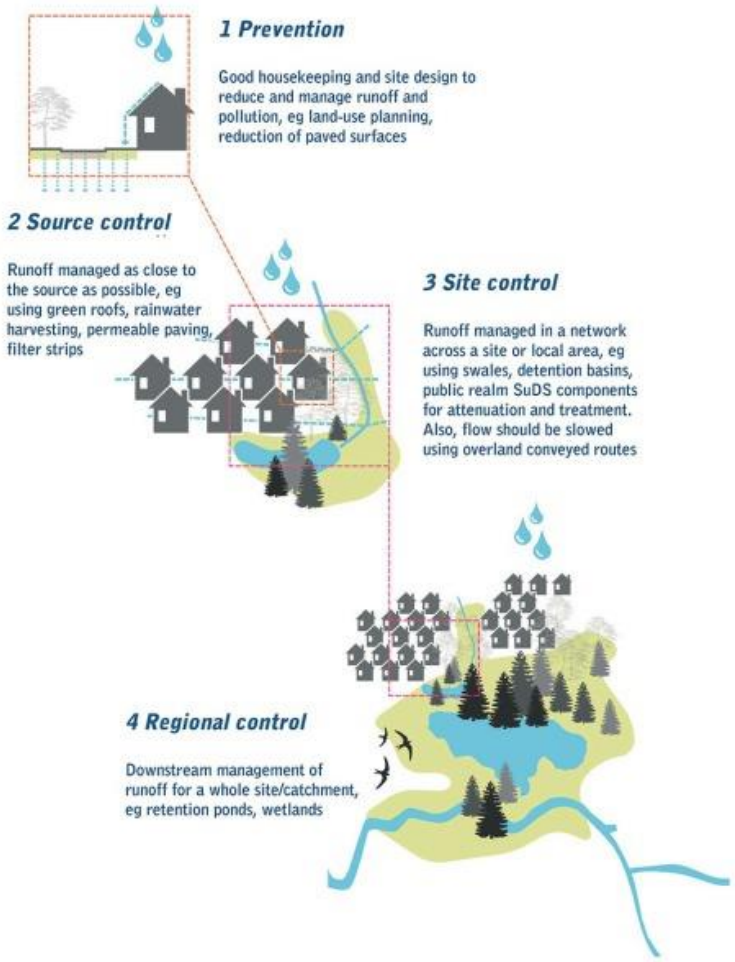
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 1

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	0.0025 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	0.7 l/s
Q (1in1yr)*	0.6 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)	0.6	0.6	0.9	1.2	1.5	1.7	1.9	2.3	2.8

hafrenwater
environmental water management

Barkers Chambers
Barker Street
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Tel: 01743 355770
www.hafrenwater.com

Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE 1, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S1/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 11:37:59 AM 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: 95A7-8605

Site name: Sandown Park - Site 1

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)	36.62	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	1.14E-09	2.66E-07
00:20:00	0.1103	0.0000	0.0097	0.0000	7E-09	1.11E-06
00:30:00	0.1286	0.0000	0.0114	0.0000	2.29E-08	2.64E-06
00:40:00	0.1499	0.0000	0.0133	0.0000	5.5E-08	4.97E-06
00:50:00	0.1746	0.0000	0.0155	0.0000	1.11E-07	8.24E-06
01:00:00	0.2033	0.0000	0.0181	0.0000	1.98E-07	1.26E-05
01:10:00	0.2367	0.0000	0.0211	0.0000	3.25E-07	1.78E-05
01:20:00	0.2753	0.0000	0.0247	0.0000	4.98E-07	2.37E-05
01:30:00	0.3201	0.0000	0.0288	0.0000	7.21E-07	3.02E-05
01:40:00	0.3718	0.0000	0.0336	0.0000	1E-06	3.75E-05
01:50:00	0.4315	0.0000	0.0392	0.0000	1.34E-06	4.58E-05
02:00:00	0.5002	0.0000	0.0457	0.0001	1.75E-06	5.51E-05
02:10:00	0.5791	0.0000	0.0533	0.0001	2.25E-06	6.58E-05
02:20:00	0.6691	0.0000	0.0621	0.0001	2.83E-06	7.81E-05
02:30:00	0.7711	0.0000	0.0722	0.0001	3.52E-06	9.23E-05
02:40:00	0.8846	0.0000	0.0838	0.0001	4.33E-06	0.000109
02:50:00	1.0043	0.0000	0.0962	0.0001	5.28E-06	0.000128
03:00:00	1.0703	0.0000	0.1039	0.0001	6.4E-06	0.00015
03:10:00	1.0043	0.0000	0.0987	0.0002	7.7E-06	0.000175
03:20:00	0.8846	0.0000	0.0880	0.0002	9.2E-06	0.000202
03:30:00	0.7711	0.0000	0.0774	0.0002	1.09E-05	0.00023
03:40:00	0.6691	0.0000	0.0678	0.0002	1.29E-05	0.000258
03:50:00	0.5791	0.0000	0.0591	0.0003	1.5E-05	0.000282
04:00:00	0.5002	0.0000	0.0514	0.0003	1.73E-05	0.000302
04:10:00	0.4315	0.0000	0.0446	0.0003	1.97E-05	0.000316
04:20:00	0.3718	0.0000	0.0386	0.0003	2.22E-05	0.000322
04:30:00	0.3201	0.0000	0.0333	0.0003	2.46E-05	0.000323
04:40:00	0.2753	0.0000	0.0288	0.0003	2.7E-05	0.000318
04:50:00	0.2367	0.0000	0.0248	0.0003	2.93E-05	0.000309
05:00:00	0.2033	0.0000	0.0214	0.0003	3.15E-05	0.000297
05:10:00	0.1746	0.0000	0.0184	0.0002	3.36E-05	0.000283
05:20:00	0.1499	0.0000	0.0158	0.0002	3.55E-05	0.000268
05:30:00	0.1286	0.0000	0.0136	0.0002	3.73E-05	0.000252
05:40:00	0.1103	0.0000	0.0117	0.0002	3.89E-05	0.000235

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	4.03E-05	0.000218
06:00:00	0.0810	0.0000	0.0086	0.0002	4.15E-05	0.000201
06:10:00	0.0000	0.0000	0.0000	0.0001	4.26E-05	0.000184
06:20:00	0.0000	0.0000	0.0000	0.0001	4.36E-05	0.000168
06:30:00	0.0000	0.0000	0.0000	0.0001	4.44E-05	0.000152
06:40:00	0.0000	0.0000	0.0000	0.0001	4.5E-05	0.000137
06:50:00	0.0000	0.0000	0.0000	0.0001	4.56E-05	0.000124
07:00:00	0.0000	0.0000	0.0000	0.0001	4.6E-05	0.000111
07:10:00	0.0000	0.0000	0.0000	0.0001	4.63E-05	9.92E-05
07:20:00	0.0000	0.0000	0.0000	0.0000	4.65E-05	8.9E-05
07:30:00	0.0000	0.0000	0.0000	0.0000	4.66E-05	8.04E-05
07:40:00	0.0000	0.0000	0.0000	0.0000	4.66E-05	7.33E-05
07:50:00	0.0000	0.0000	0.0000	0.0000	4.66E-05	6.74E-05
08:00:00	0.0000	0.0000	0.0000	0.0000	4.66E-05	6.26E-05
08:10:00	0.0000	0.0000	0.0000	0.0000	4.65E-05	5.87E-05
08:20:00	0.0000	0.0000	0.0000	0.0000	4.64E-05	5.56E-05
08:30:00	0.0000	0.0000	0.0000	0.0000	4.62E-05	5.3E-05
08:40:00	0.0000	0.0000	0.0000	0.0000	4.61E-05	5.09E-05
08:50:00	0.0000	0.0000	0.0000	0.0000	4.59E-05	4.91E-05
09:00:00	0.0000	0.0000	0.0000	0.0000	4.57E-05	4.78E-05
09:10:00	0.0000	0.0000	0.0000	0.0000	4.55E-05	4.67E-05
09:20:00	0.0000	0.0000	0.0000	0.0000	4.53E-05	4.59E-05
09:30:00	0.0000	0.0000	0.0000	0.0000	4.51E-05	4.53E-05
09:40:00	0.0000	0.0000	0.0000	0.0000	4.49E-05	4.49E-05
09:50:00	0.0000	0.0000	0.0000	0.0000	4.47E-05	4.47E-05
10:00:00	0.0000	0.0000	0.0000	0.0000	4.45E-05	4.45E-05
10:10:00	0.0000	0.0000	0.0000	0.0000	4.43E-05	4.43E-05
10:20:00	0.0000	0.0000	0.0000	0.0000	4.41E-05	4.41E-05
10:30:00	0.0000	0.0000	0.0000	0.0000	4.39E-05	4.39E-05
10:40:00	0.0000	0.0000	0.0000	0.0000	4.37E-05	4.37E-05
10:50:00	0.0000	0.0000	0.0000	0.0000	4.35E-05	4.35E-05
11:00:00	0.0000	0.0000	0.0000	0.0000	4.33E-05	4.33E-05
11:10:00	0.0000	0.0000	0.0000	0.0000	4.31E-05	4.31E-05
11:20:00	0.0000	0.0000	0.0000	0.0000	4.29E-05	4.29E-05
11:30:00	0.0000	0.0000	0.0000	0.0000	4.27E-05	4.27E-05
11:40:00	0.0000	0.0000	0.0000	0.0000	4.25E-05	4.25E-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 11:38:59 AM 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: 95A7-8605

Site name: Sandown Park - Site 1

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):	39.53	Total flow (ML):	0.03
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)	36.62	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	0.2129	0.0000	0.0188	0.0000	0	0
00:10:00	0.2484	0.0000	0.0220	0.0000	2.99E-09	7.01E-07
00:20:00	0.2898	0.0000	0.0257	0.0000	1.84E-08	2.93E-06
00:30:00	0.3379	0.0000	0.0301	0.0000	6.03E-08	6.95E-06
00:40:00	0.3938	0.0000	0.0353	0.0000	1.45E-07	1.31E-05
00:50:00	0.4588	0.0000	0.0413	0.0000	2.92E-07	2.17E-05
01:00:00	0.5344	0.0000	0.0485	0.0000	5.22E-07	3.33E-05
01:10:00	0.6220	0.0000	0.0568	0.0000	8.59E-07	4.72E-05
01:20:00	0.7236	0.0000	0.0667	0.0001	1.32E-06	6.28E-05
01:30:00	0.8411	0.0000	0.0783	0.0001	1.91E-06	8.02E-05
01:40:00	0.9771	0.0000	0.0921	0.0001	2.65E-06	9.99E-05
01:50:00	1.1340	0.0000	0.1083	0.0001	3.56E-06	0.000122
02:00:00	1.3146	0.0000	0.1275	0.0001	4.67E-06	0.000148
02:10:00	1.5219	0.0000	0.1501	0.0002	5.99E-06	0.000177
02:20:00	1.7586	0.0000	0.1770	0.0002	7.57E-06	0.000211
02:30:00	2.0265	0.0000	0.2085	0.0002	9.44E-06	0.000251
02:40:00	2.3248	0.0000	0.2453	0.0003	1.17E-05	0.000298
02:50:00	2.6393	0.0000	0.2863	0.0003	1.43E-05	0.000353
03:00:00	2.8127	0.0000	0.3143	0.0004	1.74E-05	0.000417
03:10:00	2.6393	0.0000	0.3035	0.0005	2.1E-05	0.000491
03:20:00	2.3248	0.0000	0.2743	0.0005	2.53E-05	0.000574
03:30:00	2.0265	0.0000	0.2444	0.0006	3.02E-05	0.000661
03:40:00	1.7586	0.0000	0.2161	0.0007	3.58E-05	0.000748
03:50:00	1.5219	0.0000	0.1900	0.0008	4.21E-05	0.000827
04:00:00	1.3146	0.0000	0.1663	0.0008	4.89E-05	0.000894
04:10:00	1.1340	0.0000	0.1451	0.0009	5.61E-05	0.000942
04:20:00	0.9771	0.0000	0.1263	0.0009	6.35E-05	0.00097
04:30:00	0.8411	0.0000	0.1096	0.0009	7.09E-05	0.000978
04:40:00	0.7236	0.0000	0.0950	0.0009	7.83E-05	0.00097
04:50:00	0.6220	0.0000	0.0822	0.0009	8.55E-05	0.000949
05:00:00	0.5344	0.0000	0.0710	0.0008	9.23E-05	0.000917
05:10:00	0.4588	0.0000	0.0612	0.0008	9.88E-05	0.000878
05:20:00	0.3938	0.0000	0.0527	0.0007	0.000105	0.000835
05:30:00	0.3379	0.0000	0.0454	0.0007	0.00011	0.000788
05:40:00	0.2898	0.0000	0.0390	0.0006	0.000115	0.000738

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	0.2484	0.0000	0.0335	0.0006	0.00012	0.000687
06:00:00	0.2129	0.0000	0.0288	0.0005	0.000124	0.000636
06:10:00	0.0000	0.0000	0.0000	0.0005	0.000128	0.000585
06:20:00	0.0000	0.0000	0.0000	0.0004	0.000131	0.000535
06:30:00	0.0000	0.0000	0.0000	0.0004	0.000133	0.000485
06:40:00	0.0000	0.0000	0.0000	0.0003	0.000136	0.000438
06:50:00	0.0000	0.0000	0.0000	0.0003	0.000137	0.000394
07:00:00	0.0000	0.0000	0.0000	0.0002	0.000139	0.000353
07:10:00	0.0000	0.0000	0.0000	0.0002	0.00014	0.000315
07:20:00	0.0000	0.0000	0.0000	0.0001	0.00014	0.000281
07:30:00	0.0000	0.0000	0.0000	0.0001	0.000141	0.000253
07:40:00	0.0000	0.0000	0.0000	0.0001	0.000141	0.00023
07:50:00	0.0000	0.0000	0.0000	0.0001	0.000141	0.00021
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000141	0.000194
08:10:00	0.0000	0.0000	0.0000	0.0000	0.000141	0.000182
08:20:00	0.0000	0.0000	0.0000	0.0000	0.00014	0.000171
08:30:00	0.0000	0.0000	0.0000	0.0000	0.00014	0.000163
08:40:00	0.0000	0.0000	0.0000	0.0000	0.00014	0.000156
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000139	0.00015
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000139	0.000145
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000138	0.000142
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000137	0.000139
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000137	0.000137
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000136	0.000136
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000135	0.000135
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000135	0.000135
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000134	0.000134
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000134	0.000134
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000133	0.000133
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000132	0.000132
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000132	0.000132
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000131	0.000131
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000131	0.000131
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00013	0.00013
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000129	0.000129
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000129	0.000129

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 11:39:44 AM 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: 95A7-8605

Site name: Sandown Park - Site 1

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):	52.07	Total flow (ML):	0.04
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)	36.62	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	0.2804	0.0000	0.0247	0.0000	0	0
00:10:00	0.3272	0.0000	0.0290	0.0000	3.94E-09	9.23E-07
00:20:00	0.3817	0.0000	0.0340	0.0000	2.43E-08	3.86E-06
00:30:00	0.4450	0.0000	0.0398	0.0000	7.95E-08	9.17E-06
00:40:00	0.5187	0.0000	0.0467	0.0000	1.91E-07	1.73E-05
00:50:00	0.6044	0.0000	0.0549	0.0000	3.85E-07	2.87E-05
01:00:00	0.7039	0.0000	0.0644	0.0000	6.89E-07	4.4E-05
01:10:00	0.8193	0.0000	0.0757	0.0001	1.13E-06	6.24E-05
01:20:00	0.9531	0.0000	0.0891	0.0001	1.74E-06	8.3E-05
01:30:00	1.1080	0.0000	0.1050	0.0001	2.52E-06	0.000106
01:40:00	1.2871	0.0000	0.1238	0.0001	3.51E-06	0.000133
01:50:00	1.4937	0.0000	0.1462	0.0002	4.72E-06	0.000162
02:00:00	1.7316	0.0000	0.1728	0.0002	6.19E-06	0.000197
02:10:00	2.0047	0.0000	0.2045	0.0002	7.95E-06	0.000236
02:20:00	2.3164	0.0000	0.2423	0.0003	1.01E-05	0.000283
02:30:00	2.6693	0.0000	0.2872	0.0003	1.26E-05	0.000337
02:40:00	3.0622	0.0000	0.3400	0.0004	1.56E-05	0.000401
02:50:00	3.4766	0.0000	0.3996	0.0005	1.91E-05	0.000477
03:00:00	3.7050	0.0000	0.4418	0.0005	2.33E-05	0.000566
03:10:00	3.4766	0.0000	0.4296	0.0006	2.82E-05	0.000669
03:20:00	3.0622	0.0000	0.3904	0.0008	3.41E-05	0.000786
03:30:00	2.6693	0.0000	0.3495	0.0009	4.09E-05	0.000909
03:40:00	2.3164	0.0000	0.3102	0.0010	4.86E-05	0.00103
03:50:00	2.0047	0.0000	0.2736	0.0011	5.72E-05	0.00115
04:00:00	1.7316	0.0000	0.2402	0.0012	6.67E-05	0.00124
04:10:00	1.4937	0.0000	0.2101	0.0012	7.67E-05	0.00132
04:20:00	1.2871	0.0000	0.1832	0.0013	8.71E-05	0.00136
04:30:00	1.1080	0.0000	0.1593	0.0013	9.77E-05	0.00138
04:40:00	0.9531	0.0000	0.1382	0.0013	0.000108	0.00137
04:50:00	0.8193	0.0000	0.1197	0.0012	0.000118	0.00134
05:00:00	0.7039	0.0000	0.1035	0.0012	0.000128	0.0013
05:10:00	0.6044	0.0000	0.0893	0.0011	0.000137	0.00125
05:20:00	0.5187	0.0000	0.0770	0.0010	0.000146	0.00119
05:30:00	0.4450	0.0000	0.0663	0.0010	0.000154	0.00112
05:40:00	0.3817	0.0000	0.0571	0.0009	0.000161	0.00105

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	0.3272	0.0000	0.0491	0.0008	0.000168	0.000982
06:00:00	0.2804	0.0000	0.0421	0.0007	0.000173	0.00091
06:10:00	0.0000	0.0000	0.0000	0.0007	0.000179	0.000839
06:20:00	0.0000	0.0000	0.0000	0.0006	0.000183	0.000767
06:30:00	0.0000	0.0000	0.0000	0.0005	0.000187	0.000697
06:40:00	0.0000	0.0000	0.0000	0.0004	0.00019	0.000629
06:50:00	0.0000	0.0000	0.0000	0.0004	0.000193	0.000565
07:00:00	0.0000	0.0000	0.0000	0.0003	0.000195	0.000506
07:10:00	0.0000	0.0000	0.0000	0.0003	0.000196	0.000451
07:20:00	0.0000	0.0000	0.0000	0.0002	0.000197	0.000403
07:30:00	0.0000	0.0000	0.0000	0.0002	0.000198	0.000362
07:40:00	0.0000	0.0000	0.0000	0.0001	0.000198	0.000327
07:50:00	0.0000	0.0000	0.0000	0.0001	0.000199	0.000299
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000198	0.000276
08:10:00	0.0000	0.0000	0.0000	0.0001	0.000198	0.000258
08:20:00	0.0000	0.0000	0.0000	0.0000	0.000198	0.000243
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000197	0.00023
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000196	0.00022
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000196	0.000212
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000195	0.000205
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000194	0.0002
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000193	0.000196
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000192	0.000193
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000192	0.000192
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000191	0.000191
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00019	0.00019
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000189	0.000189
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000188	0.000188
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000187	0.000187
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000186	0.000186
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000186	0.000186
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000185	0.000185
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000184	0.000184
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000183	0.000183
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000182	0.000182
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000181	0.000181

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-100-year storm) for Site 1 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.053	0.113	0.081

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	1.4	5.8	5.0	0.0	0	12.1	10.9
0.5	7.3	14.6	0.9	3.7	3.1	0.0	0	7.7	13.8
1	9.0	9.0	0.5	2.3	1.9	0.0	0	4.7	17.0
2	14.1	7.0	0.4	1.8	1.5	0.0	0	3.7	26.6
4	19.4	4.8	0.3	1.2	1.0	0.0	0	2.5	36.6
6	22.4	3.7	0.2	0.9	0.8	0.0	0	2.0	42.2
8	24.4	3.0	0.2	0.8	0.7	0.0	0	1.6	46.0
12	27.0	2.3	0.1	0.6	0.5	0.0	0	1.2	51.0
16	28.9	1.8	0.1	0.5	0.4	0.0	0	0.9	54.4
20	30.3	1.5	0.1	0.4	0.3	0.0	0	0.8	57.2
24	31.6	1.3	0.1	0.3	0.3	0.0	0	0.7	59.6
28	32.7	1.2	0.1	0.3	0.3	0.0	0	0.6	61.6
32	33.7	1.1	0.1	0.3	0.2	0.0	0	0.6	63.6
36	34.6	1.0	0.1	0.2	0.2	0.0	0	0.5	65.3
40	35.5	0.9	0.1	0.2	0.2	0.0	0	0.5	67.0
44	36.4	0.8	0.0	0.2	0.2	0.0	0	0.4	68.7
48	37.2	0.8	0.0	0.2	0.2	0.0	0	0.4	70.3

*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 1 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S1/A3.1 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.053	0.113	0.081

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	5.1	21.8	18.7	0.0	0	45.6	41.1
0.5	28.2	56.4	3.3	14.1	12.1	0.0	0	29.6	53.2
1	34.7	34.7	2.0	8.7	7.5	0.0	0	18.2	65.5
2	44.1	22.1	1.3	5.5	4.7	0.0	0	11.6	83.2
4	53.8	13.5	0.8	3.4	2.9	0.0	0	7.1	101.6
6	59.2	9.9	0.6	2.5	2.1	0.0	0	5.2	111.6
8	62.6	7.8	0.5	2.0	1.7	0.0	0	4.1	118.1
12	67.0	5.6	0.3	1.4	1.2	0.0	0	2.9	126.5
16	70.0	4.4	0.3	1.1	0.9	0.0	0	2.3	132.1
20	72.3	3.6	0.2	0.9	0.8	0.0	0	1.9	136.4
24	74.1	3.1	0.2	0.8	0.7	0.0	0	1.6	139.8
28	75.7	2.7	0.2	0.7	0.6	0.0	0	1.4	142.8
32	77.1	2.4	0.1	0.6	0.5	0.0	0	1.3	145.4
36	78.3	2.2	0.1	0.5	0.5	0.0	0	1.1	147.8
40	79.5	2.0	0.1	0.5	0.4	0.0	0	1.0	150.1
44	80.7	1.8	0.1	0.5	0.4	0.0	0	1.0	152.2
48	81.7	1.7	0.1	0.4	0.4	0.0	0	0.9	154.2

*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 1 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S1/A3.2 Date: Jan-19

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

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.053	0.113	0.081

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	6.6	28.4	24.3	0.0	0	59.4	53.4
0.5	36.9	73.8	4.3	18.5	15.8	0.0	0	38.7	69.6
1	45.8	45.8	2.7	11.5	9.8	0.0	0	24.0	86.4
2	57.4	28.7	1.7	7.2	6.2	0.0	0	15.0	108.3
4	70.4	17.6	1.0	4.4	3.8	0.0	0	9.2	132.8
6	77.7	12.9	0.8	3.2	2.8	0.0	0	6.8	146.6
8	82.6	10.3	0.6	2.6	2.2	0.0	0	5.4	155.9
12	88.9	7.4	0.4	1.9	1.6	0.0	0	3.9	167.8
16	92.9	5.8	0.3	1.5	1.2	0.0	0	3.0	175.3
20	95.8	4.8	0.3	1.2	1.0	0.0	0	2.5	180.7
24	97.9	4.1	0.2	1.0	0.9	0.0	0	2.1	184.8
28	99.6	3.6	0.2	0.9	0.8	0.0	0	1.9	188.0
32	101.1	3.2	0.2	0.8	0.7	0.0	0	1.7	190.7
36	102.4	2.8	0.2	0.7	0.6	0.0	0	1.5	193.2
40	103.5	2.6	0.2	0.6	0.6	0.0	0	1.4	195.3
44	104.6	2.4	0.1	0.6	0.5	0.0	0	1.2	197.3
48	105.6	2.2	0.1	0.6	0.5	0.0	0	1.2	199.2

