SuDS Strategy Report

Land Rear of Frognal, NW3 6AR

Project Reference: SD2204112

SuDS DESIGNS

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Revisions and Additional Material

Document History and Status

Revision	Date	Purpose/Status
-	28.04.22	First Issue
A	10.06.22	To address LLFA comments
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Document Details

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Preamble

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1.0 Introduction

1.0.1 SuDS Designs have been appointed to prepare a surface water drainage strategy and SuDS report which will aim to discharge the relevant planning conditions for the development at Land rear of 17 Frognal, NW3 6AR.

1.0.2 This report will review and aim to meet the requirements as set out by the London Borough of Camden. The report will include a surface water drainage strategy and will consider the use of SuDS wherever possible and in accordance with CC1, CC2 and CC3 of the Local Plan 2017.

2.0 Location & Existing Conditions

2.0.1 The application site is off Frognal, NW3 6AP, some 400m north of Finchley Road tube station in South Hampstead.

2.0.2 The site is specifically located off Station Road and is a greenfield site, previously a part of 17 Frognal itself. The site area totals approximately 0.035ha and is made up of predominantly landscaping.

2.0.3 The British Geological Survey (BGS) information generally shows the site to be underlain by the London Clay Formation comprising of clay, silt and sand as shown in **Figure 1** below.

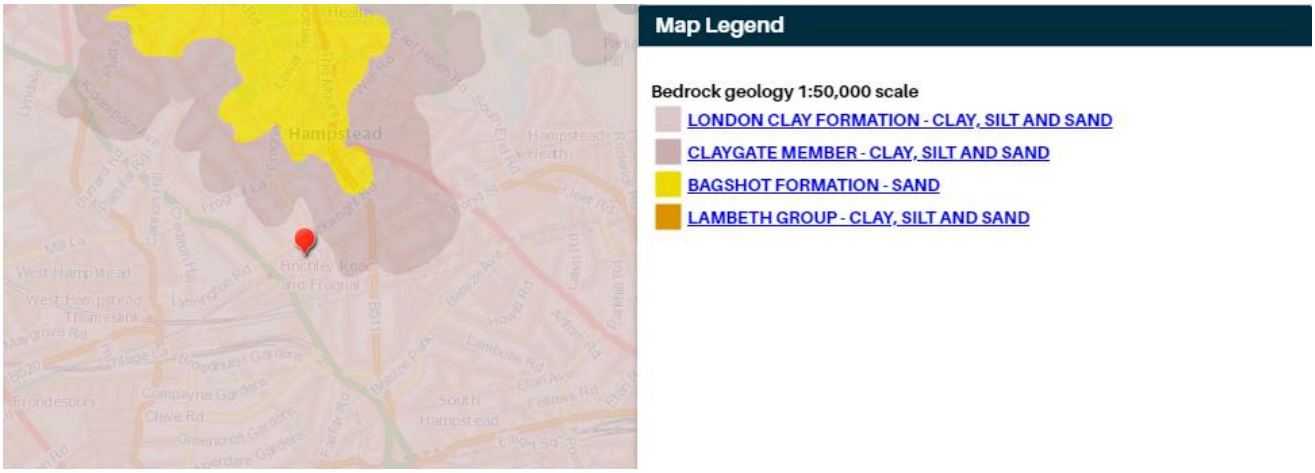


Figure 1 Bedrock Geology

2.1 Existing Sewer Assets

2.1.1 Sewer asset records show the presence of a combined sewer adjacent to the site, in Hampstead Gate. A connection is feasible due to favorable topography. The connection is subject to approval from Thames Water and will require excavation through 3rd party land which has been agreed. The drainage will run through into Hampstead Gate.

2.1.2 Greenfield Runoff rates appended

3.0 SuDS Considerations

3.0.1 Consideration of SuDS is a planning requirement for new developments. SuDS are designed to replicate the natural course of drainage as closely as possible with a view to reducing the impact of flooding, removing pollutants at source and combining water management with green space.

Developments should utilise SuDS where possible and ensure that surface water run-off is managed as close to its source as possible in line with the following hierarchy:

1. Into ground (infiltration).
2. To a surface water body.
3. To a surface water sewer.
4. To a combined sewer.

3.0.2 Sustainable Drainage Systems should be included in the design to manage surface water flood risk. SuDS should be inspired by natural drainage processes and manage water as close to its source as possible whilst offering pollution control and landscape benefits.

3.0.3 For this development the London Borough of Camden are the Local Planning Authority and set out the requirements in relation to the drainage strategy and SuDS. Those requirements refer to local council guidance documents and national policy guidelines.

3.0.4 The drainage conditions require an assessment for the potential for disposing of surface water by means of sustainable drainage systems, having regard to Defra's non-statutory technical standards for sustainable drainage systems (or any subsequent version). Information is to include:

- Design storm period and intensity, the method deployed to delay and control the surface water discharged from the site and measures taken to prevent pollution.
- Management and maintenance practices.

3.0.5 The London Borough of Camden Local Plan 2017 sets out the policy requirements, namely CC1, CC2 and CC3. Defra Sustainable Drainage Systems Non-statutory technical standards for sustainable drainage systems, March 2015 is also considered.

3.1 SuDS Incorporation

3.1.1 Surface water disposal via infiltration methods are considered in the first instance in accordance with the above hierarchy. The underlying geology suggests that disposal of surface water via infiltration is unlikely owing to the clay soil, therefore no infiltration is proposed

3.1.2 Therefore, following the hierarchy, and with no surface water body in the vicinity of the site, proposals are to discharge to the existing sewer network.

3.1.3 Table 7.1 below from the SuDS Manual sets out the various components that may be considered in providing SuDS.

Component Type	Description	Collection Mechanism	Design Criteria						Further Information (Chapter Ref)
			Water Quantity (Chapter 3)			Water Quality (Chapter 4)	Amenity (Chapter 5)	Biodiversity (Chapter 6)	
			Peak Runoff Rate	Runoff Volumes: Small Events (Interceptions)	Runoff Volumes: Large Events				
Rainwater Harvesting Systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●		11
Green roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●	12
Infiltration systems	Systems that collect and store runoff, allowing it to infiltrate into the ground	P	●	●	●	●	●	●	13
Proprietary treatment systems	Subsurface structures design to provide treatment to runoff	P				●			14
Filter strips	Grass strips hat promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○	15
Filter drains	Shallow stone-filled trenches that provide attenuation, conveyance and treatment of runoff	L	●	○		●	○	○	16
Swales	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	L	●	●	●	●	●	●	17
Bioretention systems	Trees with soil-filled tree pits, tree planters or structural soils used to collect, store and treat runoff	P	●	●	●	●	●	●	18
Trees	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	P	●	●		●	●	●	19
Pervious pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○	20
Attenuation storage tanks	Large, below-ground voided spaces used to temporarily store runoff before infiltration-controlled release or use	P	●						21
Detention basins	Vegetated depressions that store and treat runoff	P	●	●		●	●	●	22
Ponds and wetlands	Permanent pools of water used to facilitate treatment of runoff – runoff can also be stored in an attenuation zone above the pool	P	●			●	●	●	23

P-Point L-Lateral S-Surface

● – likely valuable contribution to delivery of design criterion

○ - some potential contribution to delivery of design criterion, if specifically included in the design

Figure 2 CIRIA Table 7.1 SuDS Components

3.1.4 Despite low levels of permeability, permeable surfacing can be used in accordance with a flow control which is to be set to an allowable discharge rate with the attenuation sized appropriately.

