now part of

2-4 Send Road, Caversham

Drainage Impact Assessment

On behalf of:

Abodi Investments Limited

Project Ref: 46089 | Rev: - | Date: May 2019

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Document Control Sheet

Project Name: **2-4 Send Road, Caversham**

Project Ref: **46089**

Report Title: **Drainage Impact Assessment**

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Date: **May 2019**

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For and on behalf of Peter Brett Associates LLP				

Revision	Date	Description	Prepared	Reviewed	Approved
-	May 2019	Planning Issue			

This report has been prepared by Peter Brett Associates LLP ('PBA') on behalf of its client to whom this report is addressed ('Client') in connection with the project described in this report and takes into account the Client's particular instructions and requirements. This report was prepared in accordance with the professional services appointment under which PBA was appointed by its Client. This report is not intended for and should not be relied on by any third party (i.e. parties other than the Client). PBA accepts no duty or responsibility (including in negligence) to any party other than the Client and disclaims all liability of any nature whatsoever to any such party in respect of this report.

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Contents

1 Introduction ... 3
1.1 Scope of Drainage Impact Assessment ... 3
1.2 Sources of Information ... 3
1.3 Relevant Planning Policy ... 3
2 Site Setting ... 4
2.1 Site Description and Topography ... 4
2.2 Site Geology and Hydrogeology ... 4
2.3 Existing Drainage ... 5
2.4 Proposed Development ... 5
3 Existing Surface Water Regime ... 6
4 Proposed Surface Water Drainage Strategy ... 7
4.1 Discharge Destination ... 7
4.2 Peak Flow Control – DEFRA Technical Standards S3 ... 7
4.3 Volume Control – DEFRA Technical Standards S5-S6 ... 9
4.4 Flood Risk within the Development – DEFRA Technical Standards S7-S9 ... 9
4.5 Water Quality ... 11
4.6 Maintenance Requirements ... 12
5 Proposed Foul Water Drainage Strategy ... 14
6 Summary ... 15

Figures

Figure 2.1: Site Location Plan ... 4
Figure 4.1: Outline Surface Water Drainage Strategy ... 10

Tables

Table 3.1: Existing Surface Water Runoff Rates ... 6
Table 4.1: Equivalent Greenfield Runoff Rates ... 8
Table 4.2: Runoff Rate Comparison ... 8
Table 4.3: Existing Surface Water Runoff Volumes for the 1 in 100 year 360 minute rainfall event ... 9
Table 4.4: Proposed Surface Water Runoff Volumes for the 360 minute rainfall event ... 9
Table 4.5: Climate change allowances for peak rainfall intensity ... 11
Table 4.6: Pollution hazard index and destination of runoff for the proposed site ... 12
Table 4.7: SuDS Mitigation Index ... 12
Table 4.8: SuDS Maintenance Requirements ... 12

Appendices

Appendix A Topographic Survey
Appendix B Development Proposals
Appendix C Existing Drainage Information
Appendix D Proposed Drainage

1 Introduction

1.1 Scope of Drainage Impact Assessment

1.1.1 This Drainage Impact Assessment (DIA) has been prepared by Peter Brett Associates LLP (PBA), part of Stantec; to support a planning application for the redevelopment of 2-4 Send Road, Caversham; to a block of 14 no. one-bed and 2 no. two-bed flats with 16 parking spaces.

1.1.2 The report is intended to provide sufficient detail of the foul and surface water drainage to allow Reading Borough Council (RBC) as the Local Planning Authority (LPA) and the Lead Local Flood Authority (LLFA) to review the design and confirm its suitability. The report shows the impact of the development on foul and surface water.

1.1.3 This DIA has been prepared alongside a separate Flood Risk Assessment (FRA) report, which covers all flood risk issues affecting the proposed development.

1.2 Sources of Information

1.2.1 The DIA has been prepared based on the following sources of information:

- Topographic survey of the site (Drawing reference RT/319/0503/P/0001) undertaken by Warner Surveys in April 2019 (see **Appendix A**)
- Development proposals by Colin Smith, February 2019 (see **Appendix B**)
- The Reading Borough Council (RBC) **Preliminary Flood Risk Assessment (PFRA**), June 2011;
- The Reading Borough Council (RBC) **Level 1 Strategic Flood Risk Assessment (SFRA)**, June 2017;
- The Reading Borough Council (RBC) **Level 2 Strategic Flood Risk Assessment (SFRA)**, December 2017.

1.3 Relevant Planning Policy

1.3.1 The DIA has been prepared and in accordance with the relevant national, regional and local planning policy and statutory authority guidance as follows:

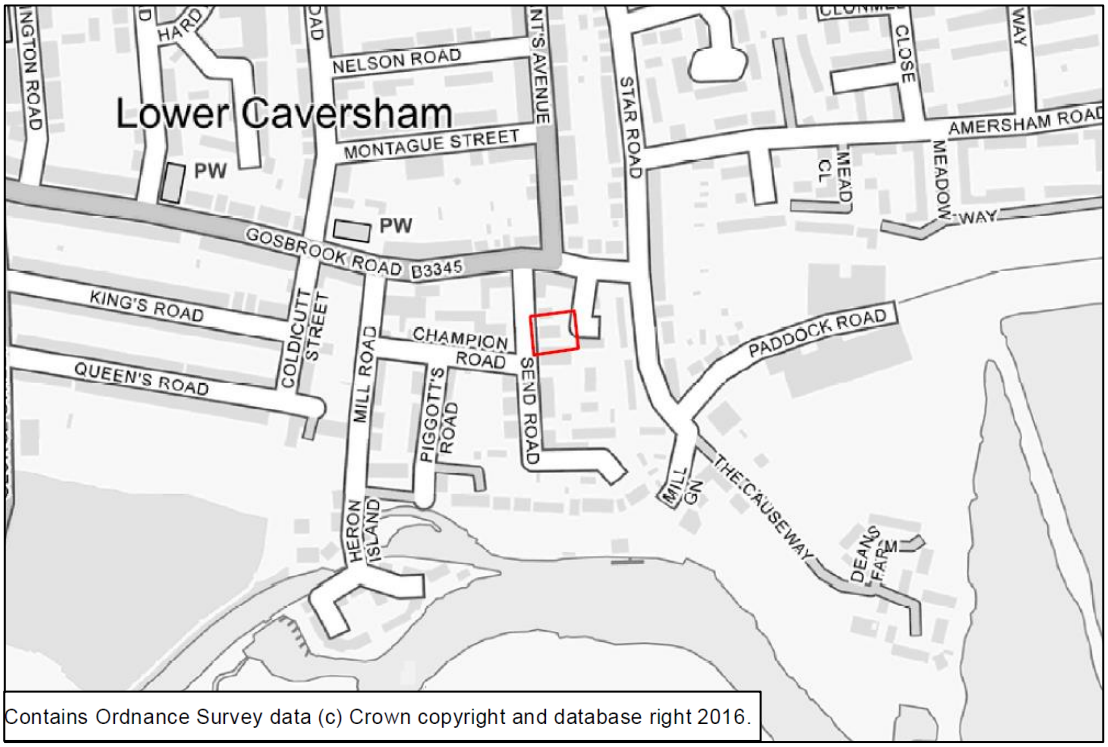
- National policy regarding flood risk as contained within the **National Planning Policy Framework (NPPF)** dated July 2018, issued by the Ministry of Housing, Communities and Local Government, with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change';
- The **NPPF Planning Practice Guidance (PPG)** released in March 2014 ('Flood Risk and Coastal Change' section) and updated in February 2016 to incorporate the **Environment Agency (EA) 'Flood Risk Assessments: Climate Change Allowances'** guidance;
- The **CIRIA SuDS Manual C753**, November 2015;
- The **DEFRA Non-Statutory Technical Standards for Sustainable Drainage Systems**, March 2015, and accompanying **Local Authority SuDS Officer Organisation (LASOO) Practice Guidance** (2016).