*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 1 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S1/A3.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 1 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.086	0.098	0.063

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

Area of Soakaway 10 m^2
Infiltration Rate 3.00E-04 m/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	2.2	5.0	3.8	0.0	-3	8.1	7.3
0.5	7.3	14.6	1.4	3.2	2.4	0.0	-3	4.0	7.2
1	9.0	9.0	0.9	2.0	1.5	0.0	-3	1.3	4.8
2	14.1	7.0	0.7	1.5	1.2	0.0	-3	0.4	2.7
4	19.4	4.8	0.5	1.1	0.8	0.0	-3	-0.7	-9.7
6	22.4	3.7	0.4	0.8	0.6	0.0	-3	-1.2	-26.1
8	24.4	3.0	0.3	0.7	0.5	0.0	-3	-1.5	-44.3
12	27.0	2.3	0.2	0.5	0.4	0.0	-3	-1.9	-82.9
16	28.9	1.8	0.2	0.4	0.3	0.0	-3	-2.1	-123.0
20	30.3	1.5	0.1	0.3	0.3	0.0	-3	-2.3	-163.6
24	31.6	1.3	0.1	0.3	0.2	0.0	-3	-2.4	-204.7
28	32.7	1.2	0.1	0.3	0.2	0.0	-3	-2.4	-246.0
32	33.7	1.1	0.1	0.2	0.2	0.0	-3	-2.5	-287.4
36	34.6	1.0	0.1	0.2	0.2	0.0	-3	-2.5	-329.0
40	35.5	0.9	0.1	0.2	0.1	0.0	-3	-2.6	-370.6
44	36.4	0.8	0.1	0.2	0.1	0.0	-3	-2.6	-412.3
48	37.2	0.8	0.1	0.2	0.1	0.0	-3	-2.6	-454.1

*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 roads, roofs and parking at Site 1 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S1/A4.1	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 1 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.086	0.098	0.063

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

$$Q_p = 2.78\,CiA$$

Where:

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

Climate change (% rainfall increase) 0 %

Infiltration loss through soakaway 3.0 l/s

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

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

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	30 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	8.3	19.0	14.5	0.0	-3	38.8	34.9
0.5	28.2	56.4	5.4	12.3	9.4	0.0	-3	24.1	43.3
1	34.7	34.7	3.3	7.6	5.8	0.0	-3	13.7	49.2
2	44.1	22.1	2.1	4.8	3.7	0.0	-3	7.6	54.6
4	53.8	13.5	1.3	2.9	2.2	0.0	-3	3.5	49.8
6	59.2	9.9	0.9	2.1	1.6	0.0	-3	1.7	37.4
8	62.6	7.8	0.7	1.7	1.3	0.0	-3	0.8	21.7
12	67.0	5.6	0.5	1.2	0.9	0.0	-3	-0.3	-13.8
16	70.0	4.4	0.4	1.0	0.7	0.0	-3	-0.9	-51.8
20	72.3	3.6	0.3	0.8	0.6	0.0	-3	-1.3	-91.1
24	74.1	3.1	0.3	0.7	0.5	0.0	-3	-1.5	-131.2
28	75.7	2.7	0.3	0.6	0.4	0.0	-3	-1.7	-171.7
32	77.1	2.4	0.2	0.5	0.4	0.0	-3	-1.8	-212.5
36	78.3	2.2	0.2	0.5	0.4	0.0	-3	-2.0	-253.5
40	79.5	2.0	0.2	0.4	0.3	0.0	-3	-2.0	-294.6
44	80.7	1.8	0.2	0.4	0.3	0.0	-3	-2.1	-335.8
48	81.7	1.7	0.2	0.4	0.3	0.0	-3	-2.2	-377.2

*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 roads, roofs and parking at Site 1 - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/S1/A4.2 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 1 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.086	0.098	0.063

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

$$Q_p = 2.78\,CiA$$

Where:

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

Climate change (% rainfall increase) 0 %

Infiltration loss through soakaway 3.0 l/s

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

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

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas *3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	10.8	24.7	18.8	0.0	-3	51.4	46.2
0.5	36.9	73.8	7.1	16.1	12.3	0.0	-3	32.4	58.4
1	45.8	45.8	4.4	10.0	7.6	0.0	-3	19.0	68.4
2	57.4	28.7	2.7	6.3	4.8	0.0	-3	10.8	77.6
4	70.4	17.6	1.7	3.8	2.9	0.0	-3	5.4	78.4
6	77.7	12.9	1.2	2.8	2.2	0.0	-3	3.2	69.4
8	82.6	10.3	1.0	2.3	1.7	0.0	-3	2.0	56.3
12	88.9	7.4	0.7	1.6	1.2	0.0	-3	0.6	24.1
16	92.9	5.8	0.6	1.3	1.0	0.0	-3	-0.2	-12.2
20	95.8	4.8	0.5	1.0	0.8	0.0	-3	-0.7	-50.5
24	97.9	4.1	0.4	0.9	0.7	0.0	-3	-1.0	-90.0
28	99.6	3.6	0.3	0.8	0.6	0.0	-3	-1.3	-130.3
32	101.1	3.2	0.3	0.7	0.5	0.0	-3	-1.5	-170.9
36	102.4	2.8	0.3	0.6	0.5	0.0	-3	-1.6	-211.9
40	103.5	2.6	0.2	0.6	0.4	0.0	-3	-1.8	-253.1
44	104.6	2.4	0.2	0.5	0.4	0.0	-3	-1.9	-294.5
48	105.6	2.2	0.2	0.5	0.4	0.0	-3	-1.9	-336.0

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Calc Sheet: 2661_OPA/S1/A4.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 1 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.086	0.098	0.063

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

Area of Soakaway 10 m^2
Infiltration Rate 3.00E-04 m/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	13.0	29.6	22.6	0.0	-3	62.2	56.0
0.5	36.9	73.8	8.5	19.3	14.7	0.0	-3	39.5	71.1
1	45.8	45.8	5.3	12.0	9.1	0.0	-3	23.4	84.2
2	57.4	28.7	3.3	7.5	5.7	0.0	-3	13.5	97.4
4	70.4	17.6	2.0	4.6	3.5	0.0	-3	7.1	102.7
6	77.7	12.9	1.5	3.4	2.6	0.0	-3	4.5	96.2
8	82.6	10.3	1.2	2.7	2.1	0.0	-3	2.9	84.8
12	88.9	7.4	0.9	1.9	1.5	0.0	-3	1.3	54.8
16	92.9	5.8	0.7	1.5	1.2	0.0	-3	0.3	19.9
20	95.8	4.8	0.5	1.3	1.0	0.0	-3	-0.2	-17.4
24	97.9	4.1	0.5	1.1	0.8	0.0	-3	-0.6	-56.1
28	99.6	3.6	0.4	0.9	0.7	0.0	-3	-1.0	-95.8
32	101.1	3.2	0.4	0.8	0.6	0.0	-3	-1.2	-136.0
36	102.4	2.8	0.3	0.7	0.6	0.0	-3	-1.4	-176.6
40	103.5	2.6	0.3	0.7	0.5	0.0	-3	-1.5	-217.4
44	104.6	2.4	0.3	0.6	0.5	0.0	-3	-1.6	-258.4
48	105.6	2.2	0.3	0.6	0.4	0.0	-3	-1.7	-299.5

*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/S1/A4.4	Date:	Jan-19

3 SANDOWN PARK – SITE 2

3.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site 2 (Urban Frontage), as shown on *Drawing 2661/OPA-S2/01*.

3.2 Location and setting

The Application Area is located at the southwestern corner of the landholding of Sandown Park and comprises a narrow, rectangular area of land which is bounded by Portsmouth Road (A307) (Esher High Street) to the east and southeast. It extends to approximately 0.47 ha.

3.3 The proposed development

The area of the proposed development currently comprises a car park with large areas of hardstanding (see *Photographs 2661/OPA-S2/P1 and P2*). The surfaces comprise areas of both compacted hardcore and tarmac. It is proposed to remove large areas of hardstanding and construct up to 49 one, two and three bedroom apartments. The current and proposed land uses are shown on *Drawing 2661/OPA-S2/01*.

3.4 Baseline conditions

A recent topographic survey was issued in November 2018. The elevation of the ground surface within the Application Area is observed to decline toward the northeast from approximately 34 mAOD to 30 mAOD.

3.5 Hydrology

A drainage ditch is located along Portsmouth Road. This was dry on the site walkover undertaken on 8th October (*Photographs 2661/OPA-S2/P3*). No other watercourses or waterbodies exist in the vicinity of the site.

3.6 Geology

This area of the site is underlain directly by the Bagshot Formation, with no superficial deposits present. The geology of the site is shown on *Drawing 2661/OPA-S2/02*.

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. It is frequently micaceous and locally clayey, with sparse seams of gravel. Thin beds and lenses of laminated pale grey to

white sandy or silty clay or clay ('pipe-clay') occur sporadically, becoming thicker towards the top of the formation. 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 base of the Bagshot Formation is marked by an erosional surface marking a change from clay, silt and fine-grained sand of the Claygate Member (London Clay Formation) to thick-bedded, pale-coloured, fine-grained sands, with a basal fine gravelly sand developed in places.

3.7 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-S6/03)*. There are generally few restrictions to development in terms of flood risk within Flood Zone 1. The exception being for development over 1 ha in extent, for which Flood Risk Assessment must be undertaken.

The Application Area is 0.47 ha in size, therefore a Flood Risk Assessment is not required.

Surface water flood risk is restricted to a narrow strip paralleling the western boundary. It is low risk, as defined by the Environment Agency (see *Drawing 2661/OPA-S2/04*).

3.8 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.

Small areas in the western extent of the site are noted as being at low risk of surface water flooding, with a likelihood of between 0.1-1%. These areas are considered likely to be associated with topographical lows within the existing ground surface which will be re-profiled during the development.

The majority of the Application Area is overlain by hardstanding. There is a local slope to the northeast of the site. Under current conditions surface water runs off across the Application Area, follows the local topography and exits the site towards Portsmouth Road. There are currently no issues with standing water within the site boundary.

The site is located above the Bagshot Formation, which comprises predominantly sand and consequentially, the natural drainability of the sub-surface is considered to be good. However, a high watertable and potentially large volumes of near surface groundwater (see below) will need to be considered.

Ground conditions were discussed with the Facilities Manager following the site meeting on 8th October. During construction of the Owners and Trainers Offices, sand was reportedly encountered to depth and water ingress was prolific. Difficulty was found in disposing of the water and piles were subsequently used for the foundations. A spring was reported to formerly be present close to the Trainers offices (approximate NGR TQ 1409 6501).

3.9 Assessment of flood risk and drainage

3.9.1 Flood risk to the development

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

There are small areas 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.

3.9.2 Flood risk from the development

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

The proposed development will modify the run-off characteristics of the site due to the change in the ground profile and surface cover. The surface water management system will be improved upon as part of the development and will ensure that volumes of surface water run-off can be retained, attenuated or infiltrated within the site boundary. The surface water drainage within the proposed development will be designed to manage volumes discharging off-site to equivalent rates to the greenfield run-off rate, as discussed in Section 3.9.3 below.

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

3.9.3 Drainage requirements

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

eastern/southeast boundary, an area comprising approximately 875 m^2. The geo-cellular storage will provide 299.1 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. In this scenario, the proposed outfall would be located along the eastern extent 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.

3.9.4 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'.

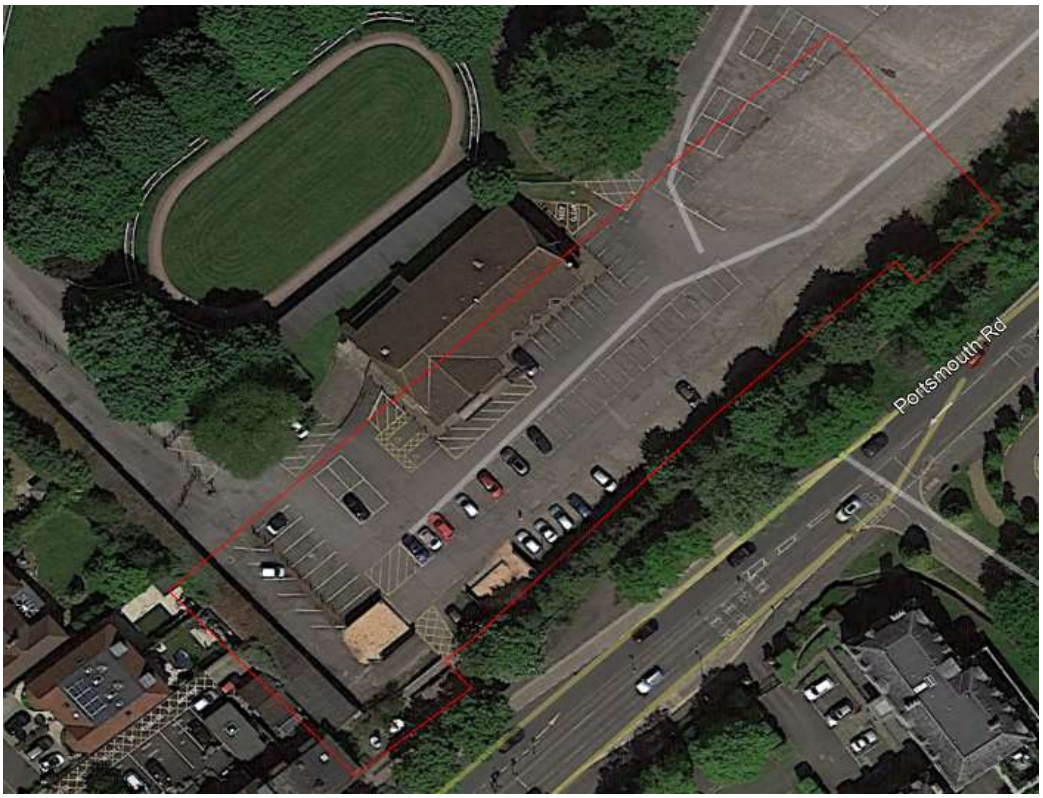
3.10 Summary and conclusions

The Application Area is located at the southwestern corner of Sandown Park and is 0.47 ha in size.

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

Small areas of the site are noted as being at low risk of surface water flooding, with a likelihood of flooding of between 0.1-1%, however these are likely associated with topographical lows within the current land cover which will be improved upon as a result of the development.

The natural drainability of the sub-surface is good and infiltration to ground via soakaway would appear to be feasible. However, a potentially high watertable will need to be considered and soakaway testing is advised. 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-S2/01: Existing development
Google earth imagery (May 2018)

2661/OPA-S2/01: Proposed development

Please note drawings are illustrative

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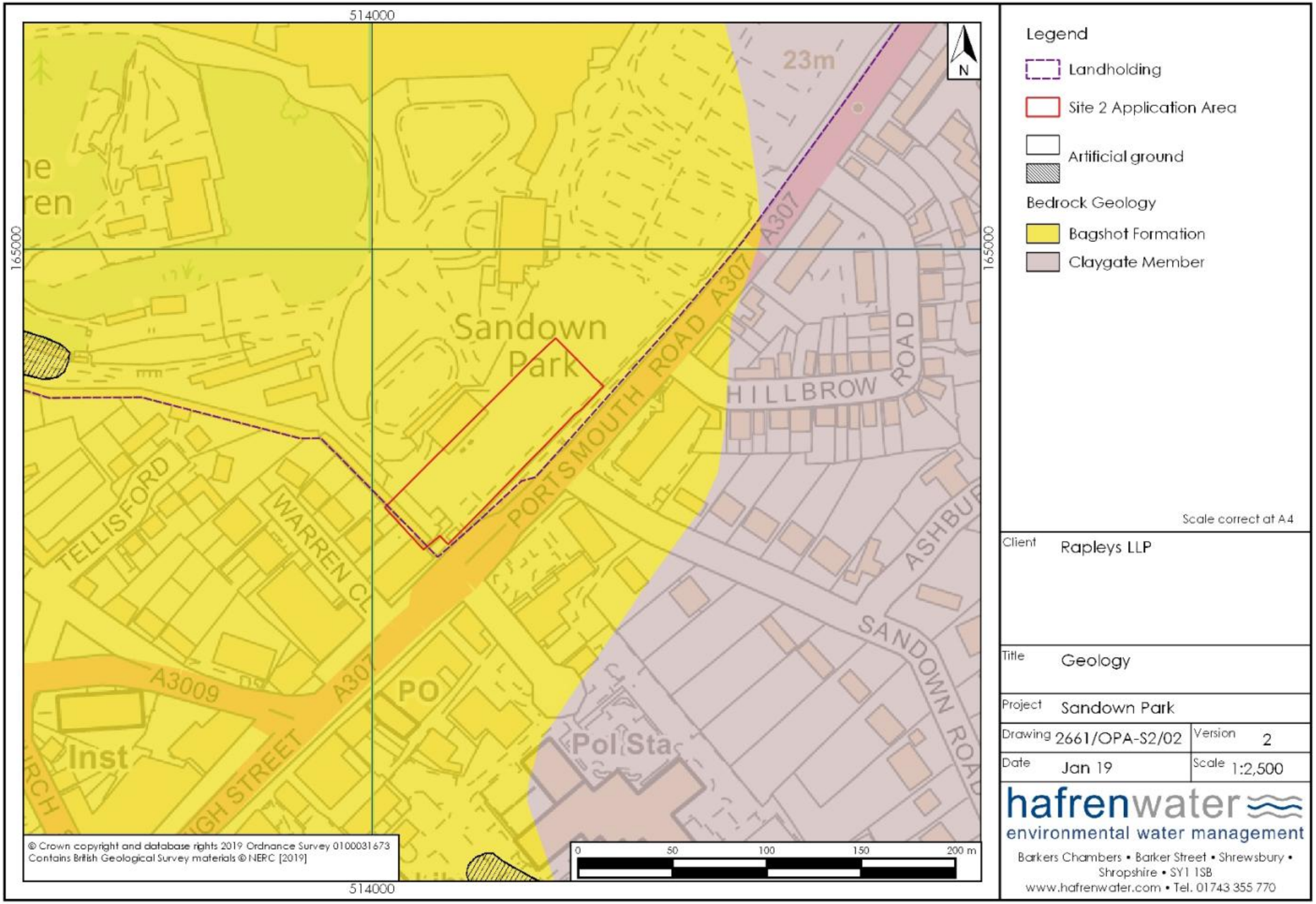
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-S2/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Landholding
- Site 2 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-S2/02
Version	2
Date	Jan 19
Scale	1:2,500

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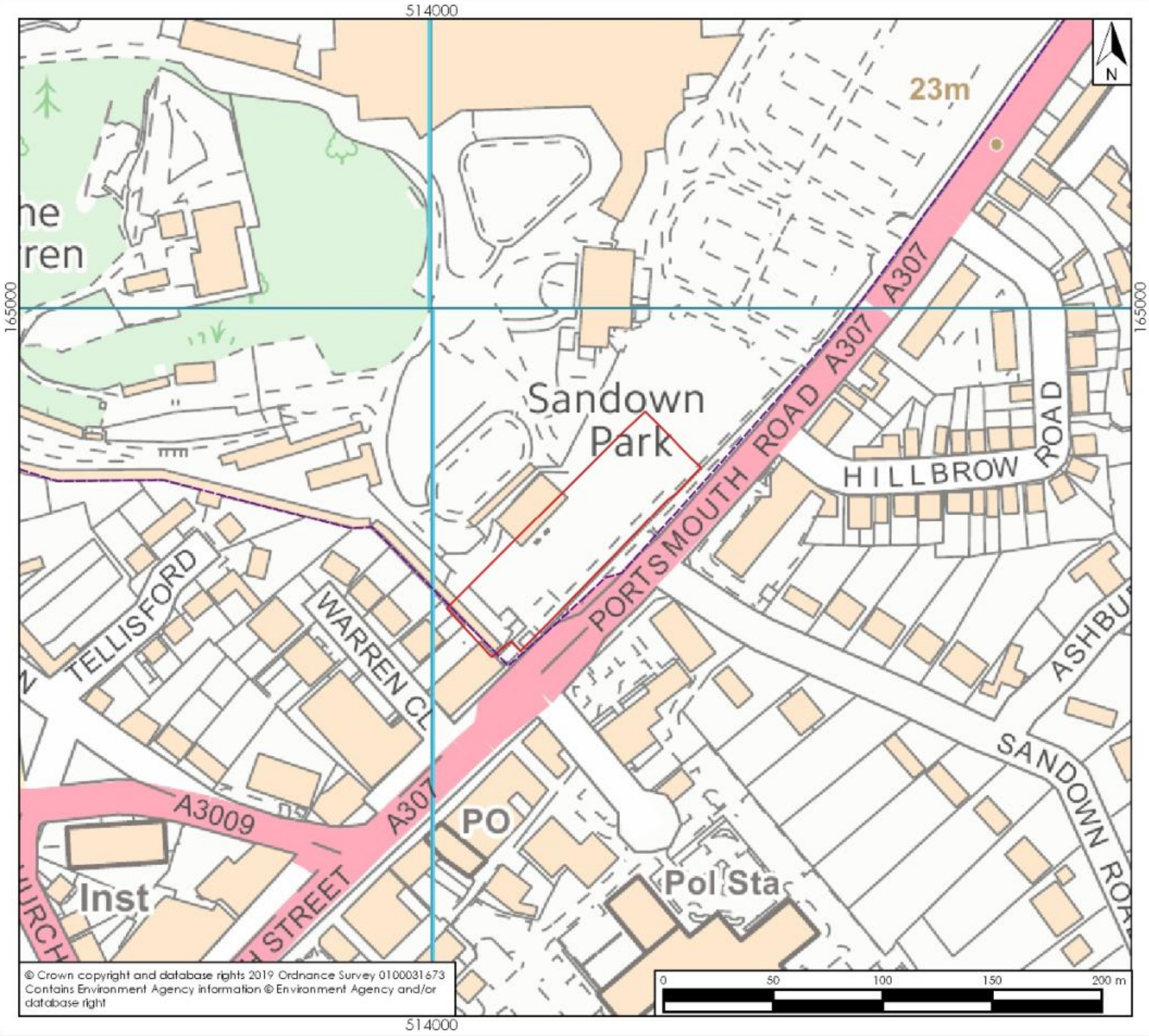

Legend

- Landholding
- Site 2 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-S2/03
Version	2
Date	Jan 19
Scale	1:2,500