3.1.5 The **Figure 2** proposals ensure that an 'at source' SuDS measure is applied, and betterment is provided in terms of surface water runoff velocity and quality. Pollution indices from different land types can be found per as per table 26.15 CIRIA SuDS Manual 2015, below.

Land use surface type (Lust)	Impermeability (IMP_{RF})	Total suspended solids pollution index (PI_{TSS})	Organic pollution index (PI_{Orgl})	Hydrocarbon pollution index (PI_{PAD})	Metals Pollution index (PI)

Roofs					
Industrial / Commercial	1.0	0.3	0.3-0.4	0.2	0.4-0.8
Residential	0.9	0.4-0.5	0.6-0.7	0.1	0.2-0.5
Highways					
Motorways	0.8-0.9	0.9	0.7	0.9	0.8
Major arterial highways	0.7-0.8	0.8	0.7	0.8	0.8
Urban distributor roads	0.6-0.7	0.7-0.8	0.5	0.8	0.7
Residential Street	0.4-0.6	0.4	0.6	0.6	0.6
Pavements	0.5-0.6	0.4	0.6	0.3	0.3
Car Parks / Hardstanding					
Industrial/Commercial	0.6-0.8	0.6-0.7	0.6-0.7	0.7	0.4-0.5
Driveways (Residential)	0.5	0.5	0.6	0.4	0.3
Open Areas					
Gardens (All types)	0.1	0.3	0.2-0.3	0	0.01
Parks/Golf Courses	0.2	0.2-0.3	0.2	0	0.02
Grassed Areas (including verges, all types)	0.1	0.2-0.3	0.2-0.3	0.05	0.05
Note 1 Pollution index values are based on reported land use type EMC distributions and impact potential thresholds from House et al (1991), Luker and Montague (1994), Butler and Clark (1995), D'Arcy et al (2000), Mitchell (2005) and Moy et al (2003)					

Figure 3 Impermeability and pollution indices for different land use types

3.1.5 Proposals for this development incorporate green roof areas which offer a SuDS element to the design. The green roof has the potential to reduce the peak runoff rate and runoff volume.

3.1.6 Where a green roof is proposed, the surface water runoff will be slowed at source by soaking through the substrate. For small events, most is absorbed with any excess runoff being directed to the roof drainage system. Green roofs offer the added benefit of biodiversity and improved quality of surface water runoff using vegetation to remove urban pollutants. **Figure** 5 below shows the make up of a typical green roof.

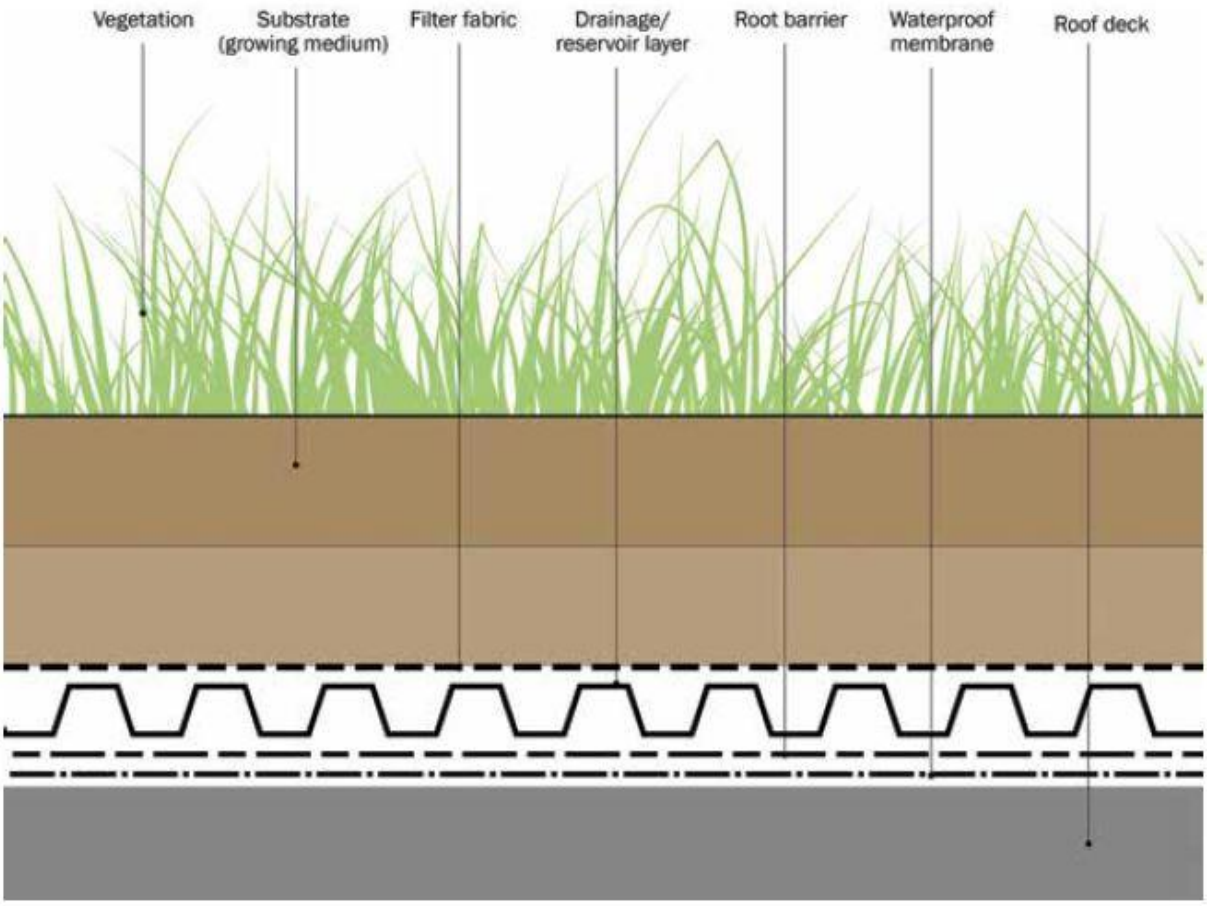


Figure 12.1 Section showing typical extensive green roof components

Figure 4 CIRIA Figure 12.1 SuDS Manual

3.1.7 Developments are generally required to reduce both runoff rate and volume from the site where reasonably practical through the appropriate incorporation of SuDS. Typically, developments should aim to achieve greenfield runoff rates and ensure that surface water runoff is managed as close as close to its source as possible in line with the drainage hierarchy.

