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Planning Statement
SuDS Strategy
Northways Parade Volvo Garage

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Introduction
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About the scheme

Eight Associates has been appointed to develop a sustainable drainage systems (SuDS) strategy for the proposed redevelopment at Northways Parade Volvo Garage, in the London Borough of Camden.

The project comprises the conversion of the existing building from a former Volvo garage to a co-working office space. A small extension has been proposed to the north of the site. The new development will provide new office space with a GIA of 1,297m^2. The total area of the development site is approximately 0.1766 hectares (1,766m^2).

Aim of this study

The purpose of this report is to develop a SuDS strategy for the proposed development at Northways Parade Volvo Garage.

All relevant potential sources of flood risk to the development will be assessed. Flood risk data has been obtained from publicly accessible data sources, including the Environment Agency and Camden Borough Council, and from data reports provided by GeoSmart.

The report will evaluate the suitability of the development site for incorporation of SuDS within the development proposal. Specific SuDS components will be recommended based on their suitability to manage surface water runoff within the constraints of the development.

Policy Summary
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National planning policy

National Planning Policy Framework (NPPF) 2019

The NPPF sets out the Government's planning policies for England and provides a framework for local planning policies and decisions. The NPPF sets out specific policies on planning and flood risk, including:

- Local plans should be influenced by a strategic flood risk assessment (SFRA).
- Local plans should apply a sequential, risk-based approach to the location of new developments.
- If it is not possible for new developments to be located in zones with a lower risk of flooding, the exception test should be applied (where appropriate).
- The application of the exception test should be supported by either the SFRA or site-specific flood risk assessment (depending on whether it is applied for during local production, or planning application stage).
- When determining planning application, local planning authorities should ensure that flood risk is not increased elsewhere and applications should be supported by a site-specific flood risk assessment, where appropriate.
- Developments should only be permitted in areas at risk of flooding (in light of the flood risk assessment) where it can be demonstrated that:
- The most vulnerable development is located in the lowest flood risk areas of the site, unless there are overriding reasons to prefer a different location.
- The development is appropriately flood resistant and resilient;
- It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate
- Any residual risk can be safely managed.
- Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

The NPPF also requires that SuDS are incorporated in all major developments (unless there is clear evidence that this would be inappropriate) and that the use of SuDS should:

- Take account of advice from the lead local flood authority.
- Have appropriate proposed minimum operational standards.
- Have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development.
- Where possible, provide multifunctional benefits.

Non-Statutory Technical Standards for Sustainable Drainage Systems 2015

This document sets out non-statutory technical standards that should be used in conjunction with the NPPF, including:

- For greenfield developments, the peak runoff rate for the 1 in 1 year and 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

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National planning policy and guidance (continued)

- For previously developed sites, the peak runoff rate for the 1 in 1 year and 1 in 100 year rainfall event should be as close as reasonably practicable to the peak greenfield runoff rate for the same event, but should never exceed the rate of discharge from the previously developed site.
- For greenfield developments, the runoff volume for the 1 in 100 year (6 hour duration) rainfall event should never exceed the greenfield runoff volume for the same event
- For previously developed sites, the runoff volume for the 1 in 100 year (6 hour duration) rainfall event should be as close as reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the previously developed site.
- The drainage scheme must be designed so that flooding does not occur on any part of the site for a 1 in 30 year rainfall event (with the exception of parts of the site that are specifically designated to hold/convey water as part of the design).
- The drainage scheme must be designed so that flooding does not occur in any part of a building (including a basement) or in any utility plant susceptible to water on the development site, for a 1 in 100 year rainfall event.
- The site must be designed so that, as far as reasonably practicable, exceedance flows from rainfall events in excess of a 1 in 100 year event, are managed by exceedance flows that minimise the risks to people and property.

Regional policy and guidance

London Plan 2016

The London Plan is the spatial development strategy, developed by the Mayor of London and the Greater London Authority (GLA), for the 32 London boroughs and the City of London. The following policies relate to flood risk and SuDS:

Policy 5.13 Sustainable Drainage

- Developments should aim to achieve greenfield runoff rates by using SuDS, unless there are practical reasons for not doing so and manage surface water as close to its source as possible, using the sustainable drainage hierarchy (see Figure 1 overleaf).
- SuDS should be design and implemented to deliver multiple benefits, including for water use efficiency and quality, biodiversity, amenity and recreation.

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Regional policy and guidance (continued)

The Draft London Plan

The draft London Plan (August 2018) is the upcoming strategic plan for London, which aims to shape the planning process over the 32 London Boroughs and the City of London for the next 20-25 years. On its adoption, the new London Plan is expected to require compliance with the following in relation to flood risk and SuDS

Policy SI13 Sustainable Drainage

- Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks.
- Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:
    1. Rainwater harvesting (including combination of green roof and blue roofs)
    2. Infiltration techniques and green roofs
    3. Rainwater attenuation in open water features for gradual release
    4. Rainwater discharge direct to watercourse (unless not appropriate)
    5. Rainwater attenuation above ground (including blue roofs)
    6. Rainwater attenuation below ground
    7. Rainwater discharge to a surface water sewer or drain
    8. Rainwater discharge to a combined sewer.
- Development proposals for impermeable paving should be refused where appropriate, including on small surfaces such as front gardens and driveways.
- Drainage should be designed and implemented in ways that address issues of water use efficiency, river water quality, biodiversity, amenity and recreation.

Sustainable Design and Construction SPG 2014

This GLA document provides guidance to London boroughs and developers on design and construction measures that may be implemented to meet London Plan requirements, including guidance on the following:

- Specific conditions and consideration on flood risk to basements, along with recommended mitigation measures.
- Climate change resilience, including increased rainfall intensities and rising sea levels.
- Major developments for pre-developed sites must achieve at least 50% attenuation of pre-development surface water runoff at peak times.
- There may be situations where it is not appropriate to discharge at greenfield runoff rates (i.e. where the calculated greenfield runoff rate is extremely low and the final outfall of a piped system would be prone to blockage); in this instance an appropriate minimum discharge rate would be 5 l/s per outfall.
- Site conditions that should be considered when assessing the suitability of SuDS include potential contaminants, catchment area, local hydrology and development type.
- Infiltration SuDS proposals should consider soil permeability, ground stability, depth to water table, soil attenuation, potential contaminants and local hydrology.

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Local policy and guidance

Camden Local Plan
The Camden Local Plan 2017 sets out the spatial vision and plan for the future of the borough and how it will be delivered. The following policy specifically address and SuDS:

Policy CC3 Water and flooding
The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible. The Council will require development to:

- Incorporate water efficiency measures;
- Avoid harm to the water environment and improve water quality;
- Consider the impact of the development in areas at risk of flooding (including drainage);
- Incorporate flood resilient measures in areas prone to flooding;
- Utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible; and
- Not locate vulnerable development in flood-prone areas

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The sustainable drainage hierarchy

Both national and local policy refers to the sustainable drainage hierarchy (Figure 1). This reflects recommendations outlined within the best practice SuDS Manual, published by CIRIA. This should be followed when specifying and installing SuDS strategies on development sites.

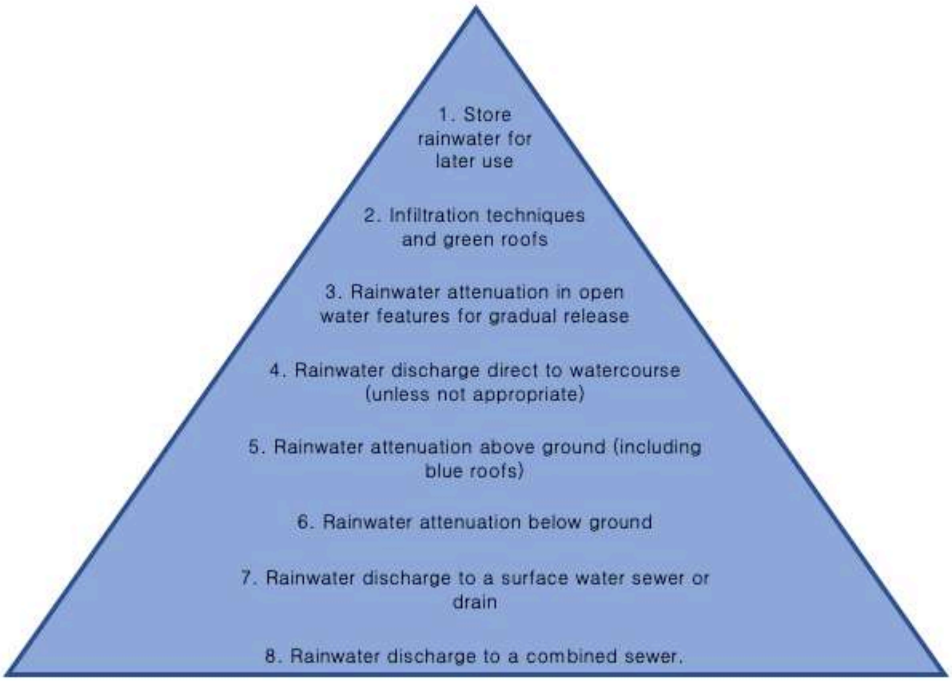

Figure 1: Sustainable drainage hierarchy (London Plan)

Site Overview
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Site location

The Northways Parade Volvo Garage (NW3 5EN) site is located off the Finchley Road and bound on the eastern side of the site by College Cresent (Figure 2). The surrounding area is densely populated and highly urbanised. Transport infrastructure in the vicinity of the development includes the local road network and railway network, including Swiss Cottage Cottage station The nearest open green space is Primrose Hill, approximately 400m southeast of the site.