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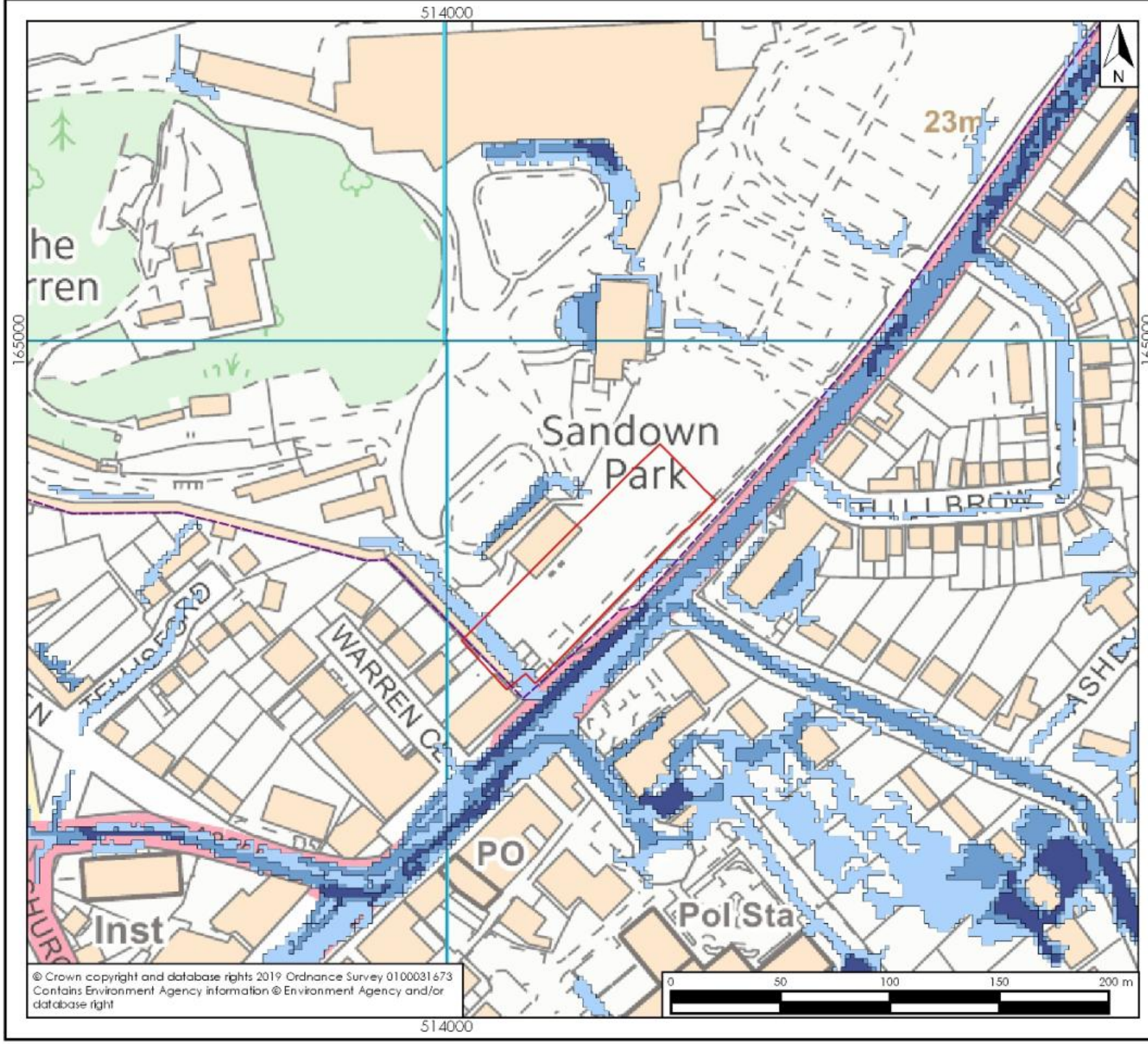

Legend

- Landholding
- Site 2 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-S2/04
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 2 – Urban Frontage
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 140 649
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	4,671 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.38 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	0.41	0.38	-0.03* *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)	Under current conditions, surface water runs off following local topography and exits the site towards Portsmouth Road. Currently no issues with standing water at the site			**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	1.4	-	-	-	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	0.61	3.7	0.0	-3.7	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	1.84	9.8	0.0	-9.8	
1in 100	2.59	12.9	0.0	-12.9	
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	19.2	80.0	33.2	-46.8	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	58.2	211.4	166.1	-45.3	
1in 100	81.8	277.7	237.3	-40.4	
1 in 100 plus 20% climate change *	N/A	N/A	299.1	-	

* 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)	Bagshot Formation, no superficial	Avoid infiltrating in made ground. **Evidence: suitable mapping/SI**
	Is ground water table less than 3m below ground?	Yes - ground conditions have been observed on-site during previous construction works. Sand was reported 'at depth' and water ingress was described as 'prolific'. Difficulty was experienced when trying to dispose of the water. Further investigation is required of groundwater level at the site.	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,	**Evidence: Infiltration rates solely estimated from desk studies are only suitable at outline planning applications unless clear**

		Table 25.1: Typical infiltration. Coefficients based on soil texture (after Bettess, 1996)	**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. The soakaway will provide attenuation storage for the 1 in 100 year plus climate change event, which is 299.1 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.	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**
How will the storage be provided on site?		

	Further information to be provided at Detailed Design stage. This will be required for the Full Planning Application.	**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)		**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

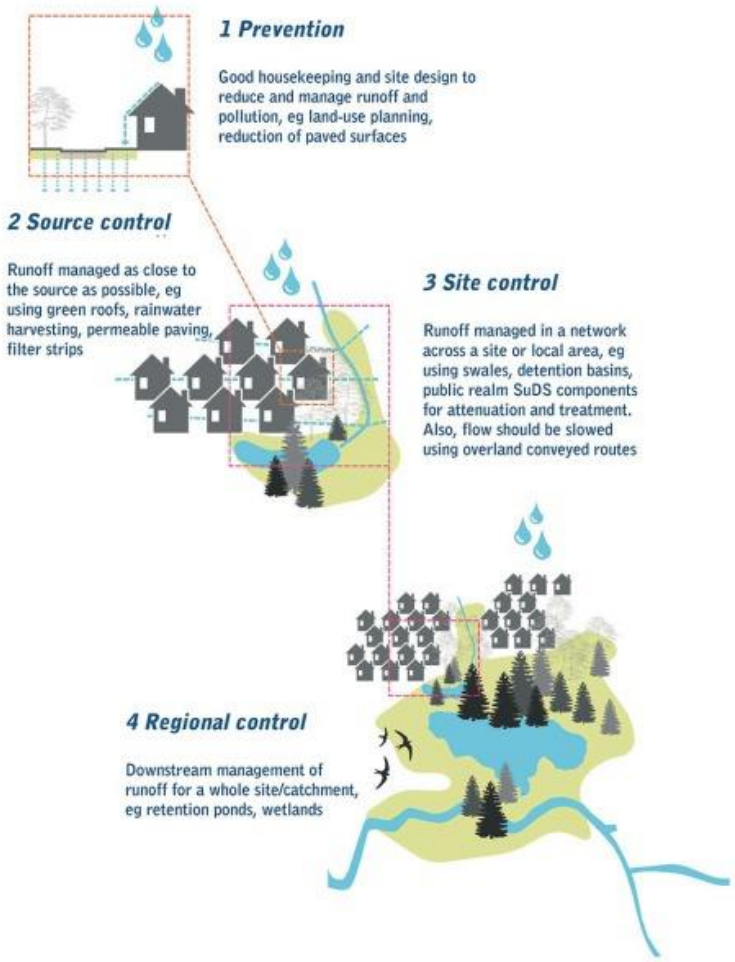
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 2

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	0.0047 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	1.4 l/s
Q (1in1yr)*	1.1 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)	1.1	1.2	1.7	2.2	2.9	3.2	3.5	4.3	5.2

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Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE 2, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S2/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 11:41:35 AM 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: 99C7-A7E5

Site name: Sandown Park - Site 2

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):	0.01
Total Rainfall (mm):	15.03	Total flow (ML):	0.02
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)	38.43	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	2.05E-09	5.03E-07
00:20:00	0.1102	0.0000	0.0097	0.0000	1.26E-08	2.1E-06
00:30:00	0.1285	0.0000	0.0114	0.0000	4.12E-08	4.99E-06
00:40:00	0.1498	0.0000	0.0133	0.0000	9.91E-08	9.39E-06
00:50:00	0.1745	0.0000	0.0155	0.0000	1.99E-07	1.56E-05
01:00:00	0.2032	0.0000	0.0181	0.0000	3.57E-07	2.38E-05
01:10:00	0.2365	0.0000	0.0211	0.0000	5.86E-07	3.37E-05
01:20:00	0.2752	0.0000	0.0247	0.0000	8.97E-07	4.47E-05
01:30:00	0.3199	0.0000	0.0288	0.0001	1.3E-06	5.7E-05
01:40:00	0.3716	0.0000	0.0336	0.0001	1.8E-06	7.08E-05
01:50:00	0.4313	0.0000	0.0392	0.0001	2.42E-06	8.64E-05
02:00:00	0.5000	0.0000	0.0457	0.0001	3.16E-06	0.000104
02:10:00	0.5788	0.0000	0.0533	0.0001	4.05E-06	0.000124
02:20:00	0.6688	0.0000	0.0621	0.0001	5.1E-06	0.000147
02:30:00	0.7707	0.0000	0.0722	0.0002	6.34E-06	0.000174
02:40:00	0.8841	0.0000	0.0837	0.0002	7.8E-06	0.000205
02:50:00	1.0038	0.0000	0.0962	0.0002	9.52E-06	0.000241
03:00:00	1.0697	0.0000	0.1038	0.0003	1.15E-05	0.000282
03:10:00	1.0038	0.0000	0.0987	0.0003	1.39E-05	0.000329
03:20:00	0.8841	0.0000	0.0879	0.0004	1.66E-05	0.000381
03:30:00	0.7707	0.0000	0.0774	0.0004	1.97E-05	0.000434
03:40:00	0.6688	0.0000	0.0677	0.0005	2.32E-05	0.000486
03:50:00	0.5788	0.0000	0.0591	0.0005	2.7E-05	0.000532
04:00:00	0.5000	0.0000	0.0513	0.0005	3.12E-05	0.000569
04:10:00	0.4313	0.0000	0.0445	0.0006	3.55E-05	0.000595
04:20:00	0.3716	0.0000	0.0385	0.0006	3.99E-05	0.000607
04:30:00	0.3199	0.0000	0.0333	0.0006	4.44E-05	0.000608
04:40:00	0.2752	0.0000	0.0288	0.0005	4.87E-05	0.000598
04:50:00	0.2365	0.0000	0.0248	0.0005	5.29E-05	0.000581
05:00:00	0.2032	0.0000	0.0214	0.0005	5.69E-05	0.000559
05:10:00	0.1745	0.0000	0.0184	0.0005	6.06E-05	0.000532
05:20:00	0.1498	0.0000	0.0158	0.0004	6.41E-05	0.000503
05:30:00	0.1285	0.0000	0.0136	0.0004	6.72E-05	0.000472
05:40:00	0.1102	0.0000	0.0117	0.0004	7.01E-05	0.000441

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	0.0003	7.27E-05	0.000408
06:00:00	0.0810	0.0000	0.0086	0.0003	7.5E-05	0.000376
06:10:00	0.0000	0.0000	0.0000	0.0003	7.7E-05	0.000345
06:20:00	0.0000	0.0000	0.0000	0.0002	7.87E-05	0.000314
06:30:00	0.0000	0.0000	0.0000	0.0002	8.01E-05	0.000284
06:40:00	0.0000	0.0000	0.0000	0.0002	8.13E-05	0.000256
06:50:00	0.0000	0.0000	0.0000	0.0001	8.23E-05	0.00023
07:00:00	0.0000	0.0000	0.0000	0.0001	8.3E-05	0.000206
07:10:00	0.0000	0.0000	0.0000	0.0001	8.36E-05	0.000184
07:20:00	0.0000	0.0000	0.0000	0.0001	8.4E-05	0.000164
07:30:00	0.0000	0.0000	0.0000	0.0001	8.42E-05	0.000148
07:40:00	0.0000	0.0000	0.0000	0.0001	8.43E-05	0.000135
07:50:00	0.0000	0.0000	0.0000	0.0000	8.43E-05	0.000123
08:00:00	0.0000	0.0000	0.0000	0.0000	8.42E-05	0.000114
08:10:00	0.0000	0.0000	0.0000	0.0000	8.41E-05	0.000107
08:20:00	0.0000	0.0000	0.0000	0.0000	8.39E-05	0.000101
08:30:00	0.0000	0.0000	0.0000	0.0000	8.36E-05	9.64E-05
08:40:00	0.0000	0.0000	0.0000	0.0000	8.33E-05	9.24E-05
08:50:00	0.0000	0.0000	0.0000	0.0000	8.3E-05	8.92E-05
09:00:00	0.0000	0.0000	0.0000	0.0000	8.27E-05	8.66E-05
09:10:00	0.0000	0.0000	0.0000	0.0000	8.24E-05	8.47E-05
09:20:00	0.0000	0.0000	0.0000	0.0000	8.21E-05	8.32E-05
09:30:00	0.0000	0.0000	0.0000	0.0000	8.17E-05	8.21E-05
09:40:00	0.0000	0.0000	0.0000	0.0000	8.14E-05	8.14E-05
09:50:00	0.0000	0.0000	0.0000	0.0000	8.1E-05	8.1E-05
10:00:00	0.0000	0.0000	0.0000	0.0000	8.06E-05	8.06E-05
10:10:00	0.0000	0.0000	0.0000	0.0000	8.03E-05	8.03E-05
10:20:00	0.0000	0.0000	0.0000	0.0000	8E-05	8E-05
10:30:00	0.0000	0.0000	0.0000	0.0000	7.96E-05	7.96E-05
10:40:00	0.0000	0.0000	0.0000	0.0000	7.93E-05	7.93E-05
10:50:00	0.0000	0.0000	0.0000	0.0000	7.89E-05	7.89E-05
11:00:00	0.0000	0.0000	0.0000	0.0000	7.86E-05	7.86E-05
11:10:00	0.0000	0.0000	0.0000	0.0000	7.82E-05	7.82E-05
11:20:00	0.0000	0.0000	0.0000	0.0000	7.79E-05	7.79E-05
11:30:00	0.0000	0.0000	0.0000	0.0000	7.76E-05	7.76E-05
11:40:00	0.0000	0.0000	0.0000	0.0000	7.72E-05	7.72E-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 11:42:18 AM 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: 99C7-A7E5

Site name: Sandown Park - Site 2

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):	0.02
Total Rainfall (mm):	39.51	Total flow (ML):	0.06
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)	38.43	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	5.38E-09	1.32E-06
00:20:00	0.2896	0.0000	0.0257	0.0000	3.32E-08	5.53E-06
00:30:00	0.3377	0.0000	0.0301	0.0000	1.09E-07	1.31E-05
00:40:00	0.3936	0.0000	0.0353	0.0000	2.61E-07	2.47E-05
00:50:00	0.4586	0.0000	0.0413	0.0000	5.25E-07	4.1E-05
01:00:00	0.5341	0.0000	0.0484	0.0001	9.41E-07	6.29E-05
01:10:00	0.6217	0.0000	0.0568	0.0001	1.55E-06	8.91E-05
01:20:00	0.7232	0.0000	0.0667	0.0001	2.37E-06	0.000118
01:30:00	0.8407	0.0000	0.0783	0.0001	3.44E-06	0.000151
01:40:00	0.9766	0.0000	0.0920	0.0002	4.78E-06	0.000189
01:50:00	1.1334	0.0000	0.1082	0.0002	6.42E-06	0.000231
02:00:00	1.3139	0.0000	0.1274	0.0003	8.41E-06	0.000279
02:10:00	1.5211	0.0000	0.1501	0.0003	1.08E-05	0.000334
02:20:00	1.7576	0.0000	0.1768	0.0004	1.36E-05	0.000399
02:30:00	2.0254	0.0000	0.2084	0.0005	1.7E-05	0.000474
02:40:00	2.3235	0.0000	0.2451	0.0005	2.1E-05	0.000563
02:50:00	2.6380	0.0000	0.2861	0.0006	2.57E-05	0.000666
03:00:00	2.8113	0.0000	0.3141	0.0008	3.13E-05	0.000787
03:10:00	2.6380	0.0000	0.3034	0.0009	3.79E-05	0.000927
03:20:00	2.3235	0.0000	0.2741	0.0010	4.56E-05	0.00108
03:30:00	2.0254	0.0000	0.2442	0.0012	5.45E-05	0.00125
03:40:00	1.7576	0.0000	0.2159	0.0013	6.46E-05	0.00141
03:50:00	1.5211	0.0000	0.1898	0.0015	7.59E-05	0.00156
04:00:00	1.3139	0.0000	0.1662	0.0016	8.81E-05	0.00168
04:10:00	1.1334	0.0000	0.1450	0.0017	0.000101	0.00178
04:20:00	0.9766	0.0000	0.1262	0.0017	0.000114	0.00183
04:30:00	0.8407	0.0000	0.1096	0.0017	0.000128	0.00184
04:40:00	0.7232	0.0000	0.0949	0.0017	0.000141	0.00183
04:50:00	0.6217	0.0000	0.0821	0.0016	0.000154	0.00178
05:00:00	0.5341	0.0000	0.0709	0.0016	0.000166	0.00172
05:10:00	0.4586	0.0000	0.0612	0.0015	0.000178	0.00165
05:20:00	0.3936	0.0000	0.0527	0.0014	0.000189	0.00157
05:30:00	0.3377	0.0000	0.0454	0.0013	0.000199	0.00148
05:40:00	0.2896	0.0000	0.0390	0.0012	0.000208	0.00138

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	0.0011	0.000216	0.00129
06:00:00	0.2128	0.0000	0.0288	0.0010	0.000224	0.00119
06:10:00	0.0000	0.0000	0.0000	0.0009	0.00023	0.00109
06:20:00	0.0000	0.0000	0.0000	0.0008	0.000236	0.001
06:30:00	0.0000	0.0000	0.0000	0.0007	0.000241	0.000906
06:40:00	0.0000	0.0000	0.0000	0.0006	0.000245	0.000816
06:50:00	0.0000	0.0000	0.0000	0.0005	0.000248	0.000732
07:00:00	0.0000	0.0000	0.0000	0.0004	0.000251	0.000655
07:10:00	0.0000	0.0000	0.0000	0.0003	0.000252	0.000583
07:20:00	0.0000	0.0000	0.0000	0.0003	0.000254	0.00052
07:30:00	0.0000	0.0000	0.0000	0.0002	0.000255	0.000467
07:40:00	0.0000	0.0000	0.0000	0.0002	0.000255	0.000422
07:50:00	0.0000	0.0000	0.0000	0.0001	0.000255	0.000386
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000255	0.000356
08:10:00	0.0000	0.0000	0.0000	0.0001	0.000255	0.000332
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000254	0.000312
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000253	0.000296
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000253	0.000283
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000252	0.000272
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000251	0.000264
09:10:00	0.0000	0.0000	0.0000	0.0000	0.00025	0.000257
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000249	0.000252
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000248	0.000249
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000247	0.000247
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000246	0.000246
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000244	0.000244
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000243	0.000243
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000242	0.000242
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000241	0.000241
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00024	0.00024
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000239	0.000239
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000238	0.000238
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000237	0.000237
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000236	0.000236
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000235	0.000235
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000234	0.000234

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 11:42:55 AM 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: 99C7-A7E5

Site name: Sandown Park - Site 2

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):	0.03
Total Rainfall (mm):	52.04	Total flow (ML):	0.08
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)	38.43	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	0.3270	0.0000	0.0290	0.0000	7.09E-09	1.74E-06
00:20:00	0.3815	0.0000	0.0340	0.0000	4.37E-08	7.29E-06
00:30:00	0.4448	0.0000	0.0398	0.0000	1.43E-07	1.73E-05
00:40:00	0.5185	0.0000	0.0467	0.0000	3.44E-07	3.26E-05
00:50:00	0.6041	0.0000	0.0548	0.0001	6.93E-07	5.42E-05
01:00:00	0.7035	0.0000	0.0644	0.0001	1.24E-06	8.31E-05
01:10:00	0.8189	0.0000	0.0757	0.0001	2.04E-06	0.000118
01:20:00	0.9526	0.0000	0.0891	0.0002	3.13E-06	0.000157
01:30:00	1.1074	0.0000	0.1049	0.0002	4.54E-06	0.000201
01:40:00	1.2864	0.0000	0.1237	0.0002	6.32E-06	0.00025
01:50:00	1.4929	0.0000	0.1461	0.0003	8.5E-06	0.000306
02:00:00	1.7307	0.0000	0.1727	0.0004	1.11E-05	0.000371
02:10:00	2.0036	0.0000	0.2044	0.0004	1.43E-05	0.000446
02:20:00	2.3152	0.0000	0.2422	0.0005	1.81E-05	0.000533
02:30:00	2.6679	0.0000	0.2870	0.0006	2.26E-05	0.000636
02:40:00	3.0606	0.0000	0.3398	0.0007	2.8E-05	0.000757
02:50:00	3.4747	0.0000	0.3994	0.0009	3.44E-05	0.000899
03:00:00	3.7030	0.0000	0.4416	0.0010	4.2E-05	0.00107
03:10:00	3.4747	0.0000	0.4293	0.0012	5.09E-05	0.00126
03:20:00	3.0606	0.0000	0.3901	0.0014	6.14E-05	0.00148
03:30:00	2.6679	0.0000	0.3492	0.0016	7.36E-05	0.00171
03:40:00	2.3152	0.0000	0.3100	0.0019	8.76E-05	0.00195
03:50:00	2.0036	0.0000	0.2734	0.0021	0.000103	0.00216
04:00:00	1.7307	0.0000	0.2401	0.0022	0.00012	0.00235
04:10:00	1.4929	0.0000	0.2100	0.0023	0.000138	0.00248
04:20:00	1.2864	0.0000	0.1831	0.0024	0.000157	0.00256
04:30:00	1.1074	0.0000	0.1592	0.0024	0.000176	0.00259
04:40:00	0.9526	0.0000	0.1381	0.0024	0.000195	0.00258
04:50:00	0.8189	0.0000	0.1196	0.0023	0.000213	0.00252
05:00:00	0.7035	0.0000	0.1034	0.0022	0.000231	0.00244
05:10:00	0.6041	0.0000	0.0892	0.0021	0.000247	0.00234
05:20:00	0.5185	0.0000	0.0769	0.0020	0.000263	0.00223
05:30:00	0.4448	0.0000	0.0663	0.0018	0.000277	0.00211
05:40:00	0.3815	0.0000	0.0570	0.0017	0.00029	0.00198

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	0.3270	0.0000	0.0490	0.0015	0.000302	0.00184
06:00:00	0.2803	0.0000	0.0421	0.0014	0.000313	0.00171
06:10:00	0.0000	0.0000	0.0000	0.0012	0.000322	0.00157
06:20:00	0.0000	0.0000	0.0000	0.0011	0.00033	0.00143
06:30:00	0.0000	0.0000	0.0000	0.0010	0.000337	0.0013
06:40:00	0.0000	0.0000	0.0000	0.0008	0.000343	0.00117
06:50:00	0.0000	0.0000	0.0000	0.0007	0.000348	0.00105
07:00:00	0.0000	0.0000	0.0000	0.0006	0.000352	0.00094
07:10:00	0.0000	0.0000	0.0000	0.0005	0.000355	0.000836
07:20:00	0.0000	0.0000	0.0000	0.0004	0.000357	0.000744
07:30:00	0.0000	0.0000	0.0000	0.0003	0.000358	0.000667
07:40:00	0.0000	0.0000	0.0000	0.0002	0.000359	0.000602
07:50:00	0.0000	0.0000	0.0000	0.0002	0.000359	0.000549
08:00:00	0.0000	0.0000	0.0000	0.0001	0.000359	0.000506
08:10:00	0.0000	0.0000	0.0000	0.0001	0.000358	0.000471
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000357	0.000442
08:30:00	0.0000	0.0000	0.0000	0.0001	0.000357	0.000419
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000355	0.0004
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000354	0.000384
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000353	0.000372
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000351	0.000363
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00035	0.000355
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000348	0.00035
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000347	0.000347
09:50:00	0.0000	0.0000	0.0000	0.0000	0.000345	0.000345
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000344	0.000344
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000343	0.000343
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000341	0.000341
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00034	0.00034
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000338	0.000338
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000337	0.000337
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000335	0.000335
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000334	0.000334
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000332	0.000332
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000331	0.000331
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000329	0.000329

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 2 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.056	0.370	0.041

