

Hornsey Town Hall

Flood Risk Assessment & Drainage Strategy

Wastewater Drainage Appraisal & SUDs Statement

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FLOOD RISK ASSESSMENT & DRAINAGE
STRATEGY

ON

Hornsey Town Hall
The Broadway,
London
N8

FOR

Crouch End (FEC) Limited

REPORT AMENDMENT REGISTER

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1 INTRODUCTION

Bradbrook Consulting have been commissioned to carry out a Flood Risk Assessment for the proposed redevelopment of the Hornsey Town Hall, Haringey.

This assessment has been prepared in accordance with National Planning Policy Framework (NPPF) and the Interim Code of Practice for Sustainable Drainage, with site-specific advice from the Environment Agency and the Local Planning Authority.

The NPPF replaced Planning Policy Statement (PPS25) 'Development and Flood Risk' along with the PPS25 Practice Guide. The NPPF is supported by the Planning Practice Guidance (PPG) website (<http://planningguidance.planningportal.gov.uk>) which was launched in March 2014 to provide more detailed guidance on applying the planning policy and supersedes the previously issued Technical Guidance to the NPPF. Section ID: 7 of the PPG deals with Flood Risk and Coastal Change.

The NPPF sets out the criteria for development and flood risk by stating that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. The key definitions are:

- “areas at risk of flooding” means land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency
- “flood risk” means risk from all sources of flooding - including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

For this site, the key aspects that require the assessment are:

- the Environment Agency's indicative flood map (Figure 5) shows the site to lie within Flood Zone 1, this indicates the site has a low level of flood risk from tidal and fluvial sources but as the site is greater than 1 hectare, a flood risk assessment is required in accordance with the NPPF.

1.1 Context and Scope

A key element of the proposed development is to prepare a Flood Risk Assessment (FRA) to establish the risk associated with the site and to propose suitable mitigation, if required to reduce the risk to a more acceptable level.

The scope of work relating to a Flood Risk Assessment is based on the guidance provided in Section 10 of NPPF and PPG. A site-specific Flood Risk Assessment must demonstrate that the site will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The local planning authority will make decisions with regard to any planning application within any floodplain or flood risk area, although the Environment Agency (EA) is a designated statutory consultee and plays a key role in providing advice on development and flood risk issues.

This FRA has been prepared in accordance with the NPPF and local planning policy. Any recommendation regarding floor levels are based on the relevant British Standards (BS8533), the standing advice provided by the EA or based on common practice. However, it should be

noted that the insurance market applies its own tests to properties in terms of determining premiums and the insurability of properties for flood risk. Those undertaking developments in areas which may be at risk of flooding are advised to contact their insurers or the Association of British Insurers (ABI) to seek further guidance prior to commencing development.

This FRA should be read in conjunction with other planning application supporting documents.

1.2 Context and Scope

A key element of the proposed development is to prepare a Flood Risk Assessment (FRA) to establish the risk associated with the site and to propose suitable mitigation, if required to reduce the risk to a more acceptable level.

The scope of work relating to a Flood Risk Assessment is based on the guidance provided in Section 10 of NPPF and PPG. A site-specific Flood Risk Assessment must demonstrate that the site will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

2 SITE DETAILS AND LOCATION

2.1 The Existing Site

The proposed redevelopment site which is the subject of this Flood Risk Assessment (FRA) is located at the centre of Hornsey with the A103 to the west of the site. The site will be accessed via Haringey Park Road which runs to the south of the site, see Figure 2.1 below. The redevelopment will consist of refurbishment and conversion of the Town Hall Building, new residential development and associated car parking and landscaping.

The total development site area of 1.33 ha (**Appendix B**).



Figure 2.1 Site Location

The existing site is a Brownfield site. The total layout of the existing on-site drainage network has been CCTV surveyed as part of the initial study on site. The topographical survey has also identified all drainage channels and existing drainage manholes located on the site. It has been shown that the existing site drains to existing manholes which connect to the public sewers located in the adjoining roads. The Thames Water Public sewer records have been appended to this report as **Appendix F**. The proposal would be to drain the development to the nearest existing public storm water network at a controlled Greenfield discharge rate, see **Appendix B**.

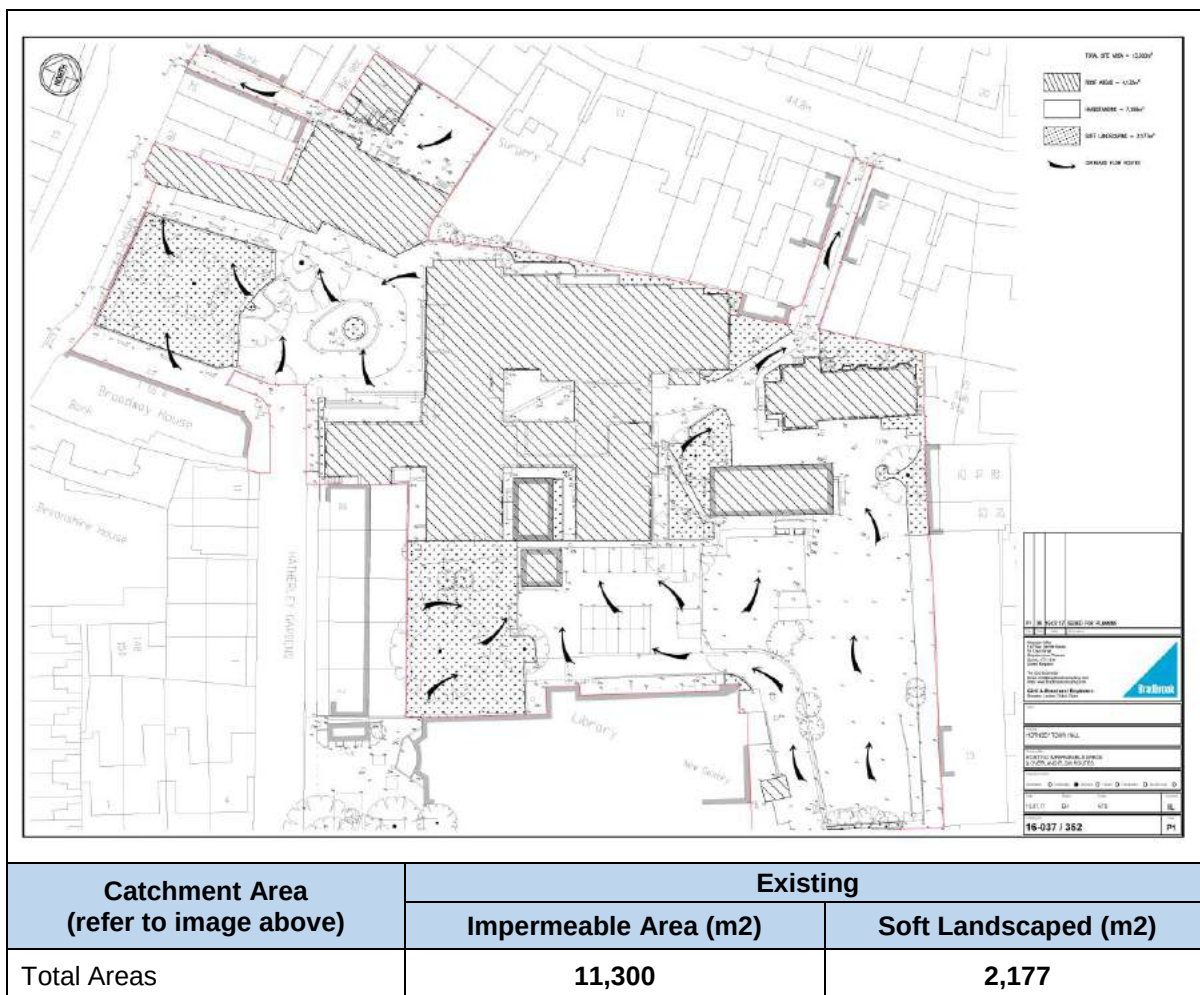
2.1.1 Site Plan and Topography

A topographical survey has been undertaken, this survey shows that the site levels are generally between 47.50 and 46.50 over the central area of the site. The lowest portion of the site is in the north-east corner which has a ground level of 45.06m AOD. Generally levels fall from the southern boundary to the north-eastern boundary. The development will be accessed via Hatherley Gardens road which connects to Haringey Park Road. Road levels will generally be 300mm lower than the finished floor level for the site.

The Existing Site topographical survey is included as **Figure 3** showing spot levels.

The existing site permeable and impermeable areas are as shown in Table **2.1** below:

Table 2.1: Existing Site - Approximate permeable and impermeable area contributions
(extract from Appendix B).



2.2 The Proposed Development

The area proposed for redevelopment within the planning application will provide new build residential units. This area will provide approximately 0.22ha of soft landscaping, with the remaining 1.13ha being building footprint, hardstanding or hard landscaping.

The proposed site permeable and impermeable areas as shown in **Table 2.2** below:

Table 2.2: Proposed Site- Approximate permeable and impermeable area contributions.



Catchment Area (refer to image above)	Proposed	
	Impermeable Area (m2)	Soft Landscaped (m2)
Combined Total Areas	10,014	2,481

2.3 Source protection zone

The site is not located within a Source Protection Zone, according to the Environment Agency's latest groundwater designation maps (Figure 6).

2.4 Geology and hydrogeology

A site investigation report has been completed for the site by **Capita Symonds September 2009**. The findings from this report are as below:

- Made Ground: 0.3-3.3m below ground level.
- Alluvial gravel Formation to depths of between 0.68-0.74m bgl.
- London Clay formation from depth of 0.3m bgl stated to be highly shrinkable.
- Groundwater encountered at (1.5m lowest) 2.0 m and 3.0m bgl in all boreholes, after 20 min ground water reached 1.15m. Higher water table may be recorded in wetter weather.

British Geological Society mapping

- From British Geological Society mapping, the site is situated on London Clay, within the London Clay Formation. The London Clay stratum is described as clay, silty in part; lower part sandy in east. The London Clay Formation is underlain by the Lambeth Group, described as mottled clay with sand and pebble beds.

The underlying geology of the site is likely to have a low degree of permeability due to the presence of thick London Clay strata.

2.5 Surrounding hydrology

The closest water features to the site are the Moselle Brook, New River water supply aqueduct, Hornsey reservoir and the Stoke Newington reservoirs (East and West).

The Moselle Brook is approximately 0.5km to the north east of the eastern boundary of the redevelopment site, although the majority of the watercourse in this area is within culvert. The New River is approximately 1.13km to the north east of the eastern boundary of the redevelopment site. The Hornsey reservoir approximately 1.4km to the north of the site and the Stoke Newington reservoirs approximately 2.3km to the south east of the site.

3 PLANNING POLICY

3.1 National

Table 3.1: National policy context

Policy/Legislation name	Key Provisions
National Planning Policy Framework	The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.

Table 3.2 National legislation

Policy/Legislation name	Key Provisions
Water Resources Act 1991	<i>Section 24</i> - The Environment Agency (EA) is empowered under this Act to maintain and improve the quality of 'controlled' waters <i>Section 85</i> - It is an offence to cause or knowingly permit pollution of controlled waters. <i>Section 88</i> - Discharge consents are required for discharges to controlled waters.
Flood and Water Management Act 2010	This legislation was formally ratified in June 2010 with the aim to implementing the findings of the 2007 Pitt Review and co-ordinating control of drainage and flood issues. There are a number of increased responsibilities within the act that affect adoption of Sustainable Drainage Systems (SuDS) features and the role of the EA to expand on the mapping data they provide. The implementation of SuDS features has many beneficial impacts on the treatment of surface water during remediation works.
Water Framework Directive (2000)	The Water Framework Directive (WFD) came in to force in 2000 and requires all inland and coastal waters to reach 'good' chemical and biological status by 2015. Flood risk management is unlikely to have a significant impact on chemical water quality except where maintenance works disturb sediment (such as de-silting) or where pollutants are mobilised from contaminated land by flood waters. The main impact of the WFD on flood risk management, both now and in the future, relates to the ecological quality of water bodies. Channel works, such as straightening and deepening, or flood risk management schemes that modify geomorphological processes can change river morphology. The WFD aims to protect conservation sites identified by the EC Habitats Directive and Birds Directive that have water-related features, by designating them as 'protected sites'.

3.2 Local

3.2.1 Haringey Local Plan: Strategic Policies 2013 – 2026 (formerly Core Strategy)

The strategic policies note in this document set out the vision and key policies for future development in Haringey up to 2026.

Key Policies from this document relevant to flooding and drainage are as follows:

Policy SP5 - Water Management and Flooding

The Council will require all development in Haringey to be water efficient during construction and operation and to reduce all forms of flood risk. All development shall:

- *Improve the water environment, water quality and drainage systems;*
- *Minimise water use and illustrate how development would contribute to general and flash flooding;*
- *All development in these areas will take account of flood risk vulnerability classification as set out in paragraph 100 of the NPPF and will apply the NPPF Sequential Test and Exception Test;*
- *Implement measures to prevent (or mitigate as last resort) local surface water and*
- *downstream flooding;*
- *Implement Sustainable Drainage Systems from strategic to individual site level to improve water attenuation, quality and amenity;*
- *Restore and enhance the Blue Ribbon Network including Pymmes Brook, Moselle Brook, the River Lee and its tributaries, deculverting wherever feasible, to improve water quality and amenity of these waterways and to help reduce flood risk (in line with London River Action Plan); and*
- *Require higher resilience and levels of flood protection for critical infrastructure to ensure the protection of essential services such as water and power.*

Flood risk

Implications of anticipated change in climate in the UK increased frequency in extreme weather conditions and the possibility of flash floods are being considered carefully. The borough contains areas of flood risk in proximity to Pymmes Brook on Pinkham Way, the Moselle Brook and the River Lee. In Haringey, risk areas include parts of the Lee Valley and South Tottenham (as identified in the Strategic Flood Risk Assessment) and areas identified by the Environment Agency mapped data showing areas susceptible to flooding. According to the Environment Agency, approximately 9% of land in Haringey has one in 100 year probability of flooding from rivers. About 8,000 properties are at risk of flooding although the defences such as the River Lee flood relief channel reduce the risk of this happening.