3.1.8 Following the hierarchy, and with no surface water body in the vicinity of the site, proposals are to discharge to the sewer network. Paragraph S3 of Defra guidance March 2015 states that for sites the peak runoff rate should be as close as reasonably practical to the greenfield runoff rate., however the runoff rate will be negligible for such a small area. Therefore, it is proposed to restrict the runoff going into the sewer network to 0.5 l/s which is low as reasonably practical considering the level of upstream source control provided by a green roof and removing potential for blockage, should it be maintained correctly.

3.1.9 Therefore, proposals are to reduce flows and volumes by use of the SuDS features provided. The extensive green roof incorporated within this development offers a means of peak flow and volume reduction. Table 7.1 from CIRIA guidance also shows that by interception, green roofs have the potential to reduce runoff volume and peak flow for small storm events.

3.1.11 Below summarises the rainfall interception performance of a green roof for varying substrate depths. The evidence below suggests that for 70-80% of rain events there is no runoff from green roofs. Only 10 out of

100 rain days per annum would see a roof act in the same way as an impermeable surface when the substrate had become saturated. Therefore, the interception qualities of a green roof demonstrate that runoff and volume can be reduced for some rainfall events throughout the year.

BOX 12.1 Reported evidence of interception delivered by green roofs

Table 12.2 summarises the results of research into the performance of green roofs in reducing runoff frequencies and volumes.

Table 12.2 Summary of available evidence of performance of green roofs

Reference	Interception provided by green roofs[1]	Substrate depth
GSA (2011)	12.5–19 mm (USA)	Substrate depth 75–100 mm
Stovin *et al* (2012)	About 12–15 mm (estimated based on 100% retention of rainfall for 1:1 year, 1 hour event in Sheffield, UK and 72% retention for 1:1 year 24 hour event)	80 mm substrate
Fassman-Beck and Simcock (2013)	About 20 mm (most frequent result was 0 mm runoff for events up to 20 mm)	100–150 mm substrate
Paudel (2009)	16.5 mm (Detroit, Michigan, USA)	100 mm substrate
Martin (2008)	About 10 mm (Ontario, Canada)	100 mm substrate

Note
1 Ie no runoff for majority of events up to these depths.

Martin (2008) reported that the reduction in depth and frequency of runoff from a green roof with 100 mm of substrate is similar to that of a naturally vegetated catchment. For the majority (70–80%) of rain events there is no runoff from green roofs (Figure 12.6) but for about 10 out of approximately 100 rain days a year green roofs have a response that is more similar to an impermeable surface (demonstrating the shift towards impermeable runoff characteristics when the substrate is saturated).

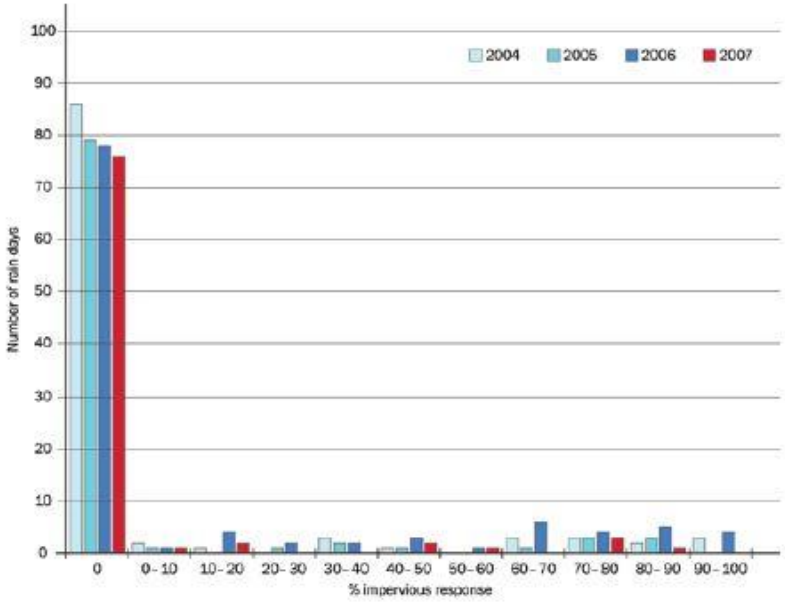


Figure 12.6 Distribution of runoff response (0% imperviousness means no runoff) (from Martin, 2008)

Figure 5 CIRIA Box 12.1: SuDS Manual

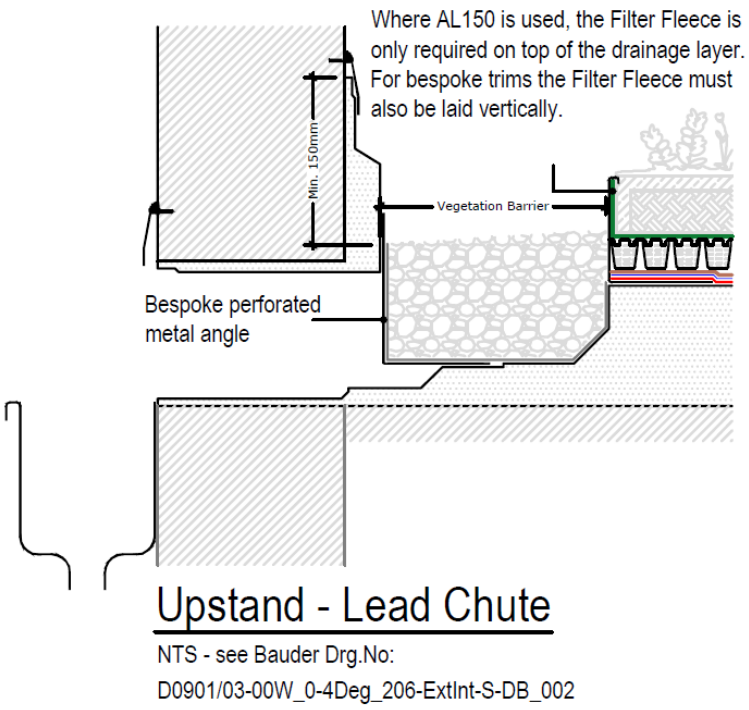


Figure 6 Typical Bauder Green Roof Drainage Detail

3.2 *Preliminary Surface Water Drainage Maintenance Schedules*

3.2.1 This section of the report gives guidance on the maintenance of the drainage system and outlines who will be responsible for this. The proposed development comprises of site clearance, landscaping, drainage and supporting infrastructure. By necessity the available SuDS systems will store, and slow down rainwater.

3.2.2 Green Roof – Maintenance of the green roof will be the responsibility of the developer see **Table 1** below.

Table 1 System storage operation and maintenance requirements (Green Roof)

Maintenance Schedule	Required Action	Recommended Frequency
Regular Inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (where applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability. Inspect substrate for evidence of erosion channels and identify any sediment sources. Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system. Inspect underside of roof for evidence of leakage.	Annually and after severe storms.

Regular Maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth. During establishment replace dead plants as required. Post establishment, replace dead plants as required. Remove fallen leaves and debris from deciduous plant foliage. Remove nuisance and invasive vegetation, including weeds. Mow grasses, prune shrubs and manage other planting as required – clippings should be removed and not allowed to accumulate.	Monthly and annually as required.
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled. If drain inlet has settled, cracked or moved, investigate and repair as appropriate.	As required

3.2.3 The design life of the development is likely to exceed the design life of each of the SuDS components listed above. During the routine inspections of any drainage components, it may become apparent that they have reached the end of their functional lifetime. In the interest of sustainability, repairs should be the first-choice solution where practicable. If this is not the case, then it will be necessary for the property owners to undertake complete replacement of the component in question.