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	1.4	19.0	2.5	0.0	0	22.9	20.6
0.5	7.3	14.6	0.9	12.0	1.6	0.0	0	14.5	26.1
1	9.0	9.0	0.6	7.4	1.0	0.0	0	8.9	32.2
2	14.1	7.0	0.4	5.8	0.8	0.0	0	7.0	50.4
4	19.4	4.8	0.3	4.0	0.5	0.0	0	4.8	69.3
6	22.4	3.7	0.2	3.1	0.4	0.0	0	3.7	80.0
8	24.4	3.0	0.2	2.5	0.3	0.0	0	3.0	87.1
12	27.0	2.3	0.1	1.9	0.2	0.0	0	2.2	96.6
16	28.9	1.8	0.1	1.5	0.2	0.0	0	1.8	103.1
20	30.3	1.5	0.1	1.2	0.2	0.0	0	1.5	108.3
24	31.6	1.3	0.1	1.1	0.1	0.0	0	1.3	112.8
28	32.7	1.2	0.1	1.0	0.1	0.0	0	1.2	116.8
32	33.7	1.1	0.1	0.9	0.1	0.0	0	1.0	120.4
36	34.6	1.0	0.1	0.8	0.1	0.0	0	1.0	123.8
40	35.5	0.9	0.1	0.7	0.1	0.0	0	0.9	127.0
44	36.4	0.8	0.1	0.7	0.1	0.0	0	0.8	130.1
48	37.2	0.8	0.0	0.6	0.1	0.0	0	0.8	133.1

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Tel: 01743 355770
www.hafrenwater.com

Client: **Rapleys LLP**

Title: Runoff rates and retention volumes for Site 2 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S2/A3.1 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Site 2 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.056	0.370	0.041

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	5.5	71.7	9.3	0.0	0	86.5	77.8
0.5	28.2	56.4	3.5	46.4	6.0	0.0	0	56.0	100.8
1	34.7	34.7	2.2	28.6	3.7	0.0	0	34.5	124.2
2	44.1	22.1	1.4	18.2	2.4	0.0	0	21.9	157.6
4	53.8	13.5	0.8	11.1	1.4	0.0	0	13.4	192.4
6	59.2	9.9	0.6	8.1	1.1	0.0	0	9.8	211.4
8	62.6	7.8	0.5	6.4	0.8	0.0	0	7.8	223.6
12	67.0	5.6	0.4	4.6	0.6	0.0	0	5.5	239.6
16	70.0	4.4	0.3	3.6	0.5	0.0	0	4.3	250.3
20	72.3	3.6	0.2	3.0	0.4	0.0	0	3.6	258.4
24	74.1	3.1	0.2	2.5	0.3	0.0	0	3.1	264.9
28	75.7	2.7	0.2	2.2	0.3	0.0	0	2.7	270.4
32	77.1	2.4	0.2	2.0	0.3	0.0	0	2.4	275.4
36	78.3	2.2	0.1	1.8	0.2	0.0	0	2.2	280.0
40	79.5	2.0	0.1	1.6	0.2	0.0	0	2.0	284.3
44	80.7	1.8	0.1	1.5	0.2	0.0	0	1.8	288.4
48	81.7	1.7	0.1	1.4	0.2	0.0	0	1.7	292.2

*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 2 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S2/A3.2 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 2 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.056	0.370	0.041

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	7.1	93.2	12.1	0.0	0	112.4	101.2
0.5	36.9	73.8	4.6	60.8	7.9	0.0	0	73.3	131.9
1	45.8	45.8	2.9	37.7	4.9	0.0	0	45.5	163.8
2	57.4	28.7	1.8	23.6	3.1	0.0	0	28.5	205.2
4	70.4	17.6	1.1	14.5	1.9	0.0	0	17.5	251.5
6	77.7	12.9	0.8	10.7	1.4	0.0	0	12.9	277.7
8	82.6	10.3	0.6	8.5	1.1	0.0	0	10.3	295.2
12	88.9	7.4	0.5	6.1	0.8	0.0	0	7.4	317.9
16	92.9	5.8	0.4	4.8	0.6	0.0	0	5.8	332.2
20	95.8	4.8	0.3	3.9	0.5	0.0	0	4.8	342.3
24	97.9	4.1	0.3	3.4	0.4	0.0	0	4.1	350.1
28	99.6	3.6	0.2	2.9	0.4	0.0	0	3.5	356.2
32	101.1	3.2	0.2	2.6	0.3	0.0	0	3.1	361.3
36	102.4	2.8	0.2	2.3	0.3	0.0	0	2.8	365.9
40	103.5	2.6	0.2	2.1	0.3	0.0	0	2.6	370.1
44	104.6	2.4	0.1	2.0	0.3	0.0	0	2.4	373.9
48	105.6	2.2	0.1	1.8	0.2	0.0	0	2.2	377.4

*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 2 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S2/A3.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-1-year storm) for Roads, Roofs and Parking at Site 2 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.088	0.044	0.335

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 3.0 l/s

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

Area of Soakaway 10 m^2

Infiltration Rate 3.00E-04 m/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	2.3	2.3	20.4	0.0	-3	21.9	19.7
0.5	7.3	14.6	1.4	1.4	12.9	0.0	-3	12.8	23.0
1	9.0	9.0	0.9	0.9	8.0	0.0	-3	6.7	24.2
2	14.1	7.0	0.7	0.7	6.2	0.0	-3	4.6	33.2
4	19.4	4.8	0.5	0.5	4.3	0.0	-3	2.2	32.2
6	22.4	3.7	0.4	0.4	3.3	0.0	-3	1.0	22.2
8	24.4	3.0	0.3	0.3	2.7	0.0	-3	0.3	8.4
12	27.0	2.3	0.2	0.2	2.0	0.0	-3	-0.6	-24.5
16	28.9	1.8	0.2	0.2	1.6	0.0	-3	-1.1	-60.6
20	30.3	1.5	0.1	0.1	1.3	0.0	-3	-1.4	-98.1
24	31.6	1.3	0.1	0.1	1.2	0.0	-3	-1.6	-136.4
28	32.7	1.2	0.1	0.1	1.0	0.0	-3	-1.7	-175.4
32	33.7	1.1	0.1	0.1	0.9	0.0	-3	-1.9	-214.6
36	34.6	1.0	0.1	0.1	0.9	0.0	-3	-2.0	-254.1
40	35.5	0.9	0.1	0.1	0.8	0.0	-3	-2.0	-293.8
44	36.4	0.8	0.1	0.1	0.7	0.0	-3	-2.1	-333.7
48	37.2	0.8	0.1	0.1	0.7	0.0	-3	-2.2	-373.6

*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 roads, roofs and parking at Site 2 - PROPOSED
Project:	Sandown Park
Calc Sheet:	2661_OPA/S2/A4.1
Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-30-year storm) for Roads, Roofs and Parking at Site 2 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.088	0.044	0.335

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

$$Q_p = 2.78\ CiA$$

Where:

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

Climate change (% rainfall increase) 0 %

Infiltration loss through soakaway 3.0 l/s

Area of Soakaway 10 m^2

Infiltration Rate 3.00E-04 m/s

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

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas*3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	30 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	21.8	87.1	8.5	8.5	77.0	0.0	-3	91.1	82.0
0.5	28.2	56.4	5.5	5.5	49.9	0.0	-3	57.9	104.2
1	34.7	34.7	3.4	3.4	30.7	0.0	-3	34.5	124.3
2	44.1	22.1	2.2	2.2	19.5	0.0	-3	20.8	149.9
4	53.8	13.5	1.3	1.3	11.9	0.0	-3	11.5	166.1
6	59.2	9.9	1.0	1.0	8.7	0.0	-3	7.7	165.3
8	62.6	7.8	0.8	0.8	6.9	0.0	-3	5.4	156.9
12	67.0	5.6	0.5	0.5	4.9	0.0	-3	3.0	131.1
16	70.0	4.4	0.4	0.4	3.9	0.0	-3	1.7	99.6
20	72.3	3.6	0.4	0.4	3.2	0.0	-3	0.9	65.1
24	74.1	3.1	0.3	0.3	2.7	0.0	-3	0.3	29.0
28	75.7	2.7	0.3	0.3	2.4	0.0	-3	-0.1	-8.2
32	77.1	2.4	0.2	0.2	2.1	0.0	-3	-0.4	-45.9
36	78.3	2.2	0.2	0.2	1.9	0.0	-3	-0.6	-84.1
40	79.5	2.0	0.2	0.2	1.8	0.0	-3	-0.9	-122.6
44	80.7	1.8	0.2	0.2	1.6	0.0	-3	-1.0	-161.4
48	81.7	1.7	0.2	0.2	1.5	0.0	-3	-1.2	-200.5

*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/S2/A4.2
Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 2 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.088	0.044	0.335

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

$$Q_p = 2.78\,CiA$$

Where:

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

Climate change (% rainfall increase) 0 %

Infiltration loss through soakaway 3.0 l/s

Area of Soakaway 10 m^2

Infiltration Rate 3.00E-04 m/s

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

Duration	Rainfall *2	Rainfall intensity	Accretion Rate from Grassed Areas*3	Accretion Rate from Hardstanding *3	Accretion Rate from Roofing *3	Accretion Rate from Groundwater *3	Accretion Rate from Watercourse *3	Net Accretion Rate in Storage	Net Accretion Volume in Storage
	100 year event								
hours	mm	mm/hr	l/s	l/s	l/s	l/s	l/s	l/s	m^3
0.25	28.3	113.2	11.1	11.1	100.2	0.0	-3	119.3	107.4
0.5	36.9	73.8	7.2	7.2	65.3	0.0	-3	76.7	138.1
1	45.8	45.8	4.5	4.5	40.5	0.0	-3	46.5	167.4
2	57.4	28.7	2.8	2.8	25.4	0.0	-3	28.0	201.7
4	70.4	17.6	1.7	1.7	15.6	0.0	-3	16.0	230.4
6	77.7	12.9	1.3	1.3	11.5	0.0	-3	11.0	237.3
8	82.6	10.3	1.0	1.0	9.1	0.0	-3	8.2	234.8
12	88.9	7.4	0.7	0.7	6.6	0.0	-3	5.0	216.3
16	92.9	5.8	0.6	0.6	5.1	0.0	-3	3.3	188.6
20	95.8	4.8	0.5	0.5	4.2	0.0	-3	2.2	156.5
24	97.9	4.1	0.4	0.4	3.6	0.0	-3	1.4	121.7
28	99.6	3.6	0.3	0.3	3.1	0.0	-3	0.8	85.1
32	101.1	3.2	0.3	0.3	2.8	0.0	-3	0.4	47.6
36	102.4	2.8	0.3	0.3	2.5	0.0	-3	0.1	9.3
40	103.5	2.6	0.3	0.3	2.3	0.0	-3	-0.2	-29.3
44	104.6	2.4	0.2	0.2	2.1	0.0	-3	-0.4	-68.4
48	105.6	2.2	0.2	0.2	1.9	0.0	-3	-0.6	-107.8

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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Title:	Runoff rates and retention volumes for roads, roofs and parking at Site 2 - PROPOSED
Project:	Sandown Park
Calc Sheet:	2661_OPA/S2/A4.3
Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm+CC) for Roads, Roofs and Parking at Site 2 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.088	0.044	0.335

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 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	13.3	13.3	120.2	0.0	-3	143.8	129.4
0.5	36.9	73.8	8.7	8.7	78.4	0.0	-3	92.7	166.8
1	45.8	45.8	5.4	5.4	48.6	0.0	-3	56.4	203.0
2	57.4	28.7	3.4	3.4	30.5	0.0	-3	34.2	246.3
4	70.4	17.6	2.1	2.1	18.7	0.0	-3	19.8	285.2
6	77.7	12.9	1.5	1.5	13.7	0.0	-3	13.8	297.7
8	82.6	10.3	1.2	1.2	11.0	0.0	-3	10.4	299.1
12	88.9	7.4	0.9	0.9	7.9	0.0	-3	6.6	285.5
16	92.9	5.8	0.7	0.7	6.2	0.0	-3	4.5	260.9
20	95.8	4.8	0.6	0.6	5.1	0.0	-3	3.2	231.0
24	97.9	4.1	0.5	0.5	4.3	0.0	-3	2.3	197.9
28	99.6	3.6	0.4	0.4	3.8	0.0	-3	1.6	162.6
32	101.1	3.2	0.4	0.4	3.4	0.0	-3	1.1	126.2
36	102.4	2.8	0.3	0.3	3.0	0.0	-3	0.7	89.0
40	103.5	2.6	0.3	0.3	2.7	0.0	-3	0.4	51.2
44	104.6	2.4	0.3	0.3	2.5	0.0	-3	0.1	12.9
48	105.6	2.2	0.3	0.3	2.3	0.0	-3	-0.1	-25.6

*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 roads, roofs and parking at Site 2 - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/S2/A4.4 Date: Jan-19

4 SANDOWN PARK – SITE 3

4.1 Background

This chapter discusses the issues relating to flooding and drainage specifically at the Application Area known as Site 3 (Villas Residential), shown on *Drawing 2661/OPA-S3/01*.

4.2 Location and setting

The Application Area is located at the northwestern corner of the landholding and comprises a narrow, elongated area of land which is bounded by Moor Lane to the west and Lower Green Road to the north. It extends to approximately 1.77 ha.

4.3 The proposed development

The area of the proposed development currently comprises buildings that serve as the Racecourse staff accommodation (see *Photographs 2661/OPA-S3/P1 and P2*). It is proposed to redevelop the area and construct approximately 114 one and two bedroom apartments. The current and proposed land uses are shown on *Drawing 2661/OPA-S3/01*.

4.4 Baseline conditions

4.4.1 Landform

A topographic survey was undertaken in November 2018. The elevation of the ground surface within the Application Area declines southwards, from approximately 13.3 mAOD to 11 mAOD.

4.5 Hydrology

A watercourse exists immediately north of the site as shown in *Photographs 2661/OPA-S3/P3 and P4* and a drain is located 80 m south of the Application Area within the racetrack (*Photographs 2661/OPA-S3/P5 and P6*).

4.6 Geology

The bedrock beneath the site is the Claygate Member. It is overlain by the Kempton Park Gravel Member in the east of the site and River Terrace and Alluvium in the western extent of the Application Area. The local geology is shown on *Drawing 2661/OPA-S3/02*.

The Claygate Member comprises dark grey clays with sand laminae, passing up into thin alternations of clays, silts and fine-grained sand. It is distinguished from the underlying Sheppey Member (of the London Clay) by the laminated character and relative abundance of sand. 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.

All of the superficial deposits comprise sand and gravel, with lenses of silt, clay or peat. Borehole logs in the vicinity recorded thicknesses of superficial deposits of between 1.4 – 6.4 m across the site.

4.7 Fluvial flood mapping

The Application Area is located within the Environment Agency's indicative Flood Zone 2 where the probability of fluvial flooding in any one year is between 1 in 1000 and 1 in 100 (Annual Exceedance Probability, AEP <1%) (*Drawing 2661/OPA-S3/03*). Correspondence with the Environment Agency stated that 'it is highly likely that the impacts from climate change will alter Site 3's flood risk classification so we would therefore treat the site as Flood Zone 3a, for purposes of flood management and mitigation'.

Flood Zone 3a has a probability of fluvial flooding in any one year of 1 in 100 or greater (AEP >1%). Due to its size and location a Flood Risk Assessment is required in accordance with the Planning Practice Guidance and the policies of Elmbridge Borough Council.

The area has been hydrologically modelled and relevant data ('Product 4') obtained from the Environment Agency (see *Appendix 2661/OPA/A7*).

4.8 Drainage characteristics

The Application Area is located within Flood Zone 2 where there is a medium risk of fluvial flooding. With consideration of climate change and advice provided by the Environment Agency, the site is to be treated as if it was located in Flood Zone 3a in terms of flood management and mitigation, where there is a high risk of fluvial flooding.

Flooding has historically occurred within the Application Area as advised by the Environment Agency, the extent of which is shown on *Drawing 2661/OPA-S3/03*.

Small areas of the site are noted as being at low, medium and high risk of surface water flooding, with a chance of flooding up to 3.3%, the extent of which is shown on *Drawing 2661/OPA-S3/04*. These areas are considered likely to be associated with topographical lows within the existing ground surface which would be re-profiled during the development.

The site comprises areas of hardstanding, gardens and residential properties with trees in a grassed area to the north of the site. A well maintained watercourse occurs immediately to

the north of the site and drains eastwards. Under current conditions surface water run-off across the Application Area is conveyed to the watercourse by pipe.

The site is located above superficial deposits which comprise sand and gravels with lenses of silt clay or peat. These overlie the slowly permeable Claygate Member, therefore the natural drainability of the sub-surface is considered to be limited.

The existing piped drainage provision is shown on *Drawing 2661/OPA-S3/05.*

4.9 Assessment of flood risk and drainage

4.9.1 Flood risk to the development

The Application Area is situated within Flood Zone 2 which has a medium risk of fluvial flooding. Residential development within this designation is permitted, subject to appropriate mitigation methods.

However, the EA has advised that for purposes of planning the area should be treated as Flood Zone 3a. Residential development is permitted in this designation, with finished floor levels (FFL) to be above the 1 in 100-year flood level, plus climate change allowance.

The sequential test has been applied as per Table 3 of the NPPF (see below).

Flood risk vulnerability classification		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zones	Zone 1	√	√	√	√	√
	Zone 2	√	√	Exception Test required	√	√
	Zone 3A	Exception Test required	√	*X*	Exception Test required	√
	Zone 3B functional floodplain	Exception Test required	√	*X*	*X*	*X*
√ Development is appropriate *X* Development should not be permitted						

This site is part of a Masterplan-led hybrid application, and cannot be directed to an area at a lower risk of flooding, such as in Flood Zone 1. Residential development is classified as 'more vulnerable'. In Flood Zone 2 this type of development is considered appropriate under the NPPF, however the Exception Test is required for sites located within Flood Zone 3A. The

Exception Test is addressed by managing and mitigating flood risk on site, principally ensuring that the FFL is raised above the modelled 1% Flood Level, plus the required Climate Change Allowance and a regional correction. Appropriate elevations have been incorporated into the design of the proposed development.

Small areas of the site are 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.

4.9.2 Flood risk from the development

The surrounds of the Application Area are also located within Flood Zone 2 which is classified as having a 'medium' fluvial flood risk. Mitigation methods will attenuate and temporarily store water generated during storm events to limit impact of the proposed development to downstream flood receptors.

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 would be improved upon as part of the development and will ensure that volumes of surface water run-off can be retained, attenuated or infiltrated within the site boundary. The surface water drainage within the proposed development will be designed to manage volumes equivalent to the greenfield run-off rate.

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

4.9.3 Climate change

Within the UK, projections of future climate change indicate that there will be more frequent, short duration, high intensity rainfall events and periods of long duration rainfall. The NPPF recommends that the effects of climate change are incorporated into Flood Risk Assessments.

4.9.4 Drainage requirements

Infiltration to ground via soakaway may not be considered feasible at this site. Therefore discharge to the watercourse on the northern site boundary is proposed. SuDS methods to reduce, retain and temporarily store water generated during storm events prior to discharge off-site would be incorporated into the development design, and would conform to best practice. These could include grassed swales, French drains and ephemeral ponds. It is

anticipated that below ground attenuation in the form of geo-cellular storage will be used and located beneath the proposed hardstanding parking areas along the northern boundary, an area comprising approximately 5,000 m^2. The geo-cellular storage will provide 962.8 m^3 for the 1 in 100-year plus 20% climate change event, assuming discharge at the QBAR greenfield rate (5.1 l/s).

The outfall into the existing ditch will be located at the downstream end of the site, along the western boundary.

The surface water drainage within the proposed development will be designed to regulate discharge off-site equivalent to the greenfield run-off rate.

The site is located within Flood Zone 2, however, impacts from climate change are likely to increase the risk of flooding in this area. Therefore mitigation measures such as raising floor levels above the 1 in 100-year (plus climate change) event and flood evacuation routes will need to be considered. 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.

4.9.5 Betterment

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

4.10 Summary and conclusions

The Application Area is located at the northwestern corner of Sandown Park and is 1.8 ha in extent.

The site is located within the Environment Agency's indicative Flood Zone 2, where the probability of fluvial flooding in any one year is between 1 in 1,000 and 1 in 100 (Annual Exceedance Probability, AEP <1%). Therefore, the site is deemed to be at a medium risk of fluvial flooding and mitigation measures are required to prevent increasing flood risk to flood receptors downstream. Design elements such as raising floor levels and appropriate flood escape routes will need to be considered.

Small areas of the site are noted as being at low, medium and high risk of surface water flooding, with a likelihood of flooding up to 3.3%. However these are likely to be associated

with topographical lows within the current land cover which will 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 site is considered to be limited and infiltration to ground via soakaway may not be feasible. However, soakaway tests should be undertaken to determine if a proportion of the water can be disposed of to ground. However, discharge to the watercourse to the north of the site will have to be considered. If SuDS methods are adopted to retain, attenuate and temporarily store water generated during storm events prior to discharge off-site, it is considered that the risk of increasing flood risk to or from the development is small.