In developing this document the Council has worked on a Strategic Flood Risk Assessment for the borough and consulted with the Environment Agency on measures which are necessary to reduce flood risk in the area and suitable mitigation where risk is identified. The best form of flood mitigation is to encourage development in areas of lower flood risk. Where a risk of flooding is identified, a Sequential Test will be required, as set out in paragraph 100 of the NPPF. The Council will prepare Area Action Plans for Tottenham Hale and Northumberland Park. This more detailed work will be informed by the Level 2 Strategic Flood Risk Assessments and will identify development sites and the quantum and type of development needed. Masterplanning exercises and development briefs will ensure that flood risk is considered at an early stage, at an appropriate scale and in close consultation with the Environment Agency. Sequential Tests will be conducted to ensure proposals are in accordance with the NPPF, and flood risk assessments for individual development proposals will need to demonstrate that development is safe.

The Flood and Water Management Act 2010 brings responsibilities to Local Authorities for more comprehensive management of flood risk for people, homes and businesses. Haringey forms part of the Drain London Forum, a partnership including London boroughs, the Environment Agency and the Mayor of London, which is formed to ensure the requirements from the Flood and Water Management Act 2010 are met in producing a Surface Water Management Plan (SWMP). The development of SWMPs include a Preliminary Flood Risk Assessment for Haringey, and for the other sub-regional boroughs to investigate and address flood risk problems.

Haringey will maintain a public register of Flood Risk Management assets by 2015. Following the PFRA, the Council will:

- 1. Finalise a Surface Water Management Plan;*
- 2. Prepare a Hazard Map for 2013; and Prepare a Flood Risk Management Plan for 2015.*

Increased flood risk due to anticipated changes in the climate also requires the Council to consider measures for adapting to climate change and focus on minimising the flood risk in the area. Hard and soft landscaping associated with new development must take account of sustainable land management practices and managing the risk of flooding by applying Sustainable Urban Drainage Systems (SUDS) in order to improve water attenuation, quality and amenity. The provision of green features including green roofs provides opportunities to reduce runoff rates and enhance biodiversity and are fully encouraged in both new development and retrofitting in older buildings.

In addition, the Development Management Policies and Site Allocations Document set out borough-wide standards and guidance for managing flood risk through development, including those relating to:

- The need to address non-fluvial sources of flooding;*
- The use and design of water recycling;*
- Requirements for site-specific Flood Risk Assessments;*
- The use and design of water attenuation (in line with the drainage hierarchy set out in the London Plan);*
- The use and design of SuDS;*
- The design and layout of developments, including setting built developments back from rivers, watercourses and flood defences; and*
- Requirements for implementation of flood resilient and resistant building techniques.*

3.2.2 London Plan

The London Plan, published in February 2011 requires local authorities to identify areas at risk from flooding. Within these areas the assessment of development proposals should be carried out in line with PPS25, in particular avoid built development in the functional floodplain.

Other relevant policies include:

- Ensure future developments meet the highest standards of sustainable design and construction.
- Ensure surface water run-off is managed as close to source as possible. The use of SUDS should be promoted for development unless there are practical reasons for not doing so.

The London Plan's Supplementary Planning Guidance (SPG) on Sustainable Design and Construction, April 2014, does not set additional policy. It does however give standards for both what it describes as "Mayor's priority" and the "Mayor's best practice" for each of the measures in the policy. The SPG provides more detailed guidance for the Local Planning Authorities to consider assessing applications:

Section 3.4 Flooding:

- Surface water flooding;
- Sustainable drainage;
- Flooding and the resilience and resistance of buildings;
- Safety;
- Flooding and basement developments;
- Flood defences;
- Flood risk management from tidal and fluvial flooding; and
- Other sources of flooding.

Section 4.6 Water Pollution:

- How sustainable drainage can contribute to water quality;
- The connection of new developments to the sewer network; and
- Private sewage plants.

The London Plan Supplementary Planning Guidance states that the 'Mayor's Priority' is that *"developers should maximise all opportunities to achieve greenfield runoff rates in their developments"*, with a minimum expectation to *"achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times."*

4 FLOOD RISK

In accordance with NPPF and advice from the Environment Agency (EA), a prediction of the flood sources and levels is required along with the effects of climate change from the present for the design life of the development. To consider these effects of climate change, EA recommends consideration of a 30% increase in peak river flows over this timeframe. An extract from revised climate change allowance issued by EA on 19/02/16 reads as per extract below:

Generally the proposed redeveloped site use would be considered to have a design life of 60 years. Therefore, for the purposes of this assessment, taking into account the recommended national precautionary sensitivity ranges for peak rainfall intensity (Table 5 in the NPPF), a 30% increase in peak rainfall intensity has been included as climate change allowance, which caters up to the year 2087.

n) The changes in peak rainfall intensity allowance are not considered to be all that significant and therefore manageable. To assist HBF members, Table 1 below has been provided – this compares the earlier peak rainfall intensity with the latest climate change allowances introduced by the EA on 19th February 2016. This comparison shows that there has been a subtle change in the 'epoch' timescales.

Parameter				
Period/Epoch	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
19 th Feb 2016 Change				
Period/Epoch	2010 to 2039	2040 to 2059	2060 to 2115	
Peak Rainfall Intensity	+10%	+20%	+40%	

Table 1 – Peak Rainfall Intensity: Impact of 2016 Climate Change Allowances

o) The EA has advised that for applications where the EA is a statutory consultee and has an interest in the control of surface water run-off in new developments, i.e. in areas with critical drainage issues, then for developments with a 100-year design life, the EA would typically recommend that the central estimate (20%) is used for design purposes when considering the impact on surface water drainage networks, i.e. an assessment of the performance of the drainage system in order to check that the system can cope with the critical duration design rainfall event.

The EA further recommends that the upper end estimate (40%), should be used to assess the potential flood risk implications arising from the critical duration design rainfall event to test the following – (a) is surface water wholly contained on site? (b) is there an increased flood risk to third parties? (c) Is any flood hazard within acceptable tolerances? (d) Can the system cope?

The flood risk elements that need to be considered for any site are defined in BS 8533 as the "Forms of Flooding" and are listed as:

- flooding from Rivers (fluvial flood risk)
- flooding from the Sea (tidal flood risk)
- flooding from the Land
- flooding from Groundwater
- flooding from Sewers (sewer and drain exceedance, pumping station failure etc)
- flooding from Reservoirs, Canals and other Artificial Structures.

4.1 Sources of Flooding

4.1.1 Environment Agency maps

The Environment Agency has produced Flood Zone maps for much of England and Wales. The current displayed map is included as Figure 5 shows the site to lie within Flood Zone 1, low risk of flooding.

The proposed development can be described as 'residential' which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be 'More Vulnerable'. There will be no change in vulnerability as a result of the development since the previous land use at the site is also considered to be 'More Vulnerable'. Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that 'More Vulnerable' development is compatible within Flood Zone 1.

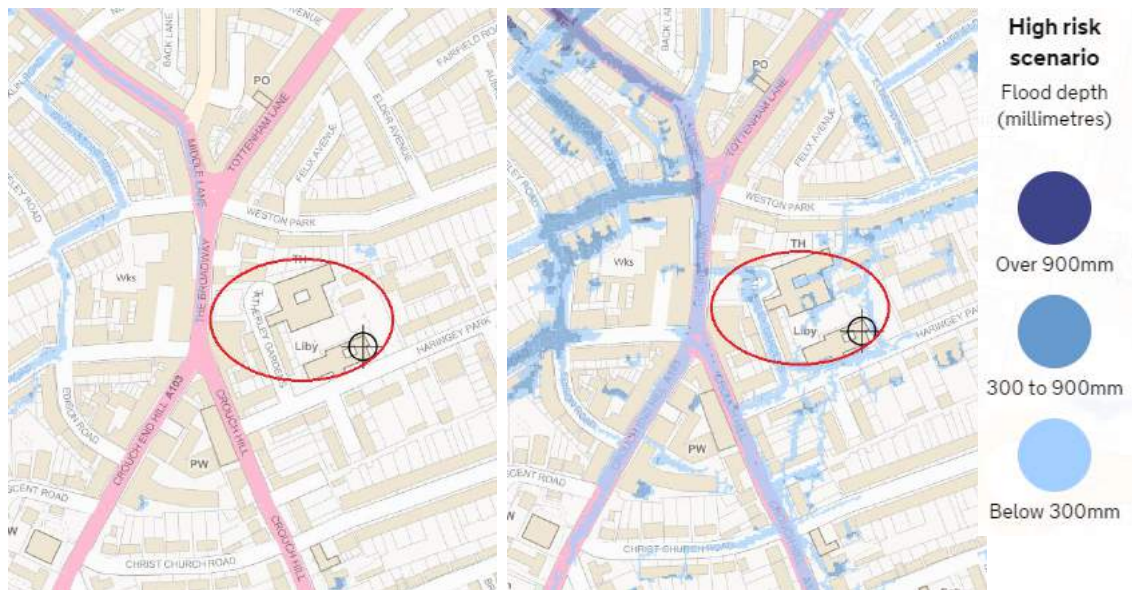
4.1.2 Flooding from the sea (tidal flood risk)

On the coast storm surges and high tides can threaten low lying coastal areas, and can be sometimes large and rapid enough to overtop defence works, causing significantly more damage than river flooding. Tidal flooding is not considered a risk to the site due to the inland location of the development.

4.1.3 Flooding from the land (overland pluvial flood risk)

If intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or another watercourse.

Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff will occur. Excess surface water flows from the site are believed to drain to the local water features, either by overland flow or via existing onsite drainage network.



High Risk Map

Low Risk Map

Figure 4.1 – www.gov.uk long term flood risk maps

The Government map of surface water flood map (Figure 4.1) shows that although there is surface water flooding in and around the site, the risk can be considered as low risk. These areas look to follow existing pipe runs on site which will be replaced as part of the redevelopment of the site. The site will therefore be at low risk of flooding following development.

The overall risk of pluvial flooding to the development can be considered **low**.

4.1.4 Flooding from groundwater

Groundwater flooding tends to occur after much longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas, the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.

The risk of this form of flooding in this area is **low** due to the expected geology of the area, see point 2.4 above.

4.1.5 Flooding from sewers

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. A sewer flood is often caused by surface water drains discharging into the combined sewer systems; sewer capacity is exceeded in large rainfall events causing the backing up of floodwaters within properties or discharging through manholes. Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption. One of the design parameters is that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30-year rainfall event. By definition a 1 in 100-year event would exceed the capacity of the surrounding sewer network as well as any proposed drainage.

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and another drainage infrastructure.

To ensure that sewer and surface water flooding is not exacerbated; surface water must be considered within the design of the site. This ensures that any additional surface water and overland flows are managed correctly, to minimise flood risk to the site and the surrounding area.

Thames Water sewer records showing the existing sewer network associated with the site and surrounding area are provided in **Appendix E**. A review of the existing topography of the site indicates that any surcharged flows would tend to drain from south to north across the site, as ground levels generally fall from approximately 49.4m AOD to 44.4m AOD, see point 2.1.1 above. However, onsite ponding may occur in localised areas that have slightly lower ground levels than the surrounding areas. It is estimated that there is a low risk of sewer flooding impacting the site.

Due to the size of the site and design and construction a new drainage network, it is anticipated that the risk of sewer flooding to the site is considered **low**.

4.1.6 Flooding from reservoirs, canals and other artificial structures

The Environment Agency has recently published flood risk mapping as a result of potential failure of reservoirs and artificial structures.

The Environment Agency's reservoir flood map (Figure 4.3) shows that the site is not in an area that is at risk of flooding from these sources.

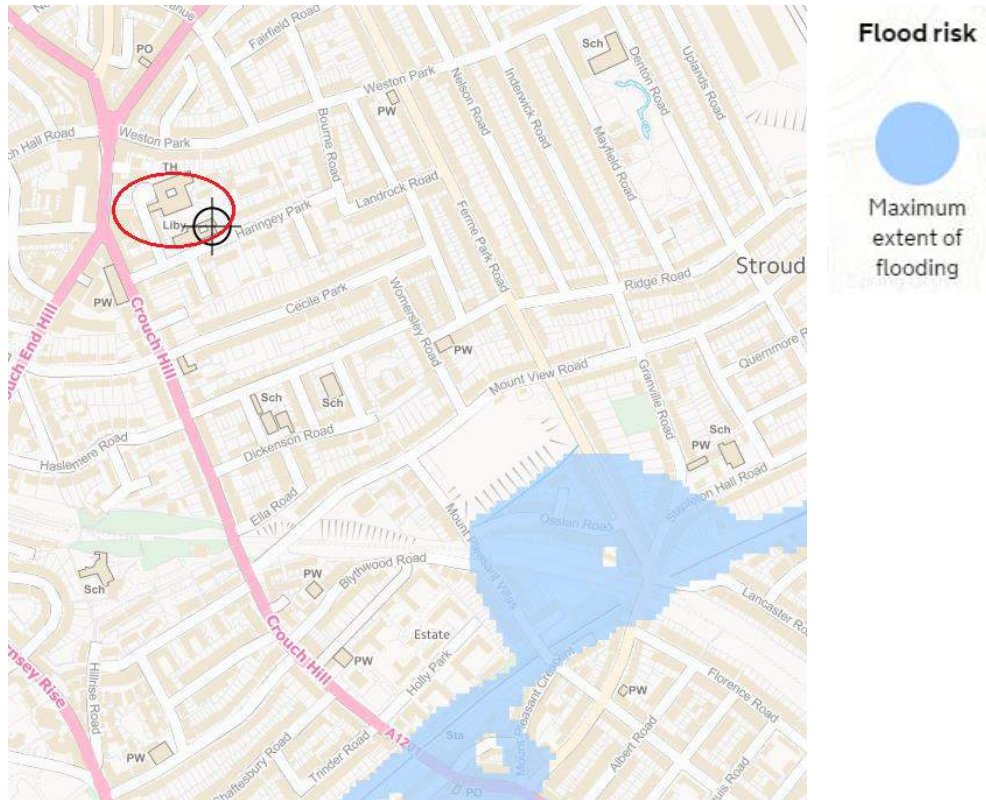


Figure 4.2 www.gov.uk long term flood risk maps

Flood risk from this source is therefore considered **low**.