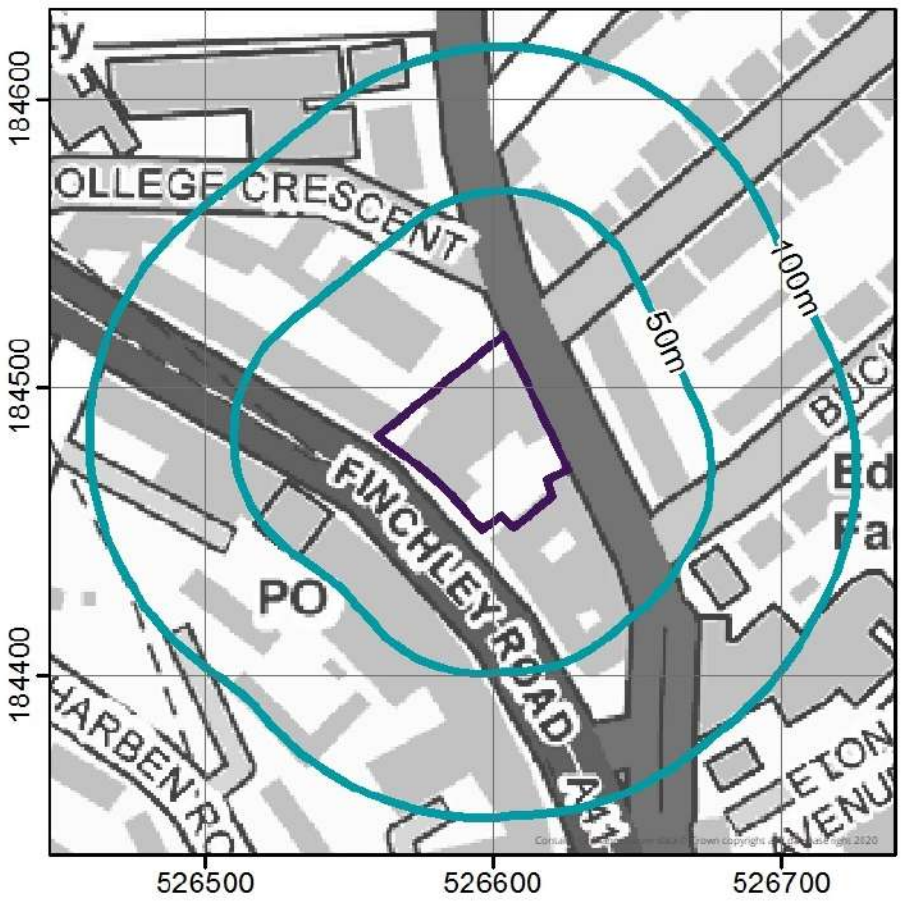

Figure 2: Map showing location of development site

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Site description

The development site is approximately 0.1766 hectares in area. The site is pre-developed and currently comprises an existing Volvo garage (Figure 3). Exact details of the existing surface water drainage network on the site are not known, however there is a sewer which runs on the north-eastern side of the site that is connected to the local drainage network. It is anticipated that surface water runoff from the roof currently drains, via guttering and downpipes, to the sewer before draining to the combined public sewer (see 'Sewer Features' section on page 14). The information provided by the design team indicates that there are currently no dedicated sustainable drainage systems (SuDS) on site.

The underlying geological characteristics of the surrounding area have been determined using the British Geological Survey's 'Geology of Britain Viewer'[1]:

- Bedrock geology – London Clay Formation (clay, silt and sand).
- Superficial geology – none recorded.

Figure 3: Aerial image of development site

[1] British Geological Survey 'Geology of Britain Viewer'. Accessed from; http://mapapps.bgs.ac.uk/geologyofbritain/home.html

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Site topography

An initial assessment of the topography of the site has been undertaken using LiDAR elevation data from the Environment Agency. The assessment identifies localised ground level depressions using a combination of GIS/OS mapping and LiDAR data. The mapping provides a comparison between the average ground levels across the development site with the ground levels of the surrounding area (Figure 4).

The mapping indicates that the ground level at the site is highest at the north-eastern boundary of the and gradually decreases to the southeast of the site; the lowest level likely to be at the southeast border of the site. The development proposals comprise of the redevelopment of the Volvo Garage which covers the majority of the site footprint, the existing site is entirely hardstanding.

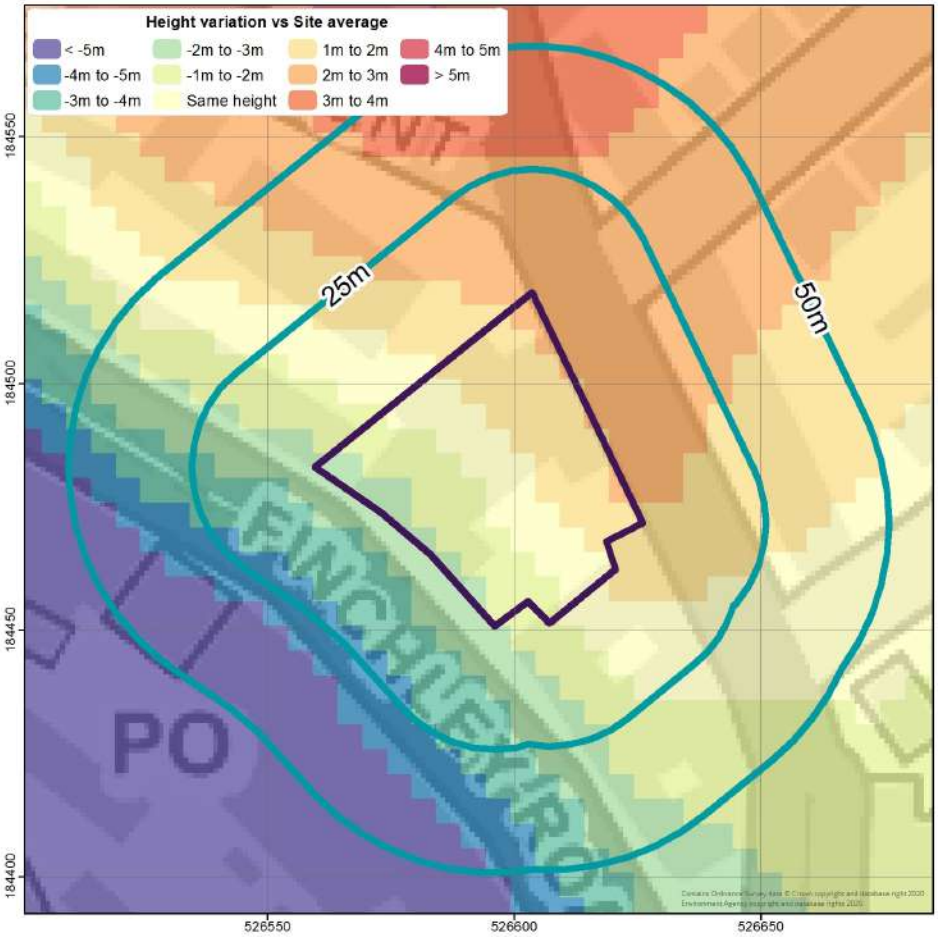

Figure 4: LiDAR elevation mapping of development site

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Development proposals

The development proposals comprise the refurbishment of the existing building at the Northways Parade Volvo Garage site and construction of a co-working office space. The new building footprint will remain largely the same, approximately 0.1223 hectares, with a small extension of approximately 0.0220 hectares. A small upgraded courtyard towards the east of the site and upgraded entrance to the western site entrance have been proposed. The ramp to the north of the site and the services road to the south are to be retained

Figure 5: Proposed development plan

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Flood Risk

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Annual probability of flooding

The Environment Agency's Flood Map for Planning[2] confirms that the site is in flood zone 1; 'an area with a low probability of flooding' (Figure 6). Flood zone 1 comprises areas assessed as having a 1% AEP (1 in 100 years) or less annual probability of flooding from rivers and the sea. As the development site is less than 1 hectare and is located in flood zone 1, a site-specific flood risk assessment (FRA) is not required, provided the site is not affected by other sources of flooding. The full Environment Agency Flood Map for Planning report is given in Appendix A.

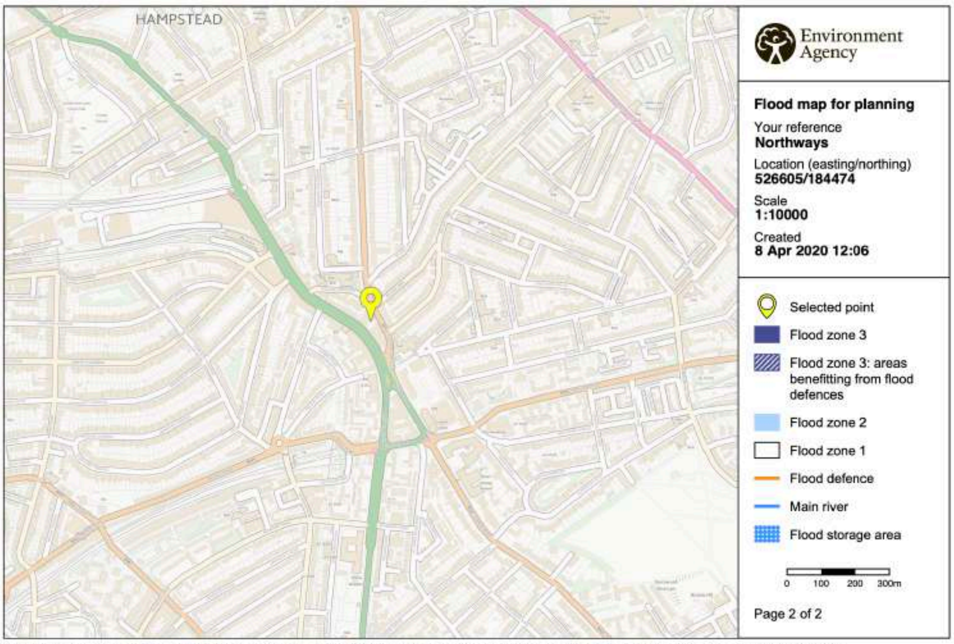

Figure 6: Environment Agency Flood Map for Planning

The Camden SFRA report[3] has been reviewed. The data indicates that the site is at low risk of flooding from groundwater, sewer and other artificial sources, with the risk of flooding from surface water between low. Neither the SFRA nor the Environment Agency data includes historical recorded flood events in the vicinity of the development site, therefore the site is considered to be at low risk of flooding overall. Therefore, the SuDS proposals are unlikely to be affected by flooding.