2661/OPA-S3/01: Existing development
Google earth imagery (May 2018)

2661/OPA-S3/01: Proposed development

Please note drawings are illustrative

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United Kingdom • SY1 1SB
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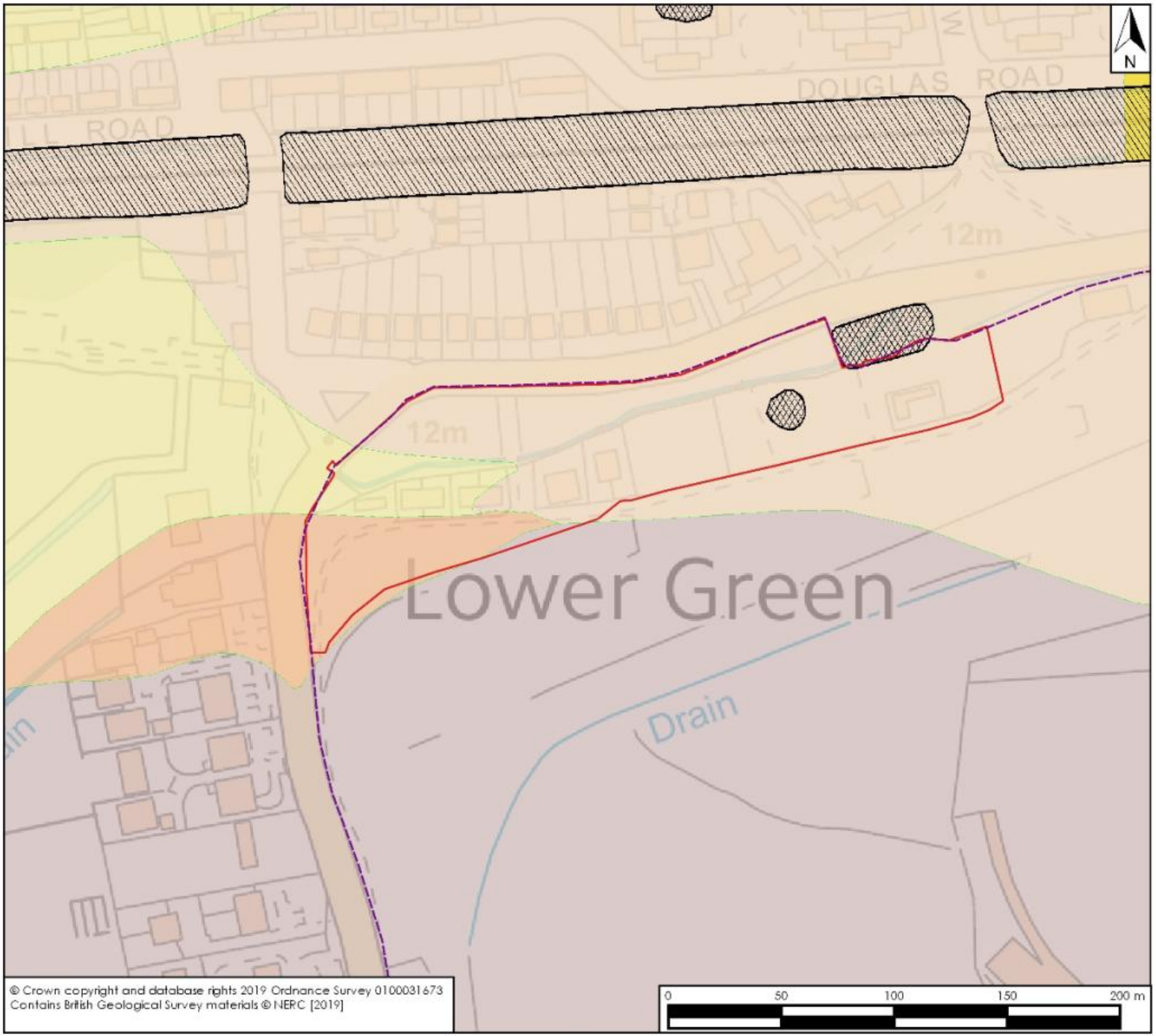
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-S3/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Landholding
- Site 3 Application Area
- Artificial ground

Superficial Geology

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

Bedrock Geology

- Claygate Member

Scale correct at A4

Client	Rapleys LLP
Title	Geology
Project	Sandown Park
Drawing	2661/OPA-S3/02
Version	2
Date	Jan 19
Scale	1:2,500

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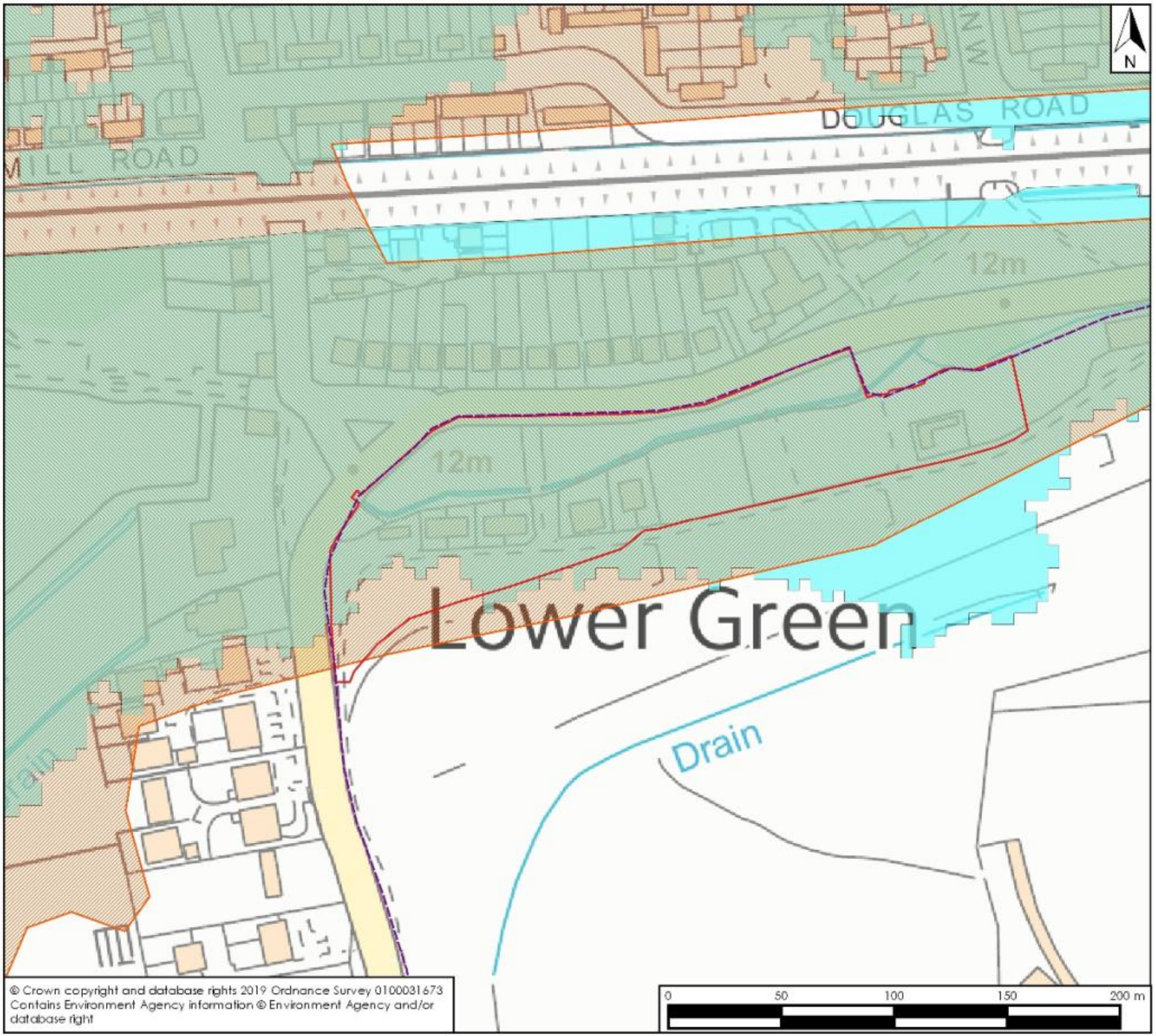

Legend

- Landholding
- Site 3 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-S3/03
Version	2
Date	Jan 19
Scale	1:2,500

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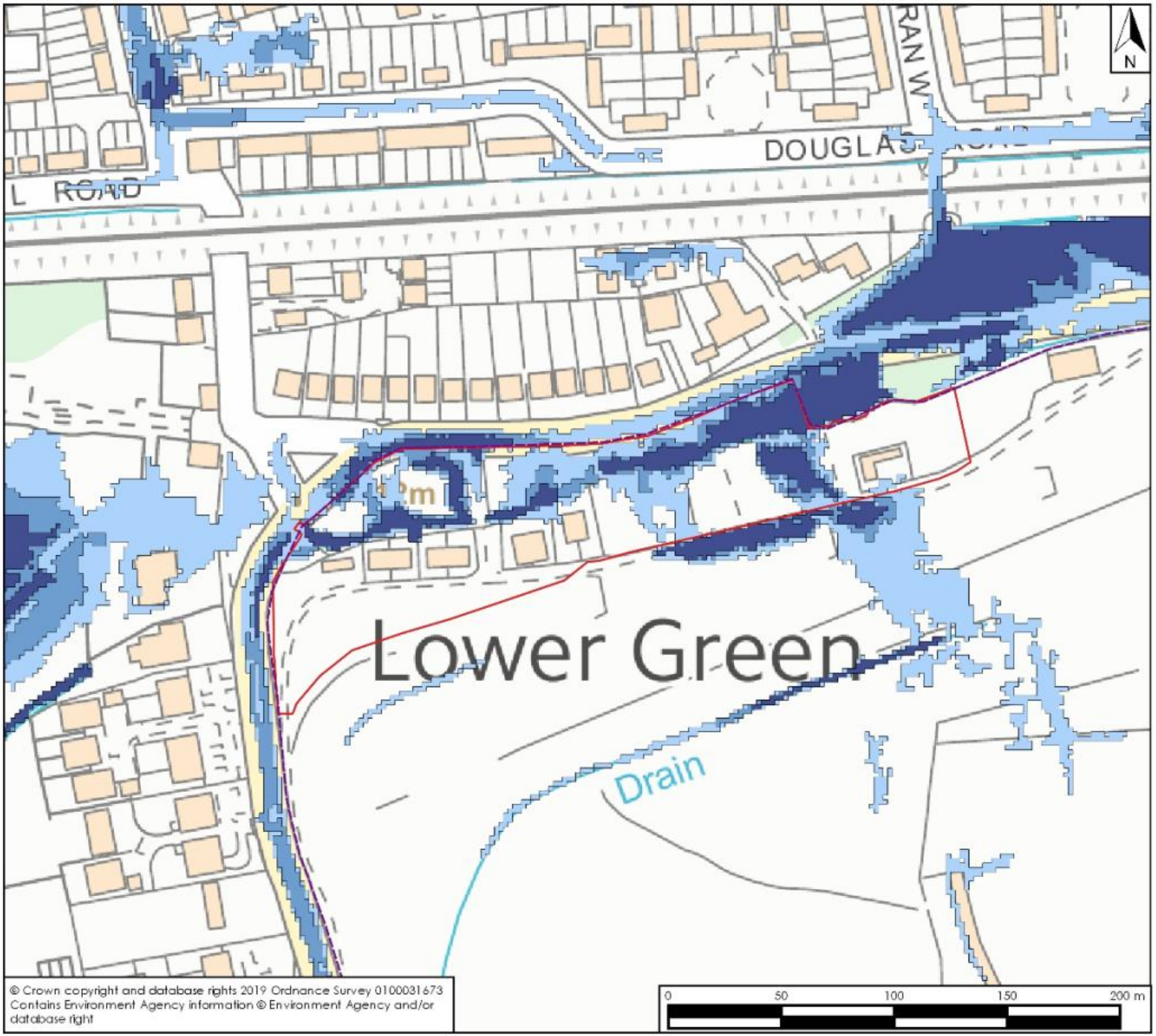

Legend

- Landholding
- Site 3 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-S3/04
Version	2
Date	Jan 19
Scale	1:2,500

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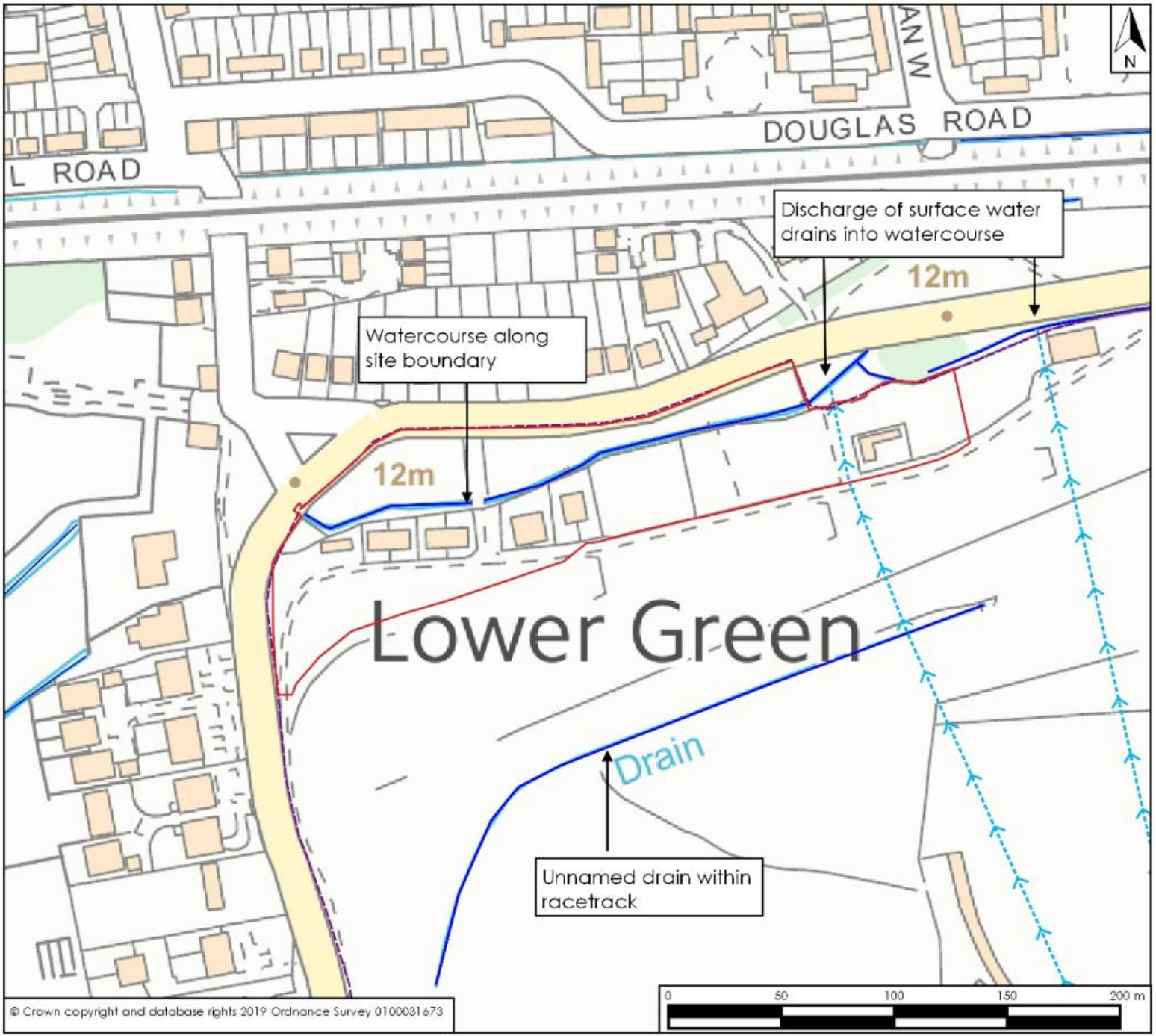

Legend

- Landholding
- Site 3 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-S3/05
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 3 – Villas Residential
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 137 656
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Developed
Total site area	17,697 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.86 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	0.40	0.86	0.51 (derived from 0.46 + 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)	Conveyed by pipe to watercourse to north of site. See Drawing 2661/OPA-S3/05			**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	**? (TBC)**	Detailed designs required to assess whether there is scope to reduce at source.	**Evidence: Details of amount of runoff reduced and storage provided**
Infiltration to ground			**Evidence: The results of infiltration tests in soakaway locations. If infiltration is deemed not viable clear site specific evidence must be provided** see Section 6 (infiltration)
Attenuated volume and discharge to watercourse	✓	Assessment of watercourse to be carried out at detailed stage	**Evidence: Details of any watercourse to which the site drains including cross-sections of any adjacent water courses for appropriate distance upstream and downstream of the discharge point (as agreed with the LLFA and/or EA)** see Section 7 (attenuated discharge)
Attenuated volume and discharge to surface water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)
Attenuated volume and discharge to combined/foul water sewer			**Evidence: Confirmation from sewer provider of agreed discharge rate and that sufficient capacity exists for this connection** see Section 7 (attenuated discharge)
	Drawings provided		**NOTES AND REQUIRED EVIDENCE**

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

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

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

	Greenfield Rates (l/s)	**Brownfield rates (l/s)** (as appropriate)	**Proposed Rates (l/s)**	**Difference (**Proposed-Existing**) (l/s)**	**NOTES AND REQUIRED EVIDENCE**
Qbar	5.1	-	-	-	Mean annual Greenfield peak flow - QBAR is approx. 1 in 2 storm events. **Qbar**$_{rural}$ should be used for this value. If the site is currently developed, the appropriate figures should be used to calculate Qbar (and associated rates) in proportion to the amount of existing hardstanding present on the site. Use Qbar$_{rural}$ and Qbar$_{urban}$ as appropriate and prorata'd to effectively model the site.
1 in 1	2.28	9.2	5.1	-4.1	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	6.91	24.2	5.1	-19.1	
1in 100	9.73	31.8	5.1	-26.7	
1 in 100 plus 20% climate change *	N/A	N/A	5.1	-	

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	72.1	197.7	141.4	-56.3	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	218.0	522.5	546.7	24.2	
1in 100	306.0	686.1	768.7	82.6	
1 in 100 plus 20% climate change *	N/A	N/A	962.8	-	

* 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)	962.8	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?	To be confirmed at full planning application stage. System will be designed	

	to attenuate the 1 in 100 year event plus 20% climate change.	**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)	To be confirmed	**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

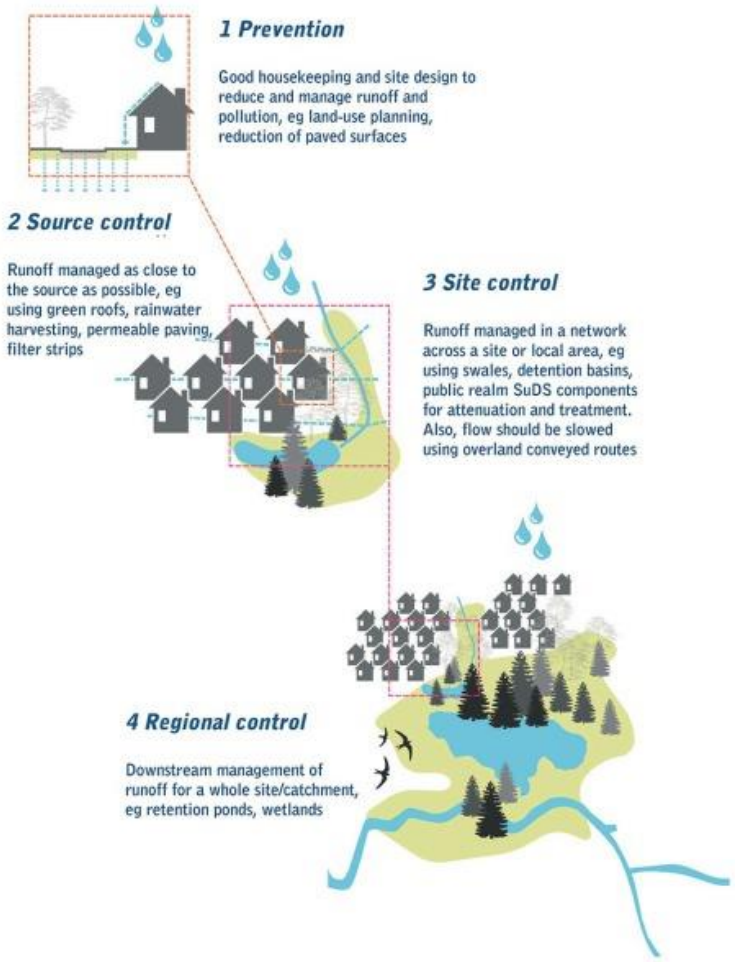
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 3

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	0.0177 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	5.1 l/s
Q (1in1yr)*	4.4 l/s
QBAR	2.9 l/s/ha
Q (1in1yr)	2.5 l/s/ha
Q (1in100yr)	9.2 l/s/ha

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

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

Return period (yr)	**1**	**2**	**5**	**10**	**25**	**30**	**50**	**100**	**200**
Q (l/s/ha)	2.5	2.5	3.7	4.7	6.2	7.0	7.6	9.2	11.2
Q (l/s)	4.4	4.5	6.6	8.3	11.0	12.3	13.4	16.4	19.8

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UK
Tel: 01743 355770
www.hafrenwater.com

Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE 3, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 11:46:40 AM 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: EC24-69BC

Site name: Sandown Park - Site 3

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

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

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.03
Total Rainfall (mm):	15.00	Total flow (ML):	0.07
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)	42.52	No
BR	1.88	No

Urbanisation parameters

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

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.0808	0.0000	0.0071	0.0000	0	0
00:10:00	0.0943	0.0000	0.0083	0.0000	6.99E-09	1.9E-06
00:20:00	0.1100	0.0000	0.0097	0.0000	4.31E-08	7.94E-06
00:30:00	0.1282	0.0000	0.0113	0.0000	1.41E-07	1.88E-05
00:40:00	0.1495	0.0000	0.0132	0.0000	3.39E-07	3.54E-05
00:50:00	0.1742	0.0000	0.0155	0.0001	6.81E-07	5.87E-05
01:00:00	0.2028	0.0000	0.0181	0.0001	1.22E-06	8.99E-05
01:10:00	0.2361	0.0000	0.0211	0.0001	2E-06	0.000127
01:20:00	0.2746	0.0000	0.0246	0.0002	3.07E-06	0.000169
01:30:00	0.3193	0.0000	0.0287	0.0002	4.44E-06	0.000215
01:40:00	0.3709	0.0000	0.0335	0.0003	6.16E-06	0.000267
01:50:00	0.4304	0.0000	0.0391	0.0003	8.27E-06	0.000326
02:00:00	0.4990	0.0000	0.0456	0.0004	1.08E-05	0.000392
02:10:00	0.5776	0.0000	0.0532	0.0005	1.38E-05	0.000468
02:20:00	0.6675	0.0000	0.0620	0.0005	1.75E-05	0.000555
02:30:00	0.7692	0.0000	0.0721	0.0006	2.17E-05	0.000656
02:40:00	0.8824	0.0000	0.0835	0.0007	2.67E-05	0.000773
02:50:00	1.0018	0.0000	0.0960	0.0009	3.26E-05	0.000908
03:00:00	1.0676	0.0000	0.1036	0.0010	3.95E-05	0.00106
03:10:00	1.0018	0.0000	0.0985	0.0012	4.75E-05	0.00124
03:20:00	0.8824	0.0000	0.0877	0.0014	5.68E-05	0.00143
03:30:00	0.7692	0.0000	0.0772	0.0016	6.74E-05	0.00163
03:40:00	0.6675	0.0000	0.0676	0.0017	7.94E-05	0.00183
03:50:00	0.5776	0.0000	0.0589	0.0019	9.25E-05	0.002
04:00:00	0.4990	0.0000	0.0512	0.0020	0.000107	0.00214
04:10:00	0.4304	0.0000	0.0444	0.0021	0.000122	0.00224
04:20:00	0.3709	0.0000	0.0385	0.0021	0.000137	0.00228
04:30:00	0.3193	0.0000	0.0332	0.0021	0.000152	0.00228
04:40:00	0.2746	0.0000	0.0287	0.0021	0.000167	0.00224
04:50:00	0.2361	0.0000	0.0247	0.0020	0.000181	0.00218
05:00:00	0.2028	0.0000	0.0213	0.0019	0.000195	0.00209
05:10:00	0.1742	0.0000	0.0183	0.0018	0.000208	0.00199
05:20:00	0.1495	0.0000	0.0158	0.0017	0.00022	0.00188
05:30:00	0.1282	0.0000	0.0135	0.0015	0.000231	0.00176
05:40:00	0.1100	0.0000	0.0116	0.0014	0.00024	0.00164

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	0.0943	0.0000	0.0100	0.0013	0.000249	0.00152
06:00:00	0.0808	0.0000	0.0086	0.0011	0.000257	0.0014
06:10:00	0.0000	0.0000	0.0000	0.0010	0.000264	0.00128
06:20:00	0.0000	0.0000	0.0000	0.0009	0.00027	0.00116
06:30:00	0.0000	0.0000	0.0000	0.0008	0.000275	0.00105
06:40:00	0.0000	0.0000	0.0000	0.0007	0.000279	0.000939
06:50:00	0.0000	0.0000	0.0000	0.0006	0.000283	0.00084
07:00:00	0.0000	0.0000	0.0000	0.0005	0.000285	0.000749
07:10:00	0.0000	0.0000	0.0000	0.0004	0.000287	0.000666
07:20:00	0.0000	0.0000	0.0000	0.0003	0.000289	0.000593
07:30:00	0.0000	0.0000	0.0000	0.0002	0.00029	0.000531
07:40:00	0.0000	0.0000	0.0000	0.0002	0.00029	0.00048
07:50:00	0.0000	0.0000	0.0000	0.0001	0.00029	0.000438
08:00:00	0.0000	0.0000	0.0000	0.0001	0.00029	0.000404
08:10:00	0.0000	0.0000	0.0000	0.0001	0.00029	0.000377
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000289	0.000355
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000288	0.000337
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000288	0.000322
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000287	0.00031
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000286	0.000301
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000285	0.000293
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000284	0.000288
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000283	0.000284
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000281	0.000282
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00028	0.00028
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000279	0.000279
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000278	0.000278
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000277	0.000277
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000276	0.000276
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000275	0.000275
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000274	0.000274
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000273	0.000273
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000272	0.000272
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000271	0.000271
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00027	0.00027
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000269	0.000269

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 11:46:22 AM 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: EC24-69BC