Critical Drainage Areas (CDAs)

Haringey Council - Strategic Flood Risk Assessment - February 2015 has guidance on Critical Drainage Areas (CDAs):

The LB of Haringey SWMP completed an analysis of the number of properties at risk of flooding for the 1 in 100 year rainfall event and reviewed the potential number of properties with surface water flooding of a depth greater than 0.03m. A review of the numbers of properties affected coupled with local knowledge of the study area identified 9 Critical Drainage Areas.

The figure below is an extract from the SFRA which shows the proposed site lies in an area designated as critical drainage.

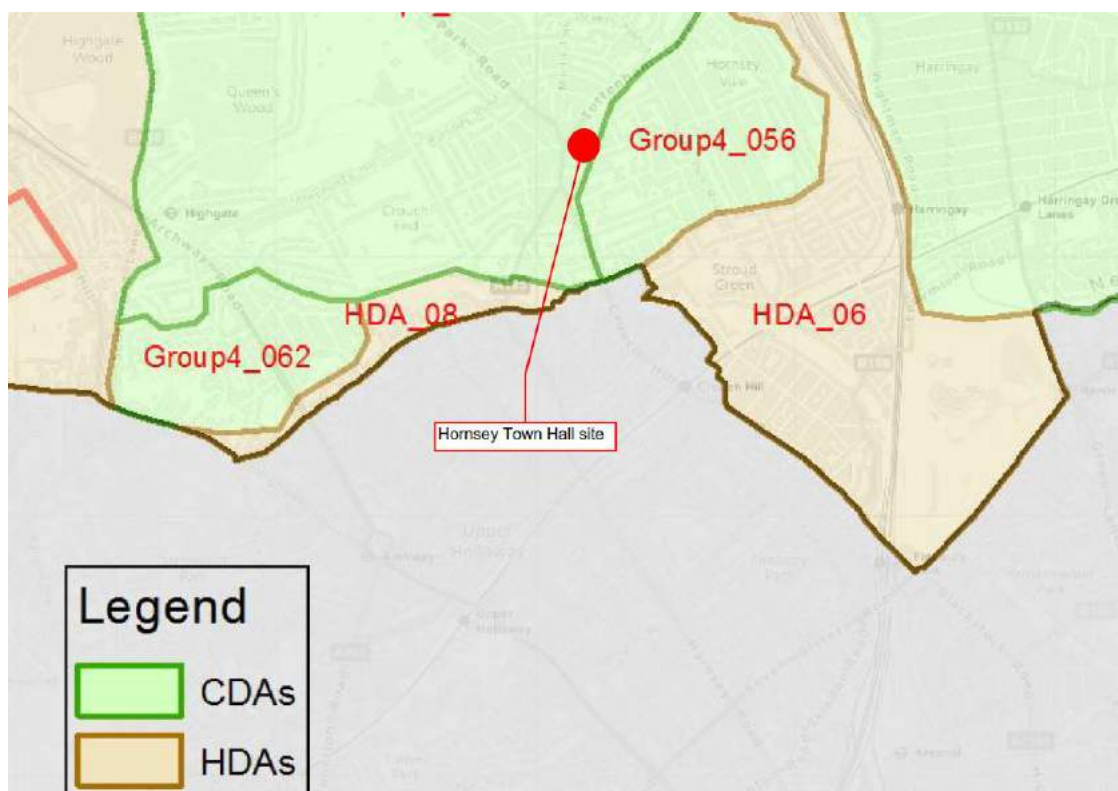


Figure 4.3 Extract from EA Product 4 data – Historic Flooding

A critical drainage area is defined in Drain London Tier 2 Technical Specification as “a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer and/or river) often cause flooding in a Flood Risk Area during severe weather thereby affecting people, property or local infrastructure.”

As noted with the SFA, Haringey should be aware of these CDAs when considering planning applications, where development is proposed, any planning application should be supported by an appropriate flood risk assessment.

The SFRA indicates that there have been less than five recorded flood events as a result of surcharging of the sewer network within the postcode area of the site between August 1997 and August 2007.

4.1.7 Historic flooding

The SFRA notes the following with regards to flooding in Haringey:

Since the completion of the SFRA Level 1 (2008) and the SWMP (2012), incidents of flooding were reported in September 2011, due to heavy rainfall at Stanhope Road, Crouch End. Flooding also impacted Coolhurst Road, Priory Gardens and Park Road, all located in Crouch End, and Muswell Hill Road, in Muswell Hill.¹⁸ In April 2012, flooding occurred on High Road Tottenham. Anecdotal evidence suggests that this was due to blocked drains in the area.¹⁹

The LB of Haringey SWMP collated data from Thames Water with regard to the mechanisms of sewer flooding. The data provided was at a high level, where incidents of sewer related flooding were reported at a broad scale. Locations of sewer flooding were identified using a four digit post code e.g. N15 4. Data showed that the majority of the incidents of sewer flooding were located in the south of the borough, around southeast Tottenham and Crouch End extending through to Highgate and Muswell Hill. Southeast Tottenham is located at the low point of the catchment, which drains into the River Lee. Restricted free flow, from surface water sewer outfalls, when the river level is higher than the soffit of the sewer outfalls would result in surcharging/ backing up of the sewer system. This could provide an explanation for the number of recorded incidents of sewer flooding incidents in this area. It should also be noted that the number of incidents were recorded at postcode level. Further details are provided within Table 3.5 of the LB of Haringey SWMP. Any proposed development located within the postcodes described in the LB of Haringey SWMP should demonstrate how, through the use of SuDS the amount of surface water entering the sewer systems is managed. It is particularly important to show how any excess surface water resulting from an increase in hard surface areas as part of the development is to be managed.

4.2 Flood risk summary

From the Environment Agency flood maps, shows the site to lie within Flood Zone 1, with a low risk of flooding from fluvial sources. Pluvial flooding is also considered very low for the site, while flooding from groundwater, sewers and artificial sources is considered low. The site is located within a critical drainage area, and as such this FRA has been produced to show how the redevelopment site with a new sustainable drainage system will minimise surface water runoff volumes and flows thereby bringing a net positive solution to the site and surrounding areas.

5 PLANNING CONTEXT

5.1 Application of planning policy

NPPF includes measures specifically dealing with development planning and flood risk using a sequential characterisation of risk based on planning zones and the Environment Agency Flood Map. The main study requirement is to identify the flood zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

Within NPPF and PPG the guidance on flood risk for each flood zone has a list of appropriate land uses dependent on vulnerability to flooding.

5.2 Land use vulnerability

From the NPPF and PPG guidance, a “Less Vulnerable” land use could be appropriate to Flood Zone 3a (High Probability of flooding at higher than 1 in 100 annual probability) with the “More Vulnerable” use only permitted if the exception test is passed. For a “More Vulnerable” class, development on this site could be appropriate within Flood Zone 2 (Medium Probability of flooding at less than 1 in 100 but higher than 1 in 1,000 annual probabilities).

In applying the sequential test, reference is made to the following table (reproduced from Table 3 contained within PPG).

Table 5.1 Flood risk vulnerability and flood zone ‘compatibility’

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

The proposed development can be described as ‘residential’ which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be ‘More Vulnerable’. There will be no change in vulnerability as a result of the development since the previous land use at the site is also considered to be ‘More Vulnerable’. Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that ‘More Vulnerable’ development is appropriate within Flood Zone 1.

6 SITE RUNOFF

This section of the FRA provides details of the existing site Greenfield runoff rates (Section 6.1) and post development site runoff (Section 6.2). Outline calculations for the use of Sustainable Urban Drainage Systems (SUDS) to reduce flows to the approved Greenfield rate are provided in Section 7.

6.1 EXISTING Site

6.1.1 Drainage Catchment Area

In terms of site hydrology, the existing site topographical survey (Figure 3) suggests the area can be considered to consist of one catchment which drains towards the north-eastern boundary. The catchment boundary is assumed to be provided by the site boundary.

6.1.2 Equivalent GREENFIELD Site Peak Flows and Volumes – FEH statistical Method

The existing run-off for the original site has been calculated using FEH statistical Method taking into account the sites characteristics SAAR 677, SPR HOST of 40.3 and area of 1.35ha the Greenfield run-off rate has been calculated for the site and included as **Appendix A**.

As extracted from **Appendix A**, the runoff rates and volumes are as follows:

Return Period	Greenfield Runoff Estimate (L/s)	Storage Volume (m3)
1 in 1 year	4.83	201.6
1 in 30 year	13.06	515.5
1 in 100 year	18.12	748.5
1 in 100 year + 30%	23.5	982.7

6.2 DEVELOPED Site Runoff

For most developments, the Local Planning Authority and Environment Agency require no increase in peak flows, or for flows to be minimised or sometimes reduced to the Greenfield rate. This requires the existing and developed site drainage peak flows to be compared to the restricted Greenfield Qbar rate of 5.68 L/s which is detailed below.

6.2.1 Percentage Runoff

The comparison of pre and post development runoff requires assumptions to be made regarding the percentage of impermeable land cover.

For the development plan (**Figure 4**) the impermeable areas cover a large portion of the site 10,014m² (see point 2.2) site which the Wallingford method predicts a 95% percentage runoff based on 5% losses to depression storage, interception etc., see **Appendix B**.

6.2.2 DEVELOPED Site Peak Flows

The peak flows have been calculated for the proposed development. The flows for the various duration storms are included as **Appendix C** with critical runoff rates and volumes included in the table below.

Return Period	Runoff Rate (L/s) Catchment A + B + C + D	Storage Volume (m3) Catchment A + B + C + D	Flooded Volume (m3) Catchment A + B + C + D
1 in 1 year	4.8	174.0	
1 in 30 year	13.0	429.6	
1 in 100 year	18.1	629.1	125.2
1 in 100 + 30% year	23.5	797.1	293.1

The proposed site runoffs for the various return periods have been controlled to ensure discharge does not exceed the calculated Greenfield runoff for the development (**Appendix A**). The resultant flow restrictions result in storage requirements for the total site both below (events up to the 30yr) and also surface flooding (**Appendix C**).

The appropriate SUDS options available to reduce these peak flow rates and volumes are considered in Section 7.

6.3 Off-site discharge options

An order of preference exists for drainage receptors. Infiltration drainage should be used where possible. Where this is not possible, or does not provide sufficient capacity, attenuated discharge to watercourses should be sought. Only where neither of these two options is available should discharge to sewers be considered, subject to approvals from the sewerage undertaker.

For this site, the proposal will be to include SuDS in the form of attenuation tank and porous car parking areas which will collect the water from the site and restrict flows off site to the equivalent Greenfield rate as noted under section 6.1 above. **Appendix B** shows the drainage strategy for the site and how these SuDS structures will link together providing the necessary storage on the site.

6.3.1 Climate Change - Increased rainfall intensity

For the surface water runoff assessment, an allowance of an increase in the rainfall intensity values by 30% have been included to account for the impact of climate change in accordance with PPG. This increase will apply towards the end of design lifetime of the Industrial spaces, and will be accommodated for in the drainage of the site.

6.3.2 Infiltration

Further intrusive investigation should be carried out to assess whether discharge to the ground, or infiltration, may be a possible drainage solution for this site; however, the effectiveness of infiltration is completely dependent on the physical conditions at the site. Potential obstacles include:

Local Variations in Permeability Preventing Infiltration - This testing should be undertaken in line with the guidance contained in BRE 365 or CIRIA R156 and the results used to firstly check feasibility and secondly to size the necessary infiltration features.

Shallow Groundwater Table - For infiltration drainage devices Building Regulation approved document H2 states that these, "should not be built in ground where the water table reaches the bottom of the device at any time of the year".

Source Protection Zones - As discussed in Section 2, the site is not located in a source protection zone. The expected local ground conditions as noted under section 2.4 could result in infiltration but this will need to be assessed once a full geotechnical study for the site is completed at detailed design stage.

6.3.3 Discharge to watercourse

As noted under point 2.5 above, the nearest watercourse lies to the north east of the site but to connect to this watercourse will require crossing 3rd party land outside of the ownership and as such is not a viable option.

6.3.4 Surface water drainage

As noted above the proposal will be to include SuDS features on site to accommodate the necessary additional storage. The outfall from the storage tank will connect to the nearest public storm water network, see **Appendix B** and point 7.1 above.

7 SUSTAINABLE DRAINAGE

7.1 Principles of Sustainable Urban Drainage Systems

To reduce storm runoff from impermeable drainage areas a range of techniques known as Sustainable Urban Drainage Systems (SUDS) can be utilised. These aim to reduce peak flows, storm volumes and improve water quality. Many Local Authorities and the Environment Agency encourage the use of such SUDS techniques in drainage designs for new or redeveloped urban areas. SUDS are physical structures and fall into three broad groups;

- Source Control Techniques. These aim to reduce the quantity of runoff at source and include porous pavements, infiltration trenches, soakaways, rainwater harvesting or green roofs,
- Permeable Conveyance Systems which slow the velocity of the runoff to allow settlement filtering and infiltration, such as filter drains, French drains or swales, and
- Passive Treatment Systems which are end of pipe systems and provide treatment to collected surface water before discharge into a watercourse and include basins, ponds and wetlands.