[2] Environment Agency: Flood Map for Planning. Accessed from: https://flood-map-for-planning.service.gov.uk/

[3] Camden SFRA Web Map. Accessed from: https://www.camden.gov.uk/documents/20142/0/download+%2815%29.pdf/37025249-3da8-4fe1-3075-aa025d3b66de

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Flood risk from rivers and sea

In accordance with Environment Agency's Risk of Flooding from Rivers and the Sea mapping tool[4], the development site has a very low risk of flooding from rivers and the sea (Figure 7). The annual probability of flooding from the rivers and the sea is less than 1 in 1,000 (<0.1% AEP).

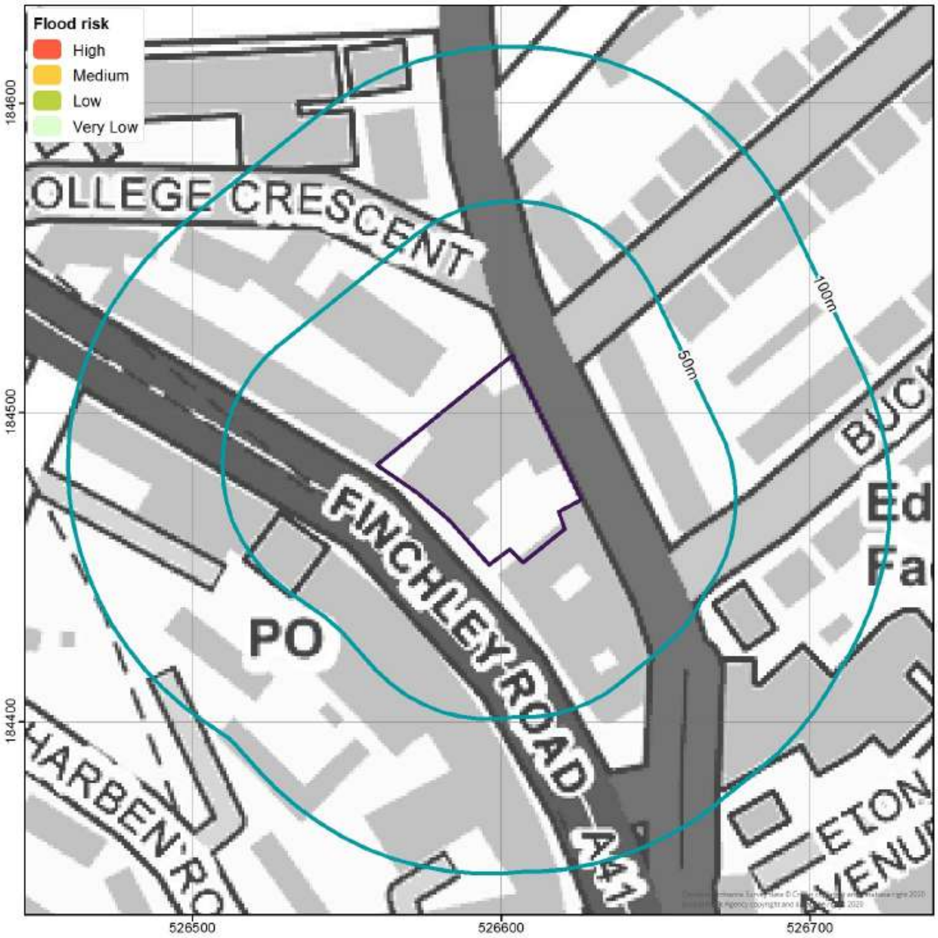

Figure 7: Environment Agency Risk of Flooding from Rivers and the Sea map

[4] Environment Agency: Risk of Flooding from Rivers and the Sea map. Accessed from; https://flood-warning-information.service.gov.uk/long-term-flood-risk/

Surface water (pluvial)

In accordance with the Environment Agency's Risk of Flooding from Surface Water mapping tool[5], the development site is at very low risk of flooding from surface water (pluvial) sources, (Figure 8).

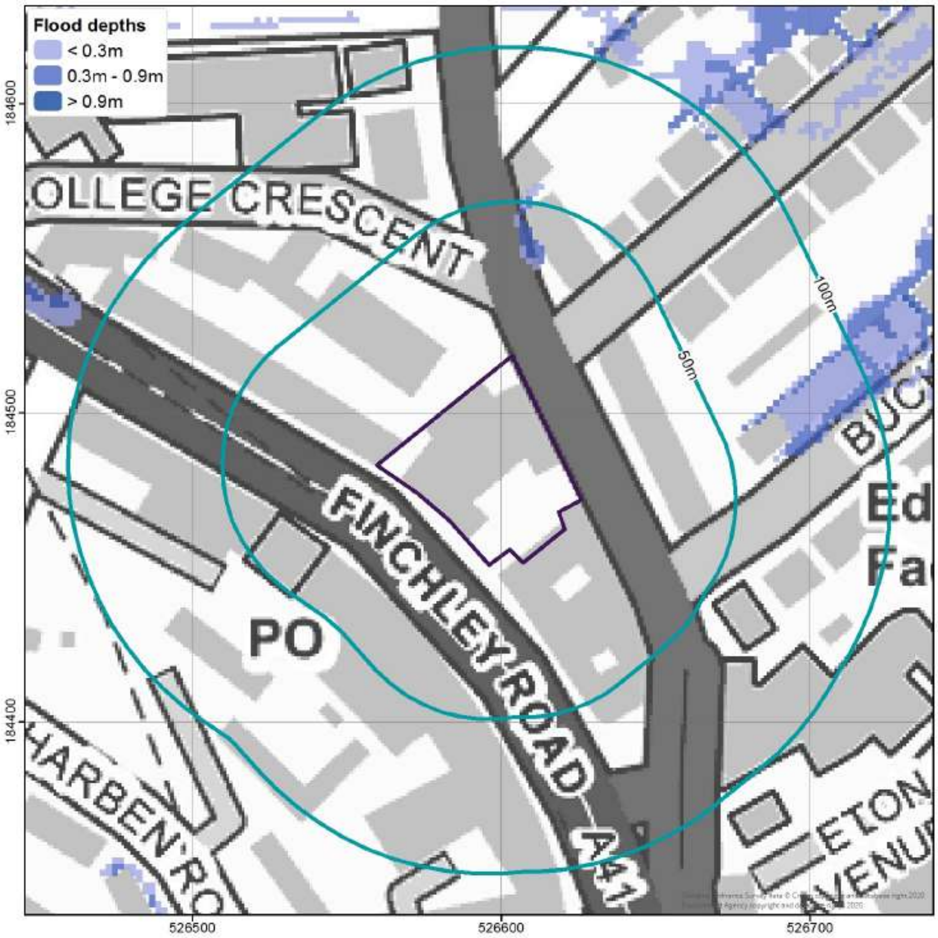

Figure 8: Environment Agency Risk of Flooding from Surface Water map

[5] Environment Agency: Risk of Flooding from Surface Water map. Accessed from; https://flood-warning-information.service.gov.uk/long-term-flood-risk/

Surface water (pluvial)

It has been noted that in 2002 there was a major flooding incident on the front to the Finchley Road, as demonstrated in Figure 3v, Appendix B of the Camden SFRA. It has been noted within the Camden SFRA that:

Appendix B Figure 3i – 3v presents this mapping for the LBC study area in combination with historical surface water flooding data recorded by LBC. It should be noted that where streets are shown to have experienced flooding during the 1975 and 2002 flood events, this mapping is relatively coarse in scale and does not allow a distinction between, for example, an entire street flooding, or an isolated section of road flooding as a result of a blocked gully.

Therefore, the exact extents of flooding are unclear from this flood event, moreover, the flood depths have not been reported. Figure 8 on the previous page indicates that any risk of surface water flooding is further north on the Finchley Road, whilst this is also recorded in Figure 3v, Appendix B of the Camden SFRA. It is possible that the historic flood event may therefore have taken place further up the Finchley Road

As per Figure 8 of this report, depths of the area of flooding are predominantly less than0.3m, with limited areas of 0.9m, or greater. The LiDAR data present in Figure 4 of this report indicates that the site levels are at least 1m to 2m higher than the levels on Finchley Road. With the data available, it can be considered that the site is resilient to the risk of surface water on Finchley Road due to the raised levels of the site.

Groundwater

GeoSmart's Groundwater Flood Risk (GW5) map (Figure 9) indicates that the development site is considered to be at negligible risk of groundwater flooding. Further investigation may be required, including surveying of ground conditions at the site, to confirm the site-specific geological and groundwater conditions with respect to groundwater flood risk.