Site name: Sandown Park - Site 3

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

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

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.08
Total Rainfall (mm):	39.43	Total flow (ML):	0.22
Peak Rainfall (mm):	2.81	Peak flow (m^3/s):	0.01

Parameters

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

Rainfall parameters (Rainfall - FEH 2013 model)

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

Loss model parameters

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

Routing model parameters

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

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	42.52	No
BR	1.88	No

Urbanisation parameters

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

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2123	0.0000	0.0187	0.0000	0	0
00:10:00	0.2478	0.0000	0.0219	0.0000	1.84E-08	5E-06
00:20:00	0.2890	0.0000	0.0257	0.0000	1.13E-07	2.09E-05
00:30:00	0.3370	0.0000	0.0300	0.0000	3.71E-07	4.96E-05
00:40:00	0.3928	0.0000	0.0352	0.0001	8.93E-07	9.34E-05
00:50:00	0.4577	0.0000	0.0412	0.0002	1.8E-06	0.000155
01:00:00	0.5330	0.0000	0.0483	0.0002	3.22E-06	0.000237
01:10:00	0.6204	0.0000	0.0567	0.0003	5.29E-06	0.000336
01:20:00	0.7217	0.0000	0.0665	0.0004	8.11E-06	0.000447
01:30:00	0.8390	0.0000	0.0781	0.0006	1.18E-05	0.000571
01:40:00	0.9747	0.0000	0.0918	0.0007	1.63E-05	0.000711
01:50:00	1.1312	0.0000	0.1080	0.0008	2.2E-05	0.00087
02:00:00	1.3113	0.0000	0.1271	0.0010	2.88E-05	0.00105
02:10:00	1.5181	0.0000	0.1497	0.0012	3.69E-05	0.00126
02:20:00	1.7541	0.0000	0.1765	0.0015	4.67E-05	0.0015
02:30:00	2.0214	0.0000	0.2079	0.0017	5.82E-05	0.00179
02:40:00	2.3189	0.0000	0.2445	0.0020	7.19E-05	0.00212
02:50:00	2.6327	0.0000	0.2854	0.0024	8.81E-05	0.00251
03:00:00	2.8057	0.0000	0.3133	0.0029	0.000107	0.00296
03:10:00	2.6327	0.0000	0.3026	0.0034	0.00013	0.00349
03:20:00	2.3189	0.0000	0.2734	0.0039	0.000156	0.00408
03:30:00	2.0214	0.0000	0.2436	0.0045	0.000187	0.00469
03:40:00	1.7541	0.0000	0.2154	0.0051	0.000221	0.0053
03:50:00	1.5181	0.0000	0.1894	0.0056	0.00026	0.00586
04:00:00	1.3113	0.0000	0.1658	0.0060	0.000302	0.00633
04:10:00	1.1312	0.0000	0.1447	0.0063	0.000346	0.00667
04:20:00	0.9747	0.0000	0.1259	0.0065	0.000392	0.00686
04:30:00	0.8390	0.0000	0.1093	0.0065	0.000438	0.00691
04:40:00	0.7217	0.0000	0.0947	0.0064	0.000484	0.00685
04:50:00	0.6204	0.0000	0.0819	0.0062	0.000528	0.00669
05:00:00	0.5330	0.0000	0.0707	0.0059	0.00057	0.00646
05:10:00	0.4577	0.0000	0.0610	0.0056	0.00061	0.00618
05:20:00	0.3928	0.0000	0.0526	0.0052	0.000648	0.00586
05:30:00	0.3370	0.0000	0.0452	0.0048	0.000682	0.00552
05:40:00	0.2890	0.0000	0.0389	0.0044	0.000714	0.00516

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	0.2478	0.0000	0.0334	0.0041	0.000742	0.00479
06:00:00	0.2123	0.0000	0.0287	0.0037	0.000768	0.00442
06:10:00	0.0000	0.0000	0.0000	0.0033	0.00079	0.00406
06:20:00	0.0000	0.0000	0.0000	0.0029	0.00081	0.00369
06:30:00	0.0000	0.0000	0.0000	0.0025	0.000827	0.00334
06:40:00	0.0000	0.0000	0.0000	0.0022	0.000841	0.003
06:50:00	0.0000	0.0000	0.0000	0.0018	0.000852	0.00268
07:00:00	0.0000	0.0000	0.0000	0.0015	0.000861	0.00239
07:10:00	0.0000	0.0000	0.0000	0.0012	0.000868	0.00212
07:20:00	0.0000	0.0000	0.0000	0.0010	0.000873	0.00188
07:30:00	0.0000	0.0000	0.0000	0.0008	0.000876	0.00168
07:40:00	0.0000	0.0000	0.0000	0.0006	0.000878	0.00151
07:50:00	0.0000	0.0000	0.0000	0.0005	0.000879	0.00137
08:00:00	0.0000	0.0000	0.0000	0.0004	0.000878	0.00126
08:10:00	0.0000	0.0000	0.0000	0.0003	0.000877	0.00117
08:20:00	0.0000	0.0000	0.0000	0.0002	0.000876	0.0011
08:30:00	0.0000	0.0000	0.0000	0.0002	0.000874	0.00104
08:40:00	0.0000	0.0000	0.0000	0.0001	0.000871	0.000986
08:50:00	0.0000	0.0000	0.0000	0.0001	0.000869	0.000947
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000866	0.000915
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000863	0.000891
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000859	0.000874
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000856	0.000861
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000853	0.000854
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00085	0.00085
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000846	0.000846
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000843	0.000843
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00084	0.00084
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000836	0.000836
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000833	0.000833
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00083	0.00083
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000827	0.000827
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000823	0.000823
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00082	0.00082
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000817	0.000817
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000814	0.000814

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 11:45:59 AM 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: EC24-69BC

Site name: Sandown Park - Site 3

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

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

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.11
Total Rainfall (mm):	51.94	Total flow (ML):	0.31
Peak Rainfall (mm):	3.70	Peak flow (m^3/s):	0.01

Parameters

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

Rainfall parameters (Rainfall - FEH 2013 model)

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

Loss model parameters

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

Routing model parameters

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

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	42.52	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	0.2797	0.0000	0.0247	0.0000	0	0
00:10:00	0.3264	0.0000	0.0289	0.0000	2.42E-08	6.59E-06
00:20:00	0.3807	0.0000	0.0339	0.0000	1.49E-07	2.75E-05
00:30:00	0.4439	0.0000	0.0397	0.0001	4.89E-07	6.54E-05
00:40:00	0.5174	0.0000	0.0466	0.0001	1.18E-06	0.000123
00:50:00	0.6029	0.0000	0.0547	0.0002	2.37E-06	0.000205
01:00:00	0.7021	0.0000	0.0643	0.0003	4.24E-06	0.000314
01:10:00	0.8172	0.0000	0.0755	0.0004	6.98E-06	0.000445
01:20:00	0.9507	0.0000	0.0889	0.0006	1.07E-05	0.000591
01:30:00	1.1052	0.0000	0.1047	0.0007	1.55E-05	0.000756
01:40:00	1.2838	0.0000	0.1235	0.0009	2.16E-05	0.000943
01:50:00	1.4900	0.0000	0.1458	0.0011	2.91E-05	0.00116
02:00:00	1.7273	0.0000	0.1723	0.0014	3.81E-05	0.0014
02:10:00	1.9996	0.0000	0.2039	0.0016	4.9E-05	0.00168
02:20:00	2.3106	0.0000	0.2416	0.0019	6.2E-05	0.00201
02:30:00	2.6626	0.0000	0.2864	0.0023	7.75E-05	0.0024
02:40:00	3.0545	0.0000	0.3390	0.0028	9.59E-05	0.00285
02:50:00	3.4678	0.0000	0.3984	0.0033	0.000118	0.00339
03:00:00	3.6957	0.0000	0.4404	0.0039	0.000144	0.00402
03:10:00	3.4678	0.0000	0.4282	0.0046	0.000174	0.00475
03:20:00	3.0545	0.0000	0.3891	0.0054	0.00021	0.00558
03:30:00	2.6626	0.0000	0.3483	0.0062	0.000252	0.00645
03:40:00	2.3106	0.0000	0.3091	0.0070	0.0003	0.00732
03:50:00	1.9996	0.0000	0.2727	0.0078	0.000353	0.00813
04:00:00	1.7273	0.0000	0.2394	0.0084	0.000411	0.00882
04:10:00	1.4900	0.0000	0.2094	0.0089	0.000474	0.00933
04:20:00	1.2838	0.0000	0.1826	0.0091	0.000538	0.00962
04:30:00	1.1052	0.0000	0.1587	0.0091	0.000603	0.00973
04:40:00	0.9507	0.0000	0.1377	0.0090	0.000667	0.00966
04:50:00	0.8172	0.0000	0.1193	0.0087	0.00073	0.00946
05:00:00	0.7021	0.0000	0.1031	0.0084	0.00079	0.00915
05:10:00	0.6029	0.0000	0.0890	0.0079	0.000847	0.00877
05:20:00	0.5174	0.0000	0.0767	0.0074	0.000901	0.00834
05:30:00	0.4439	0.0000	0.0661	0.0069	0.00095	0.00787
05:40:00	0.3807	0.0000	0.0569	0.0064	0.000995	0.00737

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	0.3264	0.0000	0.0489	0.0058	0.00104	0.00685
06:00:00	0.2797	0.0000	0.0420	0.0053	0.00107	0.00633
06:10:00	0.0000	0.0000	0.0000	0.0047	0.00111	0.00582
06:20:00	0.0000	0.0000	0.0000	0.0042	0.00113	0.0053
06:30:00	0.0000	0.0000	0.0000	0.0036	0.00116	0.0048
06:40:00	0.0000	0.0000	0.0000	0.0031	0.00118	0.00431
06:50:00	0.0000	0.0000	0.0000	0.0027	0.0012	0.00385
07:00:00	0.0000	0.0000	0.0000	0.0022	0.00121	0.00343
07:10:00	0.0000	0.0000	0.0000	0.0018	0.00122	0.00304
07:20:00	0.0000	0.0000	0.0000	0.0015	0.00123	0.00269
07:30:00	0.0000	0.0000	0.0000	0.0012	0.00123	0.0024
07:40:00	0.0000	0.0000	0.0000	0.0009	0.00123	0.00215
07:50:00	0.0000	0.0000	0.0000	0.0007	0.00124	0.00195
08:00:00	0.0000	0.0000	0.0000	0.0006	0.00124	0.00179
08:10:00	0.0000	0.0000	0.0000	0.0004	0.00123	0.00166
08:20:00	0.0000	0.0000	0.0000	0.0003	0.00123	0.00155
08:30:00	0.0000	0.0000	0.0000	0.0002	0.00123	0.00146
08:40:00	0.0000	0.0000	0.0000	0.0002	0.00123	0.00139
08:50:00	0.0000	0.0000	0.0000	0.0001	0.00122	0.00134
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00122	0.00129
09:10:00	0.0000	0.0000	0.0000	0.0000	0.00121	0.00126
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00121	0.00123
09:30:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.00121
09:40:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
09:50:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00119	0.00119
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00119	0.00119
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00118	0.00118
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00118	0.00118
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00117	0.00117
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00117	0.00117
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00116	0.00116
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00116	0.00116
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00115	0.00115
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00115	0.00115
11:40:00	0.0000	0.0000	0.0000	0.0000	0.00114	0.00114

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-100-year storm) for Site 3 - EXISTING

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	1.365	0.317	0.087

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	35.0	16.3	5.3	0.0	0	56.6	51.0
0.5	7.3	14.6	22.2	10.3	3.4	0.0	0	35.9	64.6
1	9.0	9.0	13.7	6.4	2.1	0.0	0	22.1	79.5
2	14.1	7.0	10.7	5.0	1.6	0.0	0	17.3	124.5
4	19.4	4.8	7.4	3.4	1.1	0.0	0	11.9	171.2
6	22.4	3.7	5.7	2.6	0.9	0.0	0	9.2	197.7
8	24.4	3.0	4.6	2.1	0.7	0.0	0	7.5	215.2
12	27.0	2.3	3.4	1.6	0.5	0.0	0	5.5	238.7
16	28.9	1.8	2.7	1.3	0.4	0.0	0	4.4	254.9
20	30.3	1.5	2.3	1.1	0.3	0.0	0	3.7	267.7
24	31.6	1.3	2.0	0.9	0.3	0.0	0	3.2	278.8
28	32.7	1.2	1.8	0.8	0.3	0.0	0	2.9	288.5
32	33.7	1.1	1.6	0.7	0.2	0.0	0	2.6	297.5
36	34.6	1.0	1.5	0.7	0.2	0.0	0	2.4	305.9
40	35.5	0.9	1.3	0.6	0.2	0.0	0	2.2	313.9
44	36.4	0.8	1.3	0.6	0.2	0.0	0	2.0	321.5
48	37.2	0.8	1.2	0.5	0.2	0.0	0	1.9	328.9

*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 3 - EXISTING		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A3.1	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 3 - EXISTING

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	1.365	0.317	0.087

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	132.2	61.5	20.0	0.0	0	213.7	192.3
0.5	28.2	56.4	85.6	39.8	13.0	0.0	0	138.3	249.0
1	34.7	34.7	52.7	24.5	8.0	0.0	0	85.2	306.8
2	44.1	22.1	33.5	15.6	5.1	0.0	0	54.1	389.6
4	53.8	13.5	20.4	9.5	3.1	0.0	0	33.0	475.4
6	59.2	9.9	15.0	7.0	2.3	0.0	0	24.2	522.5
8	62.6	7.8	11.9	5.5	1.8	0.0	0	19.2	552.7
12	67.0	5.6	8.5	3.9	1.3	0.0	0	13.7	592.1
16	70.0	4.4	6.6	3.1	1.0	0.0	0	10.7	618.6
20	72.3	3.6	5.5	2.6	0.8	0.0	0	8.9	638.4
24	74.1	3.1	4.7	2.2	0.7	0.0	0	7.6	654.5
28	75.7	2.7	4.1	1.9	0.6	0.0	0	6.6	668.3
32	77.1	2.4	3.7	1.7	0.6	0.0	0	5.9	680.7
36	78.3	2.2	3.3	1.5	0.5	0.0	0	5.3	692.0
40	79.5	2.0	3.0	1.4	0.5	0.0	0	4.9	702.7
44	80.7	1.8	2.8	1.3	0.4	0.0	0	4.5	712.6
48	81.7	1.7	2.6	1.2	0.4	0.0	0	4.2	722.1

*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 3 - EXISTING		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A3.2	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Site 3 - EXISTING

		Grassed areas	Hardstanding	Roof
Contribution Coefficient		0.4	0.8	0.95
Area	Ha	1.365	0.317	0.087

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	171.9	79.9	26.0	0.0	0	277.9	250.1
0.5	36.9	73.8	112.0	52.1	17.0	0.0	0	181.1	326.0
1	45.8	45.8	69.5	32.3	10.5	0.0	0	112.4	404.7
2	57.4	28.7	43.6	20.3	6.6	0.0	0	70.4	507.1
4	70.4	17.6	26.7	12.4	4.0	0.0	0	43.2	621.5
6	77.7	12.9	19.7	9.1	3.0	0.0	0	31.8	686.1
8	82.6	10.3	15.7	7.3	2.4	0.0	0	25.3	729.6
12	88.9	7.4	11.3	5.2	1.7	0.0	0	18.2	785.6
16	92.9	5.8	8.8	4.1	1.3	0.0	0	14.3	820.9
20	95.8	4.8	7.3	3.4	1.1	0.0	0	11.7	845.9
24	97.9	4.1	6.2	2.9	0.9	0.0	0	10.0	865.2
28	99.6	3.6	5.4	2.5	0.8	0.0	0	8.7	880.1
32	101.1	3.2	4.8	2.2	0.7	0.0	0	7.8	892.9
36	102.4	2.8	4.3	2.0	0.7	0.0	0	7.0	904.2
40	103.5	2.6	3.9	1.8	0.6	0.0	0	6.4	914.5
44	104.6	2.4	3.6	1.7	0.5	0.0	0	5.8	923.9
48	105.6	2.2	3.3	1.6	0.5	0.0	0	5.4	932.6

*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 3 - EXISTING

Project: Sandown Park

Calc Sheet: 2661_OPA/S3/A3.3 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 3 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.906	0.503	0.361

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 5.1 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	23.3	25.8	22.0	0.0	-5	66.0	59.4
0.5	7.3	14.6	14.7	16.4	13.9	0.0	-5	39.9	71.9
1	9.0	9.0	9.1	10.1	8.6	0.0	-5	22.6	81.4
2	14.1	7.0	7.1	7.9	6.7	0.0	-5	16.6	119.5
4	19.4	4.8	4.9	5.4	4.6	0.0	-5	9.8	141.4
6	22.4	3.7	3.8	4.2	3.6	0.0	-5	6.4	138.0
8	24.4	3.0	3.1	3.4	2.9	0.0	-5	4.3	123.2
12	27.0	2.3	2.3	2.5	2.1	0.0	-5	1.8	79.2
16	28.9	1.8	1.8	2.0	1.7	0.0	-5	0.5	26.1
20	30.3	1.5	1.5	1.7	1.4	0.0	-5	-0.4	-31.3
24	31.6	1.3	1.3	1.5	1.3	0.0	-5	-1.1	-90.8
28	32.7	1.2	1.2	1.3	1.1	0.0	-5	-1.5	-152.0
32	33.7	1.1	1.1	1.2	1.0	0.0	-5	-1.9	-214.1
36	34.6	1.0	1.0	1.1	0.9	0.0	-5	-2.1	-277.0
40	35.5	0.9	0.9	1.0	0.8	0.0	-5	-2.4	-340.5
44	36.4	0.8	0.8	0.9	0.8	0.0	-5	-2.6	-404.4
48	37.2	0.8	0.8	0.9	0.7	0.0	-5	-2.7	-468.5

*2 Obtained from FEH CD-ROM v3

*3 Climate change factored into rainfall intensity at this stage

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www.hafrenwater.com

Client: **Rapleys LLP**

Title: Runoff rates and retention volumes for roads, roofs and parking at Site 3 - PROPOSED

Project: Sandown Park

Calc Sheet: 2661_OPA/S3/A4.1 Date: Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 3 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.906	0.503	0.361

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	5.1	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	87.7	97.4	83.0	0.0	-5	263.1	236.8
0.5	28.2	56.4	56.8	63.1	53.8	0.0	-5	168.5	303.3
1	34.7	34.7	35.0	38.9	33.1	0.0	-5	101.9	366.7
2	44.1	22.1	22.2	24.7	21.0	0.0	-5	62.8	452.2
4	53.8	13.5	13.6	15.1	12.8	0.0	-5	36.3	523.2
6	59.2	9.9	9.9	11.0	9.4	0.0	-5	25.3	545.6
8	62.6	7.8	7.9	8.7	7.5	0.0	-5	19.0	546.7
12	67.0	5.6	5.6	6.2	5.3	0.0	-5	12.1	522.7
16	70.0	4.4	4.4	4.9	4.2	0.0	-5	8.4	482.5
20	72.3	3.6	3.6	4.0	3.4	0.0	-5	6.0	434.0
24	74.1	3.1	3.1	3.5	2.9	0.0	-5	4.4	380.7
28	75.7	2.7	2.7	3.0	2.6	0.0	-5	3.2	324.6
32	77.1	2.4	2.4	2.7	2.3	0.0	-5	2.3	266.7
36	78.3	2.2	2.2	2.4	2.1	0.0	-5	1.6	207.4
40	79.5	2.0	2.0	2.2	1.9	0.0	-5	1.0	147.4
44	80.7	1.8	1.8	2.1	1.7	0.0	-5	0.5	86.5
48	81.7	1.7	1.7	1.9	1.6	0.0	-5	0.1	24.9

*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 roads, roofs and parking at Site 3 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A4.2	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 3 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.906	0.503	0.361

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	5.1	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	114.1	126.7	108.0	0.0	-5	343.6	309.3
0.5	36.9	73.8	74.4	82.6	70.4	0.0	-5	222.2	399.9
1	45.8	45.8	46.2	51.2	43.7	0.0	-5	136.0	489.5
2	57.4	28.7	28.9	32.1	27.4	0.0	-5	83.3	599.6
4	70.4	17.6	17.7	19.7	16.8	0.0	-5	49.1	706.5
6	77.7	12.9	13.0	14.5	12.3	0.0	-5	34.8	750.9
8	82.6	10.3	10.4	11.5	9.8	0.0	-5	26.7	768.7
12	88.9	7.4	7.5	8.3	7.1	0.0	-5	17.7	765.6
16	92.9	5.8	5.9	6.5	5.5	0.0	-5	12.8	736.4
20	95.8	4.8	4.8	5.4	4.6	0.0	-5	9.6	694.4
24	97.9	4.1	4.1	4.6	3.9	0.0	-5	7.5	645.2
28	99.6	3.6	3.6	4.0	3.4	0.0	-5	5.9	590.5
32	101.1	3.2	3.2	3.5	3.0	0.0	-5	4.6	533.1
36	102.4	2.8	2.9	3.2	2.7	0.0	-5	3.7	473.8
40	103.5	2.6	2.6	2.9	2.5	0.0	-5	2.9	413.3
44	104.6	2.4	2.4	2.7	2.3	0.0	-5	2.2	351.6
48	105.6	2.2	2.2	2.5	2.1	0.0	-5	1.7	289.1

*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 roads, roofs and parking at Site 3 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A4.3	Date:	Jan-19

Storage Volumes vs Storm Duration (1-in-100-year storm) for Roads, Roofs and Parking at Site 3 - PROPOSED

	Grassed areas	Hardstanding	Roof
Contribution Coefficient	0.4	0.8	0.95
Area Ha	0.906	0.503	0.361

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	5.1	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	136.9	152.0	129.6	0.0	-5	413.4	372.0
0.5	36.9	73.8	89.2	99.1	84.4	0.0	-5	267.6	481.7
1	45.8	45.8	55.4	61.5	52.4	0.0	-5	164.2	591.1
2	57.4	28.7	34.7	38.5	32.8	0.0	-5	101.0	726.9
4	70.4	17.6	21.3	23.6	20.1	0.0	-5	59.9	862.5
6	77.7	12.9	15.7	17.4	14.8	0.0	-5	42.7	923.1
8	82.6	10.3	12.5	13.9	11.8	0.0	-5	33.1	951.9
12	88.9	7.4	9.0	9.9	8.5	0.0	-5	22.3	962.8
16	92.9	5.8	7.0	7.8	6.6	0.0	-5	16.4	942.4
20	95.8	4.8	5.8	6.4	5.5	0.0	-5	12.6	906.8
24	97.9	4.1	4.9	5.5	4.7	0.0	-5	10.0	862.3
28	99.6	3.6	4.3	4.8	4.1	0.0	-5	8.0	811.4
32	101.1	3.2	3.8	4.2	3.6	0.0	-5	6.6	757.2
36	102.4	2.8	3.4	3.8	3.3	0.0	-5	5.4	700.8
40	103.5	2.6	3.1	3.5	3.0	0.0	-5	4.5	642.8
44	104.6	2.4	2.9	3.2	2.7	0.0	-5	3.7	583.5
48	105.6	2.2	2.7	3.0	2.5	0.0	-5	3.0	523.2

*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 roads, roofs and parking at Site 3 - PROPOSED		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A4.4	Date:	Jan-19

5 SANDOWN PARK – SITE 4

5.1 Background

This section discusses the issues relating to flooding and drainage at the Application Area known as Site 4 (Crescent), shown on *Drawing 2661/OPA-S4/01*.

5.2 Location and setting

The Application Area is located at the eastern section of the landholding and comprises a broadly rectangular area of land which is bounded by Station Road to the east. It extends to approximately 0.57 ha.

5.3 The proposed development

The site currently comprises a grassed field (see *Photograph 2661/OPA-S4/P1*). It is proposed to construct c72 studios, two and three bedroom apartments. The current and proposed land uses are shown on *Drawing 2661/OPA-S4/01*.