There may be the opportunity to reduce the volume of site runoff by incorporating Sustainable Urban Drainage Systems (SUDS) into the drainage designs of this scheme to reduce any adverse impacts in terms of both storm volume and water quality and these are considered below.

7.2 Current surface water runoff

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage. This section considers the existing drainage system at the application site and potential impacts resulting from the proposed re-development.

The current site is a previously developed site. The proposed redevelopment will result in an impermeable coverage of **81% or 10,014m³ (see table 2.2 above)** of the total site area. This is a reduction on the existing site.

Haringey SFRA recommendation on mitigation options:

There are various SuDS techniques available, many of which are applicable in different situations. SuDS can be considered as a component of Green Infrastructure provision. Green Infrastructure affords the opportunity to improve the local environment through the implementation of green spaces, in particular within urban areas. Current best practice on the inclusion of SuDS facilities in Green Infrastructure space is generally considered to be the CIRIA SuDS manual (CIRIA, 2007); it provides a comprehensive overview of the techniques. Examples of these are listed below:

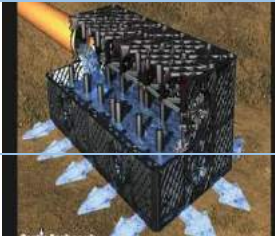
- **Permeable Pavements** such as permeable concrete blocks, crushed stone and porous asphalt will allow water to infiltrate directly into the subsoil before soaking into the ground. These features have potential to reduce the effect of urbanisation on runoff rates and volumes. Careful monitoring or maintenance is required to ensure they do not become blinded with fine silt material, which may reduce their permeability.

- **Green Roofs** can vary in type from Roof Gardens, Roof Terraces, Green Roofs and Green Walls. This SuDS technique utilises plants and their substrate to provide temporary storage of rainfall and minimise runoff from roof areas. Green roofs not only store water temporarily, they can reduce the volume of runoff through water use in the form of uptake by plants and subsequent evapotranspiration. Some types of green roof, and green walls in particular, require regular irrigation and can become net consumers of water (rather than net producers of runoff). Green roofs also offer additional biodiversity and in some cases amenity benefit. Green roofs can be used to aid climate control in buildings, insulating in the winter and cooling in the summer.
- **Rainwater Harvesting** such as the installation of water butts or more significant storage media aid in the management of runoff. By capturing all or part of the rainfall hitting roofs and hard surfaces of a development and storing the water for use on site either internally or externally for the replacement of potable water sources. Rainwater harvesting systems have significant potential to manage runoff and increase water security and are normally designed for annual average rainfall or to capture enough water for a specific purpose. By over designing these systems to have the capacity to store extreme rainfall events they are able to provide not only social and economic benefit in normal conditions but also flood generating conditions. It is important to note that such systems should be designed in such a manner as to ensure that this additional storage is available (e.g. empty) at the start of the event. This will also ensure that there is regular turnover and use of the stored water.
- **Infiltration devices** drain water directly into the ground and allow it to soakaway into the local geology. The most common example of this type of feature is an underground soakaway chamber that has capacity to hold water and, through either porous or perforated walls, allows water to infiltrate into the surrounding soils and geology. Devices may also include surface features such as ponds, vegetated rills or swales that can be used to convey runoff across the ground surface but allow water to infiltrate as it passes. Such features can be integrated into and form part of the landscaped areas. Vegetated options can act as filter strips by slowing runoff velocities and improve water quality by filtering out sediment and other pollutants. Where sites directly overlay impermeable soil types (such as where London Clay is found very close to the surface, see Figure 5-7 for further discussion of LB of Haringey soil types), the rate of infiltration can be problematic. Similarly in areas of superficial deposits, extensive long term increase in infiltration may increase the water table height of the perched water table, increasing the occurrence of ground water emergence. However this may also take the form of raising the baseflow of groundwater-fed watercourses which may provide potential enhancements to water ecology. Infiltration may not be possible in areas of contaminated land or land found to have or suspected to have issues related to soil pollution.
- **Rain gardens and detention basins / ponds** enhance flood storage capacity by providing temporary storage of runoff through the creation of landscape features within a site (which can often provide opportunities for the creation of wildlife habitats). These types of features range in both the scale of the storage they provide and the length of time they detain the stored volume. Rain Gardens typically detain the smallest volumes of water for the shortest period of time with basins and ponds providing larger storage volumes and detaining the storage volume for longer periods. All these types of features can be fed by swales, filter drains or piped systems.
- **Below ground storage** works in a similar way to rain gardens, detention basins / ponds (generically above ground storage options) outlined above. The benefit of below ground storage is that it reduces land take as the land above can be used for parking or recreational space. The disadvantage is that maintenance can be more difficult and little environmental or amenity value is provided.

7.3 *Assessment of Surface Water Management Options*

For sustainable management of surface water run-off from a new development, the use of SuDS is recommended. Table 7.1 provides a comparison of the different kinds of SuDS systems and their suitability for use at the development site.

Table 7.1 SuDS Assessment

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for Use at Site
Retention	Balancing Pond		Provides both storm water attenuation and treatment. Run-off from each rain event is detained and treated in the pool. The retention time promotes pollutant removal through sedimentation.	Good removal of pollutants, can be used where groundwater is vulnerable, good community acceptability, high ecological, and amenity benefits.	No reduction in run-off volume, land take may limit use in high density sites.	✗ Water treatment is not necessary for roof drainage and there is limited area available for areas of pond storage.
	Sub-surface Storage		Oversized pipes, tank systems and modular geocellular systems that can be used to create a below ground storage structure.	Modular and flexible, dual usage (infiltration/storage, high void ratios), can be installed beneath trafficked and soft landscaped areas.	No water quality treatment.	✓ Sub-surface storage can be used; however, consideration should be given to groundwater levels prior to design, as crates may need to be sealed with an impermeable membrane and fixed in place to prevent flotation.
Wetland	Shallow wetland		Wetlands provide storm water attenuation and treatment. They comprise shallow ponds and marshy areas, covered in aquatic vegetation. Wetlands detain flows for an extended period to allow sediments to settle and to remove contaminants. They can provide significant ecological benefits.	Good pollutant removal and if lined can be used where groundwater is vulnerable. Good community acceptability, ecological and amenity benefits.	Land take is high, requires base flow, little reduction in run-off volume, not suitable for steep sites.	✗ Wetlands areas would suit the wet soils at the site, but are not possible due to the high land take required.
	Extended detention wetland					
	Pond wetland					
	Pocket wetland					
	Submerged gravel wetland					
	Wetland channel					
Infiltration	Infiltration trench		Surface water run-off can be discharged directly to ground for infiltration by soakaways, basins, or trenches. A prerequisite is that both groundwater and ground conditions	Reduces the volume of run-off, effective at pollutant removal, contributes to groundwater recharge,	Requires appropriate pre-treatment, basins require a large flat area, offset from foundations.	✗ The existing soils on site are not suitable for use of infiltration systems.
	Infiltration basin					

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for Use at Site
	Soakaway		are appropriate to receive the quality and quantity of water generated.	simple and cost-effective, easy performance observation.		
	Porous paving		Block or porous paving allows run-off to infiltrate through to sub base layer. Water can then be infiltrated into ground or conveyed into storage or drainage systems.	Reduces the volume of run-off and if designed for infiltration contributes towards groundwater recharge. Easy to install and retrofit. Simple to manage. If lined can be used where groundwater is sensitive.	Not suitable for heavily trafficked areas or adoptable roads. Requires regular sweeping to prevent clogging with dirt.	✓ The proposed car parking areas can be used as a porous pavement with the subbase attenuating peak runoff
	Permeable paving					
Filtration	Surface sand filter		Structures designed to treat surface water run-off through filtration using a sand bed filter medium. The filters can be designed with or without infiltration. Temporary storage of run-off is achieved through ponding above the filter layer. They are used where particularly high pollutant removal is required.	Flexibility of design, efficient in removing pollutants, suitable for retrofits and in tightly constrained urban locations.	Not for high sediment content, detention times can support algae growth, minimum hydraulic head of 1.2m required, possible odour problems, high capital and maintenance cost.	✗ There is no requirement for high pollution reduction at this site
	Sub-surface sand filter					
	Perimeter sand filter					
	Bioretention/filter swale		Vegetated strips of land designed to accept run-off as overland sheet flow between a hard-surfaced area and a receiving system.	Landscaping features, effective in removing pollutants, flexible layout to fit into landscape, suited for highly impervious areas, good retrofit, capability, effective pre-treatment option.	Requires landscaping and management, large land required, not suitable for steep sites; no significant attenuation or reduction of flows.	✗ No requirement for high pollution reduction; large land areas not available.

SUDS Group	Technique	Image	Description	Advantages	Disadvantages	Suitable for Use at Site
	Filter trench/drain		Shallow excavations filled with rubble or stone that create temporary subsurface storage for filtration of storm water run-off. Receive lateral inflow from an adjacent impermeable surface.	Hydraulic benefits achieved with filter trenches, trenches can be incorporated into site landscaping and fit well beside roads and car parks.	High clogging potential without effective pre-treatment, limited to small catchments, high cost of replacing filter material.	✓ To avoid linear drainage channels, parking areas will be sloped to gravel strips.
Detention	Detention basin		Surface storage basins that provide flow control through attenuation. Normally dry and in certain situations the land may also function as a recreational facility	Cater for a wide range of rainfall events, can be used where groundwater is vulnerable, potential for dual land use, easy to maintain.	Land take, little reduction in run-off volume, detention depths constrained by levels.	✗ There is limited area available for areas of detention basin storage.
	Enhanced dry swale		Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate.	Incorporate into landscaping, good removal of pollutants, reduces run-off rates and volumes, low cost.	Not suitable for steep areas, significant land take, not suitable in areas with roadside parking.	✗ Unlikely to suit site with the proposed levels and topography of the site.
	Enhanced wet swale					
Conveyance	Conveyance swales		Formal linear drainage features in which surface water can be stored or conveyed. They can be incorporated with water features such as ponds or waterfalls where appropriate.	Negate the need for underground pipework. Can provide some attenuation. Possible reduction in run-off volume via plant uptake and infiltration.	Potential trip/wheel hazard, disable access issues.	✗ Could be used where conveyance is required, but the lack of formal outside spaces at the site makes the aesthetic aspects unnecessary.
	Rills					
Source control	Green/brown/blue roof		Multi-layered system that covers the roof of a building with vegetation cover/landscaping over a drainage layer. Designed to intercept and retain precipitation, reducing the volume of run-off and attenuating peak flows.	Mimics greenfield state of building footprint for high density developments, good removal of pollutants, ecological benefits, insulates buildings, sound absorption.	Additional weight, not appropriate for steep roofs, maintenance of roof vegetation.	✓ New roof areas will look to incorporate either Green or Blue roofs

7.4 Summary

These preliminary results are based on the proposed development plans provided (Figure 4) and hence the results are intended to indicate the magnitude and direction of any change in storm runoff rather than for design purposes. The calculations will be reassessed at the detailed design stage when the precise details of the storm water system will be available.

The volume of water falling onto the developed site during a range of storm periods has been calculated (**Appendix D**). Outline storage calculations and for these storm events have been included as **Appendix D** to this report.

7.5 Appropriate SUDS that could be used at the site

The above review on the suitability of SUDS suggests that the following SUDS techniques will be suitable for any future development at this site and have been shown on the drainage strategy which has been completed and included as **Appendix C**.

- Porous Pavements for car parking areas only
- Unlined Storage Aquacell Tanks – *subject to ground conditions*.
- Porous subbase storage
- Gravel strips
- Green & Blue roofs

The various SuDS options have been discussed with the Local Drainage Officer and the outline suggestions above for inclusion in the drainage strategy for the site have been agreed.

7.5.1 Maintenance of SUDS

Porous Pavements

The infiltration rate of a permeable pavement will decrease due to the build-up of detritus in the jointing aggregate but stabilize with age. However, evidence suggests that infiltration rates always remain significantly higher than rainfall intensity, so, even without maintenance, there should be sufficient infiltration to accommodate rainfall events. If required though, the surface can be maintained by sweeping occasionally but this is no greater than is normally undertaken on traditional pavements. This will be undertaken by the various owners of the units.

Unlike a conventional drainage system, a permeable pavement can be quickly visually assessed, particularly after a rain event as water ponding on the surface will indicate localized clogged joints that may require remedial maintenance to restore the permeability. If the joints do clog completely, which happens infrequently, the owner of the units can rehabilitate the isolated areas by either:

- removing the clogged jointing aggregate
- hand brooms,
- water blasting or a road sweeper.

Cellular crates

Maintenance access for all flow control designs, it is sensible to incorporate access (via a manhole or similar) to the location of the pipe entry, orifice or vortex control. This will enable easy removal of any blockage. The orifice itself may be protected by a debris screen.

Build-Up:

If debris enters the Cellular crates, the still water within the unit will have insufficient velocity to keep the particles moving. This can lead to any of the following undesirable consequences:

- Debris will be deposited in the Cellular crates around the pipe entry.
- Some of the void intended for water storage will begin to fill up.
- Organic matter may start to decay.
- Noxious gases may build up.

Prevention:

To prevent this, a silt trap is planned for incorporation into the pipework at the inlet to the tank. To be effective, there must be regular maintenance of the silt trap to ensure this is regular cleaning. Otherwise, if the trap is full, any additional debris will simply pass into the tank.

7.6 *Pollution Risk*

Reference is made to **Table 26.2 from CIRIA SuDS manual 2015** to ascertain the pollution hazard indicia for the site. This site which will have commercial activities has been assessed as follows:

Table 7.2 Extract of Table 26.2 from CIRIA SuDS manual 2015

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydro-carbons
Commercial yard and delivery areas	Medium	0.7	0.6	0.7

Reference is made to **Table 26.3 from CIRIA SuDS manual 2015** to obtain the SuDS mitigation indices for proposed SuDS incorporated in the design, reference point 7.5 above and **Appendix B**.