2 Site Setting

2.1 Site Description and Topography

2.1.1 The 0.1-hectare (ha) site is located at 2-4 Send Road, Caversham, Reading RG4 8EH; with rear access onto Forge Close. The OS grid reference is 472,380m E; 174,500m N.

Figure 2.1: Site Location Plan



2.1.2 The site currently consists of a detached house and rear garden, and a commercial building.

2.1.3 The site is bordered by a commercial building to the north, by Forge Close to the east, by an auto repair/car wash garage to the south and by Send Road to the west.

2.1.4 The site is largely flat with levels of approximately 37.0-37.3m AOD. The site frontage falls slightly towards Send Road at approximately 36.95m AOD, while the rear falls north-east towards Forge Close at 36.78.

2.2 Site Geology and Hydrogeology

2.2.1 The British Geological Survey (BGS) Geology of Britain online viewer indicates that the site lies on superficial deposits of the Langley Silt Member (Clay and Silt), above bedrock of the Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated).

2.2.2 The Cranfield University 'Soilscapes' online viewer indicates that the site lies above 'freely draining slightly acid but base-rich soils'.

2.2.3 The site does not lie within an EA Groundwater Source Protection Zone, although there is an area of Zone III (Total Catchment) approximately 200m north-east the site.

2.2.4 The site lies on a 'Principal' bedrock aquifer, and the area has a groundwater vulnerability classification of 'Major Aquifer High'.

2.3 Existing Drainage

2.3.1 As shown on the Thames Water asset records, both a surface water sewer and a foul water sewer lie under Send Road to the west of the site. No Thames Water sewer infrastructure is shown to be present under Forge Close on the opposite site of the site.

2.3.2 A CCTV drainage survey will be required to determine the location and condition of existing discharge connections from the site to the sewer system.

2.4 Proposed Development

2.4.1 The proposals are for the demolition of the existing buildings on the site and construction of 14 no. one-bed and 2 no. two-bed flats. Development proposals are shown in **Appendix B**.

3 Existing Surface Water Regime

3.1.1 The site has an impermeable area of approximately 0.07ha, which consists of the two buildings on the site and associated front driveways.

3.1.2 The existing brownfield runoff rates have been calculated using the Modified Rational Method and the existing greenfield runoff rates have been calculated using the ICP SuDS Method within MicroDrainage Source Control (see **Table 3.1**). A copy of the calculations is provided in **Appendix C**.

Return Period	Brownfield Runoff Rate 0.07ha (l/s)	Greenfield Runoff Rate 0.03ha (l/s)	Total Existing Runoff Rate 0.10ha (l/s)
1 in 1 year	5.5	<0.1	**5.5**
1 in 2 year	7.1	<0.1	**7.1**
1 in 30 year	13.3	<0.1	**13.3**
1 in 100 year	17.7	<0.1	**17.7**

Table 3.1: Existing Surface Water Runoff Rates

4 Proposed Surface Water Drainage Strategy

4.1 Discharge Destination

4.1.1 The NPPF recognises that flood risk and other environmental damage can be manged by minimising changes in the volume and rate of surface runoff from development sites, and recommends that priority is given to the use of SuDS in new development.

4.1.2 As the intention of SuDS is to mimic the natural drainage regime of the undeveloped site, the NPPF PPG states the following (consistent with the Building Regulations H3 hierarchy):

> "*Generally the aim should be to discharge surface runoff as high up the following hierarchy of drainage options as reasonably practicable:*
>
> 1. *into the ground (infiltration)*
> 2. *to a surface water body*
> 3. *to a surface water sewer, highway drain or another drainage system*
> 4. *to a combined sewer.*"

4.1.3 The hierarchy is considered in order below:

i) Discharge into the ground (infiltration)

4.1.4 Ground conditions at the site, as discussed in **Section 2.2**, indicate that infiltration rates will potentially be high enough to support drainage through infiltration. This will need to be confirmed through in-situ soakaway testing, prior to the detailed design stage, in accordance with the methods outlined in BRE digest 365 'Soakaway Design'.

4.1.5 Should infiltration drainage be feasible, this would be the preferred option in accordance with the above hierarchy.

ii) Discharge to a surface water body/watercourse

4.1.6 The second preference in the hierarchy is discharge to a surface water body (i.e. lake or watercourse).

4.1.7 There are no watercourses in the immediate vicinity of the site for disposal of surface water and therefore this option has been discounted.

iii) Discharge to a surface water sewer or highway drain

4.1.8 Should infiltration drainage not be feasible, then the next preferred option would be to discharge to the Thames Water surface water sewer beneath Send Road.

4.1.9 A pre-development capacity enquiry has been submitted to Thames Water and a response is awaited.

4.2 Peak Flow Control – DEFRA Technical Standards S3

4.2.1 The proposed drainage system within this FRA is based on the scenario that infiltration drainage is not feasible. In line with the hierarchy in **Section 4.1**, the next applicable option for discharge of surface water is to the surface water sewer. Therefore, it is used to assess the 'worst case' in terms of the maximum flow that would discharge from the site.

4.2.2 The DEFRA standards for peak flow control are as follows:

> "***S3.*** *For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.*"

4.2.3 This is in accordance with guidance within the Reading Borough Council Level 1 SFRA.

4.2.4 The impermeable area at the site will increase from approximately 0.07ha to 0.09ha (70% to 90%) following re-development. As the proposals are for apartments the application of an urban creep allowance is not applicable in accordance with the LASOO guidance.

4.2.5 The equivalent greenfield runoff rates for the proposed impermeable area are provided in **Table 4.1**.

Return Period	Equivalent Greenfield Runoff Rate l/s 0.1ha
1 in 1 year	<0.1
Q_{BAR}	<0.1
1 in 30 year	0.1
1 in 100 year	0.1

Table 4.1: Equivalent Greenfield Runoff Rates

4.2.6 The above runoff rates indicate that the surface water discharge from the site at the equivalent greenfield runoff rate for the proposed impermeable area would be too small to be able to manage the risk of blockage to the flow control device to an acceptable level.

4.2.7 It is therefore proposed to discharge surface water runoff from the proposed development at a rate of 5.0 l/s, which is the minimum rate considered to be achievable whilst managing the risk of blockage to the flow control device to an acceptable level in accordance with best practice (ref. EA/DEFRA '*Preliminary rainfall runoff management for developments Rev E*'). It is also below the existing runoff rate for the 1 in 1 year rainfall event, as shown in **Section 3**.