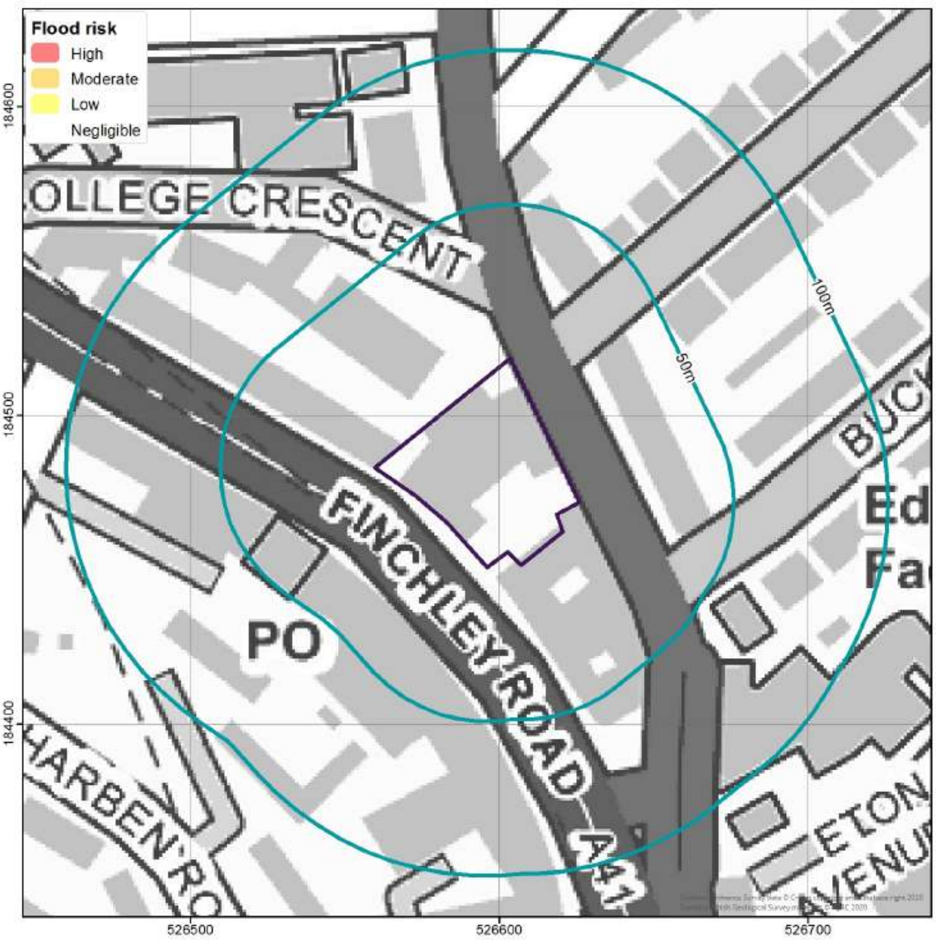

Figure 9: GeoSmart Groundwater Flood Risk (GW5) map

Development vulnerability

National and local planning policy requires that all developments should consider the vulnerability of building users when carrying out flood risk assessments. In accordance with current Environment Agency guidance and the National Planning Policy Framework (NPFF) 2018, areas of the proposed development are considered to be 'more vulnerable' – private residential units (above ground level (1st to 7th storey level) – and 'less vulnerable' – shops and other non-residential uses. However, at basement level there are areas proposed for the energy centre for the scheme and a sub-station, which would meet the definition of 'essential infrastructure', along with underground car parking and non-residential community uses ('less vulnerable'.

The sequential test

Planning policy and the NPFF typically requires that new developments must undertake a sequential test, if they are located in Flood Zone 2 or 3, or if a sequential test has not already been carried out for a development of the same type at the development site. However, a development is not required to undertake a sequential test if one has already been carried out for the same type of development at the site; the development is a minor development; the development involves the change of use; or is located in Flood Zone 1 (provided there are no other flooding issues in the area).

The development is a major development and is located in Flood Zone 1, therefore a sequential test is not required.

The exception test

Planning policy requires that new developments must undertake an exception test, if they meet the specific flood risk vulnerability and Flood Zone classifications outlined in Table 1, in order to confirm that the site and its users are safe if the site is at risk of flooding.

Table 1: Flood risk vulnerability and Flood Zone 'compatibility' for the exception test

Flood Zones	Flood risk vulnerability classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	Exception test required	✓	✓	✓
Flood Zone 3a	Exception test required	✗	Exception test required	✓	✓
Flood Zone 3b	Exception test required	✗	✗	✗	✓

✓ Development permitted

✗ Development not permitted

As the site is considered 'more vulnerable' but is within Flood Zone 1, the proposed development may proceed without an exception test being carried out, see Table 1.

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Conclusions

The development site is located in Flood Zone 1 and therefore is not required to undertake the sequential test or exception test. The risk of flooding to the development site, from specific common sources of flooding, has been assessed. The risk from the respective sources of flooding is as follows:

- Rivers and the sea – very low risk.
- Pluvial (surface water) – low risk.
- Groundwater – negligible risk.

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Introduction to SuDS

Sustainable drainage systems (SuDS) are drainage systems designed to maximise the opportunities and benefits that can be secured from surface water management. SuDS are considered to be environmentally beneficial due to their ability to manage water and flood risk within the urban and built up environment, and take account of water quality by minimising water pollution, whilst also providing the opportunities for improvements in biodiversity and amenity space for the local community.

SuDS are able to replicate the natural environment, capturing rainfall and slowing down water at its source, whilst having the ability to allow water to infiltrate and provide water storage, to slow down runoff into streams and rivers.

The SuDS Manual highlights the importance of SuDS design providing a number of benefits to the sustainability of the site (see Figure 10). In addition to slowing down water runoff and reducing flood risk, SuDS can also protect the ecology and natural hydrological systems on and surrounding the site; prevent water pollution to allow the system to be resilient for future change; create biodiverse green spaces to contribute to habitat connectivity and supporting local biodiversity; and provide a social place for the local community that can enhance the visual character of a space in a safe environment.

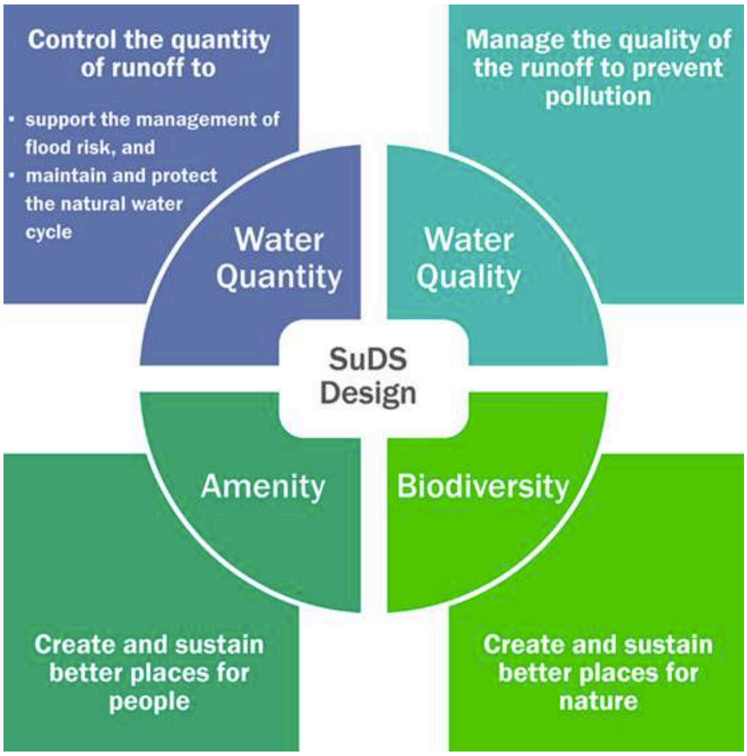

Figure 10: The four pillars of SuDS design (The SuDS Manual)

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The SuDS Manual & methodology

The SuDS Manual is published guidance by CIRIA, written by a series of experts, and based on existing guidance and research in the UK and internationally. The CIRIA guidelines within the SuDS Manual[6], and UKSuDS[7] tools have been used to as a guideline for the evaluation of SuDS suitability and to develop a SuDS strategy for the development. Additional guidance is provided by the Susdrain website[8] and the Non-Statutory Technical Standards for Sustainable Drainage Systems 2015.

SuDS best practice principles

To comply with current best practice, the drainage system should:

i. Manage runoff at or close to its source;
ii. Manage runoff at the surface;
iii. Be integrated with public open space areas and contribute towards meeting the objectives of the urban plan;
iv. Be cost-effective to operate and maintain.

The drainage system should endeavour to ensure that, for any particular site:

i. Natural hydrological processes are protected through maintaining interception of an initial depth of rainfall and prioritising infiltration, where appropriate;
ii. Flood risk is managed through the control of runoff peak flow rates and volumes discharged from the site;
iii. Stormwater runoff is treated to prevent detrimental impacts to the receiving water body as a result of urban contaminants.

In addition, it is desirable to maximise the amenity and ecological benefits associated with the drainage system where there are appropriate opportunities. SuDS are green infrastructure components and can provide health benefits, and reduce the vulnerability of developments to the impacts of climate change.

[6] CIRIA (2015) The SuDS Manual (C753)
[7] HR Wallingford: UKSuDS. Accessed from; www.ukSuDS.com
[8] Susdrain. Accessed from; http://www.susdrain.org/

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SuDS: Site Specific Evaluation

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Infiltration suitability

The GeoSmart SuDS Infiltration Suitability (SD50) map screens the potential for infiltration drainage at the site. The map combines information on the thickness and permeability of the underlying material and the depth to the high groundwater table. It indicates that there is a low potential for infiltration SuDS at the site (Figure 11). The underlying geology at the site may be relatively impermeable which would limit the effectiveness of a proposed infiltration SuDS scheme. Furthermore, the development proposals include the provision of new building with a footprint covering the entire site, which would make infiltration unsuitable.

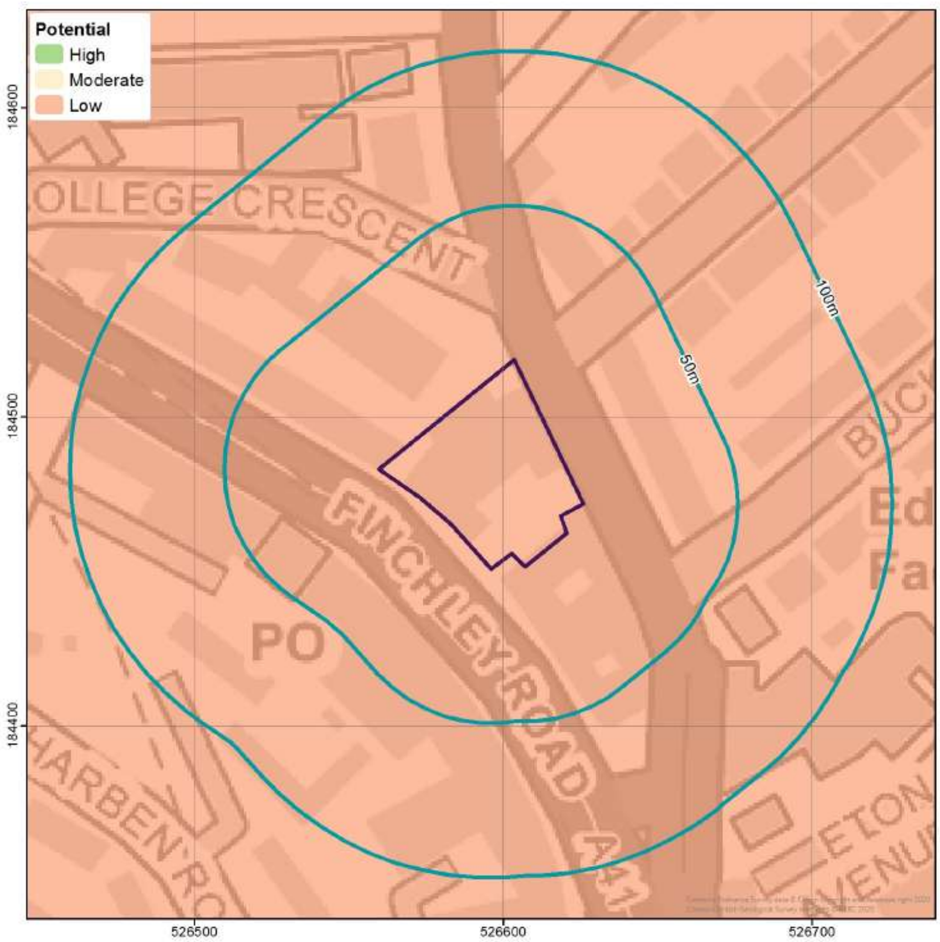

Figure 11: GeoSmart SuDS Infiltration Suitability (SD50) map

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SuDS: Site Specific Evaluation
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Source protection zones