Table 7.3 Extract of Table 26.3 from CIRIA SuDS manual 2015

<u>Access Road and Parking Areas:</u> Type of SuDS component	Total suspended solids (TSS)	Metals	Hydro-carbons
Porous Carpark	0.7	0.6	0.7
Total	0.7	0.6	0.7

The totals for the proposed SuDS solutions is higher than the pollution hazard, therefore the SuDS proposed meet the requirements to act as satisfactory pollution control.

8 CONCLUSIONS

This flood risk assessment complies with the NPPF and PPG demonstrates that flood risk from all sources has been considered in the proposed developments. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

The proposed development site lies in an area designated by the Environment Agency as Flood Zone 1, and is outlined to have a chance of flooding of less than 1 in 1000 (<0.1%) in any year.

The FEH runoff method has been used to calculate the Qbar flow from the existing site. This has been calculated as being 5.68 L/s.

The proposed redevelopment will reduce the extent of impermeable coverage of the site. The discharge from the developed site will be restricted to equivalent Greenfield runoff rates for various return periods. The peak flows from the developed site have been assessed against SUDS Hierarchy with porous paving, subbase storage or tanks, gravel strips and Green/Blue roofs shown to be appropriate for use on this site. A drainage strategy has been completed and included as **Appendix B** to this report which shows the possible drainage solution. Drainage calculations for the proposed in drainage strategy have been included as **Appendix C**.

This flood risk assessment has concluded that:

- the redeveloped site is located within Flood Zone 1, and as such is at a low risk of flooding from fluvial sources.
- the site is far enough inland not to be at risk of any tidal flooding event.
- flood risk from surface water is considered low for the site following redevelopment.
- flood risk from other sources – groundwater, sewers, reservoirs and artificial sources – is demonstrated to be low.
- the development will have no impact on other forms of flooding.
- overall, taking into account the above points, the development of the site should **not be precluded** on flood risk grounds.

According to PPG proposed “residential” use development is classified as “More vulnerable” development which is considered appropriate in Zone 1.

Appendix A

Existing Site FEH Calculations (Runoff and Storage estimation)

Calculated by: Ismail Laher
Site name: Town Hall
Site location: Hornsey

Site coordinates
Latitude: 51.57873° N
Longitude: 0.1211° W

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Reference: 5996599
Date: 2017-07-12T16:35:22

Methodology

FEH Statistical

Site characteristics

Total site area (ha)	1.35
----------------------	------

Methodology

Qmed estimation method	Specify QMed manually
BFI and SPR estimation method	Specify BFI manually
HOST class	N/A
BFI / BFIHOST	0.402
Qmed (l/s)	5
Qbar / Qmed Conversion Factor	1.14

Hydrological characteristics

	Default	Edited
SAAR (mm)	649	677
Hydrological region	6	6
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consents are usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements

(3) Is $SPR/SPRHOST \leq 0.3$?

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	NaN	5.68
1 in 1 year (l/s)	NaN	4.83
1 in 30 years (l/s)	NaN	13.06
1 in 100 years (l/s)	NaN	18.12

Bradbrook Consulting		Page 1
1st Floor Neville House 55 Eden Street Kingston KT1 1BW		
Date 12/07/2017 16:06 File	Designed by i_laher Checked by	
XP Solutions		Source Control 2015.1
<u>FEH Mean Annual Flood</u> Input Site Location SAAR (mm) 677 SPRHOST 40.300 FARL 1.000 Area (ha) 1.350 URBEXT (1990) 0.5000 BFIHOST 0.402 Results QMED Rural (l/s) 2.9 QMED Urban (l/s) 5.0		
©1982-2015 XP Solutions		

Calculated by: Ismail Laher

Site name: Town Hall

Site location: Haringey

Site coordinates

Latitude: 51.57878° N

Longitude: 0.1218° W

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Reference: 5996608

Date: 2017-07-12T16:47:05

Methodology

FEH Statistical

Site characteristics

Total site area (ha)	1.35
Significant public open space (ha)	0
Area positively drained (ha)	1.35
Pervious area contribution (%)	30
Impermeable area (ha)	1.09
Percentage of drained area that is impermeable (%)	81
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	1.35
Net impermeable area for storage volume design (ha)	4.23

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.4	1.4
Urban creep allowance factor	1.1	1.1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qmed estimation method Specify Qmed manually

BFI & SPR estimation method Specify BFI and SPR manually

	Default	Edited
Qmed (l/s)	--	5
Qbar / Qmed Conversion Factor	1.136	1.136
HOST class	---	N/A
BFI / BFIHOST	0.402	0.402
SPR / SPRHOST	40.3	40.3

Hydrology

	Default	Edited
SAAR (mm)	649	677
M5-60 Rainfall Depth (mm)	20	20
'r' Ratio M5-60/M5-2 day	0.4	0.4
Rainfall 100 yrs 6 hrs	63	
Rainfall 100 yrs 12 hrs	98.56	
FEH/FSR conversion factor	1.28	1.28
Hydrological region	6	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.62	1.62
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	--	5.68
Qbar net site area (l/s)	--	5.68
1 in 1 year (l/s)	--	5
1 in 30 years (l/s)	--	5.7
1 in 100 years (l/s)	--	5.7

Estimated storage volumes

	Default	Edited
Interception storage (m³)	--	44
Attenuation storage (m³)	--	5265
Long term storage (m³)	--	0
Treatment storage (m³)	--	131
Total storage (excluding treatment) (m³)	--	5309

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Summary of Results for **1 year Return Period**

Half Drain Time : 364 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.432	0.432	0.0	4.7	4.8	92.3	O K
30 min Summer	52.534	0.534	0.0	4.7	4.8	114.2	O K
60 min Summer	52.653	0.653	0.0	4.7	4.8	139.5	O K
120 min Summer	52.777	0.777	0.0	4.7	4.8	166.1	O K
180 min Summer	52.843	0.843	0.0	4.7	4.8	180.1	O K
240 min Summer	52.881	0.881	0.0	4.7	4.8	188.2	O K
360 min Summer	52.915	0.915	0.0	4.7	4.8	195.7	O K
480 min Summer	52.932	0.932	0.0	4.7	4.8	199.3	O K
600 min Summer	52.940	0.940	0.0	4.7	4.8	201.0	O K
720 min Summer	52.943	0.943	0.0	4.7	4.8	201.6	O K
960 min Summer	52.930	0.930	0.0	4.7	4.8	198.7	O K
1440 min Summer	52.888	0.888	0.0	4.7	4.8	189.8	O K
2160 min Summer	52.812	0.812	0.0	4.7	4.8	173.6	O K
2880 min Summer	52.729	0.729	0.0	4.7	4.8	155.9	O K
4320 min Summer	52.491	0.491	0.0	4.7	4.8	104.9	O K
5760 min Summer	52.330	0.330	0.0	4.7	4.8	70.6	O K
7200 min Summer	52.231	0.231	0.0	4.7	4.7	49.3	O K
8640 min Summer	52.171	0.171	0.0	4.5	4.6	36.6	O K
10080 min Summer	52.136	0.136	0.0	4.3	4.3	29.1	O K
15 min Winter	52.432	0.432	0.0	4.7	4.8	92.4	O K
30 min Winter	52.534	0.534	0.0	4.7	4.8	114.2	O K
60 min Winter	52.653	0.653	0.0	4.7	4.8	139.6	O K
120 min Winter	52.778	0.778	0.0	4.7	4.8	166.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.705	0.0	94.9	18
30 min Summer	19.312	0.0	119.5	33
60 min Summer	12.146	0.0	151.2	62
120 min Summer	7.639	0.0	190.3	122
180 min Summer	5.824	0.0	217.7	182
240 min Summer	4.805	0.0	239.5	240
360 min Summer	3.663	0.0	273.9	332
480 min Summer	3.022	0.0	301.2	392
600 min Summer	2.603	0.0	324.3	458
720 min Summer	2.304	0.0	344.5	522
960 min Summer	1.885	0.0	375.8	664
1440 min Summer	1.421	0.0	424.8	940
2160 min Summer	1.071	0.0	481.3	1364
2880 min Summer	0.877	0.0	525.1	1764
4320 min Summer	0.645	0.0	579.2	2504
5760 min Summer	0.519	0.0	621.8	3168
7200 min Summer	0.438	0.0	656.3	3824
8640 min Summer	0.382	0.0	685.9	4496
10080 min Summer	0.340	0.0	711.8	5144
15 min Winter	30.705	0.0	94.9	18
30 min Winter	19.312	0.0	119.5	33
60 min Winter	12.146	0.0	151.2	62
120 min Winter	7.639	0.0	190.3	120

See existing greenfield run-off for 1 year event (4.83L/s)

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Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	52.845	0.845	0.0	4.7	4.8	180.6	O K
240 min Winter	52.885	0.885	0.0	4.7	4.8	189.1	O K
360 min Winter	52.923	0.923	0.0	4.7	4.8	197.3	O K
480 min Winter	52.932	0.932	0.0	4.7	4.8	199.2	O K
600 min Winter	52.937	0.937	0.0	4.7	4.8	200.2	O K
720 min Winter	52.934	0.934	0.0	4.7	4.8	199.7	O K
960 min Winter	52.905	0.905	0.0	4.7	4.8	193.5	O K
1440 min Winter	52.825	0.825	0.0	4.7	4.8	176.4	O K
2160 min Winter	52.683	0.683	0.0	4.7	4.8	145.9	O K
2880 min Winter	52.500	0.500	0.0	4.7	4.8	106.8	O K
4320 min Winter	52.243	0.243	0.0	4.7	4.8	52.0	O K
5760 min Winter	52.138	0.138	0.0	4.3	4.4	29.4	O K
7200 min Winter	52.110	0.110	0.0	3.8	3.8	23.4	O K
8640 min Winter	52.096	0.096	0.0	3.3	3.3	20.5	O K
10080 min Winter	52.087	0.087	0.0	2.9	3.0	18.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	5.824	0.0	217.7	178
240 min Winter	4.805	0.0	239.5	234
360 min Winter	3.663	0.0	273.9	342
480 min Winter	3.022	0.0	301.2	434
600 min Winter	2.603	0.0	324.3	472
720 min Winter	2.304	0.0	344.5	550
960 min Winter	1.885	0.0	375.9	706
1440 min Winter	1.421	0.0	424.8	1012
2160 min Winter	1.071	0.0	481.3	1468
2880 min Winter	0.877	0.0	525.1	1820
4320 min Winter	0.645	0.0	579.2	2464
5760 min Winter	0.519	0.0	621.8	3056
7200 min Winter	0.438	0.0	656.3	3680
8640 min Winter	0.382	0.0	686.0	4408
10080 min Winter	0.340	0.0	711.8	5144

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Rainfall Details

Rainfall Model	FEH	D3 (1km) 0.243	Cv (Winter) 0.925
Return Period (years)	1	E (1km) 0.331	Shortest Storm (mins) 15
Site Location		F (1km) 2.497	Longest Storm (mins) 10080
C (1km)	-0.026	Summer Storms Yes	Climate Change % +0
D1 (1km)	0.331	Winter Storms Yes	
D2 (1km)	0.303	Cv (Summer) 0.925	

Time Area Diagram

Total Area (ha) 1.350

Time (mins) Area
From: To: (ha)

0 4 1.350

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Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	225.0	225.0	1.100	0.0	285.0
1.000	225.0	285.0			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0103-4800-1000-4800
Design Head (m) 1.000
Design Flow (l/s) 4.8
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 103
Invert Level (m) 52.000
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	4.8	Kick-Flo®	0.636	3.9
Flush-Flo™	0.295	4.7	Mean Flow over Head Range	-	4.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.5	1.200	5.2	3.000	7.9	7.000	11.9
0.200	4.6	1.400	5.6	3.500	8.5	7.500	12.3
0.300	4.7	1.600	5.9	4.000	9.1	8.000	12.7
0.400	4.7	1.800	6.3	4.500	9.6	8.500	13.0
0.500	4.5	2.000	6.6	5.000	10.1	9.000	13.4
0.600	4.1	2.200	6.9	5.500	10.6	9.500	13.7
0.800	4.3	2.400	7.2	6.000	11.0		
1.000	4.8	2.600	7.4	6.500	11.5		

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XP Solutions	Source Control 2015.1	