4.2.8 Restricting surface water from the proposed development in accordance with the above will provide a significant betterment in comparison to the existing scenario, as shown in **Table 4.2**.

Return Period	Total Existing Runoff Rate l/s (0.1ha)	Developed Area Runoff Rate 0.09ha (l/s)	Landscaped Area Runoff Rate 0.01ha (l/s)	Total Proposed Runoff Rate 0.1ha (l/s)	Reduction from Existing (%)
1 in 1 year	5.5	5.0	<0.1	**5.0**	**9%**
1 in 2 year/Q_{BAR}	7.1	5.0	<0.1	**5.0**	**30%**
1 in 30 year	13.3	5.0	<0.1	**5.0**	**62%**
1 in 100 year	17.7	5.0	<0.1	**5.0**	**72%**

Table 4.2: Runoff Rate Comparison

4.3 Volume Control – DEFRA Technical Standards S5-S6

4.3.1 The DEFRA standards for volume control are as follows:

> "***S5.*** *Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.*
>
> ***S6.*** *Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with* ***S4*** *or* ***S5*** *above, the runoff volume must be discharge at a rate that does not adversely affect flood risk.*"

4.3.2 The existing runoff volumes for the site for the 1 in 100 year 360 minute rainfall event is shown in **Table 4.3**. Copies of the calculations are provided in **Appendix C**.

Rainfall Event (6 hours)	Brownfield Runoff Volume 0.07ha (m^3)	Greenfield Runoff Volume 0.03ha (m^3)	Total Runoff Volume 0.10ha (m^3)
1 in 100 year	37.0	1.5	**38.5**

Table 4.3: Existing Surface Water Runoff Volumes for the 1 in 100 year 360 minute rainfall event

4.3.3 The impermeable area will increase post re-development at the site. It is therefore proposed to restrict the runoff rate from the site to 5.0 l/s which is considered to not adversely affect flood risk in accordance with the above standards.

4.3.4 The proposed runoff volumes from the site are shown in **Table 4.4** and in the calculations/MicroDrainage results in **Appendix D**.

Rainfall Event (6 hours)	Brownfield Runoff Volume Developed Area 0.09ha (m^3)	Runoff Volume Landscaped Area 0.01ha (m^3)	Total Runoff Volume 0.1ha (m^3)
1 in 100 year (summer)	37.3	0.5	**37.8**
1 in 100 year (winter)	42.1	0.5	**42.6**

Table 4.4: Proposed Surface Water Runoff Volumes for the 360 minute rainfall event

4.3.5 Based on the conservative presumption of no infiltration (to be reviewed at detailed design stage, the proposed runoff volume for this event is therefore comparable to the existing.

4.4 Flood Risk within the Development – DEFRA Technical Standards S7-S9

4.4.1 DEFRA standards for flood risk within the development are as follows:

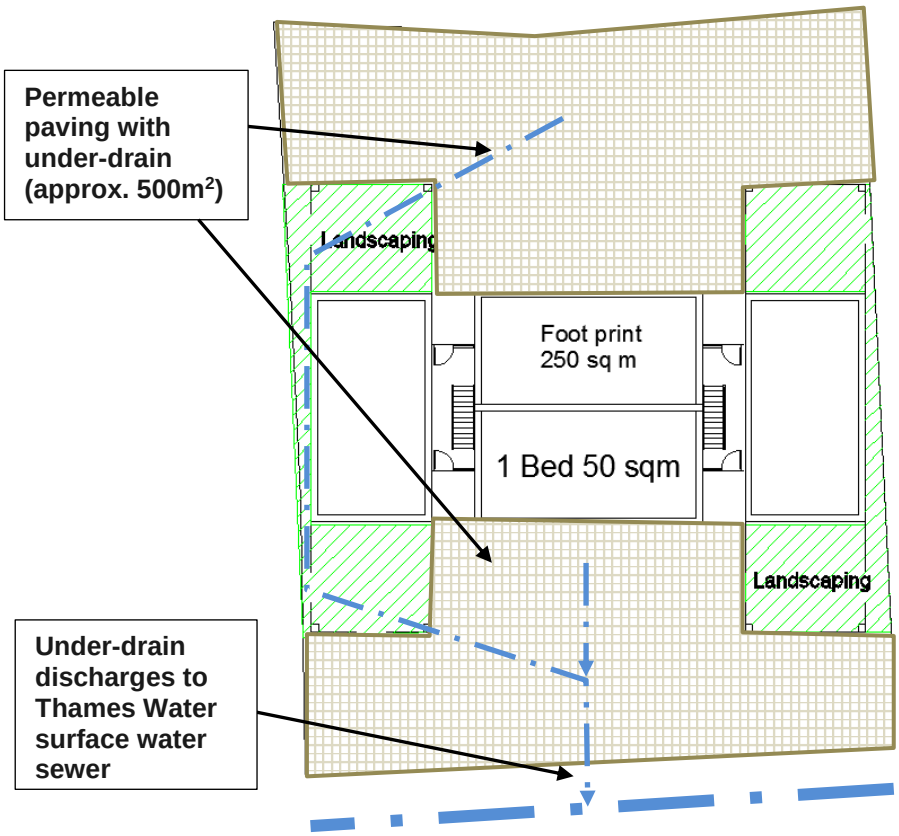
> "***S7.*** *The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year event.*
>
> ***S8.*** *The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement) or in any utility*

plant susceptible to water (e.g. pumping station or electricity substation) within the development."

4.4.2 The proposed surface water drainage system will consist of a piped network system and tanked permeable paving specified as follows:

- **The tanked permeable paving will be applied for the parking and access areas which cover approximately half of the site area (0.05 ha)**
- **Underneath the paving layer will be 300mm of tanked sub-base comprising high-void (approx. 30%) aggregate e.g. M.O.T. type 3, providing 45m^3 of attenuation volume**
- **The permeable paving structure will feature a perforated under-drain pipe (typically 150mm in diameter) at the bottom of the sub-base layer, which will convey surface water to the surface water sewer**
- **Where necessary, the base of the paving structure will be lined with an impermeable membrane to prevent infiltration within 5m of buildings or roads**
- **Discharge rates form the sub-base attenuation to the surface water sewer will be controlled using a 'Hydro-brake' vortex flow control device or similar.**

Figure 4.1: Outline Surface Water Drainage Strategy



4.4.3 **Table 4.5** shows the climate change allowances for peak rainfall intensity, taken from the EA 'Flood risk assessment - climate change allowances' guidance.

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total anticipated change for 2060 to 2115
Upper End	+10%	+20%	**+40%**
Central	+5%	+10%	**+20%**

Table 4.5: Climate change allowances for peak rainfall intensity

4.4.4 The proposed development is residential and is considered to have a lifetime of 100 years. In accordance with **Table 4.5**, the range of climate change allowances to be considered for the proposed development is 20% to 40%.