An assessment of the Environment Agency's groundwater Source Protection Zones (SPZs) within the vicinity of the development site has been undertaken (Figure 12). The site is within 50m of a SPZ, therefore, if suitable, infiltration to the ground would be likely to be acceptable providing suitable mitigation measures are in place if required to prevent an impact on water quality from the proposed or historical land use and contaminated land.

Figure 12: Source Protection Zones map

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SuDS: Site Specific Evaluation

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Surface water features

The presence of potential surface water, foreshore and tidal water features in proximity to the site has been determined (Figure 13). The map shows the there are no surface water features within 100m of the development site, therefore, discharge to a surface water feature is unlikely to be appropriate.

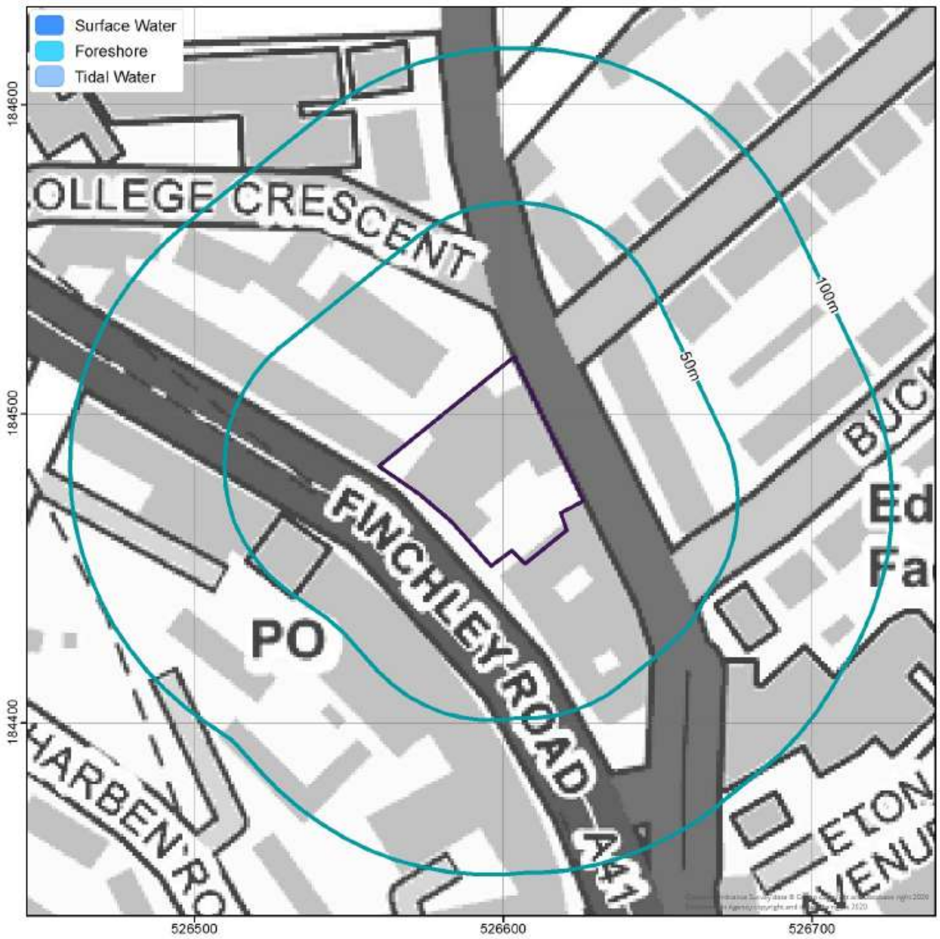

Figure 13: Surface Water Features map

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Sewer features

The location of sewer features in proximity to the site has been confirmed with a Regulated Drainage and Water Search (see Appendix B). The site is within 100m of a public combined sewer, therefore discharge from the site to the local combined sewer is likely to be appropriate (see Figure 14).

Detailed analysis of the connections and condition of the public sewer systems should be undertaken by the future structural or drainage engineer, which may be confirmed by CCTV survey, and/or by consultation with the local sewerage undertaker. Confirmation of the sewer invert will be required to ensure that surface water can be discharged via gravity. Verification of the capacity of the public sewer and permission to connect and discharge to the sewer should be obtained from the local sewerage undertaker.

Figure 14: Map of sewer features in relation to the development site

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SuDS: Site Specific Evaluation

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Sustainable drainage systems

There are a number of sustainable drainage systems (SuDS) that can be implemented on sites, when considering the constraints of the location, including the topology, geology and density of the space. The potential for the use of different SuDS components is evaluated in this report. Typical SuDS components include:

- Rainwater harvesting systems;
- Green roofs;
- Infiltration systems;
- Pervious paving;
- Swales;
- Attenuation storage tanks;
- Ponds & wetlands.

Suitability for methods of discharge from site

Infiltration

In accordance with the sustainable drainage hierarchy (see page 3), infiltration should be prioritised as the method of controlling surface water runoff, where possible. It is unlikely that the site conditions are suitable for infiltration (see page 14). Furthermore, due to constraints for space at the site, there is insufficient space for implementation of infiltration SuDS components.

Watercourse

It is unlikely that discharge to a watercourse will be a viable option for discharge from site, as there are no surface water features located within 100m of the site.

Surface water sewer

There is not a public surface water sewer within 100m of the site, therefore discharge to the local surface water sewer is not proposed.

Combined sewer

There are two public combined sewers in the road adjacent to the site (Finchley Road and College Cresent). It is preferred to discharge to a public surface water sewer, in accordance with the sustainable drainage hierarchy, however there is not one available, therefore, discharge to a combined sewer is proposed.

Hydraulic design

Local planning policy requires that peak runoff rates and volumes are no greater than they were pre-development. A SuDS strategy will be proposed which limits the rate of discharge to no greater than the pre-development peak runoff rates and where feasible, will limit the discharge volume to pre-development runoff volumes. Note that on small-scale urban sites, where there are significant constraints on the SuDS components, which may be implemented, the reduction of runoff volume in particular, may be difficult to achieve.

SuDS: Site Specific Evaluation

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Water quality and hazard classification

Current best practice takes a risk-based approach to managing discharges of surface runoff to the receiving environment. The potential for runoff to transport pollutants from the site to neighbouring areas should be considered. This is a particular risk when there are significant polluting activities taking place on a development site, for example where proposals include car parking and vehicular servicing areas.

The development proposals do not include the provision of parking however there is a delivery route through the site to neighbouring properties. There is a risk to the quality of surface water runoff from these areas, therefore pollution control treatment measures are evaluated in this report.

Figure 15: Plan of proposed service level showing no car parking and allocated deliveries area associated with the development

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SuDS: Site Specific Evaluation

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SuDS component feasibility

The site conditions and development proposals have been assessed for their suitability for different SuDS components. The following SuDS components are considered for the proposed development and are recommended based on their feasibility for the site.

Each SuDS component has been assessed under three broader categories. There are key criteria for each category on which the SuDS component is evaluated. The key criteria have been given a weighting based on a tick-system, an example representation of this is shown below:

✓✓✓✓✓= 3 scored out of a possible 5

The weighting of each of the criteria within the categories is shown below:

- Local area and site impact (maximum score of 10):
  - Local planning policy priority = ✓✓
  - Space required for component = ✓✓✓
  - Applicability with development design = ✓✓
  - Compatibility with geological conditions and flood risk = ✓✓✓
- Multi-beneficial design principles (maximum score of 10):
  - Water quantity = ✓✓✓✓
  - Water quality = ✓✓
  - Amenity = ✓✓
  - Biodiversity = ✓✓
- Capital cost, operation and maintenance (maximum score of 5):
  - Capital cost of component = ✓✓
  - Regular maintenance requirements = ✓✓
  - Impact of remedial actions = ✓

Key comments on each of the criteria and the corresponding score will be provided in a table (example below) for each of the SuDS components. The score for each of the criteria will be summed and each of the technologies will then be ranked. The assessment of each technology is undertaken on the following pages.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Example component	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓

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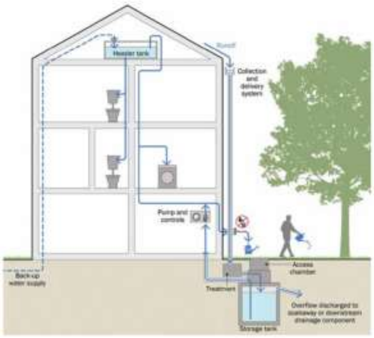
SuDS: Site Specific Evaluation

SuDS Strategy

Northways Parade Volvo Garage

SuDS component feasibility (continued)



Rainwater harvesting system

A rainwater harvesting system collects and stores rainwater for use in a development. Systems range from small-scale rainwater storage butts for irrigation, to large-scale systems to serve non-potable (and in some cases, potable) uses within a building. Rainwater harvesting systems intercept surface water from roofs and can be designed to reduce the runoff volume of a development, via recycling and reuse to meet water demand on-site.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Rainwater harvesting system	✓✓✓✓✓ ✓✓✓✓✓ Policy priority. Space required for storage tank(s). Residential use likely to meet demand. Ground/flood compatible.	✓✓✓✓✓ ✓✓✓✓✓ Control runoff volumes from roofs. Treatment for internal non-potable use. No direct amenity or biodiversity benefits.	✓✓✓✓✓ Relatively high capital cost. Regular maintenance and inspection required.

