Resilience and Flood Risk

252 Finchley Road, NW3 7AA

OUTLINE DRAINAGE STRATEGY

11th August 2015
Draft 1.0
RAB: 1180B

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Resilience and Flood Risk

Revision history

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Quality control

Action	Signature	Date
Prepared	Alexandros Tsavdaris BEng MSc	11/08/2015
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Disclaimer

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Abbreviations

Abbreviation	Definition
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FSR	Flood Studies Report
IDB	Internal Drainage Board
m AOD	metres Above Ordnance Datum
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems

1.0 Introduction

1.1. Terms of Reference

RAB Consultants was appointed by Mr Alessandro Penna on behalf of Gapland Ltd to undertake this drainage strategy (DS) in support of a proposed new development located at 252 Finchley Road, London. The London Borough of Camden and National Planning Policy Framework requires a drainage strategy to be carried out to ensure that the implementation of SuDS to the proposed development is considered

This drainage strategy has been prepared in accordance with the Council's recommendations in respect of SuDS.

1.2. Drainage Strategy Requirements

It is a requirement for development applications to consider the use of SuDS to a proposed development over its expected lifetime.

Where appropriate, the following aspects of drainage should be addressed in outline planning applications:

- The foot print of the area being drained (this includes all buildings and carparks).
- Calculation of the Greenfield Runoff Rates for 1in 1 Year event and 1 in 100 year event plus climate change.
- Calculation of the proposed storage volume.
- The controlled discharge rate of the site.
- Overland flow routes.
- Information on proposed SuDS design.
- An explanation of why the proposed SuDS design has been selected with respect to the drainage hierarchy.
- Management Plan for future maintenance.

This report follows government guidance on new development and SuDS (National Planning Policy Framework, The SuDS Manual, scientific literature).

1.3. Site Details

Figure 1 - Summary of site details

Site name	252 Finchley Road, London, NW3 7AA
Site footprint	Approximately 650m²
Existing land-use	Residential
Purpose of development	Residential
Estimated lifespan	100 years
OS NGR	525628 185421
Country	England (NPPF applies)
Local planning authority	London Borough of Camden
Other Authorities	Environment Agency

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1.4. Site Description

The 0.065ha (approximately) site is located at 252 Finchley Road, London and is currently a residential property. The existing impermeable area is 530m².

1.5. Development Proposals

The proposed development is the erection of new residential properties (12 flats) with associated access roads, parking areas, driveways, waste and bicycle storage, and paths. The proposed development will reduce the impermeable area by 10m². Hence the proposed impermeable area will be 520m². This includes buildings and paved surfaces (access road, driveways, etc.).

1.6. Existing Drainage Network

The site is formally drained at the moment using the public sewer.

2.0 Site Visit – 10th August 2015

2.1. General Site Observations

The site visit was undertaken by RAB Consultants on the 10th of July 2015, a dry and cloudy day.

The proposed development site is located at Finchley Road (Figure 2) and access was gained via the inclined access road (Figure 3). The existing slope and difference in level between Finchley Road and the existing property is quite significant, suggesting that conveyance of rainwater from the property to the public sewer will not be an issue (Figure 4). The existing property actively manages surface water runoff via rainwater pipes (Figure 5). Surface water runoff from the front greenfield area drains into the ground and discharges through specific orifices placed at the retaining wall of the side access road (Figure 6). A greenfield area lies at the rear of the existing property (Figure 7, Figure 8, Figure 9). The greenfield area slopes from the north to the south of the site. In addition, there are road gullies right in front of the existing property located at Finchley Road (Figure 10) which was clear of debris and in excellent condition (at the site visit).