4.4.5 The proposed surface water drainage system has been designed to accommodate the 1 in 100 annual probability +40% allowance for climate change rainfall event with no flooding (see MicroDrainage results in **Appendix D**)

4.4.6 DEFRA standard **S9** states that:

> "*the design of the site must ensure that so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimises the risks to people and property*."

4.4.7 In an exceedance event where the proposed drainage system floods, the flood water will be directed onto the roads lying adjacent to the site given that they are at a lower topography. The proposed site topography is to be relatively level, so surface water will not pool in specific areas of the site.

4.5 Water Quality

4.5.1 The new SuDS Manual (Ciria C753, November 2015) introduces slightly different approach compared to the previous version for the water quality management of surface water. The Manual describes risks posed by the surface water runoff to the receiving environment as a function of:

- The pollution hazard at a particular site (i.e. the pollution source).
- The effectiveness of SuDS treatment components in reducing levels of pollutants to environmentally acceptable levels.
- The sensitivity of the receiving environment.

4.5.2 The recommended approaches for water quality risk management are given in Table 26.1 of the SuDs Manual. The Simple Index approach will be used as a design method for this site.

4.5.3 Table 26.2 of the SuDS Manual provides hazard classification for different land uses, which for this site are as follows:

- Roof area
- Private car parking area and access road surfaces

4.5.4 To deliver adequate treatment, the selected SuDs components should have a total pollution mitigation index for each contaminant type that equals or exceeds the pollution hazard index for each contaminant type. Therefore, the following will have to be achieved for the surface running off the site.

Total SuDS mitigation index >=pollution hazard index

4.5.5 Pollution Hazard Indices are given for different land uses in Table 26.2 of the SuDS manual and are tabulated in **Table 4.6**.

Land Use	Destination of Runoff	Pollution Hazard Level	Total Suspended Solids	Metals	Hydrocarbons
Residential roof	Surface Water Sewer	Very Low	0.2	0.2	0.05
Access roads and car parks	Surface Water Sewer	Low	0.5	0.4	0.4

Table 4.6: Pollution hazard index and destination of runoff for the proposed site

4.5.6 The SuDS mitigation index has been obtained from Table 26.3 (for surface water) of the SuDS manual. The SuDS mitigation index is tabulated in **Table 4.7**.

Mitigation Indices				
Runoff Source	**Type of SuDS Component**	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
All Runoff	Permeable Paving	0.7	0.6	0.7

Table 4.7: SuDS Mitigation Index

4.5.7 In summary, the SuDs component mitigation indices are greater than pollution hazard indices and therefore the required level of treatment is provided before surface water is discharged from the site.

4.6 Maintenance Requirements

4.6.1 The surface water drainage proposals for this site will be subject to the following recommended maintenance measures, as suggested by the CIRIA SuDS Manual C753 overpage:

SuDS Component	Maintenance Requirement	Description
Permeable Paving	Inspection	Regular inspections to identify and remedy potential maintenance issues e.g. blockages.
	Litter and Debris Removal	Regular maintenance activity – litter and debris should be removed from the paving surface to prevent blockages.
	Sediment Management	Occasional maintenance activity – sediment should be removed from the permeable pavement under-drain and from gaps in paving blocks.
	Vacuum Sweeping and Brushing	Occasional maintenance activity – removes some of the sediments that may have become trapped within the pavement build-up.

Table 4.8: SuDS Maintenance Requirements

4.6.2 The overall drainage system, including pipes, roof sumps and manholes, should also be inspected on a regular basis and cleared of sediments, litter and debris.

4.6.3 The site will be managed by an agreed maintenance company and therefore there will be a high level of inspection and maintenance as part of the wider management of the site.

5 Proposed Foul Water Drainage Strategy

5.1.1 As shown on Thames Water asset records, a foul water sewer runs along the frontage of the site beneath Send Road. It is most likely that foul sewage from the site currently discharges to this sewer, however the location and condition of any existing connection will need to be determined in due course with a CCTV survey.

5.1.2 The proposed development consists of 14 no. one-bed and 2 no. two-bed flats. As shown in **Appendix D**, the expected peak discharge rate from these 16 units is 0.8 l/s. A pre-development capacity enquiry has been submitted to Thames Water and a response is awaited.

6 Summary

6.1.1 This Drainage Impact Assessment (DIA) has been prepared by Peter Brett Associates LLP (PBA), part of Stantec, to support a planning application for the redevelopment of 2-4 Send Road, Caversham to a block of 14 no. one-bed and 2 no. two-bed flats with 16 parking spaces.

6.1.2 The hierarchy of surface water drainage options detailed in the NPPF PPG (and consistent with the Building Regulations H3) has been considered as follows:

- **Infiltration:** An assessment of available information regarding ground conditions at the site indicates that infiltration drainage is potentially feasible for the development. This will need to be confirmed through in-situ soakaway testing, prior to the detailed design stage, in accordance with the methods outlined in BRE digest 365 'Soakaway Design'.
- **Watercourse:** No watercourses are located in the vicinity of the site.
- **Surface Water Sewer:** Thames Water sewer records indicate that a surface water sewer runs under Send Road along the frontage of the site. If infiltration drainage is found not to be viable, it is proposed to drain the site at a controlled rate to this sewer.

6.1.3 The proposed surface water drainage strategy has been produced based on the scenario that infiltration drainage is not viable, and as such represents the 'worst-case' in terms of discharge rates to the surface water sewer.

6.1.4 The strategy consists of attenuation provided through 0.05ha of tanked permeable paving beneath parking and access areas. This will feature a 300mm deep high-void aggregate sub base, with a controlled discharge to 5.0 l/s using a 'Hydro-brake' vortex flow control device or similar. This results in a reduction of up to 72% in peak runoff rates from the site, for a range of rainfall events.

6.1.5 A pre-development capacity enquiry has been submitted to Thames Water for foul and surface water drainage, and a response is awaited.

6.1.6 A management company for the development will be set up and be responsible for the long-term maintenance of the proposed drainage system as part of the wider management of the site.

6.1.7 In conclusion, the principles advocated by relevant national, regional and local planning policy guidance in relation to surface water and foul drainage have been satisfactorily addressed.