3.2.4 Rainwater Pipes, and Chambers

Table 2– Rainwater Pipes, and Chambers: System storage operation and maintenance requirements

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Inspection of silt trap chamber and removal of debris when necessary	Quarterly or as required following monitoring
Remedial Actions	Check for blockages in manholes and pipes. Rodding and jetting of pipes to be carried out. CCTV survey can be carried out to inspect condition of pipework	Quarterly or as required following monitoring

Monitoring	Inspect collection apparatus for debris and litter. Remove where necessary to prevent blockages in the system.	Monthly or after periods of heavy rainfall

3.2.5 Permeable Paving

Table 3 – Permeable Paving: System operation and maintenance requirements

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Sweeping. [NOTE: Any jointing material between the blocks that is lost or displaced as a result of sweeping must be replaced. New jointing material must be the same type as that removed or a suitable replacement]	3 no. times a year: - • At the end of Winter; • Mid-summer; and • After autumn leaf fall. Also as required based on site specific observations
Occasional Maintenance	Stabilise and mow contributing and adjacent areas to prevent excess sediment being washed into the paving	As required
Remedial actions	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users	As required

4.0 Surface Water Strategy

The surface water strategy is based upon the SuDS implementation as outlined above:

A. Store rainwater for later use:

Rainwater storage can be utilised in the form of a grey water harvesting system (for the purposes of the calculations it has been discounted to offer a worst case scenario where the system is at fault, or full)

B. Use infiltration techniques, such as porous surfaces:

Infiltration is not supported on this site. However the green roof offers a porous surface for source control, and also the added benefit of reducing the amount of water entering the network.

C. Attenuate rain water in ponds or open water features for gradual release:

The proposed site layout does not provide sufficient area for open water features.

D. Attenuate rainwater by storing in tanks or sealed water features for gradual release:

The green roof 150mm substrate will provide an element of attenuation and will only release surface water into the outlet when fully saturated. In doing so, the development will significantly lower the runoff rate and volume compared with a conventional hard surfaced roof. The green roof outlets will connect into the sub-base of the permeable surfacing area, this will offer storage during peak events, with an outflow control applied of 0.5 l/s where the green roof area is 100m^2 and the additional permeable surfaced area is 70m^2.

Permeable paving volume is 29.925m^3, sub-base set at 450mm depth, to accord with the sub-base replacement crates required

With 150mm substrate, green roof volume is 4.5m^3

E. Direct rainwater direct to the watercourse:

Not applicable.

F. Discharge rainwater to a surface water sewer/drain:

Not Applicable.

G. Discharge rainwater to combined sewer:

All runoff to be directed to the existing combined sewer network.

H. Discharge rainwater to foul sewer:

Not applicable, see F.

Supporting calculations are appended

4.1 Surface Water Management During Construction

4.1.1 Consideration for surface water needs to be taken during the construction process, and how it is managed, including flood risk and pollution control.

4.1.2 Project and Site Managers should sign up for the Met Office weather warning system and take appropriate action. https://www.metoffice.gov.uk/public/weather/warnings

4.1.3 Consideration for the following legislation and guidance should be made for a construction surface water management plan:

Legislation and Guidance
The Water Environment (England and Wales) Regulation 2009
Land Drainage Act 1991
SEPA Engineering in the Water Environment Good Practice Guide Temporary Construction Methods
Control of Water Pollution from Construction Sites – Guide to Good Practice (SP156)
Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532)
Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648)
Control of Water Pollution from Linear Construction Projects – Site Guide (C649)
Environmental Good Practice – Site Guide (C650)
Site Handbook for the Construction of SUDS (C698)
The SUDS Manual (C753)
BS 8582:2013 Code of Practice for Surface Water Management for Development Sites

Figure 7 Legislation and Guidance for Surface Water Construction Management

4.2 Exceedance Calculations

4.2.1 CIRIA document C635 *Designing for exceedance in urban drainage – good practice* states that "at present there are no guidelines on the return period of event (extreme event) that should be used for design exceedance". However, Section 3.4 also states that "it is suggested that return periods of 1 in 30, to 1 in 100 or 1 in 200-year events would form a suitable framework for most applications".

4.2.2 In accordance with the above, the drainage network has been modelled using a 1 in 200-year event, and the calculations are appended to show the capability and resilience of the network to deal with such a storm event. Exceedance flows are therefore directed to the drainage system.

5.0 SuDS Health & Safety Risks

5.1 Green Roof

Provide easy access

Roof access is essential for maintenance. Safe access can come in the form of safety ladders, walkways or internal hatches. These should be both safe and secure in themselves, but also allow workers to access a green roof with the tools they need to undertake maintenance.

Inspections

Unlike normal roof inspections, green roofs require specific attention, such as removing weeds or replacing dead plants, checking drainage outlets and the roofing membrane. Dead plants can clog up guttering and make the roof look untidy, so they should be removed regularly.

The structure of a green roof is a multi-layered blend of membranes, liners, insulation and organic matter. As such, any damage to the roof may be difficult to detect and fix.

Prevent falls from height

Ideally, every roof would have full containment, but unfortunately this is not always feasible. Alternatives, such as anchor points, hand rails and walkways can give workers safe access to the areas of the roof they need to inspect. Whatever means of fall protection you opt for, they should all be inspected annually.

One more natural way to prevent falls from height from a green roof is to plant discouraging shrubs – such as hawthorn or pyracantha – near the edge. However, this should be in addition to, not replacing, measures that meet regulation standards.

Handrails and walkways are ideal for most roof access needs. However, when it comes to green roofs, you can run into problems.

Guardrail alternatives

If your roof has a lawn that needs mowing, a handrail becomes a liability. Mowing with one hand is hard enough, but when you're on a roof, it moves from being a hassle to a hazard.

Employees can attach harnesses to personal fall arrest devices. These literal lifelines allow the user continual hands-free protection along a roof without running the risk of detaching. Whenever possible these systems should also limit worker access to the edge of the roof.

Be mindful of the weather

The Work at Height Regulations 2005 specifically state that work should not be carried out if weather conditions could endanger the health and safety of workers. This includes rain, ice, wind, and possibly extremely hot weather.

5.2 Below Ground Drainage

Unknown Services / Excavations

Drawings to be included in H&S file of results from ground scan for unknown utilities/services that may cross the site without prior knowledge. This will also have a potential effect on foundations. Finish site levels maintained a much as practical to minimise extent of excavations, working in confined spaces may be required. Bedding and laying of pipework and construction of inspection chambers where unconfirmed groundwater poses a risk will result in de-watering of trenches and pits.

Public highway

Liaise with highway authority to understand constraints of access and working activities within the highway. Geo-investigation is often excluded near to boundaries, so there must be an avoidance of works affecting existing highways and footpaths where destabilisation could take place. Highway approval may be required where there are movements through local residential areas.