Summary of Results for 30 year Return Period

Half Drain Time : 332 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.589	0.589	0.1	13.0	13.1	322.5	O K
30 min Summer	52.687	0.687	0.1	13.0	13.1	376.1	O K
60 min Summer	52.790	0.790	0.1	13.0	13.1	432.3	O K
120 min Summer	52.884	0.884	0.1	13.0	13.1	483.6	O K
180 min Summer	52.923	0.923	0.1	13.0	13.1	505.3	O K
240 min Summer	52.939	0.939	0.1	13.0	13.1	513.8	O K
360 min Summer	52.938	0.938	0.1	13.0	13.1	513.3	O K
480 min Summer	52.929	0.929	0.1	13.0	13.1	508.3	O K
600 min Summer	52.915	0.915	0.1	13.0	13.1	500.9	O K
720 min Summer	52.900	0.900	0.1	13.0	13.1	492.3	O K
960 min Summer	52.854	0.854	0.1	13.0	13.1	467.5	O K
1440 min Summer	52.762	0.762	0.1	13.0	13.1	417.2	O K
2160 min Summer	52.612	0.612	0.1	13.0	13.1	334.8	O K
2880 min Summer	52.485	0.485	0.1	13.0	13.1	265.2	O K
4320 min Summer	52.290	0.290	0.1	13.0	13.1	158.7	O K
5760 min Summer	52.196	0.196	0.1	12.5	12.6	107.2	O K
7200 min Summer	52.162	0.162	0.1	11.3	11.4	88.4	O K
8640 min Summer	52.143	0.143	0.1	9.9	10.0	78.3	O K
10080 min Summer	52.130	0.130	0.1	8.8	8.9	71.3	O K
15 min Winter	52.589	0.589	0.1	13.0	13.1	322.5	O K
30 min Winter	52.687	0.687	0.1	13.0	13.1	376.1	O K
60 min Winter	52.790	0.790	0.1	13.0	13.1	432.3	O K
120 min Winter	52.884	0.884	0.1	13.0	13.1	483.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.337	0.0	326.6	19
30 min Summer	62.923	0.0	387.0	33
60 min Summer	37.233	0.0	462.7	62
120 min Summer	22.032	0.0	547.8	122
180 min Summer	16.209	0.0	604.7	182
240 min Summer	13.037	0.0	648.5	240
360 min Summer	9.591	0.0	715.8	316
480 min Summer	7.714	0.0	767.6	380
600 min Summer	6.515	0.0	810.4	444
720 min Summer	5.675	0.0	847.1	512
960 min Summer	4.528	0.0	901.0	652
1440 min Summer	3.294	0.0	982.5	926
2160 min Summer	2.396	0.0	1075.8	1320
2880 min Summer	1.912	0.0	1144.2	1676
4320 min Summer	1.357	0.0	1216.7	2336
5760 min Summer	1.064	0.0	1275.1	3000
7200 min Summer	0.881	0.0	1319.7	3680
8640 min Summer	0.755	0.0	1357.0	4408
10080 min Summer	0.663	0.0	1388.2	5136
15 min Winter	106.337	0.0	326.6	18
30 min Winter	62.923	0.0	387.0	33
60 min Winter	37.233	0.0	462.7	62
120 min Winter	22.032	0.0	547.8	120

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	52.925	0.925	0.1	13.0	13.1	506.3	O K
240 min Winter	52.942	0.942	0.1	13.0	13.1	515.7	O K
360 min Winter	52.942	0.942	0.1	13.0	13.1	515.5	O K
480 min Winter	52.924	0.924	0.1	13.0	13.1	505.4	O K
600 min Winter	52.905	0.905	0.1	13.0	13.1	495.1	O K
720 min Winter	52.881	0.881	0.1	13.0	13.1	482.0	O K
960 min Winter	52.815	0.815	0.1	13.0	13.1	446.0	O K
1440 min Winter	52.662	0.662	0.1	13.0	13.1	362.4	O K
2160 min Winter	52.447	0.447	0.1	13.0	13.1	244.8	O K
2880 min Winter	52.295	0.295	0.1	13.0	13.1	161.7	O K
4320 min Winter	52.164	0.164	0.1	11.5	11.6	89.7	O K
5760 min Winter	52.134	0.134	0.1	9.1	9.2	73.4	O K
7200 min Winter	52.118	0.118	0.1	7.6	7.7	64.5	O K
8640 min Winter	52.107	0.107	0.1	6.5	6.6	58.4	O K
10080 min Winter	52.099	0.099	0.1	5.7	5.8	53.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	16.209	0.0	604.7	176
240 min Winter	13.037	0.0	648.5	232
360 min Winter	9.591	0.0	715.8	340
480 min Winter	7.714	0.0	767.6	388
600 min Winter	6.515	0.0	810.4	464
720 min Winter	5.675	0.0	847.1	542
960 min Winter	4.528	0.0	901.0	696
1440 min Winter	3.294	0.0	982.7	994
2160 min Winter	2.396	0.0	1075.8	1360
2880 min Winter	1.912	0.0	1144.2	1696
4320 min Winter	1.357	0.0	1216.8	2252
5760 min Winter	1.064	0.0	1275.2	2944
7200 min Winter	0.881	0.0	1319.8	3680
8640 min Winter	0.755	0.0	1357.1	4408
10080 min Winter	0.663	0.0	1388.5	5136

See existing greenfield run-off for 30 year event (13.06 L/s)

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Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	30	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 1.350

Time (mins)	Area
From:	To: (ha)

0	4	1.350
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Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	576.0	576.0	1.100	0.0	672.0
1.000	576.0	672.0			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0164-1310-1000-1310
Design Head (m) 1.000
Design Flow (l/s) 13.1
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 164
Invert Level (m) 52.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	13.0	Kick-Flo®	0.694	11.0
Flush-Flo™	0.314	13.0	Mean Flow over Head Range	-	11.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	14.2	3.000	21.9	7.000	33.0
0.200	12.6	1.400	15.3	3.500	23.6	7.500	34.1
0.300	13.0	1.600	16.3	4.000	25.2	8.000	35.2
0.400	12.9	1.800	17.2	4.500	26.7	8.500	36.2
0.500	12.6	2.000	18.1	5.000	28.0	9.000	37.2
0.600	12.1	2.200	18.9	5.500	29.4	9.500	38.2
0.800	11.7	2.400	19.7	6.000	30.6		
1.000	13.0	2.600	20.5	6.500	31.8		

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Summary of Results for 100 year Return Period

Half Drain Time : 354 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.633	0.633	0.1	18.0	18.1	505.8	O K
30 min Summer	52.723	0.723	0.1	18.0	18.1	577.7	O K
60 min Summer	52.814	0.814	0.1	18.0	18.1	650.5	O K
120 min Summer	52.894	0.894	0.1	18.0	18.1	714.5	O K
180 min Summer	52.925	0.925	0.1	18.0	18.1	739.1	O K
240 min Summer	52.934	0.934	0.1	18.0	18.1	746.6	O K
360 min Summer	52.924	0.924	0.1	18.0	18.1	738.3	O K
480 min Summer	52.908	0.908	0.1	18.0	18.1	725.4	O K
600 min Summer	52.889	0.889	0.1	18.0	18.1	710.6	O K
720 min Summer	52.869	0.869	0.1	18.0	18.1	694.7	O K
960 min Summer	52.818	0.818	0.1	18.0	18.1	653.7	O K
1440 min Summer	52.714	0.714	0.1	18.0	18.1	570.5	O K
2160 min Summer	52.560	0.560	0.1	18.0	18.1	447.5	O K
2880 min Summer	52.439	0.439	0.1	18.0	18.1	351.1	O K
4320 min Summer	52.268	0.268	0.1	17.9	18.0	213.8	O K
5760 min Summer	52.194	0.194	0.1	16.9	17.1	155.1	O K
7200 min Summer	52.168	0.168	0.1	14.5	14.6	133.8	O K
8640 min Summer	52.150	0.150	0.1	12.6	12.7	119.8	O K
10080 min Summer	52.138	0.138	0.1	11.1	11.2	109.9	O K
15 min Winter	52.633	0.633	0.1	18.0	18.1	505.6	O K
30 min Winter	52.723	0.723	0.1	18.0	18.1	577.7	O K
60 min Winter	52.814	0.814	0.1	18.0	18.1	650.6	O K
120 min Winter	52.894	0.894	0.1	18.0	18.1	714.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	166.149	0.0	507.8	19
30 min Summer	96.184	0.0	588.6	33
60 min Summer	55.682	0.0	690.8	62
120 min Summer	32.234	0.0	800.2	122
180 min Summer	23.413	0.0	872.0	182
240 min Summer	18.661	0.0	926.8	240
360 min Summer	13.554	0.0	1009.9	324
480 min Summer	10.803	0.0	1073.2	384
600 min Summer	9.060	0.0	1125.0	446
720 min Summer	7.846	0.0	1169.1	514
960 min Summer	6.204	0.0	1232.1	654
1440 min Summer	4.455	0.0	1326.3	926
2160 min Summer	3.199	0.0	1435.8	1300
2880 min Summer	2.529	0.0	1512.9	1668
4320 min Summer	1.773	0.0	1587.4	2332
5760 min Summer	1.378	0.0	1650.3	2992
7200 min Summer	1.133	0.0	1695.8	3680
8640 min Summer	0.966	0.0	1733.3	4408
10080 min Summer	0.844	0.0	1763.7	5144
15 min Winter	166.149	0.0	507.8	19
30 min Winter	96.184	0.0	588.7	33
60 min Winter	55.682	0.0	690.8	62
120 min Winter	32.234	0.0	800.2	120

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	52.926	0.926	0.1	18.0	18.1	740.0	O K
240 min Winter	52.937	0.937	0.1	18.0	18.1	748.5	O K
360 min Winter	52.927	0.927	0.1	18.0	18.1	740.9	O K
480 min Winter	52.902	0.902	0.1	18.0	18.1	720.3	O K
600 min Winter	52.877	0.877	0.1	18.0	18.1	701.1	O K
720 min Winter	52.850	0.850	0.1	18.0	18.1	678.9	O K
960 min Winter	52.778	0.778	0.1	18.0	18.1	621.4	O K
1440 min Winter	52.614	0.614	0.1	18.0	18.1	490.3	O K
2160 min Winter	52.411	0.411	0.1	18.0	18.1	328.2	O K
2880 min Winter	52.274	0.274	0.1	17.9	18.0	219.1	O K
4320 min Winter	52.172	0.172	0.1	14.9	15.0	137.6	O K
5760 min Winter	52.143	0.143	0.1	11.8	11.9	114.4	O K
7200 min Winter	52.126	0.126	0.1	9.7	9.8	100.8	O K
8640 min Winter	52.114	0.114	0.1	8.3	8.4	91.3	O K
10080 min Winter	52.105	0.105	0.1	7.2	7.3	84.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	23.413	0.0	872.0	178
240 min Winter	18.661	0.0	926.8	234
360 min Winter	13.554	0.0	1009.9	342
480 min Winter	10.803	0.0	1073.2	392
600 min Winter	9.060	0.0	1125.0	466
720 min Winter	7.846	0.0	1169.2	542
960 min Winter	6.204	0.0	1232.2	700
1440 min Winter	4.455	0.0	1326.8	980
2160 min Winter	3.199	0.0	1435.8	1340
2880 min Winter	2.529	0.0	1513.0	1668
4320 min Winter	1.773	0.0	1587.7	2252
5760 min Winter	1.378	0.0	1650.4	2992
7200 min Winter	1.133	0.0	1695.9	3680
8640 min Winter	0.966	0.0	1733.5	4416
10080 min Winter	0.844	0.0	1764.3	5144

See existing greenfield run-off for 100 year event (18.12L/s)

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 1.350

Time (mins)	Area
From:	To: (ha)

0	4	1.350
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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	841.0	841.0	1.100	0.0	957.0
1.000	841.0	957.0			

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0190-1810-1000-1810
Design Head (m) 1.000
Design Flow (l/s) 18.1
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 190
Invert Level (m) 52.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	18.0	Kick-Flo®	0.711	15.3
Flush-Flo™	0.330	18.0	Mean Flow over Head Range	-	15.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.6	1.200	19.7	3.000	30.5	7.000	45.9
0.200	17.3	1.400	21.2	3.500	32.8	7.500	47.5
0.300	18.0	1.600	22.6	4.000	35.0	8.000	49.0
0.400	17.9	1.800	23.9	4.500	37.1	8.500	50.5
0.500	17.6	2.000	25.1	5.000	39.0	9.000	51.9
0.600	17.0	2.200	26.3	5.500	40.9	9.500	53.3
0.800	16.2	2.400	27.4	6.000	42.6		
1.000	18.0	2.600	28.5	6.500	44.3		

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 371 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.687	0.687	0.1	22.4	22.5	658.4	O K
30 min Summer	52.784	0.784	0.1	22.5	22.6	751.4	O K
60 min Summer	52.883	0.883	0.1	22.5	22.6	846.2	O K
120 min Summer	52.972	0.972	0.1	22.5	22.6	931.9	O K
180 min Summer	53.010	1.010	0.1	22.5	22.6	967.4	O K
240 min Summer	53.032	1.032	0.1	22.5	22.6	980.5	O K
360 min Summer	53.020	1.020	0.1	22.5	22.6	974.6	O K
480 min Summer	53.002	1.002	0.1	22.5	22.6	960.8	O K
600 min Summer	52.985	0.985	0.1	22.5	22.6	943.9	O K
720 min Summer	52.965	0.965	0.1	22.5	22.6	925.1	O K
960 min Summer	52.912	0.912	0.1	22.5	22.6	874.1	O K
1440 min Summer	52.808	0.808	0.1	22.5	22.6	774.7	O K
2160 min Summer	52.671	0.671	0.1	22.3	22.5	643.7	O K
2880 min Summer	52.560	0.560	0.1	22.0	22.1	536.6	O K
4320 min Summer	52.384	0.384	0.1	20.5	20.7	367.8	O K
5760 min Summer	52.280	0.280	0.1	18.9	19.0	268.0	O K
7200 min Summer	52.219	0.219	0.1	17.5	17.6	210.2	O K
8640 min Summer	52.189	0.189	0.1	15.7	15.8	181.2	O K
10080 min Summer	52.170	0.170	0.1	14.0	14.2	162.8	O K
15 min Winter	52.687	0.687	0.1	22.4	22.5	658.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	215.994	0.0	657.6	19
30 min Summer	125.040	0.0	762.4	33
60 min Summer	72.386	0.0	897.2	62
120 min Summer	41.905	0.0	1039.4	122
180 min Summer	30.437	0.0	1132.7	182
240 min Summer	24.259	0.0	1203.8	240
360 min Summer	17.620	0.0	1311.7	330
480 min Summer	14.043	0.0	1394.0	384
600 min Summer	11.777	0.0	1461.2	446
720 min Summer	10.200	0.0	1518.5	512
960 min Summer	8.065	0.0	1600.3	646
1440 min Summer	5.791	0.0	1722.1	910
2160 min Summer	4.159	0.0	1866.1	1300
2880 min Summer	3.288	0.0	1966.4	1676
4320 min Summer	2.305	0.0	2062.6	2380
5760 min Summer	1.791	0.0	2145.4	3064
7200 min Summer	1.473	0.0	2204.4	3744
8640 min Summer	1.255	0.0	2252.9	4416
10080 min Summer	1.097	0.0	2292.0	5144
15 min Winter	215.994	0.0	657.6	18