Figure 2 – Finchley Road

Figure 3 – Side access road to the site

Figure 4 – Side view of the existing property

Figure 5 – Rainwater pipes

Figure 6 – Groundwater drainage

Figure 7 – South-east facing view of the greenfield area

Figure 8 – North-east facing view of the greenfield area	Figure 9 - South-west facing view of the greenfield area
	
Figure 10 – North-west facing view of the greenfield area	Figure 11 – Road gullies in front of the existing property
	

3.0 Development and Local Policy

3.1. The Local Plan for the London Borough of Camden

The proposed development should comply with policies in the Local Plan for the London Borough of Camden with respect to management of surface water and flooding. From 6th April 2015, the London Borough of Camden, as a Lead Local Flood Authority (LLFA), is a statutory consultee for major planning applications in relation to surface water drainage. According to the London Borough of Camden: "*SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and 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:*

- *store rainwater for later use*
- *use infiltration techniques, such as porous surfaces in non-clay areas*
- *attenuate rainwater in ponds or open water features for gradual release*
- *attenuate rainwater by storing in tanks or sealed water features for gradual release*
- *discharge rainwater direct to a watercourse*
- *discharge rainwater to a surface water sewer/drain*
- *discharge rainwater to the combined sewer."*

Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required.

4.0 Surface Water Runoff Pre-development Rates

4.1. Pre-development runoff rate

Using the IH124 method for determining Greenfield runoff rate built into Microdrainage WinDes 2013.1 (including the modification given in the Interim Code of Practice for SUDS, Chapter 6):

- AREA = 1ha.
- SAAR = 617mm
- SPR = 47
- **Pre-development QBAR = 3.826 l/s/ha.**
- **Pre-development peak flow with 1 year return period = 3.252 l/s/ha.**
- **Pre-development Peak flow with 30 year return period = 8.67 l/s/ha.**
- **Pre-development Peak flow with 100 year return period = 12.204 l/s/ha.**
- **Pre-development Peak flow with 100 year return period plus 30% climate change = 15.865 l/s/ha.**

4.2. Pre-development runoff volume

Using the FSR method to determine rainfall and FSSR 16 fixed percentage runoff model for volume (Greenfield runoff volume analysis module built into Microdrainage WinDes 2013.1):

- M5_60 = 20.000mm.
- Ratio R = 0.434.
- Areal reduction factor = 1 (for small site).
- Return period = 100 year.
- Storm duration = 360 minutes.
- Area = 1ha.
- SAAR = 617mm (obtained from WinDes 2013.1 built in FSR map).
- CWI = 90.06
- Urban = 0.000.
- SPR = 47.000
- **PR% = 42.32%.**

Pre-development Greenfield runoff volume = 272.308 m^3/ha.

Consequently, the Greenfield volume for the 520m^2 proposed development is 14.16m^3.

5.0 Drainage Impact Assessment – Background Information

5.1. Groundwater/Geology

British Geological Survey (BGS) maps of the area show that the site overlays bedrock of London Clay Formation – clay, silt and sand with superficial deposits present at the site. The risk from groundwater flooding in Camden is uncertain and more information is required to build up an understanding of it. Groundwater flooding occurs when the water table rises to the ground surface and inundates low lying areas. According to the 2013 London Borough of Camden Flood Risk Management Strategy, there are a small number of recorded incidents of groundwater flooding throughout Camden, but mainly for basements and cellars. The presence of clay suggests that infiltration SuDS may be an issue at the site; this, however, depends on the depth of the water table. Please note that infiltration tests (BRE Digest 365) are required to validate this. It should be noted that the site is not within an Environment Agency groundwater vulnerability zone.

5.2. Surface Water and Sewer Flood Risk

When the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded, excess rainwater flows overland; this water will collect in topographic depressions and at obstructions, and can inundate development downslope. The severity of the rainfall event, the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use all contribute to and affect the severity of overland flow.

The Environment Agency's most recent flood map for surface water published in December 2013 is freely available online at their website and can be used to see the approximate areas that would experience surface water flooding from a variety of rainfall return periods. The risk is categorised based on annual probability of occurrence. The different risk categories are displayed below in Table 1.

The surface water maps identify that the site has a very low risk of flooding from surface water.