Off-site Drainage Connections

Risk is posed by working on live sewers, working in a live highway, with potential excavation risks associated with working close to adjacent boundaries. Excavations to be kept to a minimum, and appropriate depth batter control for excavations required including traffic management.

6.0 Conclusions

6.0.1 The existing site is current a greenfield – a back garden development.

6.0.2 Surface water disposal via infiltration is not considered feasible owing to clay soil conditions and approved site layout.

6.0.3 An existing sewer network provides an outfall in accordance with the hierarchy.

6.04 A green roof is proposed which will provide SuDS measures as required.

6.0.5 The existing public sewers require further investigation and consultation with Thames Water prior to connection.

6.0.6 The drainage strategy and SuDS measures in this report are in accordance with the requirements of the London Borough of Camden

7.0 Appendices

Surface Water Calculations (1 in 100yr + 40%)

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

Half Drain Time : 1830 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	50.428	0.128	0.0	0.0	0.0	8.5	O K
30 min Summer	50.469	0.169	0.0	0.0	0.0	11.2	O K
60 min Summer	50.506	0.206	0.0	0.1	0.1	13.7	O K
120 min Summer	50.544	0.244	0.0	0.1	0.1	16.2	O K
180 min Summer	50.565	0.265	0.0	0.1	0.1	17.6	O K
240 min Summer	50.579	0.279	0.0	0.2	0.2	18.5	O K
360 min Summer	50.595	0.295	0.0	0.2	0.2	19.6	O K
480 min Summer	50.604	0.304	0.0	0.2	0.2	20.2	O K
600 min Summer	50.609	0.309	0.0	0.2	0.2	20.5	O K
720 min Summer	50.611	0.311	0.0	0.2	0.2	20.7	O K
960 min Summer	50.613	0.313	0.0	0.2	0.2	20.8	O K
1440 min Summer	50.616	0.316	0.0	0.2	0.2	21.0	O K
2160 min Summer	50.617	0.317	0.0	0.2	0.2	21.1	O K
2880 min Summer	50.615	0.315	0.0	0.2	0.2	20.9	O K
4320 min Summer	50.606	0.306	0.0	0.2	0.2	20.4	O K
5760 min Summer	50.596	0.296	0.0	0.2	0.2	19.7	O K
7200 min Summer	50.586	0.286	0.0	0.2	0.2	19.0	O K
8640 min Summer	50.576	0.276	0.0	0.2	0.2	18.4	O K
10080 min Summer	50.567	0.267	0.0	0.1	0.1	17.8	O K
15 min Winter	50.445	0.145	0.0	0.0	0.0	9.6	O K
30 min Winter	50.488	0.188	0.0	0.1	0.1	12.5	O K
60 min Winter	50.530	0.230	0.0	0.1	0.1	15.3	O K
120 min Winter	50.574	0.274	0.0	0.1	0.1	18.2	O K
180 min Winter	50.598	0.298	0.0	0.2	0.2	19.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	147.171	0.0	0.0	125
30 min Summer	95.108	0.0	0.1	131
60 min Summer	58.456	0.0	2.9	108
120 min Summer	34.709	0.0	5.6	144
180 min Summer	25.261	0.0	7.2	190
240 min Summer	20.053	0.0	8.3	244
360 min Summer	14.450	0.0	9.9	362
480 min Summer	11.451	0.0	11.1	482
600 min Summer	9.554	0.0	12.0	600
720 min Summer	8.237	0.0	12.8	720
960 min Summer	6.514	0.0	14.0	834
1440 min Summer	4.673	0.0	15.5	1068
2160 min Summer	3.347	0.0	18.0	1468
2880 min Summer	2.639	0.0	19.3	1872
4320 min Summer	1.886	0.0	21.0	2680
5760 min Summer	1.485	0.0	22.4	3464
7200 min Summer	1.233	0.0	23.3	4248
8640 min Summer	1.059	0.0	23.9	4952
10080 min Summer	0.931	0.0	24.3	5712
15 min Winter	147.171	0.0	0.0	126
30 min Winter	95.108	0.0	1.4	95
60 min Winter	58.456	0.0	4.6	104
120 min Winter	34.709	0.0	7.7	142
180 min Winter	25.261	0.0	9.5	188

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
240 min Winter	50.613	0.313	0.0	0.2	0.2	20.8	O K
360 min Winter	50.632	0.332	0.0	0.2	0.2	22.1	O K
480 min Winter	50.643	0.343	0.0	0.2	0.2	22.8	O K
600 min Winter	50.649	0.349	0.0	0.2	0.2	23.2	O K
720 min Winter	50.652	0.352	0.0	0.2	0.2	23.4	O K
960 min Winter	50.654	0.354	0.0	0.2	0.2	23.5	O K
1440 min Winter	50.654	0.354	0.0	0.2	0.2	23.6	O K
2160 min Winter	50.650	0.350	0.0	0.2	0.2	23.3	O K
2880 min Winter	50.642	0.342	0.0	0.2	0.2	22.7	O K
4320 min Winter	50.623	0.323	0.0	0.2	0.2	21.5	O K
5760 min Winter	50.604	0.304	0.0	0.2	0.2	20.2	O K
7200 min Winter	50.587	0.287	0.0	0.2	0.2	19.1	O K
8640 min Winter	50.573	0.273	0.0	0.1	0.1	18.1	O K
10080 min Winter	50.560	0.260	0.0	0.1	0.1	17.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	20.053	0.0	10.7	242
360 min Winter	14.450	0.0	12.5	358
480 min Winter	11.451	0.0	13.8	472
600 min Winter	9.554	0.0	14.9	584
720 min Winter	8.237	0.0	15.7	694
960 min Winter	6.514	0.0	17.0	902
1440 min Winter	4.673	0.0	18.5	1112
2160 min Winter	3.347	0.0	21.7	1568
2880 min Winter	2.639	0.0	23.2	2016
4320 min Winter	1.886	0.0	25.1	2852
5760 min Winter	1.485	0.0	26.8	3648
7200 min Winter	1.233	0.0	27.8	4424
8640 min Winter	1.059	0.0	28.6	5184
10080 min Winter	0.931	0.0	29.1	5944

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)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.024

Time From:	(mins) To:	Area (ha)
0	4	0.024

Green Roof

Area (m^3) 100 Evaporation (mm/day) 3
Depression Storage (mm) 5 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.001817	32	36	0.000367	64	68	0.000074	96	100	0.000015
4	8	0.001488	36	40	0.000300	68	72	0.000061	100	104	0.000012
8	12	0.001218	40	44	0.000246	72	76	0.000050	104	108	0.000010
12	16	0.000997	44	48	0.000201	76	80	0.000041	108	112	0.000008
16	20	0.000817	48	52	0.000165	80	84	0.000033	112	116	0.000007
20	24	0.000669	52	56	0.000135	84	88	0.000027	116	120	0.000006
24	28	0.000547	56	60	0.000111	88	92	0.000022			
28	32	0.000448	60	64	0.000090	92	96	0.000018			