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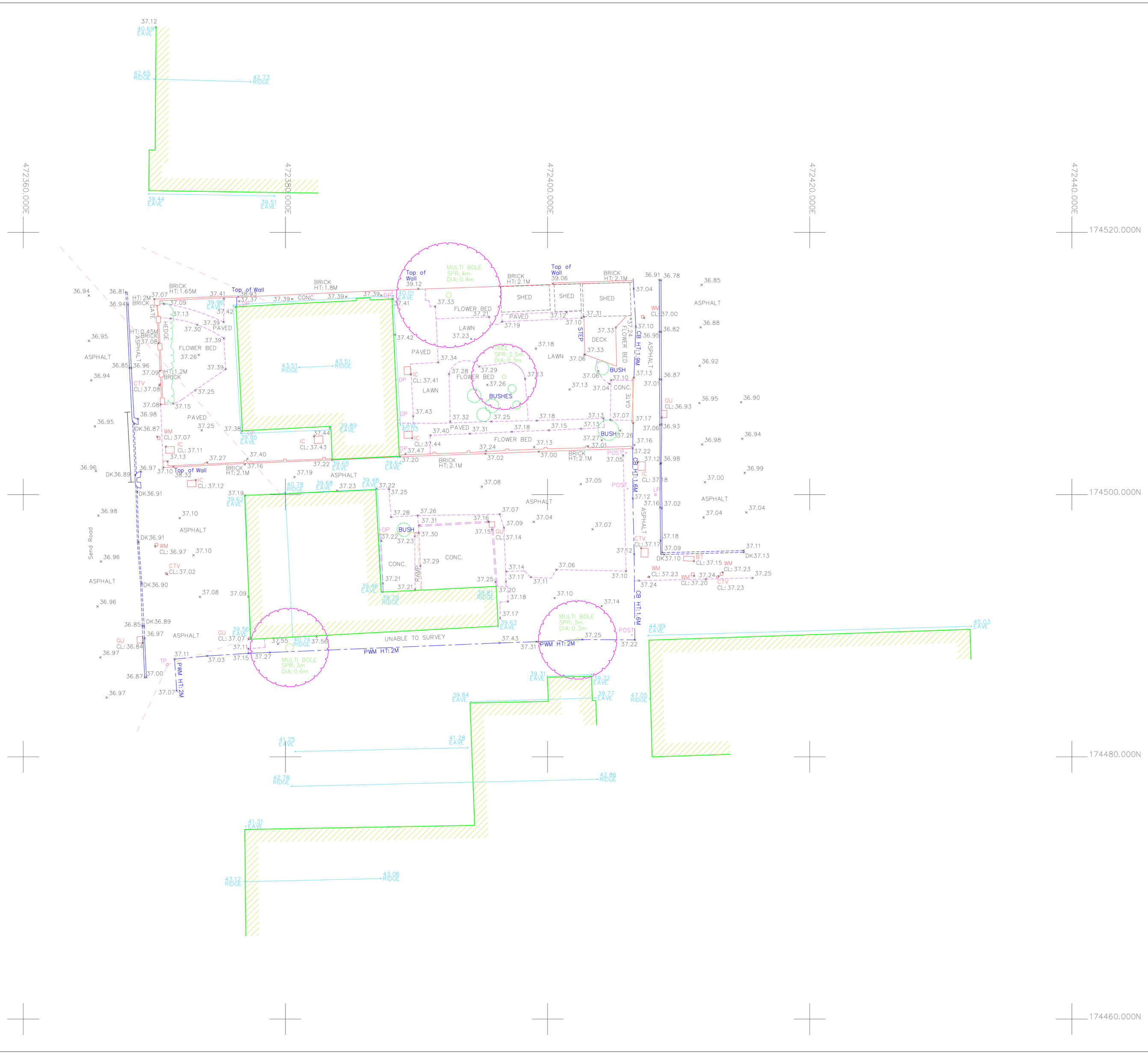
Appendix A Topographic Survey

Topographic Survey RT/319/0503/P/0001 by Warner Surveys (April 2019)



Notes

The survey has been oriented to Ordnance Survey (OS) National Grid (OSGB36) using Industry Standard Network RTK GPS equipment utilising the OS Active Network (OS Net).
A true OSGB36 coordinate has been established on site using the OSTN15 (transformation) & OSGB15 (geoid) models.
The survey detail has been correlated to this point and a further one (or more) OSGB36 points established to produce a true OS bearing for angle orientation.
Scale factor 1.0 has been applied therefore the survey coordinates are shown on a pseudo OS grid.
All dimensions are in metres unless otherwise specified

Rev	QA Check	Description	Date
5	-	-	-
4	-	-	-
3	-	-	-
2	-	-	-
1	-	-	-
0	PM	First Complete Issue	23/04/2019
Prelim	-	Preliminary - Not Complete	-

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DRAWN	MS	
SCALE	1:200	

2-4 Send Road, reading, RG4 8EH

TOPOGRAPHICAL SURVEY

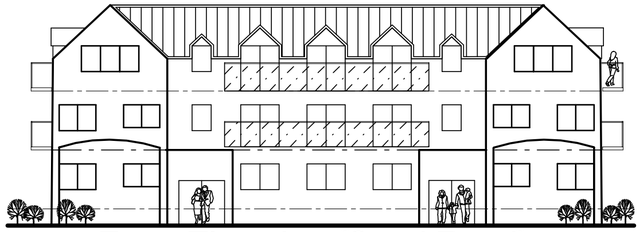
JOB No	DRAWING NUMBER
RT/319/0503	RT/319/0503/P/0001

A2 Sheet - 594mm X 420mm

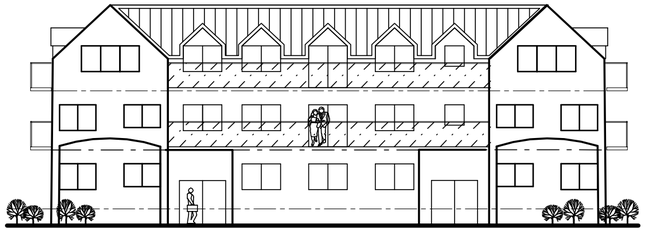
Appendix B Development Proposals

Sketch Development Proposals by Colin Smith (February 2019)

Subject to site survey
Indicative layouts
do not scale

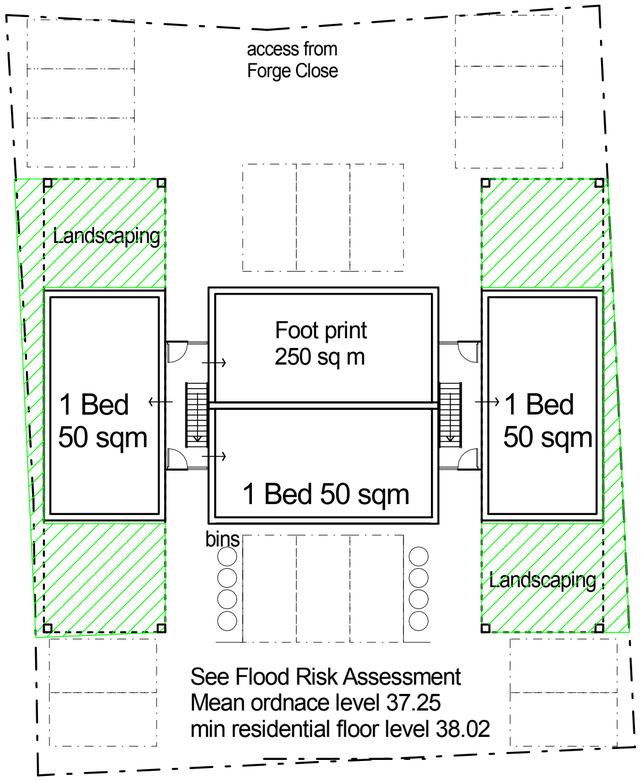


Front Elevation (Send Road)