Green roof

A green roof is a roof of a building that is covered with a growing medium and vegetation, planted over a waterproofing membrane. Green roofs intercept rainfall and may facilitate flow control, attenuation and treatment of surface water. Green roofs may be particularly beneficial in high-density, urbanised areas, where there are otherwise limited opportunities for incorporating SuDS in landscaping. Green roofs provide additional benefits for biodiversity and reducing the urban heat island effect.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Green roof	✓✓✓✓✓ ✓✓✓✓✓ Policy priority. Some roof areas may be feasible. Large areas of existing and retained roofing may be difficult to upgrade.	✓✓✓✓✓ ✓✓✓✓✓ Runoff rate/volume control only for small rainfall events. Limited treatment functions provided. Amenity benefits provided if visible. Significant biodiversity benefits provided.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required.

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SuDS component feasibility (continued)

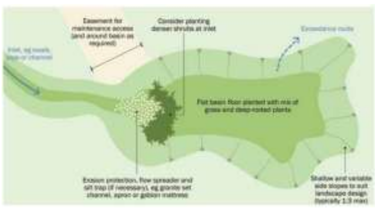
Infiltration system

Infiltration system types include:

- Soakaway – sub-surface storage structure (typically rubble-filled voids beneath lawns) that stores runoff from a single house or development and allows for efficient infiltration into adjacent soil.
- Infiltration trench – trench filled with permeable granular material, designed to promote infiltration of water to the ground.

Infiltration systems should be located at least 5m from all buildings and roads and at least 3m from the site boundary. The viability of infiltration should be validated with site investigations confirming groundwater levels (which should remain a minimum of 1m below the base of any infiltration systems) and infiltration rates (in accordance with BRE Digest 365).

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Infiltration system	✓✓✓✓✓ ✓✓✓✓✓ Policy priority. Must be 5m from buildings/roads. Infiltration capacity and ground water levels must be verified.	✓✓✓✓✓ ✓✓✓✓✓ Excellent runoff rate/ volume control. Limited treatment functions provided. No direct amenity or biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required. Pre-treatment sediment removal required.



Infiltration basin

An infiltration basin is a vegetated basin or depression, which is designed to promote infiltration and is typically dry, except in periods of heavy rainfall.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Infiltration basin	✓✓✓✓✓ ✓✓✓✓✓ Policy priority. Significant space requirement. Infiltration capacity and ground water levels must be verified.	✓✓✓✓✓ ✓✓✓✓✓ Excellent runoff rate/ volume control. Limited treatment functions provided. Good amenity benefits. Good biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required.

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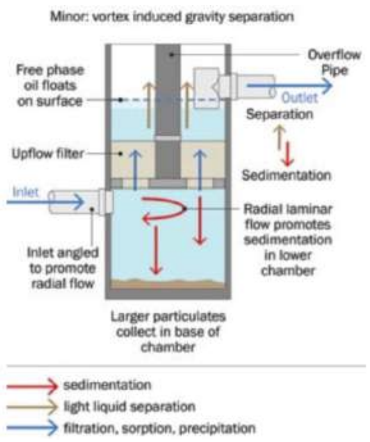
SuDS component feasibility (continued)



Proprietary treatment system

A proprietary treatment system is a manufactured product that removes specified pollutants from surface water runoff. They are often useful where site constraints preclude the use of other methods. System types include:

- Treatment channels.
- Hydrodynamic or vortex separators.
- Proprietary filtration systems.
- Oil separators.
- Multi-process systems.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Proprietary treatment system	✓✓✓✓✓ ✓✓✓✓✓ Small space requirement. Ground/flood compatible.	✓✓✓✓✓ ✓✓✓✓✓ Treatment functions provided. May be combined with flow rate control. No direct amenity or biodiversity benefits.	✓✓✓✓✓ Moderate capital cost. Regular maintenance and inspection required. Pre-treatment may be required.

Filter strip

Filter strips are gently sloping, vegetated strips of land that that treat runoff by filtering and promoting the settlement of pollutants, commonly installed in proximity to impermeable surfaces (for instance roads and car parks). They may be used as a pre-treatment component before swales, bioretention systems and trenches or a treatment component (where the flow path length across the strip is sufficient).

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Filter strip	✓✓✓✓✓ ✓✓✓✓✓ Significant space requirement. Best-suited for use adjacent to large impermeable surfaces.	✓✓✓✓✓ ✓✓✓✓✓ Limited runoff rate/volume control. Moderate treatment functions provided. Moderate amenity benefits. Moderate biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Infrequent maintenance and inspection required. May provide pre-treatment function.

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SuDS component feasibility (continued)

Filter drain

Filter drains are shallow trenches, filled with stone or gravel, and constructed slightly below the adjacent ground surface. Filter drains are typically most effective when installed alongside impermeable areas such as roads and car parks, to attenuate water runoff in a storm event, whilst also providing a treatment function.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Filter drain	✓✓✓✓✓ ✓✓✓✓✓ Best-suited for use adjacent to large impermeable surfaces. Compatible with contaminated land/ high groundwater levels.	✓✓✓✓✓ ✓✓✓✓✓ Limited runoff rate/volume control. Good treatment functions provided. No direct amenity or biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required. Risk of blockages/ pollutant build up.

Swale

Swales are linear vegetated drainage features that convey and attenuation surface water, along with in some instances facilitating infiltration and providing pollutant control by allowing settlement. Swales intercept rainfall and may facilitate flow control and volume reduction (via infiltration, where viable), along with conveying water to the on-site drainage network. Check dams and berms can also be installed along a swale to incorporate attenuation storage, and promote settling and infiltration.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Swale	✓✓✓✓✓ ✓✓✓✓✓ Moderate space requirement. Compatible with contaminated land/ high groundwater levels (if lined).	✓✓✓✓✓ ✓✓✓✓✓ Good runoff rate/volume control. Moderate treatment functions provided. Good amenity benefits. Good biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required. Inlets, culverts and outlets need to be cleared.

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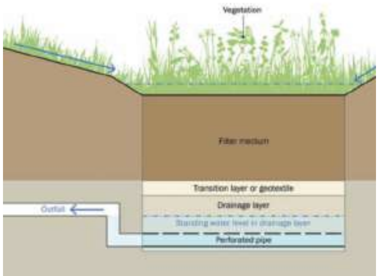
SuDS component feasibility (continued)



Bioretention system

Bioretention systems are shallow vegetated landscaped depressions, which are typically under drained and constructed with engineered soils. Bioretention systems are typically referred to as rain gardens, when constructed on a small scale, without engineered soils. Bioretention systems intercept rainwater (typically at least the first 5mm) and facilitate flow control and volume reduction (via infiltration, where viable) from frequent and smaller rainfall events, along with filtering sediment and pollutants from surface water.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Bioretention system	✓✓✓✓✓ ✓✓✓✓✓ Small space requirement. Compatible with contaminated land/ high groundwater levels (if lined).	✓✓✓✓✓ ✓✓✓✓✓ Moderate runoff rate/volume control. Good treatment functions provided. Good amenity benefits. Moderate biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required.

Pervious paving

Pervious paving may be used for the construction of otherwise impermeable surfaces (i.e. roads (typically with speeds less than 30 mph), car parks, patios and pedestrian pathways), with materials that allow infiltration to a subsurface medium, from where water may be infiltrated to the ground or piped to the surface water drainage network. Pervious paving includes:

- Porous paving – paving that infiltrates water across the entire surface.
- Permeable paving – paving that infiltrates water through the gaps between solid blocks.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Pervious paving	✓✓✓✓✓ ✓✓✓✓✓ Compatible with hard landscaping proposals. Compatible with contaminated land/ high groundwater levels (if lined).	✓✓✓✓✓ ✓✓✓✓✓ Good runoff rate/volume control. Good treatment functions provided. Low direct amenity or biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Regular maintenance and inspection required. Risk of clogging with poor maintenance.

SuDS: Site Specific Evaluation
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SuDS component feasibility (continued)

Attenuation storage

Attenuation storage may be provided to temporarily store runoff volumes prior to discharge from the site. An attenuation storage structure may be located under external landscaping areas, or within a proposed building. Runoff from the roof and any other impermeable surfaces may be collected and stored in the structure. Types of storage structure include:

- Geocellular storage structure (typically modular plastic units).
- Oversized concrete, plastic or corrugated steel pipes.
- Precast or in situ concrete panel structures and tanks.
- Glass-reinforced plastic (GRP) tanks.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Attenuation storage	✓✓✓✓✓ ✓✓✓✓✓ Large sub-surface space required (compatible beneath landscaping). May be compatible with high groundwater levels.	✓✓✓✓✓ ✓✓✓✓✓ Excellent runoff rate/volume control. No direct treatment functions provided. No direct amenity or biodiversity benefits.	✓✓✓✓✓ Relatively high capital cost. Regular maintenance and inspection required. Accessibility and maintainability key.

Detention basin

A detention basin is a surface storage basin or depression, that provides flow control through attenuation of surface water runoff. Detention basins are normally dry and in certain situations the land may also function as a recreational facility. However, basins can also be mixed, including both a permanently wet area for wildlife or treatment of the runoff and an area that is usually dry to cater for flood attenuation. They also facilitate some settling of particulate pollutants.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Detention basin	✓✓✓✓✓ ✓✓✓✓✓ Large space required. May be compatible with high and vulnerable groundwater (if lined).	✓✓✓✓✓ ✓✓✓✓✓ Moderate runoff rate/volume control. Moderate treatment functions provided. Good amenity benefits. Moderate biodiversity benefits.	✓✓✓✓✓ Relatively low capital cost. Limited maintenance and inspection required.