5.4 Baseline conditions

5.4.1 Landform

A recent topographic survey was issued in November 2018. The elevation of the ground surface within the Application Area is observed to decline toward the north-northeast from approximately 13.6 mAOD to 12.8 mAOD.

5.5 Hydrology

A drainage ditch is located immediately north of the Application Area and flows towards Station Road (*Photograph 2661/OPA-S4/P2*). Another drainage ditch is located on the eastern side of Station Road.

A small waterbody is located approximately 130 m west of the site.

5.6 Geology

The bedrock beneath the site comprises the London Clay Formation, and is overlain by the Kempton Park Gravel Member. The geology of the site is shown on *Drawing 2661/OPA-S4/02*.

The Kempton Park Gravel Member comprises sand and gravel, with lenses of silt, clay or peat. Logs of nearby BGS boreholes indicate a thickness of superficial deposits of between 1.4 – 6.4 m in the vicinity.

The London Clay mainly comprises blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay.

5.7 Fluvial flood mapping

The majority of 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%). An area in the south of the site is located in Flood Zone 2, where the probability of fluvial flooding in any one year is between 1 in 1000 and 1 in 100 (*Drawing 2661/OPA-S4/03*).

5.8 Drainage characteristics

The Application Area is partly located within Flood Zone 2 and therefore has a medium risk of fluvial flooding. This area has also been known to flood historically as advised by the Environment Agency, the extent of which is shown on *Drawing 2661/OPA-S4/03*.

The entire area of the site is noted as being at very low risk of surface water flooding (see *Drawing 2661/OPA-S4/04*).

The Application Area is composed of grass and the topographic survey shows it to be largely level, reducing by less than 1 m to the north. A drain is located immediately to the north of the site which is considered likely to capture the majority of surface water run-off. Under current conditions surface water run-off across the Application Area follows the local topography and exits the site via the drain or towards Station Road to the east. There are no known issues associated with standing water within the site boundary.

Existing drainage provision is shown on *Drawing 2661/OPA-S4/05*.

The site is located above the Kempton Park Gravel Member which comprises predominantly sand and gravels with presence of clayey silt lenses. The natural drainability of the sub-surface is therefore considered to be good. Infiltration at this location should be assessed. However, it may be possible to utilise the existing drain located immediately to the north of the site.

The nearest BGS borehole (TQ16NW89) is located north of the site and records a rest water level of approximately 11.8 mAOD, which would equate to between 1 to 1.8 mbgl at the site.

5.9 Assessment of flood risk and drainage

5.9.1 Flood risk to the development

The Application Area is partially located within Flood Zone 2, therefore a medium risk of fluvial flooding pertains. However, the residential part of the development is inside Flood Zone 1 and only the proposed parking intrudes over Flood Zone 2.

The entire site is designated as very low risk of surface water (pluvial) flooding. Therefore surface water flooding to the proposed development is not anticipated.

The sequential test has been applied as per Table 3 of the NPPF (see below).

Flood risk vulnerability classification		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zones	Zone 1	√	√	√	√	√
	Zone 2	√	√	Exception Test required	√	√
	Zone 3A	Exception Test required	√	X	Exception Test required	√
	Zone 3B functional floodplain	Exception Test required	√	X	X	X
√ Development is appropriate *X* Development should not be permitted						

This site is part of a Masterplan-led hybrid application, and cannot be directed to an area at a lower risk of flooding, such as in Flood Zone 1. Residential development is classified as 'more vulnerable' and car parking classified as 'less vulnerable'. In Flood Zone 2 both types of development is considered appropriate under the NPPF, however the Exception Test is required for residential sites located within Flood Zone 2. The Exception Test is addressed by managing and mitigating flood risk on site, principally ensuring that the FFL is raised above the modelled 1% Flood Level, plus the required Climate Change Allowance and a regional correction.

5.9.2 Flood risk from the development

Large areas north of the Application Area and immediately to the south are located in Flood Zone 2, which is classified as having a 'medium' fluvial flood risk. Appropriate mitigation

methods will be developed to reduce, attenuate and temporarily store water generated during storm events to limit increased flood risk to flood receptors downstream.

The proposed development will modify the run-off characteristics of the site due to the change in the ground profile and surface cover. The surface water management will ensure that surface water run-off can be retained, attenuated or infiltrated within the site boundary. The surface water drainage within the proposed development will be designed to manage volumes discharged off-site to a rate equivalent to the greenfield run-off rate.

5.9.3 Drainage requirements

Infiltration to ground via soakaway may be feasible at this site, however this will need to be assessed. The site is partly located within Flood Zone 2, therefore design considerations to limit flood risk to and from the development will need to be considered. However, it should be noted that the residential development block is not situated within Flood Zone 2. SuDS should be used to maximise infiltration as well as retain and temporarily store any water generated during storm events prior to infiltration to the ground. Intrusive soakaway testing could not be completed at this outline stage due to access restrictions on site (the site is actively in-use).

The surface water drainage within the proposed development will be designed to manage off-site discharge rates equivalent to the pre-development greenfield run-off rate. 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 along the southern boundary, an area comprising approximately 1,490 m^2. The geo-cellular storage will provide 276.4 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, then run-off would be discharged into the drain located along the northern boundary. In this scenario, the proposed outfall would be located in the north/north-eastern corner of the site (at the downstream end of the drain).

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.

5.9.4 Betterment

If SuDS methods to retain and attenuate water are incorporated into the development design, it is considered that the risk of increasing flood risk to or from the development is small.

5.10 Summary and conclusions

The Application Area is located at the eastern section of Sandown Park and is 0.57 ha in size.

Whilst the majority of the site is located in Flood Zone 1, it is partly located within the Environment Agency's indicative Flood Zone 2, where the probability of fluvial flooding in any one year is in between 1 in 1000 and 1 in 100 (Annual Exceedance Probability, AEP <1%). However, the proposed residential block is located in an area of low flood risk, with only the proposed car park being located in Flood Zone 2. The proposed development will alter the run-off characteristics of the site by altering the currently permeable surface to impermeable hardstanding and roofs. Appropriate mitigation measures are, therefore, required.

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 natural drainability of the sub-surface beneath the site is considered to be moderate and infiltration to ground via soakaway will need to be assessed via soakaway testing. If unsuitable, discharge to the drain immediately north of the site will need to be assessed. If SuDS methods to retain and temporarily store 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-S4/01: Existing development
Google earth imagery (May 2018)

2661/OPA-S4/01: Proposed development

Please note drawings are illustrative

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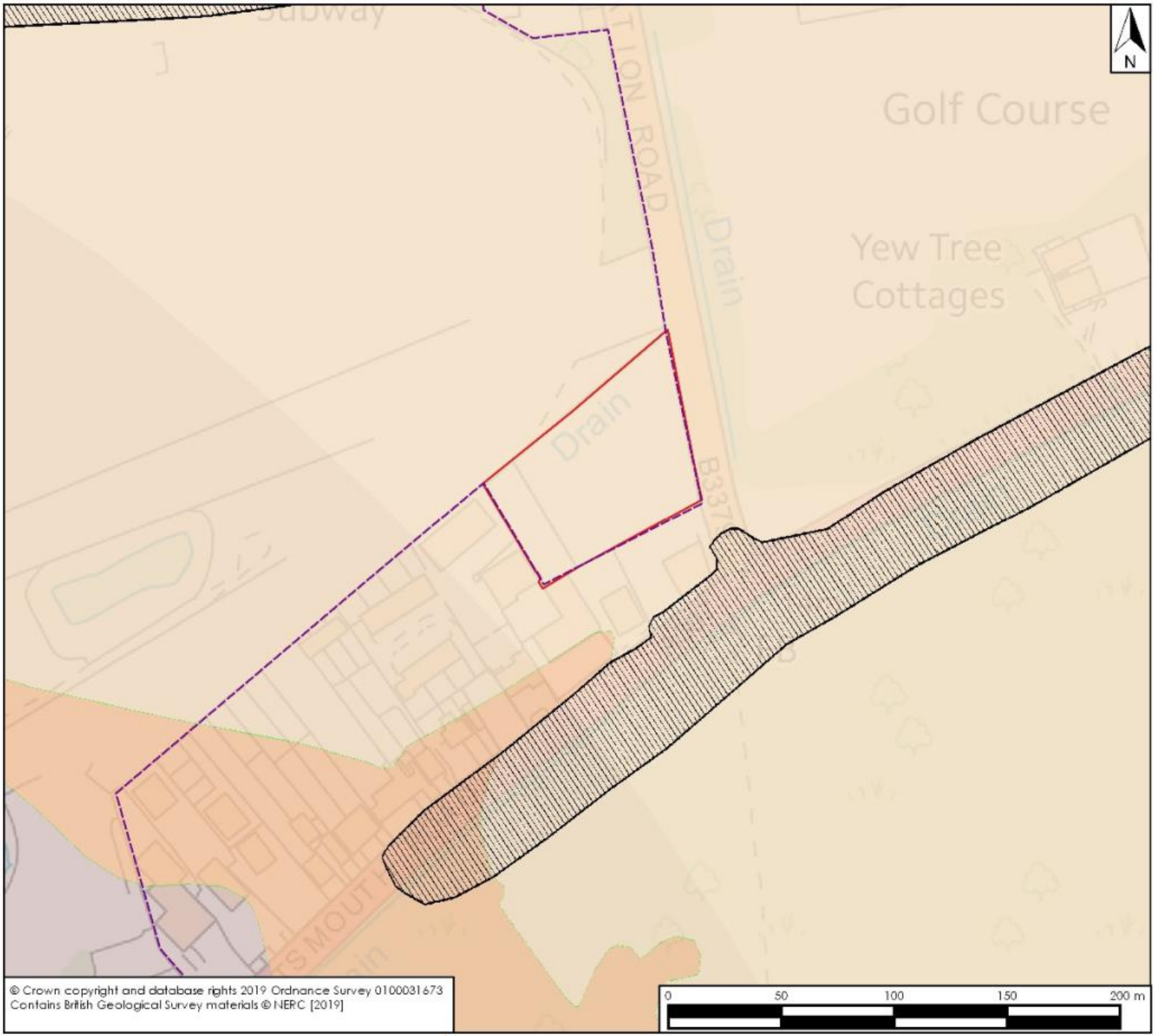
Client	Rapleys		
Title	Existing and proposed development		
Project	Sandown Park		
Drawing	2661/OPA-S4/01	Version	3
Date	Feb-19	Scale	nts



Legend

- Landholding
- Site 4 Application Area
- Artificial ground

Superficial Geology

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

Bedrock Geology

- Claygate Member
- London Clay Formation

Scale correct at A4

Client	Rapleys LLP
Title	Geology
Project	Sandown Park
Drawing	2661/OPA-S4/02
Version	2
Date	Jan 19
Scale	1:2,500

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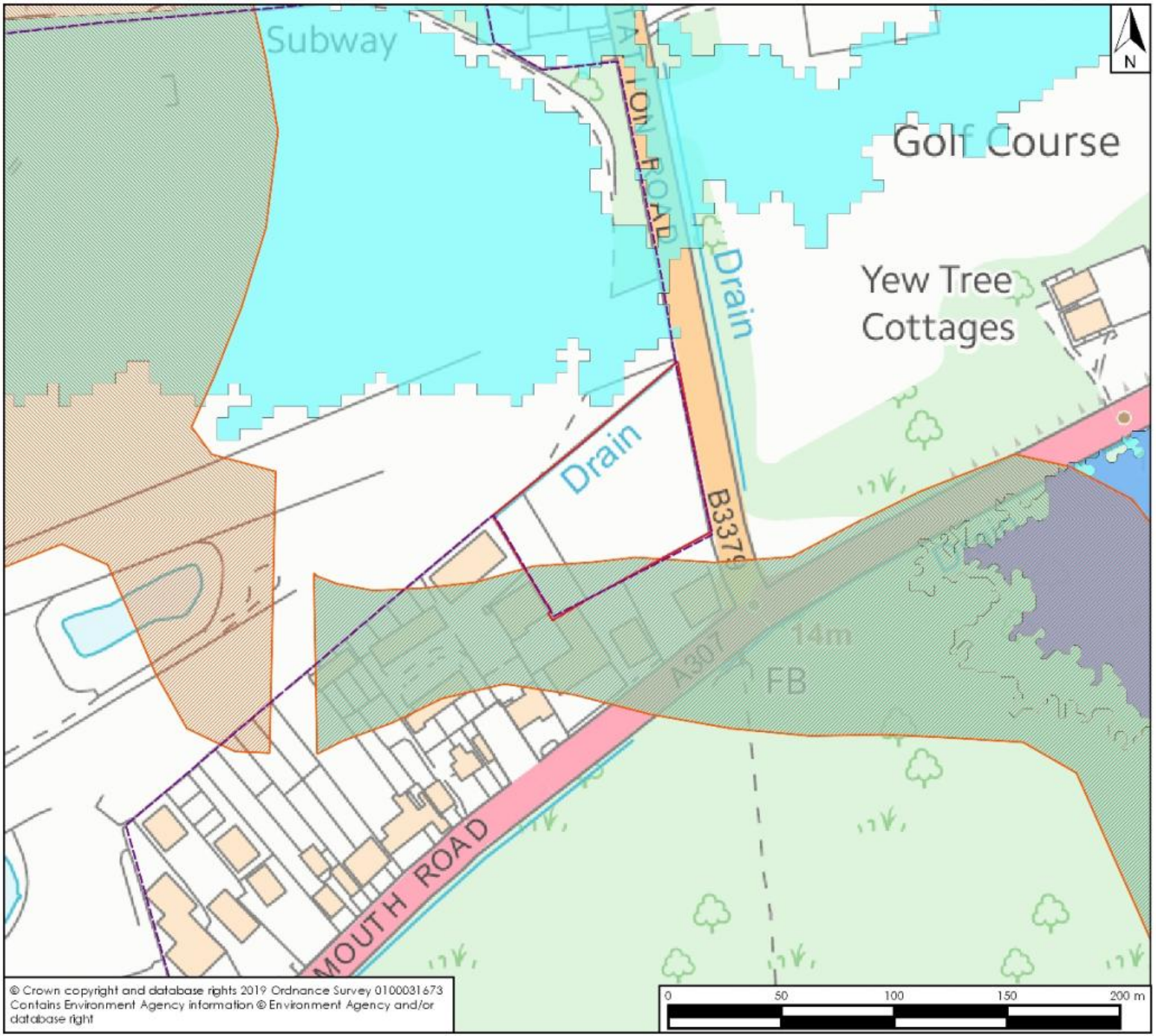

Legend

- Landholding
- Site 4 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-S4/03
Version	2
Date	Jan 19
Scale	1:2,500

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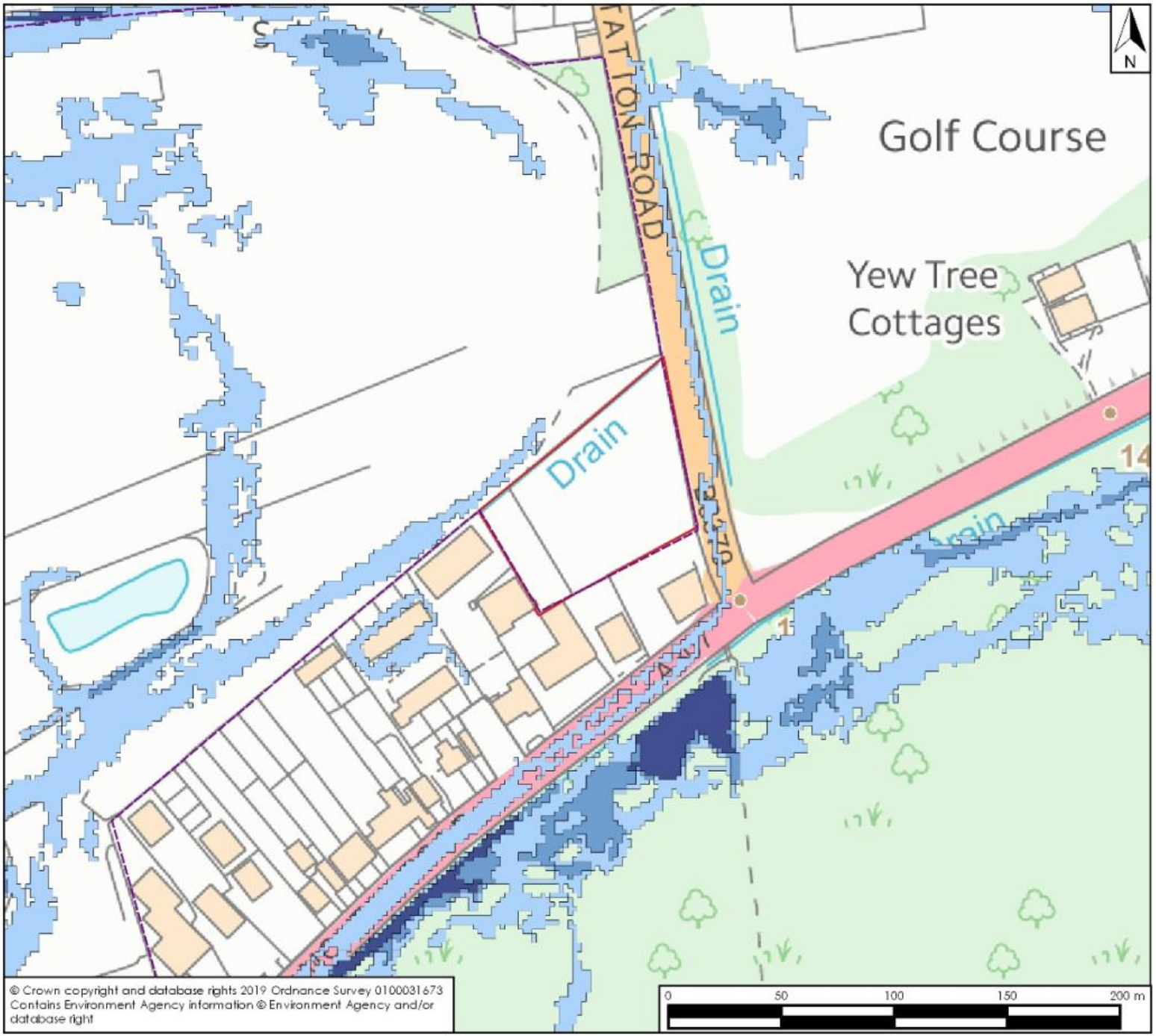

Legend

- Landholding
- Site 4 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-S4/04
Version	2
Date	Jan 19
Scale	1:2,500

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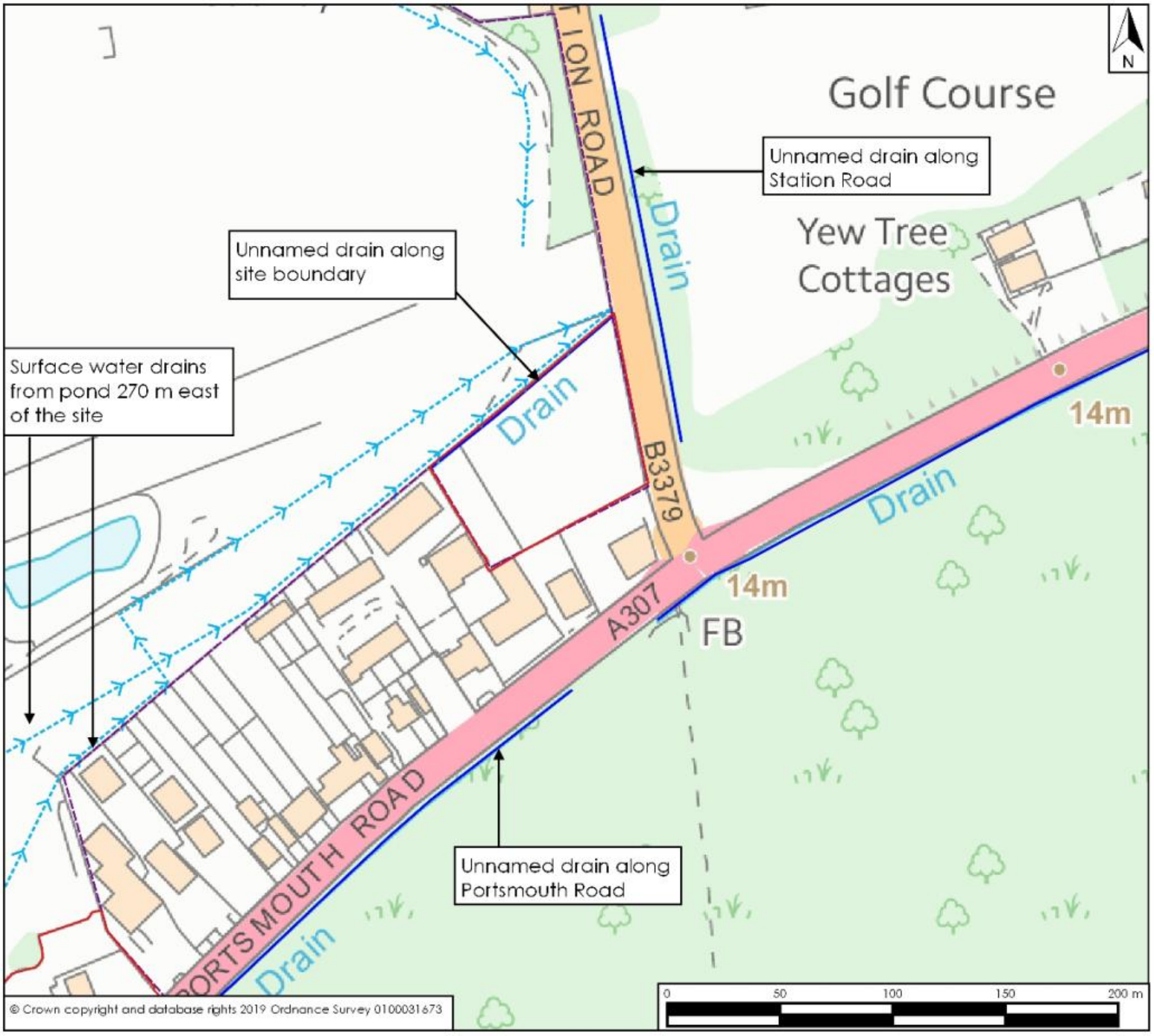

Legend

- Landholding
- Site 4 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-S4/05
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 4 – Crescent
Address & post code	Sandown Park, Portsmouth Road, Esher. KT10 9AJ
Grid reference	TQ 146 655
LPA reference	
Type of application (e.g. full, outline etc)	Outline
Is the existing site developed or greenfield?	Greenfield (with small area of hardstanding)
Total site area	5,658 m^2
Site area served by proposed drainage system (excluding open space) (Ha)*	0.29 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	0.09	0.29	0.23	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)	Drain to east of site at Station Road. See Drawing 2661/OPA-S4/05			**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	1.6	-	-	-	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	0.74	2.7	0.0	-2.7	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	2.23	7.1	0.0	-7.1	
1in 100	3.14	9.4	0.0	-9.4	
1 in 100 plus 20% climate change *	N/A	N/A	0.0	-	

5. Calculate discharge volumes - Technical Standards S4 to S8

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

	Greenfield Volume (m^3)	Brownfield Volume (m^3) (as appropriate)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	NOTES AND REQUIRED EVIDENCE
1 in 1	23.3	58.3	30	-28.3	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	70.4	154.2	153.8	-0.4	
1in 100	99.0	202.4	219.5	17.1	
1 in 100 plus 20% climate change *	N/A	N/A	276.4	-	