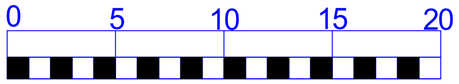


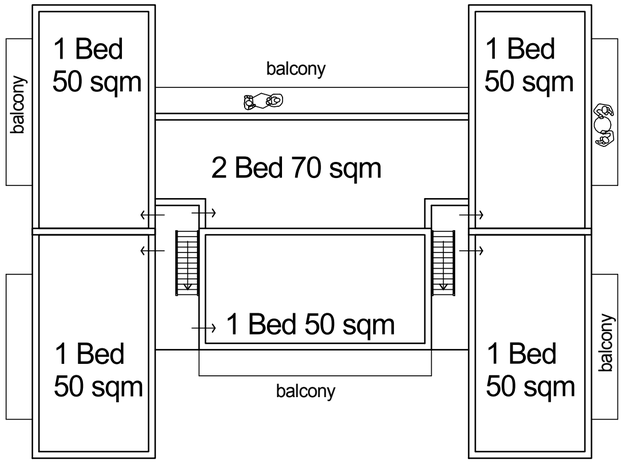
Rear Elevation (Forge Close)

Side Elevation (West and East)



Site and Ground Floor 1:200



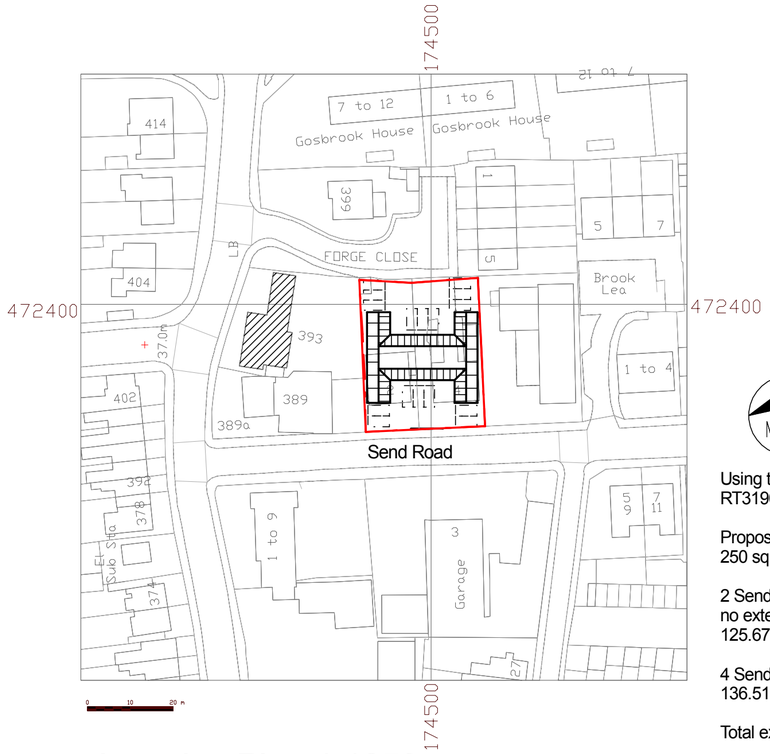


First and Second Floor 1:200

14x One Bed Flats
50 sqm nett area each

2 x Two Bed Flats
70 sqm nett area each

16 parking spaces



Location Plan 1:1250

Using topographical survey drawing
RT3190503P0001

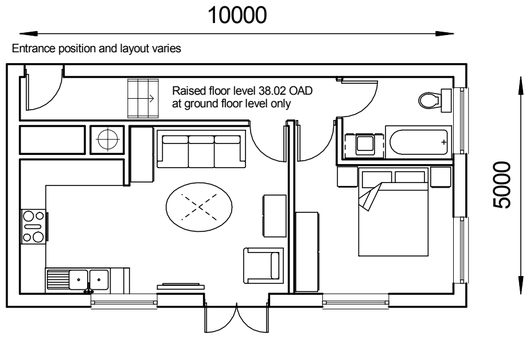
Proposed Foot print
250 sq m

2 Send Road, Bungalow
no extensions or outbuildings
125.67 sq m

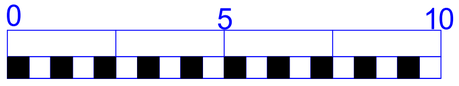
4 Send Road Commercial Building
136.51 sq m

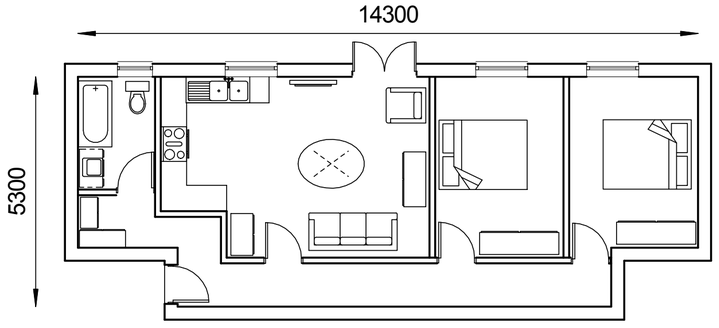
Total existing area = 262.18 sq.m

Nett Gain Area -12.18 sqm (negative)



1 Bed flat layout 1:100





2 Bed flat layout 1:100

Proposed Development
16 Flats
2 - 4 Send Road
Reading RG4 8EH

1:200 A2 Feb 2019 sk3 rev A

Appendix C Existing Drainage Information

Developed area runoff – 1ha

Greenfield runoff rates 1ha

Greenfield runoff volume 1ha

pba peterbrett	Send Road, Caversham Surface Water Drainage Existing Brownfield Runoff Rates & Volumes	JOB No: 46089		SHEET: 1 of 1
		DATE:	BY: DM	CHECKED: EE

Calculation based on 'Modified Rational Method', HR Wallingford.

Assumes that water travels across the site at 1m/s from the furthest point to the connection with the existing network

Data

M5-60min 19 mm Q=2.78CiA
r 0.40

Calculation - 1 in 1 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M1-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	1.000	15	0.60	11.40	0.62	7.07	28.3	78.6
							Total	**78.6** l/s
							Total	78.6 l/s/ha

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	*Z1*
5	*0.35*
10	*0.55*
15	*0.60*

M5	*Z2 for 1 in 1yr*
5	*0.620*
10	*0.610*
15	*0.620*

Calculation - 1 in 2 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M1-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	1.000	15	0.60	11.40	0.80	9.12	36.5	101.4
							Total	**101.4** l/s
							Total	101.4 l/s/ha

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	*Z1*
5	*0.35*
10	*0.55*
15	*0.60*

M5	*Z2 for 1 in 2yr*
5	*0.790*
10	*0.790*
15	*0.800*

Calculation - 1 in 30 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M1-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	1.000	15	0.60	11.40	1.50	17.10	68.4	190.2
							Total	**190.2** l/s
							Total	190.2 l/s/ha

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	*Z1*
5	*0.35*
10	*0.55*
15	*0.60*

M5	*Z2 for 1 in 30yr*
5	*1.450*
10	*1.490*
15	*1.500*

Calculation - 1 in 100 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M100-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	1.000	15	0.60	11.40	1.99	22.69	90.7	252.3
							Total	**252.3** l/s
							Total	252.3 l/s/ha