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SuDS component feasibility (continued)

Pond/wetland

Ponds and wetlands can provide attenuation storage and treatment functions for surface water, at varying scales, along with promoting the ecological benefits of SuDS. A pond can perform the role of a retention pond or a detention pond. Wetlands comprise shallow ponds and marshy areas, covered almost entirely in aquatic vegetation. Wetlands detain flows for an extended period to allow sediments to settle, and to remove contaminates by facilitating adhesion to vegetation and aerobic decomposition. They also provide significant ecological benefits.

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance
Pond/wetland	✓✓✓✓✓ ✓✓✓✓✓ Policy priority when aligned with biodiversity objectives. Large space required. May be compatible with high and vulnerable groundwater (if lined).	✓✓✓✓✓ ✓✓✓✓✓ Good runoff rate/volume control. Good treatment functions provided. Excellent amenity benefits. Excellent biodiversity benefits.	✓✓✓✓✓ Relatively high capital cost due to large size. Moderate maintenance and inspection required. Vegetation management required.

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SuDS component evaluation

Table 2: SuDS component evaluation matrix

SuDS component	Local area and site impact	Multi-beneficial design principles	Capital cost, operation and maintenance	Total score	Proposed	Rationale
Rainwater harvesting system	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	14 out of 25	No	Insufficient space for the demand
Green roof	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	14 out of 25	Yes	Sufficient suitable roof space
Infiltration system	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	13 out of 25	No	Low infiltration potential, insufficient space
Infiltration basin	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	17 out of 25	No	Low infiltration potential, insufficient space
Proprietary treatment system	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	13 out of 25	No	Low pollution hazard
Filter strip	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	12 out of 25	No	Insufficient space
Filter drain	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	13 out of 25	No	Insufficient space
Swale	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	15 out of 25	No	Insufficient space
Bioretention system	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	17 out of 25	No	Insufficient space
Pervious paving	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	15 out of 25	Yes	Suitable paving areas proposed in areas where hard landscaping is upgraded
Attenuation storage	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	12 out of 25	Yes	May be located under upgraded entrance
Detention basin	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	14 out of 25	No	Insufficient space
Pond/wetland	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓ ✓✓✓✓✓	✓✓✓✓✓	14 out of 25	No	Insufficient space

SuDS: Site Specific Evaluation

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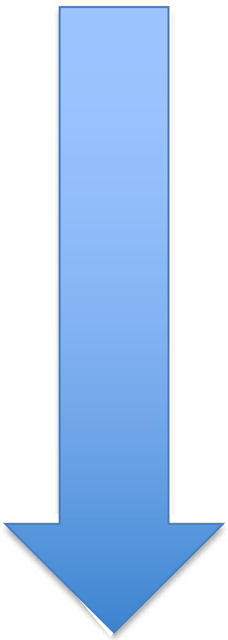
SuDS recommendations

The development proposals comprise the demolition of the existing building at Northways Parade Volvo Garage and redevelopment of the entire site, therefore there is the opportunity for a site-wide integrated SuDS design as part of the development proposals. Options for the management of surface water runoff and specific SuDS components have been evaluated based on their suitability and preference in accordance with the sustainable drainage hierarchy. The following is proposed for the development:



1. *Store rainwater for later use* – Not proposed: whilst there is likely to be sufficient demand for potable and non-potable water use within the office space. Space resitrctions also mean this is not feasible.
2. *Use infiltration techniques and green roofs* – Proposed: a total area of approximately 95m^2 will be used for green roofs, to allow rainfall to infiltrate into the drainage network.
3. *Attenuate rainwater in ponds or open water features for gradual release* – Not proposed: insufficient space and lack of suitable areas on the site.
4. *Discharge rainwater direct to a watercourse* – Not proposed: no watercourses within 100m of the site.
5. *Rainwater attenuation above ground (including blue roofs)* – Not proposed: majority of the roof is to be retained or is beneath existing neighbouring buildings. New roof area proposed is to be green roof rather than blue roof.
6. *Rainwater attenuation below ground* –Proposed: an area of geocellular storage has been proposed beneath the upgraded entrance area to store up to 100m^3 of water before infiltrating into the sewers.
7. *Discharge rainwater to a surface water sewer/drain* – Not proposed: there is no public surface water sewer within 100m of the site.
8. *Discharge rainwater to the combined sewer* –Proposed: there is a public combined sewer within Finchley Road that the existing site likely connects to, this is to be utilised.

The implementation of SuDS as outlined above will provide a range of other additional benefits for the development including storm water management, combating the heat island effect, increasing biodiversity, ecological value, along with the potential to improve the health wellbeing of building users by providing a pleasant communal space.

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Hydraulic design criteria

In accordance with local planning policy, the hydraulic design of the scheme will meet the following design principles:

Flood risk
The surface water drainage network will be designed so that flooding does not occur on any part of the site for a 1 in 30 year rainfall event (aside from areas specifically design to hold or convey water) and flooding does not occur in any part of a building for a 1 in 100 year event (with 40% climate change allowance).

Peak runoff flow control and runoff volume control
The peak runoff rate for the 1 in 1 year, 1 in 30 year and 1 in 100 year rainfall events for the post-developed site will not exceed the pre-development runoff rates from the site for the same rainfall events and will be as close as reasonably practicable to the greenfield runoff rates for the same rainfall events.

The runoff volume for the 1 in 100 year (6 hour duration) rainfall event for the post-developed site will not exceed the pre-developed site runoff volume and will be as close as reasonably practicable to the greenfield runoff volume for the same event.

Water quality
All appropriate best-practice guidance for runoff pollution control will be following, to ensure that the water quality of any receiving water body will not be adversely affected by the development. As there are car parking areas proposed for the development, there is a potential pollution hazard.

Designing for exceedance
Rainfall events in excess of a 1 in 100 year rainfall event (with 40% climate change allowance) will be managed with appropriate exceedance flow routes, which will ensure that flooding is not caused to properties on or off site.

Highway drainage
There will be no SuDS features proposed within existing highways or new proposed highways for adoption.

Climate change
The effects of climate change will be accounted for in calculations, with an allowance of 40% made for increased rainfall intensities for the 1 in 100 year rainfall event, in accordance with the latest guidance provided by the Environment Agency.

Urban creep
The potential future expansion within the development will be accounted for by making an allowance for urban creep of 10% within calculations.

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Hydraulic modelling

Flow[9] is a hydraulic modelling software for the design and analysis of surface water and foul water drainage networks. Flow has been used to calculate peak runoff rates and runoff volumes for the site and model a notional surface water drainage network and SuDS components. See Appendix C for the set of results reports from Flow.

Flow uses the EPA Storm Water Management Model (SWMM), which is a dynamic rainfall runoff simulation model used for single event or continuous simulation of runoff quantity and quality. SWMM conceptualises a drainage system as a series of water and material flows between major environmental compartments and a network of conveyance and storage elements. The functionality of the atmosphere, land surface and groundwater compartments is not directly accounted for in SWMM.

Runoff rates and volumes

Greenfield and peak runoff rates have been calculated using Flow, in accordance with the best-practice estimation methods outlined in the SuDS Manual:

- Greenfield runoff rates using the Institute of Hydrology 124 (IH124) method.
- Pre-development runoff rates using the Modified Rational Method (MRM).

In accordance with local planning policy, for previously developed sites, the peak runoff rate for the 1 in 1 year, 1 in 30 year and 1 in 100 year rainfall events for the post-developed site must not exceed the pre-development runoff rates from the site for the same rainfall events and should be as close as reasonably practicable to greenfield runoff rates. A minimum betterment of 50% from the pre-development peak runoff rates is targeted for the discharge rates for the same rainfall events from the proposed development site (Table 2). Note that the discharge rates targeted in this report are derived from preliminary hydraulic modelling, based on a notional surface water drainage network. Targeted discharge rates are subject to change, following the review and verification by a structural/drainage engineer during the detailed design stages.

Table 2: Greenfield, pre-development and post-development peak runoff rates

Return period	Greenfield peak runoff rates (l/s)	Pre-development peak runoff rates (l/s)	Post-development proposed discharge rates (l/s)	Betterment from pre-development peak runoff rates (%)
Q_{BAR}	0.8	–	–	–
Q1 (1 in 1 year)	0.7	2.2	1.0	55%
Q30 (1 in 30 year)	1.5	5.1	2.0	61%
Q100 (1 in 100 year)	1.9	6.5	2.5	62%
Q100 (1 in 100 year + 40% cc)	–	–	2.6	–

[9]Flow+ Version 9, Causeway

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Runoff rates and volumes (continued)

Greenfield and pre-development runoff volumes have been calculated using Flow, in accordance with the best-practice estimation methods outlined in the SuDS Manual:

- Greenfield runoff volumes using the Flood Studies Report (FSR) rainfall and Fixed Percentage Runoff Model (FSSR 16) method.
- Pre-development runoff volumes using the Modified Rational Method (MRM) and FSSR 16 method.

In accordance with local planning policy, for previously developed sites, the runoff volume for the 1 in 100 year (6 hour duration) rainfall event should be as close as reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the previously developed site.

Preliminary hydraulic modelling indicates that it would not be realistic to target a post-development discharge volume which is less than the pre-development runoff volume. The proposed discharge volume is 56m^3, compared to the pre-development runoff volume of 83m^3 (Table 3). Note that a climate change allowance of 40% is included in the post-development discharge volume. The equivalent event has a discharge of 56m^3.

Opportunities to reduce the runoff volume, via interception and evapotranspiration from new vegetated areas, have been optimised through the inclusion of green roofs. Rainwater harvesting systems and infiltration SuDS, which would further reduce the runoff volume, are not deemed to be suitable for the site, nor is there sufficient space for the provision of long-term storage.