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	16-037 Hornsey Town Hall Hornsey Attenuation : PLANNING	
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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	52.784	0.784	0.1	22.5	22.6	751.6	O K
60 min Winter	52.883	0.883	0.1	22.5	22.6	846.7	O K
120 min Winter	52.973	0.973	0.1	22.5	22.6	932.5	O K
180 min Winter	53.012	1.012	0.1	22.5	22.6	968.6	O K
240 min Winter	53.037	1.037	0.1	22.5	22.6	982.7	O K
360 min Winter	53.026	1.026	0.1	22.5	22.6	977.9	O K
480 min Winter	52.995	0.995	0.1	22.5	22.6	953.6	O K
600 min Winter	52.971	0.971	0.1	22.5	22.6	931.3	O K
720 min Winter	52.944	0.944	0.1	22.5	22.6	904.8	O K
960 min Winter	52.871	0.871	0.1	22.5	22.6	834.9	O K
1440 min Winter	52.727	0.727	0.1	22.4	22.6	696.9	O K
2160 min Winter	52.546	0.546	0.1	21.9	22.0	523.1	O K
2880 min Winter	52.412	0.412	0.1	20.9	21.0	394.9	O K
4320 min Winter	52.241	0.241	0.1	18.0	18.1	231.0	O K
5760 min Winter	52.181	0.181	0.1	15.1	15.2	173.7	O K
7200 min Winter	52.154	0.154	0.1	12.6	12.7	147.8	O K
8640 min Winter	52.138	0.138	0.1	10.7	10.9	132.0	O K
10080 min Winter	52.126	0.126	0.1	9.4	9.5	120.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	125.040	0.0	762.5	33
60 min Winter	72.386	0.0	897.2	62
120 min Winter	41.905	0.0	1039.4	120
180 min Winter	30.437	0.0	1132.7	178
240 min Winter	24.259	0.0	1203.8	234
360 min Winter	17.620	0.0	1311.7	342
480 min Winter	14.043	0.0	1394.0	394
600 min Winter	11.777	0.0	1461.3	464
720 min Winter	10.200	0.0	1518.5	542
960 min Winter	8.065	0.0	1600.4	692
1440 min Winter	5.791	0.0	1722.4	968
2160 min Winter	4.159	0.0	1866.1	1364
2880 min Winter	3.288	0.0	1966.5	1728
4320 min Winter	2.305	0.0	2063.0	2380
5760 min Winter	1.791	0.0	2145.5	3048
7200 min Winter	1.473	0.0	2204.5	3744
8640 min Winter	1.255	0.0	2253.2	4416
10080 min Winter	1.097	0.0	2292.8	5152

See existing greenfield run-off for 100 year + 30% event (23.5L/s)

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 1.350

Time (mins) Area
From: To: (ha)

0 4 1.350

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	16-037 Hornsey Town Hall Hornsey Attenuation : PLANNING	
Date 12 July 2017	Designed by IL	
File 16-037SRC_Pro-forma Attenuati...	Checked by GV	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	1009.2	1009.2	1.000	1009.2	1148.4	1.100	0.0	1148.4

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0184-2350-3000-2350
Design Head (m) 3.000
Design Flow (l/s) 23.5
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 184
Invert Level (m) 52.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	3.000	23.5	Kick-Flo®	1.642	17.6
Flush-Flo™	0.800	22.5	Mean Flow over Head Range	-	20.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.4	0.800	22.5	2.000	19.4	4.000	27.0	7.000	35.3
0.200	16.6	1.000	22.3	2.200	20.3	4.500	28.5	7.500	36.5
0.300	19.3	1.200	21.6	2.400	21.1	5.000	30.0	8.000	37.7
0.400	20.7	1.400	20.5	2.600	21.9	5.500	31.4	8.500	38.8
0.500	21.6	1.600	18.3	3.000	23.5	6.000	32.8	9.000	39.9
0.600	22.1	1.800	18.4	3.500	25.3	6.500	34.1	9.500	40.9

Appendix B

Proposed Site Drainage Strategy Plan



TOTAL CATCHMENT (A+B+C+D)

• TOTAL AREA	13,300m ²
•• ROOF	5,865m ²
•• PAVING	5,149m ²
••• PERMEABLE	913m ²
••• IMPERMEABLE	4,236m ²
•• SOFT	2,482m ²
• DISCHARGE RATE	
•• 1:1YR	4.8l/s
•• 1:30YR	13.1l/s
•• 1:100YR	18.1l/s
•• 1:100YR+30%	23.5l/s
• STORAGE REQUIRED	817m ³
•• 1:1YR	178m ³
•• 1:30YR	439m ³
•• 1:100YR	621-754m ³
•• 1:100YR +30%	817-1090m ³
• STORAGE PROVIDED	552m ³
•• SUBBASE	370m ³
•• (2465x0.5x0.3)	
•• SURFACE	182m ³

CATCHMENT A

• TOTAL AREA	909m ²
•• ROOF	557m ²
•• PAVING	352m ²
••• PERMEABLE	155m ²
••• IMPERMEABLE	197m ²
•• SOFT	0m ²
• DISCHARGE RATE	
•• 1:30YR	1l/s
•• 1:100YR+30%	1.6l/s
• STORAGE REQUIRED	69m ³
•• 1:30YR	38m ³
•• 1:100YR+30%	69m ³
• STORAGE AVAILABLE	22m ³
•• SUBBASE	20m ³
•• (135x0.5x0.3)	
•• SURFACE	2m ³

CATCHMENT B

• TOTAL AREA	3861m ²
•• ROOF	1360m ²
•• PAVING	1674m ²
••• PERMEABLE	0m ²
••• IMPERMEABLE	1674m ²
•• SOFT	827m ²
• DISCHARGE RATE	
•• 1:30YR	3l/s
•• 1:100YR+30%	6.7l/s
• STORAGE REQUIRED	222m ³
•• 1:30 YR	126m ³
•• 1:100 YR +30%	222m ³
• STORAGE PROVIDED	245m ³
•• SUBBASE	170m ³
•• (1135x0.5x0.3)	
•• SURFACE	75m ³

CATCHMENT C

• TOTAL AREA	2060m ²
•• ROOF	550m ²
•• PAVING	1215m ²
••• PERMEABLE	358m ²
••• IMPERMEABLE	857m ²
•• SOFT	295m ²
• DISCHARGE RATE	
•• 1:30YR	2l/s
•• 1:100YR+30%	3.6l/s
• STORAGE REQUIRED	135m ³
•• 1:30 YR	70m ³
•• 1:100 YR +30%	135m ³
• STORAGE PROVIDED	200m ³
•• SUBBASE	120m ³
•• (795x0.5x0.3)	
•• SURFACE	80m ³

CATCHMENT D

• TOTAL AREA	6666m ²
•• ROOF	3398m ²
•• PAVING	1908m ²
••• PERMEABLE	400m ²
••• IMPERMEABLE	1508m ²
•• SOFT	1360m ²
• DISCHARGE RATE	
•• 1:30YR	7l/s
•• 1:100YR+30%	11.6l/s
• STORAGE REQUIRED	391m ³
•• 1:30 YR	205m ³
•• 1:100 YR +30%	391m ³
• STORAGE PROVIDED	85m ³
•• SUBBASE	60m ³
•• (400x0.5x0.3)	
•• SURFACE	25m ³

P1	DH	19.07.17	ISSUED FOR PLANNING
Rev	Tech	Date	Description
Kingston Office 1st Floor, Neville House 55 Eden Street Kingston upon Thames Surrey, KT11 1BW United Kingdom Tel: 020 8339 9006 Email: info@bradbrookconsulting.com Web: www.bradbrookconsulting.com Civil & Structural Engineers Kingston, London, Dubai, Qatar			
Client			
Job title HORNSEY TOWN HALL			
Drawing title DRAINAGE STRATEGY DESIGN CONCEPT STAGE			
Purpose of issue Information Preliminary Approval Tender Construction Record Copy			
Date	Drawn	Scale	Checked
15.06.17	DH	NTS	IL
Drawing no. 16-037 / 300			Rev P1

Appendix C

Proposed Site Runoff and Storage Calculations

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	16-037 Hornsey Town Hall Hornsey Catchment A : PLANNING	
Date 12 July 2017 File 16-037SRC_Catchment A_P1 - 1y...	Designed by IL Checked by GV	
XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period

Half Drain Time : 370 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.081	0.081	0.0	0.2	0.3	6.2	O K
30 min Summer	52.101	0.101	0.0	0.3	0.3	7.7	O K
60 min Summer	52.123	0.123	0.0	0.3	0.3	9.4	O K
120 min Summer	52.146	0.146	0.0	0.3	0.3	11.2	O K
180 min Summer	52.159	0.159	0.0	0.3	0.4	12.2	O K
240 min Summer	52.166	0.166	0.0	0.3	0.4	12.8	O K
360 min Summer	52.175	0.175	0.0	0.3	0.4	13.5	O K
480 min Summer	52.181	0.181	0.0	0.3	0.4	13.9	O K
600 min Summer	52.185	0.185	0.0	0.3	0.4	14.2	O K
720 min Summer	52.187	0.187	0.0	0.4	0.4	14.4	O K
960 min Summer	52.187	0.187	0.0	0.4	0.4	14.3	O K
1440 min Summer	52.181	0.181	0.0	0.3	0.4	13.9	O K
2160 min Summer	52.169	0.169	0.0	0.3	0.4	13.0	O K
2880 min Summer	52.157	0.157	0.0	0.3	0.4	12.0	O K
4320 min Summer	52.130	0.130	0.0	0.3	0.3	10.0	O K
5760 min Summer	52.110	0.110	0.0	0.3	0.3	8.5	O K
7200 min Summer	52.094	0.094	0.0	0.2	0.3	7.3	O K
8640 min Summer	52.082	0.082	0.0	0.2	0.3	6.3	O K
10080 min Summer	52.072	0.072	0.0	0.2	0.2	5.6	O K
15 min Winter	52.081	0.081	0.0	0.2	0.3	6.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.705	0.0	6.1	19
30 min Summer	19.312	0.0	7.7	33
60 min Summer	12.146	0.0	10.0	62
120 min Summer	7.639	0.0	12.6	122
180 min Summer	5.824	0.0	14.4	180
240 min Summer	4.805	0.0	15.9	238
360 min Summer	3.663	0.0	18.2	294
480 min Summer	3.022	0.0	20.0	358
600 min Summer	2.603	0.0	21.5	426
720 min Summer	2.304	0.0	22.8	494
960 min Summer	1.885	0.0	24.9	634
1440 min Summer	1.421	0.0	28.1	910
2160 min Summer	1.071	0.0	32.1	1316
2880 min Summer	0.877	0.0	35.0	1704
4320 min Summer	0.645	0.0	38.5	2464
5760 min Summer	0.519	0.0	41.4	3176
7200 min Summer	0.438	0.0	43.7	3896
8640 min Summer	0.382	0.0	45.7	4664
10080 min Summer	0.340	0.0	47.4	5352
15 min Winter	30.705	0.0	6.1	18

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XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	52.101	0.101	0.0	0.3	0.3	7.7	O K
60 min Winter	52.123	0.123	0.0	0.3	0.3	9.4	O K
120 min Winter	52.147	0.147	0.0	0.3	0.3	11.3	O K
180 min Winter	52.159	0.159	0.0	0.3	0.4	12.2	O K
240 min Winter	52.167	0.167	0.0	0.3	0.4	12.8	O K
360 min Winter	52.175	0.175	0.0	0.3	0.4	13.4	O K
480 min Winter	52.180	0.180	0.0	0.3	0.4	13.8	O K
600 min Winter	52.183	0.183	0.0	0.3	0.4	14.0	O K
720 min Winter	52.184	0.184	0.0	0.3	0.4	14.1	O K
960 min Winter	52.180	0.180	0.0	0.3	0.4	13.9	O K
1440 min Winter	52.169	0.169	0.0	0.3	0.4	13.0	O K
2160 min Winter	52.150	0.150	0.0	0.3	0.3	11.5	O K
2880 min Winter	52.133	0.133	0.0	0.3	0.3	10.2	O K
4320 min Winter	52.101	0.101	0.0	0.3	0.3	7.7	O K
5760 min Winter	52.079	0.079	0.0	0.2	0.3	6.0	O K
7200 min Winter	52.063	0.063	0.0	0.2	0.2	4.9	O K
8640 min Winter	52.052	0.052	0.0	0.2	0.2	4.0	O K
10080 min Winter	52.045	0.045	0.0	0.2	0.2	3.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	19.312	0.0	7.7	33
60 min Winter	12.146	0.0	10.0	62
120 min Winter	7.639	0.0	12.6	120
180 min Winter	5.824	0.0	14.4	176
240 min Winter	4.805	0.0	15.9	230
360 min Winter	3.663	0.0	18.2	326
480 min Winter	3.022	0.0	20.0	372
600 min Winter	2.603	0.0	21.5	452
720 min Winter	2.304	0.0	22.8	528
960 min Winter	1.885	0.0	24.9	682
1440 min Winter	1.421	0.0	28.1	970
2160 min Winter	1.071	0.0	32.1	1388
2880 min Winter	0.877	0.0	35.0	1788
4320 min Winter	0.645	0.0	38.5	2552
5760 min Winter	0.519	0.0	41.4	3288
7200 min Winter	0.438	0.0	43.7	3968
8640 min Winter	0.382	0.0	45.7	4672
10080 min Winter	0.340	0.0	47.4	5352

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	1	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.090

Time (mins) Area
From: To: (ha)

0 4 0.090

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	256.0	256.0	0.500	256.0	288.0	0.600	0.0	288.0