Model Details

Storage is Online Cover Level (m) 51.000

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.0
Max Percolation (l/s)	19.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	50.300	Cap Volume Depth (m)	0.450

Orifice Outflow Control

Diameter (m) 0.015 Discharge Coefficient 0.600 Invert Level (m) 50.465

Greenfield Runoff Rates

ICP SUDS Mean Annual Flood

Input

Return Period (years) 1 SAAR (mm) 600 Urban 0.000
Area (ha) 0.035 Soil 0.300 Region Number Region 6

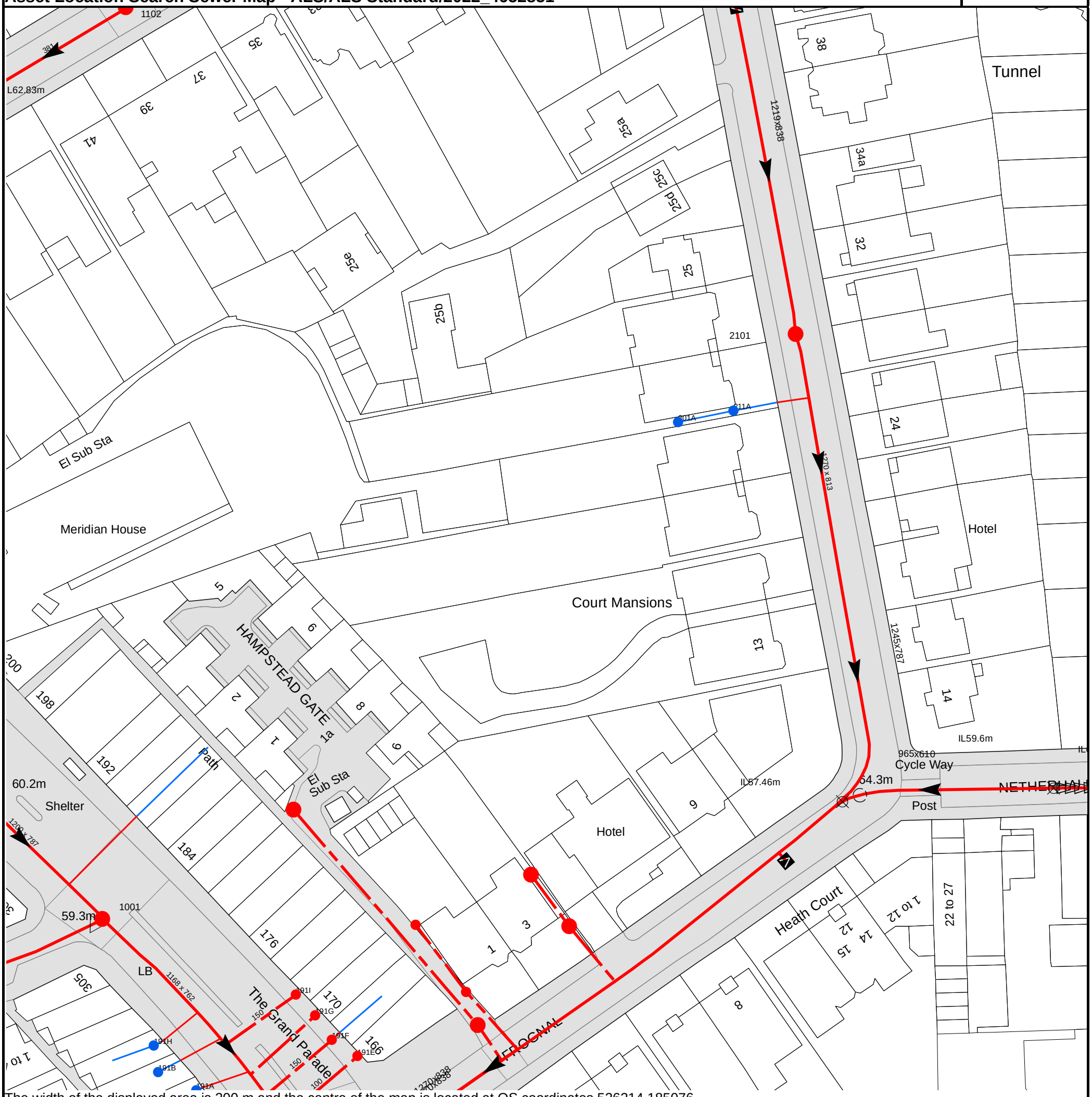
Results l/s

QBAR Rural 0.1
QBAR Urban 0.1

Q1 year 0.0

Q1 year 0.0
Q30 years 0.1
Q100 years 0.2

Asset Location Search Sewer Map - ALS/ALS Standard/2022_4652851



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 526214,185076

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map (2020) with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

Thames Water Approval

DS reference DS4108545

developer.services@thameswater.co.uk

0800 009 3921
Monday to Friday, 8am to 5pm

thameswater.co.uk/developerservices

Mr Nicky Sofroniou
Flat 14 Taplow
London
NW3 3NY

1 July 2022

Notice of consent to indirectly connect to a public sewer

Site address: Rear Of 17 Frognal, 17a Frognal, LONDON, NW3 6AR

Dear Mr Sofroniou,

Thank you for your application for a new sewer connection at the above address.

We are pleased to inform you that we have given our conditional consent for your proposed indirect connection(s) to the public sewer, under Section 106 of the Water Industry Act 1991.

What is this consent for?

This consent is given solely for the legal right of communication (i.e. method/mode of connection) with the public sewer, in accordance with the description below.

This consent does not guarantee capacity exists within our network. For capacity-based enquiries or preplanning concerns regarding our network please make a Pre-Planning Enquiry application. Applications can be made on the Thames Water website.

This Consent does not give you any inferred right to enter or cross land owned by a third party and must not be used to discharge any drainage-related planning conditions. You will be responsible for obtaining any necessary licences and/or permission from the highway authority, planning authority and/or third-party land owners.

You must obtain permission from the owner of the private drainage system you propose to connect to.

Inspections

We usually do not need to inspect your works because your connection as agreed below is to a private drainage system which is not owned or maintained by Thames Water.
We will however need to carry out or witness a connectivity check for your connection to ensure that your private drains are discharging into the correct sewer for the following boroughs;
Brent, Barnet, Ealing, Enfield, Harrow, Hillingdon, and Kingston Upon Thames
This is due to a significant rise in the number of pollutions caused by misconnections within these boroughs.

If your site is not within the above-mentioned boroughs, your contractor can carry out the connection, which we do not need to supervise/inspect.
If your site is within the above-mentioned boroughs, please call us on 0800 009 3921 to schedule a connectivity check, at least ten working days prior to your estimated completion date for the connection works.

Our consent is subject to the below conditions:

Location: Rear Of 17 Frognal, 17a Frognal, London, NW3 6AR
Description: Indirect combined water Connection 1 x foul & x 1 surface water drain connections into an existing 100mm diameter combined lateral (private) drain via an existing chamber within the development site As per drawing No. 200 Issue: P1

Please note that we will allow ONE amendment to be made to this consent within 12 months from date of issue. Any more than ONE amendment within this time period will entail additional fees. Any amendments sought beyond this time period will require a new application to be submitted.