Table 1 - Environment Agency Surface Water Risk Categories

Environment Agency Surface Water Risk Category	Surface water flooding annual probability of occurrence
Very Low	Less than 0.1% (1 in 1,000 years)
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1,000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	Greater than 3.3% (1 in 30 years)

This type of flooding can be difficult to predict as it is hard to forecast where or how much rain will fall in any storm. The Environment Agency's flood map is based on the best information available to them, such as ground levels and drainage assumptions.

The public sewerage network in Camden is managed by Thames Water Utilities Limited (Thames Water). According to the SFRA (2013), Thames Water's records show that only 3 foul water sewer-flooding incidents have been reported in the vicinity in the last ten years (2003 – 2013), no surface water sewer flooding has been reported in this time.

5.3. Natural flow path

On the basis of the topographic survey (Appendix D), the natural flow paths were identified. Figure 12 shows the natural flow paths of the proposed development. The site topography encourages water to flow from the north-west part of the site towards the south-east part. This will help conveyance of water while during an extreme rainfall event water will flow towards Finchley Road.

Figure 12 - Natural flow paths

6.0 Post-development Surface Water Runoff

The development will reduce the impermeable area at the site by 10m^2. In order to minimise the effect of the surface water run-off downstream and to increase the aesthetic value of the site, the installation of SuDS should be incorporated to the development (as described in the Council's Planning Policy).

6.1. SuDS

Paragraph 1.3.2 from the SuDS manual (C697) discusses the SuDS 'management train' which is intended to mimic the natural catchment process as closely as possible. The hierarchy of techniques used to achieve the management train are shown below in Table 2.

Table 2 - Hierarchy of SuDS techniques

Technique	Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area or site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

There is an opportunity for the application of SuDS techniques:

Table 3 - Feasible SuDS techniques for the site

Technique	Issues	Feasible? Y/N
Prevention Good site design and housekeeping/rainwater harvesting/green roofs/education.	• The proposed development could utilise water butts for rainwater harvesting to reduce runoff. • Education to prospective owners about how to manage flood risk could be implemented.	Yes Yes
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	• Ground testing has not been conducted at the site and consequently the potential for infiltration SuDS is unknown. The underlying geology suggests this may be not feasible.	Maybe
Site and Regional Control Infiltration/detention basins/ balancing ponds/ wetlands/swales/retention ponds.	• Ground testing has not been conducted at the site and consequently the potential for infiltration SuDS is unknown. The underlying geology suggests this may be not feasible. • There is sufficient room at the site for an attenuation pond/tank to be accommodated.	Maybe Yes

According to the SuDS Manual (CIRIA, 2007), the surface water coming from roofs/paved areas should receive one treatment stage (low pollution potential). Given the fact that the road within the development will have a very low daily traffic load, one treatment stage is employed in the drainage strategy. A conceptual drainage strategy can be found in Appendix B. The drainage strategy implies that the south-east part of the existing greenfield area will have been slightly re-profiled (if necessary) to a lower level to match the rear ground level of the proposed development; this is to ensure that there will be efficient slope to convey the rainwater from the proposed development to the proposed pond. Ideally the cover level of the pond should match the ground level of the rear side of the proposed development.

The chosen method of discharge (discharge to the public sewer) was chosen due to the location of the site (no watercourse nearby), and the site geology (low infiltration potential).