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

Design details	**Infiltration type** (soakaway, deep bore, blanket etc)	Soakaway	**Evidence: Suitable designs must be provided**
	Storage volume provided within infiltration feature (m^3)	Further work is required (in the form of intrusive ground investigation) to allow specific rates of infiltration to be determined. These will be used in the design of soakaways at the site. Soakaway will attenuate the 1 in 100 year plus climate change event, which is 276.4 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 soakaway will be sized to accommodate a 1 in 100-year (+CC) event. Further information to be provided at Detailed Design stage. This will be required for the Full Planning Application.	Volume provided to attenuate on site to discharging at existing rates. See section 5. **Evidence: Attenuation must be designed to ensure that at no flooding occurs onsite in a 1 in 30 year event except in designed areas and no flooding occurs offsite in a 1 in 100 year (+CC allowance) event. A 10% additional allowance should be included for underground attenuation systems which cannot be fully accessed/cleansed as well as the provision of u/s siltation protection and access/jetting points. Calculations showing available volume of proposed attenuation storage. Plan and Cross sectional drawings of proposed storage**
How will the storage be provided on site?		
Half drain times of attenuation feature (hr)		**Evidence: suitable calculations to show feature**

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

CONSIDERATION	Details	NOTES AND REQUIRED EVIDENCE
How will exceedance/infrastructure failure events be catered on site without significantly increasing flood risks (both on site and outside the development)? Technical Standard S9	No flooding will occur in a 1 in 100-year (+CC) event. Should a flood occur that exceeds this, water will discharge downslope 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

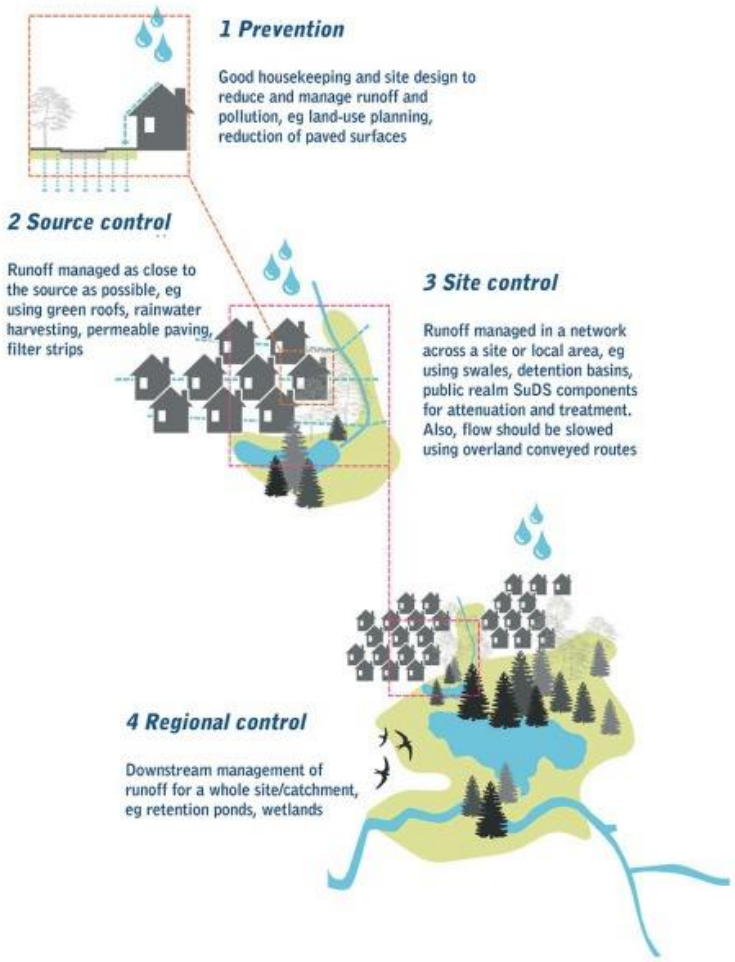
This chart details the minimum evidence required to be submitted regarding surface water drainage provision at each stage of planning:

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 3

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	0.0177 km^2
SAAR	610
SOIL	0.40
FSR region	6
Return period	2
Growth curve factor	0.88

Results	
QBAR(rural)	5.1 l/s
Q (1in1yr)*	4.4 l/s
QBAR	2.9 l/s/ha
Q (1in1yr)	2.5 l/s/ha
Q (1in100yr)	9.2 l/s/ha

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

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

Return period (yr)	**1**	**2**	**5**	**10**	**25**	**30**	**50**	**100**	**200**
Q (l/s/ha)	2.5	2.5	3.7	4.7	6.2	7.0	7.6	9.2	11.2
Q (l/s)	4.4	4.5	6.6	8.3	11.0	12.3	13.4	16.4	19.8

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Client: **Rapleys LLP**

Title:	Greenfield run-off rates from SITE 3, using IH124 formula		
Project:	Sandown Park		
Calc Sheet:	2661_OPA/S3/A2		Date: Jan-19

UK Design Flood Estimation

Generated on Thursday, January 24, 2019 11:46:40 AM 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: EC24-69BC

Site name: Sandown Park - Site 3

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

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

Using plot scale calculations: Yes

Site description: None

Model run: 1 year

Summary of results

Rainfall - FEH 2013 (mm):	22.55	Total runoff (ML):	0.03
Total Rainfall (mm):	15.00	Total flow (ML):	0.07
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)	42.52	No
BR	1.88	No

Urbanisation parameters

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

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.0808	0.0000	0.0071	0.0000	0	0
00:10:00	0.0943	0.0000	0.0083	0.0000	6.99E-09	1.9E-06
00:20:00	0.1100	0.0000	0.0097	0.0000	4.31E-08	7.94E-06
00:30:00	0.1282	0.0000	0.0113	0.0000	1.41E-07	1.88E-05
00:40:00	0.1495	0.0000	0.0132	0.0000	3.39E-07	3.54E-05
00:50:00	0.1742	0.0000	0.0155	0.0001	6.81E-07	5.87E-05
01:00:00	0.2028	0.0000	0.0181	0.0001	1.22E-06	8.99E-05
01:10:00	0.2361	0.0000	0.0211	0.0001	2E-06	0.000127
01:20:00	0.2746	0.0000	0.0246	0.0002	3.07E-06	0.000169
01:30:00	0.3193	0.0000	0.0287	0.0002	4.44E-06	0.000215
01:40:00	0.3709	0.0000	0.0335	0.0003	6.16E-06	0.000267
01:50:00	0.4304	0.0000	0.0391	0.0003	8.27E-06	0.000326
02:00:00	0.4990	0.0000	0.0456	0.0004	1.08E-05	0.000392
02:10:00	0.5776	0.0000	0.0532	0.0005	1.38E-05	0.000468
02:20:00	0.6675	0.0000	0.0620	0.0005	1.75E-05	0.000555
02:30:00	0.7692	0.0000	0.0721	0.0006	2.17E-05	0.000656
02:40:00	0.8824	0.0000	0.0835	0.0007	2.67E-05	0.000773
02:50:00	1.0018	0.0000	0.0960	0.0009	3.26E-05	0.000908
03:00:00	1.0676	0.0000	0.1036	0.0010	3.95E-05	0.00106
03:10:00	1.0018	0.0000	0.0985	0.0012	4.75E-05	0.00124
03:20:00	0.8824	0.0000	0.0877	0.0014	5.68E-05	0.00143
03:30:00	0.7692	0.0000	0.0772	0.0016	6.74E-05	0.00163
03:40:00	0.6675	0.0000	0.0676	0.0017	7.94E-05	0.00183
03:50:00	0.5776	0.0000	0.0589	0.0019	9.25E-05	0.002
04:00:00	0.4990	0.0000	0.0512	0.0020	0.000107	0.00214
04:10:00	0.4304	0.0000	0.0444	0.0021	0.000122	0.00224
04:20:00	0.3709	0.0000	0.0385	0.0021	0.000137	0.00228
04:30:00	0.3193	0.0000	0.0332	0.0021	0.000152	0.00228
04:40:00	0.2746	0.0000	0.0287	0.0021	0.000167	0.00224
04:50:00	0.2361	0.0000	0.0247	0.0020	0.000181	0.00218
05:00:00	0.2028	0.0000	0.0213	0.0019	0.000195	0.00209
05:10:00	0.1742	0.0000	0.0183	0.0018	0.000208	0.00199
05:20:00	0.1495	0.0000	0.0158	0.0017	0.00022	0.00188
05:30:00	0.1282	0.0000	0.0135	0.0015	0.000231	0.00176
05:40:00	0.1100	0.0000	0.0116	0.0014	0.00024	0.00164

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	0.0943	0.0000	0.0100	0.0013	0.000249	0.00152
06:00:00	0.0808	0.0000	0.0086	0.0011	0.000257	0.0014
06:10:00	0.0000	0.0000	0.0000	0.0010	0.000264	0.00128
06:20:00	0.0000	0.0000	0.0000	0.0009	0.00027	0.00116
06:30:00	0.0000	0.0000	0.0000	0.0008	0.000275	0.00105
06:40:00	0.0000	0.0000	0.0000	0.0007	0.000279	0.000939
06:50:00	0.0000	0.0000	0.0000	0.0006	0.000283	0.00084
07:00:00	0.0000	0.0000	0.0000	0.0005	0.000285	0.000749
07:10:00	0.0000	0.0000	0.0000	0.0004	0.000287	0.000666
07:20:00	0.0000	0.0000	0.0000	0.0003	0.000289	0.000593
07:30:00	0.0000	0.0000	0.0000	0.0002	0.00029	0.000531
07:40:00	0.0000	0.0000	0.0000	0.0002	0.00029	0.00048
07:50:00	0.0000	0.0000	0.0000	0.0001	0.00029	0.000438
08:00:00	0.0000	0.0000	0.0000	0.0001	0.00029	0.000404
08:10:00	0.0000	0.0000	0.0000	0.0001	0.00029	0.000377
08:20:00	0.0000	0.0000	0.0000	0.0001	0.000289	0.000355
08:30:00	0.0000	0.0000	0.0000	0.0000	0.000288	0.000337
08:40:00	0.0000	0.0000	0.0000	0.0000	0.000288	0.000322
08:50:00	0.0000	0.0000	0.0000	0.0000	0.000287	0.00031
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000286	0.000301
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000285	0.000293
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000284	0.000288
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000283	0.000284
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000281	0.000282
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00028	0.00028
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000279	0.000279
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000278	0.000278
10:20:00	0.0000	0.0000	0.0000	0.0000	0.000277	0.000277
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000276	0.000276
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000275	0.000275
10:50:00	0.0000	0.0000	0.0000	0.0000	0.000274	0.000274
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000273	0.000273
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000272	0.000272
11:20:00	0.0000	0.0000	0.0000	0.0000	0.000271	0.000271
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00027	0.00027
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000269	0.000269

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 11:46:22 AM 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: EC24-69BC

Site name: Sandown Park - Site 3

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

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

Using plot scale calculations: Yes

Site description: None

Model run: 30 year

Summary of results

Rainfall - FEH 2013 (mm):	59.26	Total runoff (ML):	0.08
Total Rainfall (mm):	39.43	Total flow (ML):	0.22
Peak Rainfall (mm):	2.81	Peak flow (m^3/s):	0.01

Parameters

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

Rainfall parameters (Rainfall - FEH 2013 model)

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

Loss model parameters

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

Routing model parameters

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

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	42.52	No
BR	1.88	No

Urbanisation parameters

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

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.2123	0.0000	0.0187	0.0000	0	0
00:10:00	0.2478	0.0000	0.0219	0.0000	1.84E-08	5E-06
00:20:00	0.2890	0.0000	0.0257	0.0000	1.13E-07	2.09E-05
00:30:00	0.3370	0.0000	0.0300	0.0000	3.71E-07	4.96E-05
00:40:00	0.3928	0.0000	0.0352	0.0001	8.93E-07	9.34E-05
00:50:00	0.4577	0.0000	0.0412	0.0002	1.8E-06	0.000155
01:00:00	0.5330	0.0000	0.0483	0.0002	3.22E-06	0.000237
01:10:00	0.6204	0.0000	0.0567	0.0003	5.29E-06	0.000336
01:20:00	0.7217	0.0000	0.0665	0.0004	8.11E-06	0.000447
01:30:00	0.8390	0.0000	0.0781	0.0006	1.18E-05	0.000571
01:40:00	0.9747	0.0000	0.0918	0.0007	1.63E-05	0.000711
01:50:00	1.1312	0.0000	0.1080	0.0008	2.2E-05	0.00087
02:00:00	1.3113	0.0000	0.1271	0.0010	2.88E-05	0.00105
02:10:00	1.5181	0.0000	0.1497	0.0012	3.69E-05	0.00126
02:20:00	1.7541	0.0000	0.1765	0.0015	4.67E-05	0.0015
02:30:00	2.0214	0.0000	0.2079	0.0017	5.82E-05	0.00179
02:40:00	2.3189	0.0000	0.2445	0.0020	7.19E-05	0.00212
02:50:00	2.6327	0.0000	0.2854	0.0024	8.81E-05	0.00251
03:00:00	2.8057	0.0000	0.3133	0.0029	0.000107	0.00296
03:10:00	2.6327	0.0000	0.3026	0.0034	0.00013	0.00349
03:20:00	2.3189	0.0000	0.2734	0.0039	0.000156	0.00408
03:30:00	2.0214	0.0000	0.2436	0.0045	0.000187	0.00469
03:40:00	1.7541	0.0000	0.2154	0.0051	0.000221	0.0053
03:50:00	1.5181	0.0000	0.1894	0.0056	0.00026	0.00586
04:00:00	1.3113	0.0000	0.1658	0.0060	0.000302	0.00633
04:10:00	1.1312	0.0000	0.1447	0.0063	0.000346	0.00667
04:20:00	0.9747	0.0000	0.1259	0.0065	0.000392	0.00686
04:30:00	0.8390	0.0000	0.1093	0.0065	0.000438	0.00691
04:40:00	0.7217	0.0000	0.0947	0.0064	0.000484	0.00685
04:50:00	0.6204	0.0000	0.0819	0.0062	0.000528	0.00669
05:00:00	0.5330	0.0000	0.0707	0.0059	0.00057	0.00646
05:10:00	0.4577	0.0000	0.0610	0.0056	0.00061	0.00618
05:20:00	0.3928	0.0000	0.0526	0.0052	0.000648	0.00586
05:30:00	0.3370	0.0000	0.0452	0.0048	0.000682	0.00552
05:40:00	0.2890	0.0000	0.0389	0.0044	0.000714	0.00516

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	0.2478	0.0000	0.0334	0.0041	0.000742	0.00479
06:00:00	0.2123	0.0000	0.0287	0.0037	0.000768	0.00442
06:10:00	0.0000	0.0000	0.0000	0.0033	0.00079	0.00406
06:20:00	0.0000	0.0000	0.0000	0.0029	0.00081	0.00369
06:30:00	0.0000	0.0000	0.0000	0.0025	0.000827	0.00334
06:40:00	0.0000	0.0000	0.0000	0.0022	0.000841	0.003
06:50:00	0.0000	0.0000	0.0000	0.0018	0.000852	0.00268
07:00:00	0.0000	0.0000	0.0000	0.0015	0.000861	0.00239
07:10:00	0.0000	0.0000	0.0000	0.0012	0.000868	0.00212
07:20:00	0.0000	0.0000	0.0000	0.0010	0.000873	0.00188
07:30:00	0.0000	0.0000	0.0000	0.0008	0.000876	0.00168
07:40:00	0.0000	0.0000	0.0000	0.0006	0.000878	0.00151
07:50:00	0.0000	0.0000	0.0000	0.0005	0.000879	0.00137
08:00:00	0.0000	0.0000	0.0000	0.0004	0.000878	0.00126
08:10:00	0.0000	0.0000	0.0000	0.0003	0.000877	0.00117
08:20:00	0.0000	0.0000	0.0000	0.0002	0.000876	0.0011
08:30:00	0.0000	0.0000	0.0000	0.0002	0.000874	0.00104
08:40:00	0.0000	0.0000	0.0000	0.0001	0.000871	0.000986
08:50:00	0.0000	0.0000	0.0000	0.0001	0.000869	0.000947
09:00:00	0.0000	0.0000	0.0000	0.0000	0.000866	0.000915
09:10:00	0.0000	0.0000	0.0000	0.0000	0.000863	0.000891
09:20:00	0.0000	0.0000	0.0000	0.0000	0.000859	0.000874
09:30:00	0.0000	0.0000	0.0000	0.0000	0.000856	0.000861
09:40:00	0.0000	0.0000	0.0000	0.0000	0.000853	0.000854
09:50:00	0.0000	0.0000	0.0000	0.0000	0.00085	0.00085
10:00:00	0.0000	0.0000	0.0000	0.0000	0.000846	0.000846
10:10:00	0.0000	0.0000	0.0000	0.0000	0.000843	0.000843
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00084	0.00084
10:30:00	0.0000	0.0000	0.0000	0.0000	0.000836	0.000836
10:40:00	0.0000	0.0000	0.0000	0.0000	0.000833	0.000833
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00083	0.00083
11:00:00	0.0000	0.0000	0.0000	0.0000	0.000827	0.000827
11:10:00	0.0000	0.0000	0.0000	0.0000	0.000823	0.000823
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00082	0.00082
11:30:00	0.0000	0.0000	0.0000	0.0000	0.000817	0.000817
11:40:00	0.0000	0.0000	0.0000	0.0000	0.000814	0.000814

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 11:45:59 AM 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: EC24-69BC

Site name: Sandown Park - Site 3

Easting: 514193

Northing: 165406

Country: England, Wales or Northern Ireland

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

Using plot scale calculations: Yes

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	78.06	Total runoff (ML):	0.11
Total Rainfall (mm):	51.94	Total flow (ML):	0.31
Peak Rainfall (mm):	3.70	Peak flow (m^3/s):	0.01

Parameters

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

Rainfall parameters (Rainfall - FEH 2013 model)

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

Loss model parameters

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

Routing model parameters

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

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0	No
BL (hr)	42.52	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	0.2797	0.0000	0.0247	0.0000	0	0
00:10:00	0.3264	0.0000	0.0289	0.0000	2.42E-08	6.59E-06
00:20:00	0.3807	0.0000	0.0339	0.0000	1.49E-07	2.75E-05
00:30:00	0.4439	0.0000	0.0397	0.0001	4.89E-07	6.54E-05
00:40:00	0.5174	0.0000	0.0466	0.0001	1.18E-06	0.000123
00:50:00	0.6029	0.0000	0.0547	0.0002	2.37E-06	0.000205
01:00:00	0.7021	0.0000	0.0643	0.0003	4.24E-06	0.000314
01:10:00	0.8172	0.0000	0.0755	0.0004	6.98E-06	0.000445
01:20:00	0.9507	0.0000	0.0889	0.0006	1.07E-05	0.000591
01:30:00	1.1052	0.0000	0.1047	0.0007	1.55E-05	0.000756
01:40:00	1.2838	0.0000	0.1235	0.0009	2.16E-05	0.000943
01:50:00	1.4900	0.0000	0.1458	0.0011	2.91E-05	0.00116
02:00:00	1.7273	0.0000	0.1723	0.0014	3.81E-05	0.0014
02:10:00	1.9996	0.0000	0.2039	0.0016	4.9E-05	0.00168
02:20:00	2.3106	0.0000	0.2416	0.0019	6.2E-05	0.00201
02:30:00	2.6626	0.0000	0.2864	0.0023	7.75E-05	0.0024
02:40:00	3.0545	0.0000	0.3390	0.0028	9.59E-05	0.00285
02:50:00	3.4678	0.0000	0.3984	0.0033	0.000118	0.00339
03:00:00	3.6957	0.0000	0.4404	0.0039	0.000144	0.00402
03:10:00	3.4678	0.0000	0.4282	0.0046	0.000174	0.00475
03:20:00	3.0545	0.0000	0.3891	0.0054	0.00021	0.00558
03:30:00	2.6626	0.0000	0.3483	0.0062	0.000252	0.00645
03:40:00	2.3106	0.0000	0.3091	0.0070	0.0003	0.00732
03:50:00	1.9996	0.0000	0.2727	0.0078	0.000353	0.00813
04:00:00	1.7273	0.0000	0.2394	0.0084	0.000411	0.00882
04:10:00	1.4900	0.0000	0.2094	0.0089	0.000474	0.00933
04:20:00	1.2838	0.0000	0.1826	0.0091	0.000538	0.00962
04:30:00	1.1052	0.0000	0.1587	0.0091	0.000603	0.00973
04:40:00	0.9507	0.0000	0.1377	0.0090	0.000667	0.00966
04:50:00	0.8172	0.0000	0.1193	0.0087	0.00073	0.00946
05:00:00	0.7021	0.0000	0.1031	0.0084	0.00079	0.00915
05:10:00	0.6029	0.0000	0.0890	0.0079	0.000847	0.00877
05:20:00	0.5174	0.0000	0.0767	0.0074	0.000901	0.00834
05:30:00	0.4439	0.0000	0.0661	0.0069	0.00095	0.00787
05:40:00	0.3807	0.0000	0.0569	0.0064	0.000995	0.00737

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	0.3264	0.0000	0.0489	0.0058	0.00104	0.00685
06:00:00	0.2797	0.0000	0.0420	0.0053	0.00107	0.00633
06:10:00	0.0000	0.0000	0.0000	0.0047	0.00111	0.00582
06:20:00	0.0000	0.0000	0.0000	0.0042	0.00113	0.0053
06:30:00	0.0000	0.0000	0.0000	0.0036	0.00116	0.0048
06:40:00	0.0000	0.0000	0.0000	0.0031	0.00118	0.00431
06:50:00	0.0000	0.0000	0.0000	0.0027	0.0012	0.00385
07:00:00	0.0000	0.0000	0.0000	0.0022	0.00121	0.00343
07:10:00	0.0000	0.0000	0.0000	0.0018	0.00122	0.00304
07:20:00	0.0000	0.0000	0.0000	0.0015	0.00123	0.00269
07:30:00	0.0000	0.0000	0.0000	0.0012	0.00123	0.0024
07:40:00	0.0000	0.0000	0.0000	0.0009	0.00123	0.00215
07:50:00	0.0000	0.0000	0.0000	0.0007	0.00124	0.00195
08:00:00	0.0000	0.0000	0.0000	0.0006	0.00124	0.00179
08:10:00	0.0000	0.0000	0.0000	0.0004	0.00123	0.00166
08:20:00	0.0000	0.0000	0.0000	0.0003	0.00123	0.00155
08:30:00	0.0000	0.0000	0.0000	0.0002	0.00123	0.00146
08:40:00	0.0000	0.0000	0.0000	0.0002	0.00123	0.00139
08:50:00	0.0000	0.0000	0.0000	0.0001	0.00122	0.00134
09:00:00	0.0000	0.0000	0.0000	0.0001	0.00122	0.00129
09:10:00	0.0000	0.0000	0.0000	0.0000	0.00121	0.00126
09:20:00	0.0000	0.0000	0.0000	0.0000	0.00121	0.00123
09:30:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.00121
09:40:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
09:50:00	0.0000	0.0000	0.0000	0.0000	0.0012	0.0012
10:00:00	0.0000	0.0000	0.0000	0.0000	0.00119	0.00119
10:10:00	0.0000	0.0000	0.0000	0.0000	0.00119	0.00119
10:20:00	0.0000	0.0000	0.0000	0.0000	0.00118	0.00118
10:30:00	0.0000	0.0000	0.0000	0.0000	0.00118	0.00118
10:40:00	0.0000	0.0000	0.0000	0.0000	0.00117	0.00117
10:50:00	0.0000	0.0000	0.0000	0.0000	0.00117	0.00117
11:00:00	0.0000	0.0000	0.0000	0.0000	0.00116	0.00116
11:10:00	0.0000	0.0000	0.0000	0.0000	0.00116	0.00116
11:20:00	0.0000	0.0000	0.0000	0.0000	0.00115	0.00115
11:30:00	0.0000	0.0000	0.0000	0.0000	0.00115	0.00115
11:40:00	0.0000	0.0000	0.0000	0.0000	0.00114	0.00114

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