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	*Z1*
5	*0.35*
10	*0.55*
15	*0.60*

M5	*Z2 for 1 in 100yr*
5	*1.790*
10	*1.910*
15	*1.990*

Brownfield Runoff Volumes

Rainfall intensities derived from MicroDrainage (v. 2016.1) rainfall profiles for the 360 min storm

1 in 100 Year

Rainfall Intensity 11.0 mm/hr

Rainfall Depth 66.0 mm

Volume 528.4 m^3

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	SAAR (mm)	700	Urban	0.000
Area (ha)	1.000	Soil	0.150	Region Number	Region 6

Results	**l/s**
QBAR Rural	0.4
QBAR Urban	0.4
Q100 years	1.3
Q1 year	0.3
Q30 years	0.9
Q100 years	1.3

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Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	19.000
Ratio R	0.400
Areal Reduction Factor	1.00
Area (ha)	1.000
SAAR (mm)	700
CWI	105.000
Urban	0.000
SPR	10.000

Results

Percentage Runoff (%)	8.64
Greenfield Runoff Volume (m^3)	51.661

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Appendix D Proposed Drainage

Foul Discharge Rates

Permeable Paving MicroDrainage output – 1 in 100 year +40% Climate Change

Permeable Paving MicroDrainage output – 1 in 100 year ‘present-day’, including discharge volume

pba peterbrett	2-4 Send Road, Caversham	JOB No: 46089		SHEET: 1 of 1
	Proposed Foul Discharge	DATE: 23/04/2019	BY: DM	CHECKED: EE

Proposed Foul Discharge

Peak Flow rate based on 4000 litres per dwelling per day in accordance with the Sewers for Adoption 7th edition plus 10% allowance for infiltration

No of Units	**16**
Estimated Peak Flow	**0.7 l/s**
Estimated Peak Flow (including 10% allowance for infiltration)	**0.8 l/s**

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 58 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.116	0.116	0.0	4.7	4.7	17.4	Flood Risk
30 min Summer	0.145	0.145	0.0	5.0	5.0	21.8	Flood Risk
60 min Summer	0.165	0.165	0.0	5.0	5.0	24.8	Flood Risk
120 min Summer	0.175	0.175	0.0	5.0	5.0	26.2	Flood Risk
180 min Summer	0.171	0.171	0.0	5.0	5.0	25.7	Flood Risk
240 min Summer	0.163	0.163	0.0	5.0	5.0	24.5	Flood Risk
360 min Summer	0.144	0.144	0.0	5.0	5.0	21.6	Flood Risk
480 min Summer	0.128	0.128	0.0	4.9	4.9	19.1	Flood Risk
600 min Summer	0.116	0.116	0.0	4.7	4.7	17.4	Flood Risk
720 min Summer	0.108	0.108	0.0	4.4	4.4	16.2	Flood Risk
960 min Summer	0.095	0.095	0.0	3.8	3.8	14.3	Flood Risk
1440 min Summer	0.080	0.080	0.0	3.0	3.0	12.0	Flood Risk
2160 min Summer	0.067	0.067	0.0	2.2	2.2	10.1	Flood Risk
2880 min Summer	0.060	0.060	0.0	1.8	1.8	9.0	Flood Risk
4320 min Summer	0.050	0.050	0.0	1.3	1.3	7.5	Flood Risk
5760 min Summer	0.044	0.044	0.0	1.1	1.1	6.6	Flood Risk
7200 min Summer	0.040	0.040	0.0	0.9	0.9	6.0	Flood Risk
8640 min Summer	0.037	0.037	0.0	0.8	0.8	5.6	Flood Risk
10080 min Summer	0.035	0.035	0.0	0.7	0.7	5.2	Flood Risk
15 min Winter	0.132	0.132	0.0	4.9	4.9	19.8	Flood Risk
30 min Winter	0.167	0.167	0.0	5.0	5.0	25.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	130.597	0.0	19.1	17
30 min Summer	85.825	0.0	26.0	30
60 min Summer	53.779	0.0	33.5	48
120 min Summer	32.595	0.0	41.2	82
180 min Summer	24.012	0.0	45.7	116
240 min Summer	19.224	0.0	48.9	150
360 min Summer	13.954	0.0	53.4	212
480 min Summer	11.125	0.0	56.8	272
600 min Summer	9.325	0.0	59.6	330
720 min Summer	8.069	0.0	61.8	390
960 min Summer	6.417	0.0	65.5	510
1440 min Summer	4.640	0.0	70.8	750
2160 min Summer	3.350	0.0	76.5	1108
2880 min Summer	2.656	0.0	80.3	1472
4320 min Summer	1.912	0.0	85.6	2204
5760 min Summer	1.513	0.0	89.4	2936
7200 min Summer	1.261	0.0	92.0	3672
8640 min Summer	1.086	0.0	93.9	4400
10080 min Summer	0.957	0.0	95.2	5136
15 min Winter	130.597	0.0	21.7	17
30 min Winter	85.825	0.0	29.5	31

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	0.189	0.189	0.0	5.0	5.0	28.3	Flood Risk
120 min Winter	0.194	0.194	0.0	5.0	5.0	29.1	Flood Risk
180 min Winter	0.184	0.184	0.0	5.0	5.0	27.6	Flood Risk
240 min Winter	0.169	0.169	0.0	5.0	5.0	25.3	Flood Risk
360 min Winter	0.138	0.138	0.0	5.0	5.0	20.7	Flood Risk
480 min Winter	0.118	0.118	0.0	4.8	4.8	17.6	Flood Risk
600 min Winter	0.105	0.105	0.0	4.3	4.3	15.8	Flood Risk
720 min Winter	0.096	0.096	0.0	3.8	3.8	14.4	Flood Risk
960 min Winter	0.084	0.084	0.0	3.2	3.2	12.6	Flood Risk
1440 min Winter	0.070	0.070	0.0	2.4	2.4	10.4	Flood Risk
2160 min Winter	0.058	0.058	0.0	1.7	1.7	8.7	Flood Risk
2880 min Winter	0.051	0.051	0.0	1.4	1.4	7.6	Flood Risk
4320 min Winter	0.042	0.042	0.0	1.0	1.0	6.4	Flood Risk
5760 min Winter	0.037	0.037	0.0	0.8	0.8	5.6	Flood Risk
7200 min Winter	0.034	0.034	0.0	0.6	0.6	5.1	Flood Risk
8640 min Winter	0.031	0.031	0.0	0.6	0.6	4.7	Flood Risk
10080 min Winter	0.029	0.029	0.0	0.5	0.5	4.4	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	53.779	0.0	37.9	54
120 min Winter	32.595	0.0	46.4	90
180 min Winter	24.012	0.0	51.5	126
240 min Winter	19.224	0.0	55.2	160
360 min Winter	13.954	0.0	60.2	222
480 min Winter	11.125	0.0	64.0	278
600 min Winter	9.325	0.0	67.1	338
720 min Winter	8.069	0.0	69.7	398
960 min Winter	6.417	0.0	73.8	520
1440 min Winter	4.640	0.0	79.8	760
2160 min Winter	3.350	0.0	86.3	1124
2880 min Winter	2.656	0.0	90.7	1496
4320 min Winter	1.912	0.0	96.7	2244
5760 min Winter	1.513	0.0	101.2	2944
7200 min Winter	1.261	0.0	104.3	3680
8640 min Winter	1.086	0.0	106.6	4272
10080 min Winter	0.957	0.0	108.4	5112