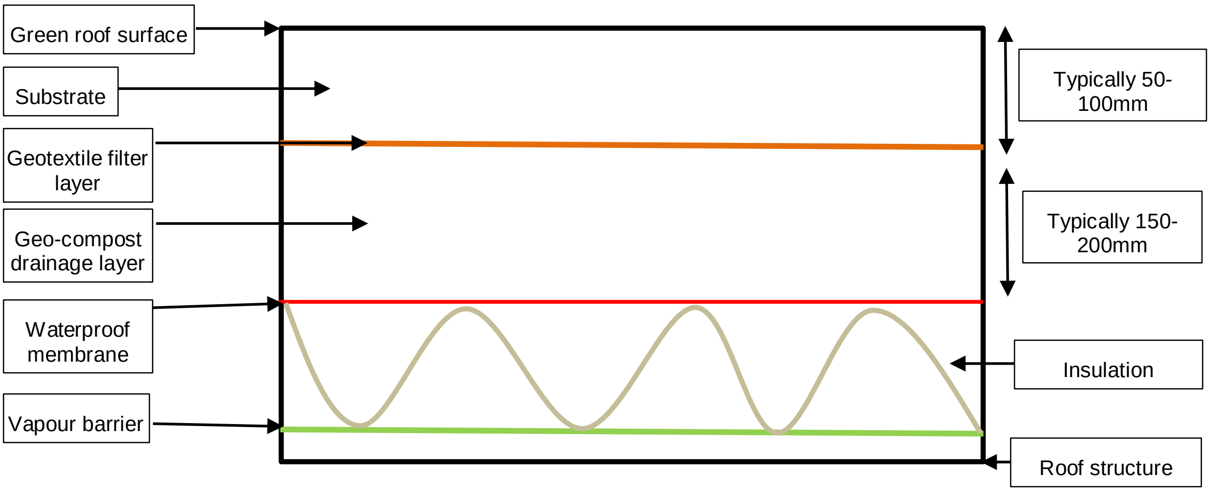
6.2. Conceptual Drainage Strategy

6.2.1. Prevention

The use of good housekeeping measures such as rainwater harvesting can reduce the sites surface water runoff and put the rainwater collected to good use, such as watering plants, washing cars and even flushing toilets. However, in order for rainwater harvesting to be cost-effective, its efficiency should be assessed. The rainwaterharvesting.co.uk has developed a tank size calculator which evaluates the efficiency of rainwater harvesting systems on the basis of site-specific information. On the basis of the results (see Appendix E), there is not enough roof water to manage the needs of the proposed development. Therefore, the use of rainwater harvesting systems is unfeasible for the given site.

The site will incorporate green roofs at specific locations (see Appendix B). It is suggested that extensive green roofs are installed due to the low maintenance requirements (CIRIA, 2007). Extensive roofs cover the entire roof area with low growing, low maintenance plants. They are only accessed for maintenance and can be flat or sloping. The green roof should be comprised of a 100mm thick growing medium in which a variety of hardy, drought tolerant, low-level plants are grown (mosses, succulents, grasses). The green roof will (typically) consist of the following components:

Figure 13 - Proposed green roof layout



Good drainage is vital to the long-term performance of a green roof. Water ponding on the roof surface or within the green roof construction on top of the water-proofing layer must be prevented. Falls should be designed to 1 in 40 and must be consistently graded, without deflections or depressions in which water may pond. An inspection chamber(s) should be placed at the green roof(s) to allow for regular maintenance. The more the chambers the more efficient the performance (green roof) will be. These inspection chambers are small in size and their depth is the same as the green roof's depth.

6.2.2. Source Control

The soil permeability has not been evaluated for the site but given the local geology it is highly doubtful that infiltration could be an option at the site. Infiltration in clay soils, especially where steep slopes exist, can present issues in terms of structural integrity (foundations), consolidation rate (soil), and shear strength (soil).

Other techniques could be utilised which involve the use of engineered soils which promote infiltration (gravel). Such a feature which is highly effective for the management of road runoff is a filter drain or an infiltration trench with a perforated pipe installed at the bottom. The conceptual drainage strategy presented in Appendix B incorporates infiltration SuDS (assuming engineered soil and capped at the bottom and the side), underground pipes (conveyance), and a balancing (vegetated) pond. The infiltration SuDS is a filter drain located at the side of the main access road. Since it is assumed that the soil is not suitable for infiltration, perforated pipes are being suggested for the conveyance of the runoff to the public sewer. The conceptual drainage strategy recommends that water from the paved areas will be directed to the filter drain which in turn will lead the water to the pond.