Table 3: Greenfield, pre-development and post-development runoff volumes

Return period	Greenfield runoff volume (m^3)	Pre-development runoff volume (m^3)	Post-development proposed discharge volume (m^3)
Q100 (1 in 100 year, 6 hour duration)	48	83	56.7

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Surface water drainage model

Positively drained area

The total area of the proposed development site is approximately 0.1766 ha. The total site area will be positively drained and is comprised of areas at ground floor and small area of first floor level. All areas are assumed to be positively drained for the preliminary surface water drainage model. A plan of the existing site areas is given in Appendix E and the proposed site areas in Appendix F.

Drains, manholes and pipes

All drains, manholes and pipes will be designed in accordance with Building Regulations Part H and Sewers for Adoption 7th Edition. A notional series of drains, manholes and pipes has been developed to evaluate the surface water drainage potential for the proposed site.

Green roof

A total surface area of green roofs of approximately 95m^2 is proposed for the development (over the roof levels at 1st floor level (see Appendix F)). In order to provide significant benefits for the development in terms of managing surface water runoff, biodiversity and amenity value, the green roofs should meet the following minimum criteria:

- Extensive sedum green roof-type system.
- Substrate depth should be maximised, within the limitations of the extensive green roof system. It is recommended that a minimum depth of substrate of 150mm should be used for the green roof areas. The system must be verified by a structural engineer with regards to the structural capacity of the building to withstand the imposed loads, including the saturated weight of the system, other imposed loads (including maintenance loadings and snow cover) and the load-bearing capacity of the underlying roof deck and structure.
- Substrate comprising commercial brick-base aggregate (or equivalent).
- Long-term plant coverage should be maximised through either of the seeded or 'biodiverse' roof types, to maximise the evapotranspiration performance of the green roof. It is acknowledged that the 'biodiverse' roof type would result in an initial lack of plant coverage but would be achieved once the indigenous plant species become established.

(Continued overleaf…)

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Surface water drainage model (continued)

The proposed green roof area has been incorporated in the surface water drainage model as an input hydrograph, using a time-area diagram to specify the relationship between time of travel and the portion of the area that contributes runoff during that travel time. This time-area diagram represents the delay that the green roof provides in runoff from the green roof entering the drainage model. The following hydrograph parameters have been used:

- Total depression storage area of 95.2m^2 (effective green roof area).
- Depression storage depth of 8mm (the proposed green roof substrate depth is 150mm and approximately 5% of the substrate depth is typically considered to provide depression storage depth).
- Evapotranspiration of 0 mm/day (assuming a worst-case scenario, more likely for winter rainfall events, where no evapotranspiration is provided by the vegetation).
- Hydrograph duration of 20 minutes, comprising a linear time-area relationship with five equal 4-minute timesteps contributing an additional 1/5th with each timestep.

Green roof systems should be designed and constructed in accordance with the SuDS Manual (Chapter 12 'Green Roofs').

Attenuation storage structure

It is estimated that a minimum storage volume of approximately 88m^3 would be required (in addition to the upstream combined rainwater harvesting and attenuation storage) to temporarily store surface water runoff, prior to discharge from site at the allowable discharge rates. The storage structure may a geocellular storage structure (or oversized concrete, plastic or corrugated steel pipes, or precast or in situ concrete panel structure or tank), subject to verification of ground suitability and system specification by a structural or drainage engineer. This attenuation storage structure should be installed after the entry point for runoff from all positively drained areas, but prior to the flow control device, limiting the final discharge rates from the site.

The design of attenuation storage structures and associated infrastructure should seek to prevent a build-up of silt and other debris (e.g. by use of benching and low-flow channels) and should be designed to allow access for regular maintenance. Attenuation storage should be designed and constructed in accordance with the SuDS Manual (Chapter 21 'Attenuation Storage Tanks').

Surface water drainage model (continued)

Flow control

In order to target discharge rates from the site that are in accordance with local planning policy, a flow control device should be installed prior to the point of connection with the local surface water sewer. The actual flow rate(s) and variability of flow rates between each simulated rainfall event will be confirmed at the detailed design stages with the specification of a suitable flow control product. Key considerations include:

- Flow control devices may be static (such as fixed orifice plates or vortex flow controls) or variable (such as pistons or slide valves).
- Static controls should have a minimum opening size of 100 mm chamber, or equivalent.
- Variable controls may have a smaller opening provided they have a self-cleansing mechanism.
- Static controls typically have less onerous maintenance requirements than variable controls, but variable controls typically can achieve greater variability of flow rates than static controls.
- A bypass should be included with a surface operated penstock or valve; and access should be provided to the upstream and downstream sections of a flow control device to allow maintenance.

Note that the flow control function may be performed by the pumping system, installed further upstream (provided no additional runoff enters the drainage network after the flow control provided by the pumping system).

Flow controls devices should be designed and constructed in accordance with the SuDS Manual (Chapter 28 'Inlets, Outlets and Flow Control Systems').

Exceedance events and overland flows

As the proposed development site is comprised mostly by the building footprint and there are numerous neighbouring and adjacent buildings, the surface water drainage network should be designed to safely contain volumes of surface water up to the 1 in 100 year (with 40% climate change) event. The preliminary hydraulic modelling estimates that all events will be contained within the surface water drainage network and proposed attenuation storage structure, the capacity of which has been increased for this purpose.

Outline SuDS management plan

To ensure that SuDS features and components work effectively it is essential that they are adequately maintained and working to their expected capacity. A detailed site-specific SuDS management plan will be produced for the development, including responsibilities and a programme of maintenance works and inspections. An outline management plan for the proposed SuDS components is provided below. A template SuDS inspection and maintenance checklist form, which may be used to record the site inspections and management and maintenance actions undertaken, is provided in Appendix D to this report.

Management and maintenance of all surface water drainage and SuDS components within the curtilages of the properties will be the responsibility of the respective property owners, for the lifetime of the development. All surface water drainage and SuDS components outside of the property curtilages, but within the curtilages of the overall development site, will be the shared responsibility of the respective property owners and will be managed and maintained via a management agreement or similar contractual arrangement, for the lifetime of the development. The outline SuDS management plan and site inspections and management and maintenance currently belongs to the building owner, European Property Investment Corporation, who have the responsibility to pass on the maintenance plan to the incoming building management team (currently unknown) to implement.

To ensure that the maintenance requirements and responsibilities for the proposed SuDS components are met, information will be made available to the first owners of each property in a clear and concise format to clarify their requirements. The developer shall be responsible for providing a framework management agreement for SuDS outside of the property curtilages, for the future property owners.

Management and maintenance requirements should be determined in accordance with all best-practice guidance and the SuDS Manual (Chapter 32: Operation and Maintenance), including:

a) Regular maintenance activities.
b) Occasional maintenance activities.
c) Remedial maintenance requirements.
d) Ongoing monitoring requirements.

All management, monitoring and maintenance activities should follow guidance from the SuDS system manufacturer, where applicable.

Drains, manholes and pipes

All drains, manholes and pipes should be constructed, operated and maintained in accordance with Building Regulations Part H, Sewers for Adoption 7th Edition and BS EN 752:2017 'Drain and sewer systems outside buildings'.

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Outline SuDS management plan (continued)

Green roofs

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspections and remedial works to control weeds and invasive plants	Monthly
Occasional maintenance	Replacement of vegetation may be required, depending on the type of green roof	Quarterly
Remedial actions	Structural rehabilitation or repair may be required if inspections reveal damage to the underlying structure	Annually (or as required)
Safety	Maintenance should be carried out by the green roof landscaper/installer. This should be undertaken in accordance with the Work at Height Regulations (WAHR) and European Council Directive 92/57/EEC, CDM 2007.	As per Regular maintenance, Occasional maintenance and Remedial actions

Pervious paving

Maintenance schedule	Required action	Typical frequency
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 manufacturer's recommendations).
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using glyphospate 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 landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm 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 hazard to users, and replace lost jointing material.	As required.

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Outline SuDS management plan (continued)

Pervious paving (continued)

Maintenance schedule	Required action	Typical frequency
Remedial actions	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 hours after large storms in first six months.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.
	Monitor inspection chambers.	Annually.

Attenuation storage structure

Maintenance schedule	Required action	Typical frequency
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, outlet, overflows and vents.	As required.
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually.
	Survey inside of tank for sediment build–up and remove if necessary.	Every 5 years, or as required.

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Outline SuDS management plan (continued)

Flow control devices

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspection of the device and filter for debris and sediment build-up.	Annually (and following poor performance).
	Cleaning of device inlet/outlet, chamber and sump.	Annually (and following poor performance).
Occasional maintenance	Cleaning and/or replacement of any filters.	Three monthly (or as required).
Remedial actions	Repair of flow control device.	As required.
Monitoring	Visual inspection within chamber to ensure that the device is in good condition and operating as designed.	Annually.
	Survey from inside of chamber for sediment build-up and remove if necessary.	Every 5 years, or as required.

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Conclusions

An integrated SuDS strategy has been proposed for the development. The suitability of SuDS components within the development proposals been evaluated. Alongside the landscaping proposals, the following specific SuDS components are recommended as part of an integrated SuDS design, in accordance with the sustainable drainage hierarchy:

- Geocellular attenuation storage with capacity of approximately 88m^3.
- Green roof (extensive sedum green roof-type system) with approximately 95.2m2 total surface area.
- Pervious paving in areas of upgraded landscaping amounting to 144.5m^2
- Surface water to be discharged at controlled rate (to achieve a 50% or greater betterment against the pre-development runoff rates) from the site to the local public surface water sewer.

The impact of SuDS proposals on the post-development site will reduce surface water runoff from the existing site as well as delivering a range of others benefits, including biodiversity and reducing the heat island effect.

It is recommended that all proposed SuDS technologies are designed in accordance with the SuDS Manual (CIRIA, 2015) and will require the adoption of robust maintenance and management plans to ensure they maintain their effectiveness over the development's lifetime.

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Appendix A: Environment Agency Flood Map

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Appendix B: Regulated Drainage & Water Search

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Appendix C: Hydraulic Modelling Results

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Appendix D: SuDS Inspection & Maintenance Checklist

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Appendix E: Existing Site Plan

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Appendix F: Proposed Site Plan

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Appendix G: Preliminary SuDS Layout

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Appendix H: Camden SuDS Proforma

SuDS Strategy

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