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.090

Time (mins) From:	To:	Area (ha)
0	4	0.090

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Model Details

Storage is Online Cover Level (m) 0.300

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	25.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	138.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	0.000	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0115-5000-0300-5000
Design Head (m)	0.300
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	115
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	5.0	Kick-Flo®	0.253	4.6
Flush-Flo™	0.161	5.0	Mean Flow over Head Range	-	3.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.0	1.200	9.6	3.000	14.8	7.000	22.5
0.200	4.9	1.400	10.3	3.500	15.8	7.500	23.3
0.300	5.0	1.600	11.0	4.000	17.0	8.000	24.1
0.400	5.7	1.800	11.6	4.500	18.0	8.500	24.8
0.500	6.3	2.000	12.2	5.000	19.0	9.000	25.5
0.600	6.9	2.200	12.7	5.500	19.9	9.500	26.2
0.800	7.9	2.400	13.3	6.000	20.8		
1.000	8.8	2.600	13.8	6.500	21.7		

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Summary of Results for 100 year Return Period

Half Drain Time : 52 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.080	0.080	0.0	2.9	2.9	12.0	Flood Risk
30 min Summer	0.099	0.099	0.0	4.0	4.0	14.9	Flood Risk
60 min Summer	0.112	0.112	0.0	4.5	4.5	16.8	Flood Risk
120 min Summer	0.118	0.118	0.0	4.8	4.8	17.7	Flood Risk
180 min Summer	0.116	0.116	0.0	4.7	4.7	17.4	Flood Risk
240 min Summer	0.112	0.112	0.0	4.5	4.5	16.7	Flood Risk
360 min Summer	0.102	0.102	0.0	4.1	4.1	15.4	Flood Risk
480 min Summer	0.095	0.095	0.0	3.8	3.8	14.2	Flood Risk
600 min Summer	0.088	0.088	0.0	3.4	3.4	13.3	Flood Risk
720 min Summer	0.083	0.083	0.0	3.1	3.1	12.5	Flood Risk
960 min Summer	0.075	0.075	0.0	2.7	2.7	11.3	Flood Risk
1440 min Summer	0.065	0.065	0.0	2.1	2.1	9.7	Flood Risk
2160 min Summer	0.055	0.055	0.0	1.6	1.6	8.2	Flood Risk
2880 min Summer	0.049	0.049	0.0	1.3	1.3	7.3	Flood Risk
4320 min Summer	0.041	0.041	0.0	0.9	0.9	6.2	Flood Risk
5760 min Summer	0.037	0.037	0.0	0.8	0.8	5.5	Flood Risk
7200 min Summer	0.033	0.033	0.0	0.6	0.6	5.0	Flood Risk
8640 min Summer	0.031	0.031	0.0	0.5	0.5	4.6	Flood Risk
10080 min Summer	0.029	0.029	0.0	0.5	0.5	4.3	Flood Risk
15 min Winter	0.091	0.091	0.0	3.5	3.5	13.6	Flood Risk
30 min Winter	0.113	0.113	0.0	4.6	4.6	16.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	93.284	0.0	12.8	17
30 min Summer	61.304	0.0	17.7	30
60 min Summer	38.413	0.0	23.2	44
120 min Summer	23.282	0.0	28.6	78
180 min Summer	17.151	0.0	31.8	112
240 min Summer	13.731	0.0	34.1	144
360 min Summer	9.967	0.0	37.3	206
480 min Summer	7.946	0.0	39.7	268
600 min Summer	6.660	0.0	41.6	328
720 min Summer	5.763	0.0	43.2	390
960 min Summer	4.584	0.0	45.7	510
1440 min Summer	3.314	0.0	49.3	752
2160 min Summer	2.393	0.0	53.2	1124
2880 min Summer	1.897	0.0	55.8	1472
4320 min Summer	1.365	0.0	59.0	2204
5760 min Summer	1.080	0.0	61.4	2936
7200 min Summer	0.900	0.0	62.8	3672
8640 min Summer	0.776	0.0	63.7	4408
10080 min Summer	0.684	0.0	64.2	5136
15 min Winter	93.284	0.0	14.7	17
30 min Winter	61.304	0.0	20.2	30

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Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	0.126	0.126	0.0	4.9	4.9	18.9	Flood Risk
120 min Winter	0.128	0.128	0.0	4.9	4.9	19.1	Flood Risk
180 min Winter	0.120	0.120	0.0	4.9	4.9	18.1	Flood Risk
240 min Winter	0.113	0.113	0.0	4.6	4.6	16.9	Flood Risk
360 min Winter	0.099	0.099	0.0	4.0	4.0	14.9	Flood Risk
480 min Winter	0.089	0.089	0.0	3.5	3.5	13.4	Flood Risk
600 min Winter	0.082	0.082	0.0	3.0	3.0	12.3	Flood Risk
720 min Winter	0.076	0.076	0.0	2.7	2.7	11.4	Flood Risk
960 min Winter	0.067	0.067	0.0	2.2	2.2	10.1	Flood Risk
1440 min Winter	0.057	0.057	0.0	1.7	1.7	8.5	Flood Risk
2160 min Winter	0.048	0.048	0.0	1.2	1.2	7.1	Flood Risk
2880 min Winter	0.042	0.042	0.0	1.0	1.0	6.3	Flood Risk
4320 min Winter	0.035	0.035	0.0	0.7	0.7	5.3	Flood Risk
5760 min Winter	0.031	0.031	0.0	0.6	0.6	4.7	Flood Risk
7200 min Winter	0.028	0.028	0.0	0.5	0.5	4.2	Flood Risk
8640 min Winter	0.026	0.026	0.0	0.4	0.4	3.9	Flood Risk
10080 min Winter	0.024	0.024	0.0	0.3	0.3	3.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	38.413	0.0	26.3	48
120 min Winter	23.282	0.0	32.4	84
180 min Winter	17.151	0.0	36.0	118
240 min Winter	13.731	0.0	38.5	152
360 min Winter	9.967	0.0	42.1	216
480 min Winter	7.946	0.0	44.8	276
600 min Winter	6.660	0.0	47.0	338
720 min Winter	5.763	0.0	48.8	398
960 min Winter	4.584	0.0	51.7	522
1440 min Winter	3.314	0.0	55.8	764
2160 min Winter	2.393	0.0	60.2	1124
2880 min Winter	1.897	0.0	63.2	1488
4320 min Winter	1.365	0.0	67.0	2204
5760 min Winter	1.080	0.0	69.9	2928
7200 min Winter	0.900	0.0	71.7	3656
8640 min Winter	0.776	0.0	72.9	4464
10080 min Winter	0.684	0.0	73.7	5136

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