Using Microdrainage WinDes, the structural characteristics of the filter drain were calculated. The safety factor used in the calculations is 2.0. The filter drain is designed to serve 150m^2 and will not flood during the 1 in 100 plus climate change flood event. The depth of the gravel trench of the filter drain will be 1.5m while the width and length will be 0.2m and 30m, respectively. The perforated pipe will be 200mm. The slope of the filter drain from start to end should ideally be <2%. However, given the local topography this value could reach 10%. The outflow will be controlled via a Hydro-brake which will limit the discharge to 5 l/s (minimum flow requirement to prevent blockages; CIRIA, 2007). The post-development flow for the 1 in 100 plus climate change flood will be (Microdrainage WinDes):

- **Post-development peak-flow with 100 year return period plus climate change: 4.1l/s – 15 minutes (winter) critical storm duration; please note that this value is an estimate.**

The gravel of the trench should be 40 to 60 mm in diameter while the voids ratio should be sufficiently high to allow adequate percolation and to reduce the risk of blockage. The filter drain will also receive the outflow from the pond.

6.2.3. Site Control

The site is thought to be sufficiently sized to accommodate the use of an attenuation pond or storage tank to ensure that the runoff volume, as a result of the development, will be discharged at QBAR for the 1 in 100 year rainfall event. The outlet from the attenuation pond/tank will control to 5l/s minimum. The 5l/s rule is required due to the small greenfield runoff rate which would otherwise result in an unacceptably small orifice diameter with associated blockage risk.

A conservative approach to the storage capacity of the pipe network leading from the developed area to the pond has been taken; consequently, this value was left as 0 m^3.

6.2.4. Attenuation Pond

Please note that the attenuation pond has been sized to accommodate for all impermeable (0.052ha – worst case scenario) surfaces without taking into consideration any other features such as underground pipes, filter drains, etc. This approach improves significantly the existing situation as all runoff from the development will be attenuated and discharged to a limiting flow rate.

The Hydro-brake delivers water more efficiently across the full range of water heads than other outlet controls such as an orifice. Because of this, the Hydro-Brake controls to a low rate whilst maintaining a suitably sized orifice diameter which helps mitigate against blockage.

The effectiveness of this conceptual drainage option has been tested using Microdrainage WinDes 2013.1 Source Control module, under the following conditions (Table 4). The area relates to that which will be formally drained.

Table 4 – Drainage Design Conditions

Win Des Parameter	Value used
Global Variables	
Inflow	Rainfall Data
Additional inflow	None
Storage structure	Tank or Pond
Outflow control	Hydro-brake
Overflow control	None
Climate change (%)	30
Rainfall details	
Return period (years)	100
Region	England and Wales
M5-60 (mm)	20
Ratio R	0.434
Storms	Summer and Winter
Cv	0.750 (summer) 0.840 (winter)
Shortest storm duration (mins)	15
Longest storm duration (mins)	10080
Network storage volume (m3)	0
Time area diagram	
0 – 4 minutes	0.026 ha
8 - 12 minutes	0.026 ha
12 - 16 minutes	0 ha
16 minutes onwards	0 ha
Pond Structure	
Cover level (m)	100.000
Invert Level (m)	99.000

Storage (online/offline)	Online
Depth (m) - Area (m^2)	1.0 - 20
Hydro-Brake Outflow Control	
Invert Level (m)	99.000
Design Head (m)	1.50
Design Flow (l/s)	5
Hydro-Brake Type	MD-SHE-0105-5000-1000-5000

The runoff volume created as a result of this development will be controlled to 5l/s and discharged to the public sewer. However, this has to be confirmed with Thames Water.

The critical storm had a 15 min duration (winter) for all return periods. The post-development runoff rates are as follows:

- **Post-development peak-flow with 1 year return period: 3.7l/s.**
- **Post-development peak-flow with 30 year return period: 4.9l/s.**
- **Post-development peak-flow with 100 year return period: 4.9l/s.**
- **Post-development peak-flow with 100 year return period plus climate change: 4.9l/s.**

The post-development runoff volume for the 1 in 100 plus climate change flood will be 35.9m^3.