The reference number for your application is **DS4108545** please quote this in any future correspondence.

If you're proposing to build within three metres of a public sewer, or within one metre of a lateral drain, you'll need to apply to us for a separate build over agreement. You can do this via **thameswater.co.uk/buildover**.

Please take note of the 'Additional guidance/conditions' included below.

If you've any queries, please call our helpdesk on 0800 009 3921 (8am to 5pm, Monday to Friday) or email developer.services@thameswater.co.uk.

Yours sincerely,

Colins Akemche
Technical Coordinator
Developer Services – Wastewater

Additional Guidance/Conditions

An infrastructure charge will be payable as a result of connecting a property to the public sewerage system for the first time for domestic purposes, under Section 146(2)b of the Water Industry Act 1991. We will invoice this charge separately if applicable.

Please note that this approval only covers the connections detailed in the attached notice. No other works affecting the public sewerage system may be carried out without our written consent.

Under no circumstances should foul water be discharged into the surface water sewerage system. Surface water drainage must not discharge to the foul sewerage system unless otherwise stated in the description above.

It is your responsibility to confirm the exact location, diameter, and invert levels of the public sewer prior to making the connection. You will be held liable for any misconnection (i.e. foul water discharge to a surface water sewer or surface water discharge to foul water sewer) resulting from this connection. You should carry out connectivity surveys to confirm the type of sewer your existing private drains connect to and take appropriate action to rectify if you find cross connections.

When detailing the private drainage, we advise you to assume that the public sewer may occasionally surcharge up to ground level and particular care is needed where development is proposed in low lying areas.

Where the developer/owner/occupier proposes to discharge trade effluent into the public sewer, a trade effluent consent will be required. Trade effluent can be best described as anything other than domestic sewage (toilet, bath or sink waste) or uncontaminated surface water and roof drainage (rainwater). For enquiries and application forms contact your Retailer or visit the Thames Water website at https://wholesale.thameswater.co.uk/Wholesale-services/Business-customers/Trade-effluent

Exceedance Calculations (1 in 200yr + 40%)

Summary of Results for 200 year Return Period (+40%)

Half Drain Time : 1471 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	50.451	0.151	0.0	0.0	0.0	10.0	O K
30 min Summer	50.495	0.195	0.0	0.1	0.1	13.0	O K
60 min Summer	50.541	0.241	0.0	0.1	0.1	16.0	O K
120 min Summer	50.586	0.286	0.0	0.2	0.2	19.0	O K
180 min Summer	50.611	0.311	0.0	0.2	0.2	20.7	O K
240 min Summer	50.626	0.326	0.0	0.2	0.2	21.7	O K
360 min Summer	50.643	0.343	0.0	0.2	0.2	22.8	O K
480 min Summer	50.653	0.353	0.0	0.2	0.2	23.5	O K
600 min Summer	50.658	0.358	0.0	0.2	0.2	23.8	O K
720 min Summer	50.660	0.360	0.0	0.2	0.2	24.0	O K
960 min Summer	50.661	0.361	0.0	0.2	0.2	24.0	O K
1440 min Summer	50.663	0.363	0.0	0.2	0.2	24.1	O K
2160 min Summer	50.662	0.362	0.0	0.2	0.2	24.1	O K
2880 min Summer	50.657	0.357	0.0	0.2	0.2	23.8	O K
4320 min Summer	50.645	0.345	0.0	0.2	0.2	22.9	O K
5760 min Summer	50.631	0.331	0.0	0.2	0.2	22.0	O K
7200 min Summer	50.617	0.317	0.0	0.2	0.2	21.1	O K
8640 min Summer	50.604	0.304	0.0	0.2	0.2	20.2	O K
10080 min Summer	50.593	0.293	0.0	0.2	0.2	19.5	O K
15 min Winter	50.470	0.170	0.0	0.0	0.0	11.3	O K
30 min Winter	50.519	0.219	0.0	0.1	0.1	14.5	O K
60 min Winter	50.571	0.271	0.0	0.1	0.1	18.0	O K
120 min Winter	50.622	0.322	0.0	0.2	0.2	21.4	O K
180 min Winter	50.649	0.349	0.0	0.2	0.2	23.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.212	0.0	0.0	127
30 min Summer	111.130	0.0	2.0	92
60 min Summer	68.442	0.0	5.4	104
120 min Summer	40.613	0.0	8.6	142
180 min Summer	29.502	0.0	10.4	188
240 min Summer	23.370	0.0	11.6	244
360 min Summer	16.787	0.0	13.4	362
480 min Summer	13.276	0.0	14.7	482
600 min Summer	11.058	0.0	15.7	600
720 min Summer	9.520	0.0	16.6	720
960 min Summer	7.511	0.0	17.8	834
1440 min Summer	5.369	0.0	19.2	1068
2160 min Summer	3.832	0.0	22.4	1468
2880 min Summer	3.014	0.0	23.8	1872
4320 min Summer	2.145	0.0	25.7	2680
5760 min Summer	1.684	0.0	27.3	3464
7200 min Summer	1.394	0.0	28.2	4248
8640 min Summer	1.195	0.0	28.9	4984
10080 min Summer	1.049	0.0	29.3	5744
15 min Winter	171.212	0.0	0.2	120
30 min Winter	111.130	0.0	3.6	88
60 min Winter	68.442	0.0	7.5	102
120 min Winter	40.613	0.0	11.1	142
180 min Winter	29.502	0.0	13.1	188

Summary of Results for 200 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
240 min Winter	50.666	0.366	0.0	0.2	0.2	24.4	O K
360 min Winter	50.686	0.386	0.0	0.2	0.2	25.7	O K
480 min Winter	50.698	0.398	0.0	0.2	0.2	26.5	O K
600 min Winter	50.704	0.404	0.0	0.2	0.2	26.9	Flood Risk
720 min Winter	50.708	0.408	0.0	0.2	0.2	27.1	Flood Risk
960 min Winter	50.709	0.409	0.0	0.2	0.2	27.2	Flood Risk
1440 min Winter	50.706	0.406	0.0	0.2	0.2	27.0	Flood Risk
2160 min Winter	50.699	0.399	0.0	0.2	0.2	26.5	O K
2880 min Winter	50.688	0.388	0.0	0.2	0.2	25.8	O K
4320 min Winter	50.662	0.362	0.0	0.2	0.2	24.1	O K
5760 min Winter	50.638	0.338	0.0	0.2	0.2	22.5	O K
7200 min Winter	50.617	0.317	0.0	0.2	0.2	21.1	O K
8640 min Winter	50.599	0.299	0.0	0.2	0.2	19.9	O K
10080 min Winter	50.583	0.283	0.0	0.2	0.2	18.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	23.370	0.0	14.5	242
360 min Winter	16.787	0.0	16.4	358
480 min Winter	13.276	0.0	17.9	472
600 min Winter	11.058	0.0	19.0	584
720 min Winter	9.520	0.0	19.9	694
960 min Winter	7.511	0.0	21.2	904
1440 min Winter	5.369	0.0	22.3	1120
2160 min Winter	3.832	0.0	26.6	1576
2880 min Winter	3.014	0.0	28.3	2016
4320 min Winter	2.145	0.0	30.3	2856
5760 min Winter	1.684	0.0	32.2	3688
7200 min Winter	1.394	0.0	33.4	4464
8640 min Winter	1.195	0.0	34.2	5192
10080 min Winter	1.049	0.0	34.8	5952