On the basis of the above findings, a pond with a plan area of 20m^2 and a depth of 1.0m will attenuate the critical 360min – 1:100+CC storm volume while discharging to a controlled rate of up to 5l/s. This will minimise flood risk downstream while reducing the impact of the increase in impermeable area on surface water management. The pond should include vegetation but only at its benches and not within the actual basin. This is due to the fact that vegetation may reduce the discharge capacity of the pond and increase the potential for biogenic-debris generation; this may influence the treatment capacity of the pond system. The benches of the pond should be planted either with thick grass or reeds such as *Typha latifolia, Glyceria maxima,* and *Phragmites australis* which have proven to be efficient in managing heavy metal pollution. The maximum water level of the pond should be at least 300mm below floor levels of the adjacent properties. Please note that the above pond size has the capacity to safely (1 in 100 plus climate change flood) manage (no flooding) the runoff for the entire proposed impermeable area. The size of the pond is sufficient enough to ensure flood safety and protection *in-situ*. The required attenuation guideline value for the proposed development is **0.0385m^3 per 1m^2** of impermeable area. The pond should be ideally of an elliptical shape with a submerged island in the middle to promote plug-flow and gravity sedimentation.

From the outlet of the filter drain surface water will be discharged to the existing combined sewer manhole located at Finchley Road (see Appendix C – manhole reference number=5401; Invert Level=69.44m AOD).

In the event of an extreme storm event the natural flow path will lead the water to the pond and if exceedance occurs at the pond then the water will flow towards Finchley Road. As demonstrated in Section 5.2 the site is at no risk of surface water flooding.

6.2.5. Maintenance Requirements

Maintenance can be categorised to into three main groups:

- Regular maintenance
- Occasional maintenance
- Remedial maintenance

The level of inspection and maintenance will vary depending on the type of SuDS component and scheme, the land use, and the type of vegetation. It is vital that SuDS construction is supervised and inspected on completion if owners and the Lead Local Flood Authority are to avoid taking on liabilities. This will help to ensure that the specified materials are being used and that they are being placed correctly. Incorrect materials or installation should be rejected as they will adversely affect the performance, maintenance costs and ultimately the design life of SuDS.

The two SuDS features incorporated to this particular design have to be maintained in order to ensure efficient water treatment and water management.

Table 5 - Inspection and Maintenance Activities

SuDS Feature	Activity	Frequency	Typical Tasks
Filter Drain	Routine maintenance	1 per month	• Inspection for signs of clogging. • Litter removal. • Inspection of inlets and outlets. • Grass cutting.
	Occasional maintenance	1 per six months	• Silt control and removal around components and on the top layer of the filter drain. • Vegetation management around components.
	Remedial maintenance	As required	• Inlet/outlet repairs. • Erosion repairs. • Removal of silt build-up. • Replacement of gravel layer (usually every 5 years) to ensure treatment efficiency.
Attenuation pond	Routine maintenance	1 per month	• Litter removal. • Inspect control structures to/from pond. • Grass cutting on slopes.

SuDS Feature	Activity	Frequency	Typical Tasks
	Occasional maintenance	1 per twelve months	• Scrub clearance from bankside. • Remove invasive species (if spotted). • Vegetation management – 30% cut (cutting of reeds located at the side slopes– if applicable). • Maintain a sparse vegetation cover (reeds – if applicable) to reduce the generation of biogenic debris (increased suspended solids).
	Remedial maintenance	As required	• Remove silt from the bottom of the pond (1 every 7 years). • Inlet/outlet repairs. • Erosion repairs.
Green Roofs	Routine maintenance	1 every six months or as required	• Remove debris and litter to prevent clogging of drains and interference with plant growth. • Replace and remove dead plants. • Remove fallen leaves and debris from deciduous plant foliage. • Remove invasive vegetation including weeds. • Mow grasses (as required)
	Occasional maintenance	1 per twelve months	• Inspect all components for proper operation, integrity of waterproofing, and structural stability. • Inspect underside of roof for signs of leakage. • Inspect drain inlets and substrate.