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	200	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.024

Time From:	(mins) To:	Area (ha)
0	4	0.024

Green Roof

Area (m^3) 100 Evaporation (mm/day) 3
Depression Storage (mm) 5 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.001817	32	36	0.000367	64	68	0.000074	96	100	0.000015
4	8	0.001488	36	40	0.000300	68	72	0.000061	100	104	0.000012
8	12	0.001218	40	44	0.000246	72	76	0.000050	104	108	0.000010
12	16	0.000997	44	48	0.000201	76	80	0.000041	108	112	0.000008
16	20	0.000817	48	52	0.000165	80	84	0.000033	112	116	0.000007
20	24	0.000669	52	56	0.000135	84	88	0.000027	116	120	0.000006
24	28	0.000547	56	60	0.000111	88	92	0.000022			
28	32	0.000448	60	64	0.000090	92	96	0.000018			

Model Details

Storage is Online Cover Level (m) 51.000

Complex Structure

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	7.0
Max Percolation (l/s)	19.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.95	Evaporation (mm/day)	3
Invert Level (m)	50.300	Cap Volume Depth (m)	0.450

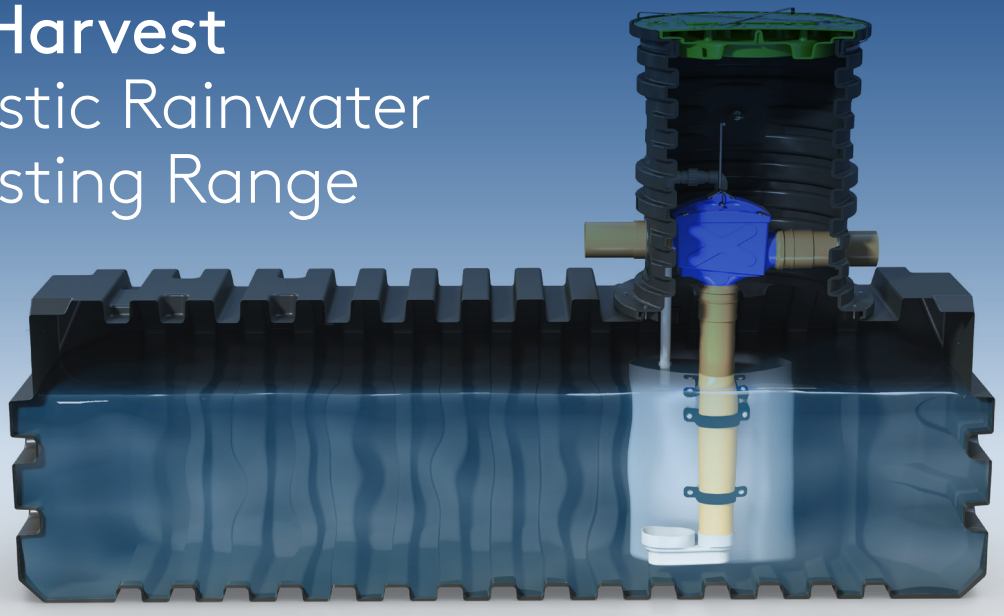
Orifice Outflow Control

Diameter (m) 0.015 Discharge Coefficient 0.600 Invert Level (m) 50.465

Water Management Solutions

Klargester

AquaHarvest Domestic Rainwater Harvesting Range



The AquaHarvest rainwater solution is a Direct System suitable for domestic applications. This system is used where it is impractical to have a header tank, for example in homes that have converted attic spaces and less room. Therefore, filtered rainwater is pumped direct from the holding tank to the various appliances.

Save up to 30,000 litres per year!

A 4 bedroom house with typical 222 litre per day water usage – generally **30%** of this total used for toilet flushing, **7%** for outdoor and car washing (https://www.waterwise.org.uk/save-water)

With AquaHarvest used for toilet flushing and outdoor use, save **37%** of **222 litres** per day

This equates to approximately **29,981 litres** per year.

As part of our Planet Passionate programme, Kingspan are dedicated to delivering innovative surface water management technologies, developed on the back of 65 years' experience.

Kingspan

WE ARE PLANET PASSIONATE

Klargester AquaHarvest
Domestic Rainwater Harvesting Range

How it works

Rainwater directed to the system is firstly filtered by an in line leaf filter, before further filtering on the pump inlet. Final fine filtration is catered for by the inline filter supplied as part of the kit. The Grundfos 'intelligent' pump has the necessary sensors to allow automatic operation when demand is called for by drop of pressure in the system. If the storage tank has a low level of rainwater, there is a small automatic charge of mains water into the tank to ensure the system never runs dry. The main advantage of this system is that rainwater is delivered to the appliances at mains pressure or higher.

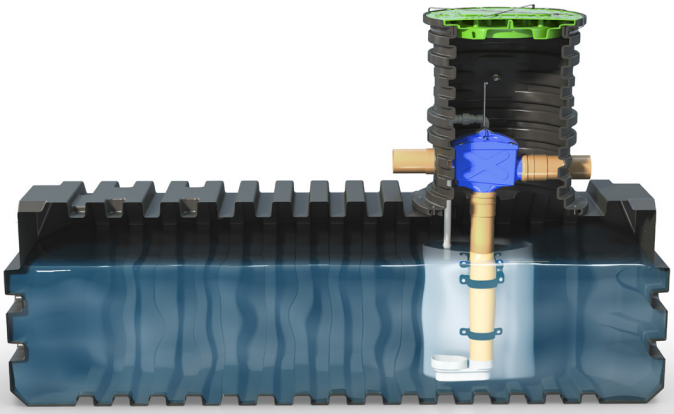
Why choose an AquaHarvest solution?

- Suitable for shallow dig applications
- Fully compliant against EN 16941-1:2018 standard (supersedes EN 8515) for peace of mind
- Easy to read display panel included as standard, with early fault warnings and water supply status built in
- Smart design featuring a calmed inlet at the bottom of the tank to prevent disturbance of any material at surface level
- Features intelligent Grundfos pump for total reliability

Uses

- WC and urinal flushing
- Irrigation and landscape watering
- Garden watering
- Vehicle washing
- Domestic laundry

AquaHarvest Domestic Rainwater Harvesting Range	
Product Code	**Description**
GRW080DKSW	Rainwater 2350 Ltrs Direct < 80m²
GRW110DKSW	Rainwater 3100 Ltrs Direct < 110m²
GRW160DKSW	Rainwater 4600 Ltrs Direct < 160m²



For more information on any of our products: **T:** +44 (0)1296 633 033
E: klargester@kingspan.com or visit **kingspan.co.uk/klargester**

4382-gb-07/2022-v2

Questions?
Contact us.

www.sudsdesigns.co.uk
info@sudsdesigns.co.uk