SuDS Feature	Activity	Frequency	Typical Tasks
	Remedial maintenance	As required	• If erosion channels are evident, these should be stabilised with additional soil substrate similar to the original material. • If drain inlet has settled, cracked or move, investigate and repair as appropriate.

Green waste from SuDS maintenance operations can be managed in a number of ways and is no different to that of from normal landscape maintenance:

1. Shredded for surface spreading – as a mulch mimicking natural leaf or wood fall.
2. As wildlife piles to provide habitat usually removed from managed landscapes.
3. Removed from site to off-site composting facilities (Council Green Waste).
4. Removal from site to tip (least sustainable option).
5. Agree a sustainable approach to silt management with the Environment Agency.

6.2.6. Amenity

Given the size of the proposed development three key principles should be considered in the SuDS design process:

- Health and Safety
- Visual Impact
- Amenity Benefit

Health and safety needs to be considered when designing ponds due to the perception that these features are unsafe. In reality these features are as safe as the many watercourses, ponds and lakes that are unfenced in parks, country parks and similar locations throughout the country. Ponds should have shallow side slopes (1 in 3 minimum slope), shallow shelving edges and strategically placed vegetation. A discreet wooden fence should be ideally placed around the pond to promote health and safety while a strategically placed warning sign is necessary.

Maximising the ecological value of SuDS can provide an important contribution to biodiversity enhancement at a development site and can facilitate the movement of wildlife through the creation of green corridors within the proposed development. Ecological diversity through SuDS can be achieved by: (i) the use of native planting, (ii) retaining and enhancing natural drainage systems, (iii) creating a range of habitat types, and (iv), implementing an appropriate maintenance and management plan to ensure visual amenity.

7.0 Conclusion

The proposed development at 252 Finchley Road is located within Flood Zone 1 (low probability flooding; 0.1% annual probability) as described in Table 1 of the Planning Practice Guidance to the National Planning Policy Framework. This report evaluated the feasibility of various drainage options related to sustainable features in accordance with the Local Planning Policy. Planning consent is sought for the development of new residential units with associated roads, gardens, and paved areas.

Due to the site geology and the site topography, engineered infiltration in combination with a wet pond were suggested to manage the surface water runoff from the proposed development. In addition, the development benefits from the installation of green roofs at the south-east part of the site (bicycle storage units). The existing understanding of surface water and groundwater flood risk is based on all available information and data from the relevant SFRA and the EA flood maps. The site is not at risk of surface water/groundwater flooding. It should be noted that infiltration tests are absent at this stage although the site geology indicates that source control is not viable at the site.

It can be concluded that the proposed development is suitable at this location and it will not impact on flood risk elsewhere, provided that the SuDS proposed in this report are incorporated to the final design.

8.0 Recommendations

- Prior to the detailed design of a SuDS scheme, infiltration tests that meet BRE Digest 365 should be undertaken at multiple locations throughout the site in order to evaluate the soil's infiltration rate and the groundwater level.
- Surface water should be managed by SuDS techniques in order to promote sustainability, amenity, and bio-diversity. Use of SuDS to manage surface water should be examined and incorporated into the design where possible as outlined in Chapter 6.0, subject to infiltration tests.
- Finished floor levels should ideally be set 150mm above the existing ground to mitigate against the unpredictable occurrence of surface water flooding.
- Discharge consent from Thames Water should be granted prior to detailed drainage design.

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Appendix A - Development Proposals

Provided in a separate folder.

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Appendix B - Conceptual Drainage Strategy

KEY:

Flow path

Wet pond

Filter drain

Underground pipe

Manhole/Inspection chamber

Hydro-brake flow control chamber

Green roof

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Appendix C – Thames Water Asset Map

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Appendix D - Topographic Survey

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Appendix E - Rainwater Harvesting Calculation

Provided in a separate folder.