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period

Half Drain Time : 345 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.078	0.078	0.1	0.8	0.9	21.0	O K
30 min Summer	52.096	0.096	0.1	0.9	1.0	26.0	O K
60 min Summer	52.118	0.118	0.1	1.0	1.1	31.8	O K
120 min Summer	52.140	0.140	0.1	1.1	1.2	37.8	O K
180 min Summer	52.152	0.152	0.1	1.2	1.3	41.0	O K
240 min Summer	52.159	0.159	0.1	1.2	1.3	42.9	O K
360 min Summer	52.168	0.168	0.1	1.2	1.3	45.4	O K
480 min Summer	52.174	0.174	0.1	1.2	1.4	47.0	O K
600 min Summer	52.178	0.178	0.1	1.3	1.4	48.0	O K
720 min Summer	52.180	0.180	0.1	1.3	1.4	48.6	O K
960 min Summer	52.180	0.180	0.1	1.3	1.4	48.6	O K
1440 min Summer	52.175	0.175	0.1	1.3	1.4	47.3	O K
2160 min Summer	52.163	0.163	0.1	1.2	1.3	44.1	O K
2880 min Summer	52.151	0.151	0.1	1.2	1.3	40.8	O K
4320 min Summer	52.126	0.126	0.1	1.0	1.2	33.9	O K
5760 min Summer	52.107	0.107	0.1	0.9	1.1	28.9	O K
7200 min Summer	52.093	0.093	0.1	0.9	1.0	25.0	O K
8640 min Summer	52.081	0.081	0.1	0.8	0.9	22.0	O K
10080 min Summer	52.073	0.073	0.1	0.7	0.9	19.6	O K
15 min Winter	52.078	0.078	0.1	0.8	0.9	21.0	O K
30 min Winter	52.096	0.096	0.1	0.9	1.0	26.0	O K
60 min Winter	52.118	0.118	0.1	1.0	1.1	31.8	O K
120 min Winter	52.140	0.140	0.1	1.1	1.2	37.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.705	0.0	19.8	19
30 min Summer	19.312	0.0	25.1	33
60 min Summer	12.146	0.0	33.4	62
120 min Summer	7.639	0.0	42.1	122
180 min Summer	5.824	0.0	48.2	180
240 min Summer	4.805	0.0	53.1	228
360 min Summer	3.663	0.0	60.7	286
480 min Summer	3.022	0.0	66.8	350
600 min Summer	2.603	0.0	71.9	418
720 min Summer	2.304	0.0	76.3	488
960 min Summer	1.885	0.0	83.2	626
1440 min Summer	1.421	0.0	93.7	896
2160 min Summer	1.071	0.0	107.8	1300
2880 min Summer	0.877	0.0	117.5	1696
4320 min Summer	0.645	0.0	129.1	2424
5760 min Summer	0.519	0.0	139.4	3168
7200 min Summer	0.438	0.0	147.2	3888
8640 min Summer	0.382	0.0	153.7	4584
10080 min Summer	0.340	0.0	159.1	5344
15 min Winter	30.705	0.0	19.8	18
30 min Winter	19.312	0.0	25.1	33
60 min Winter	12.146	0.0	33.4	62
120 min Winter	7.639	0.0	42.1	118

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XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	52.152	0.152	0.1	1.2	1.3	41.2	O K
240 min Winter	52.160	0.160	0.1	1.2	1.3	43.1	O K
360 min Winter	52.167	0.167	0.1	1.2	1.3	45.2	O K
480 min Winter	52.172	0.172	0.1	1.2	1.4	46.6	O K
600 min Winter	52.175	0.175	0.1	1.3	1.4	47.2	O K
720 min Winter	52.176	0.176	0.1	1.3	1.4	47.5	O K
960 min Winter	52.173	0.173	0.1	1.2	1.4	46.6	O K
1440 min Winter	52.162	0.162	0.1	1.2	1.3	43.7	O K
2160 min Winter	52.144	0.144	0.1	1.1	1.2	38.8	O K
2880 min Winter	52.127	0.127	0.1	1.0	1.2	34.2	O K
4320 min Winter	52.097	0.097	0.1	0.9	1.0	26.2	O K
5760 min Winter	52.077	0.077	0.1	0.8	0.9	20.8	O K
7200 min Winter	52.064	0.064	0.1	0.7	0.8	17.2	O K
8640 min Winter	52.055	0.055	0.1	0.6	0.7	14.9	O K
10080 min Winter	52.050	0.050	0.1	0.5	0.6	13.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	5.824	0.0	48.2	176
240 min Winter	4.805	0.0	53.1	230
360 min Winter	3.663	0.0	60.7	292
480 min Winter	3.022	0.0	66.8	368
600 min Winter	2.603	0.0	71.9	446
720 min Winter	2.304	0.0	76.3	522
960 min Winter	1.885	0.0	83.2	674
1440 min Winter	1.421	0.0	93.7	964
2160 min Winter	1.071	0.0	107.8	1368
2880 min Winter	0.877	0.0	117.5	1760
4320 min Winter	0.645	0.0	129.1	2508
5760 min Winter	0.519	0.0	139.4	3232
7200 min Winter	0.438	0.0	147.2	3896
8640 min Winter	0.382	0.0	153.7	4576
10080 min Winter	0.340	0.0	159.1	5256

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	1	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.303

Time (mins) Area
From: To: (ha)

0 4 0.303

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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	0.600	0.0	960.0
0.500	900.0	960.0			

Orifice Outflow Control

Diameter (m) 0.039 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period

Half Drain Time : 324 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.065	0.065	0.1	0.5	0.6	12.2	O K
30 min Summer	52.081	0.081	0.1	0.5	0.6	15.2	O K
60 min Summer	52.098	0.098	0.1	0.6	0.7	18.5	O K
120 min Summer	52.117	0.117	0.1	0.7	0.8	21.9	O K
180 min Summer	52.126	0.126	0.1	0.7	0.8	23.6	O K
240 min Summer	52.132	0.132	0.1	0.7	0.8	24.7	O K
360 min Summer	52.139	0.139	0.1	0.8	0.8	26.1	O K
480 min Summer	52.144	0.144	0.1	0.8	0.9	27.0	O K
600 min Summer	52.147	0.147	0.1	0.8	0.9	27.5	O K
720 min Summer	52.148	0.148	0.1	0.8	0.9	27.8	O K
960 min Summer	52.148	0.148	0.1	0.8	0.9	27.7	O K
1440 min Summer	52.142	0.142	0.1	0.8	0.8	26.7	O K
2160 min Summer	52.132	0.132	0.1	0.7	0.8	24.7	O K
2880 min Summer	52.121	0.121	0.1	0.7	0.8	22.7	O K
4320 min Summer	52.099	0.099	0.1	0.6	0.7	18.7	O K
5760 min Summer	52.084	0.084	0.1	0.6	0.6	15.7	O K
7200 min Summer	52.072	0.072	0.1	0.5	0.6	13.5	O K
8640 min Summer	52.063	0.063	0.1	0.5	0.6	11.9	O K
10080 min Summer	52.056	0.056	0.1	0.4	0.5	10.6	O K
15 min Winter	52.065	0.065	0.1	0.5	0.6	12.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.705	0.0	11.6	19
30 min Summer	19.312	0.0	14.8	33
60 min Summer	12.146	0.0	19.6	62
120 min Summer	7.639	0.0	24.7	122
180 min Summer	5.824	0.0	28.2	180
240 min Summer	4.805	0.0	31.0	216
360 min Summer	3.663	0.0	35.5	278
480 min Summer	3.022	0.0	39.1	344
600 min Summer	2.603	0.0	42.1	412
720 min Summer	2.304	0.0	44.7	484
960 min Summer	1.885	0.0	48.7	618
1440 min Summer	1.421	0.0	54.9	894
2160 min Summer	1.071	0.0	63.0	1296
2880 min Summer	0.877	0.0	68.7	1672
4320 min Summer	0.645	0.0	75.5	2420
5760 min Summer	0.519	0.0	81.4	3168
7200 min Summer	0.438	0.0	86.0	3888
8640 min Summer	0.382	0.0	89.8	4584
10080 min Summer	0.340	0.0	92.9	5248
15 min Winter	30.705	0.0	11.6	18

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XP Solutions		Source Control 2015.1

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	52.081	0.081	0.1	0.5	0.6	15.2	O K
60 min Winter	52.099	0.099	0.1	0.6	0.7	18.5	O K
120 min Winter	52.117	0.117	0.1	0.7	0.8	21.9	O K
180 min Winter	52.127	0.127	0.1	0.7	0.8	23.8	O K
240 min Winter	52.132	0.132	0.1	0.7	0.8	24.8	O K
360 min Winter	52.138	0.138	0.1	0.7	0.8	26.0	O K
480 min Winter	52.142	0.142	0.1	0.8	0.8	26.7	O K
600 min Winter	52.144	0.144	0.1	0.8	0.9	27.0	O K
720 min Winter	52.144	0.144	0.1	0.8	0.9	27.0	O K
960 min Winter	52.141	0.141	0.1	0.8	0.8	26.4	O K
1440 min Winter	52.131	0.131	0.1	0.7	0.8	24.5	O K
2160 min Winter	52.114	0.114	0.1	0.7	0.8	21.4	O K
2880 min Winter	52.100	0.100	0.1	0.6	0.7	18.7	O K
4320 min Winter	52.075	0.075	0.1	0.5	0.6	14.1	O K
5760 min Winter	52.059	0.059	0.1	0.4	0.5	11.1	O K
7200 min Winter	52.049	0.049	0.1	0.4	0.5	9.2	O K
8640 min Winter	52.044	0.044	0.1	0.4	0.4	8.3	O K
10080 min Winter	52.041	0.041	0.1	0.3	0.4	7.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	19.312	0.0	14.8	33
60 min Winter	12.146	0.0	19.6	62
120 min Winter	7.639	0.0	24.7	118
180 min Winter	5.824	0.0	28.2	174
240 min Winter	4.805	0.0	31.0	228
360 min Winter	3.663	0.0	35.5	286
480 min Winter	3.022	0.0	39.1	362
600 min Winter	2.603	0.0	42.1	440
720 min Winter	2.304	0.0	44.7	518
960 min Winter	1.885	0.0	48.7	664
1440 min Winter	1.421	0.0	54.9	952
2160 min Winter	1.071	0.0	63.0	1360
2880 min Winter	0.877	0.0	68.7	1756
4320 min Winter	0.645	0.0	75.5	2468
5760 min Winter	0.519	0.0	81.4	3176
7200 min Winter	0.438	0.0	86.0	3888
8640 min Winter	0.382	0.0	89.8	4576
10080 min Winter	0.340	0.0	93.0	5240

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	1	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.177

Time (mins) Area
From: To: (ha)

0 4 0.177

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Date 12 July 2017 File 16-037SRC_Catchment C_P1 - 1y...	Designed by IL Checked by GV	
XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	625.0	625.0	0.500	625.0	675.0	0.600	0.0	675.0

Orifice Outflow Control

Diameter (m) 0.032 Discharge Coefficient 0.600 Invert Level (m) 52.000

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	16-037 Hornsey Town Hall Hornsey Catchment D : PLANNING	
Date 12 July 2017 File 16-037SRC_Catchment D_P1 - 1y...	Designed by IL Checked by GV	
XP Solutions	Source Control 2015.1	

Summary of Results for 1 year Return Period

Half Drain Time : 302 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.089	0.089	0.2	1.5	1.7	36.8	O K
30 min Summer	52.111	0.111	0.2	1.8	2.0	45.5	O K
60 min Summer	52.135	0.135	0.2	2.0	2.2	55.3	O K
120 min Summer	52.159	0.159	0.2	2.2	2.4	65.4	O K
180 min Summer	52.172	0.172	0.2	2.3	2.5	70.5	O K
240 min Summer	52.179	0.179	0.2	2.4	2.6	73.6	O K
360 min Summer	52.190	0.190	0.2	2.5	2.6	77.9	O K
480 min Summer	52.196	0.196	0.2	2.5	2.7	80.5	O K
600 min Summer	52.200	0.200	0.2	2.5	2.7	82.0	O K
720 min Summer	52.202	0.202	0.2	2.5	2.7	82.9	O K
960 min Summer	52.201	0.201	0.2	2.5	2.7	82.5	O K
1440 min Summer	52.193	0.193	0.2	2.5	2.7	79.4	O K
2160 min Summer	52.178	0.178	0.2	2.4	2.6	73.3	O K
2880 min Summer	52.164	0.164	0.2	2.3	2.4	67.3	O K
4320 min Summer	52.135	0.135	0.2	2.0	2.2	55.5	O K
5760 min Summer	52.115	0.115	0.2	1.8	2.0	47.1	O K
7200 min Summer	52.100	0.100	0.2	1.6	1.8	41.0	O K
8640 min Summer	52.089	0.089	0.2	1.5	1.7	36.3	O K
10080 min Summer	52.080	0.080	0.2	1.4	1.6	33.0	O K
15 min Winter	52.090	0.090	0.2	1.5	1.7	36.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.705	0.0	34.4	19
30 min Summer	19.312	0.0	43.8	33
60 min Summer	12.146	0.0	58.5	62
120 min Summer	7.639	0.0	73.8	122
180 min Summer	5.824	0.0	84.5	180
240 min Summer	4.805	0.0	93.0	210
360 min Summer	3.663	0.0	106.4	272
480 min Summer	3.022	0.0	117.0	338
600 min Summer	2.603	0.0	125.9	408
720 min Summer	2.304	0.0	133.7	478
960 min Summer	1.885	0.0	145.8	616
1440 min Summer	1.421	0.0	164.3	882
2160 min Summer	1.071	0.0	188.9	1280
2880 min Summer	0.877	0.0	205.9	1668
4320 min Summer	0.645	0.0	226.1	2416
5760 min Summer	0.519	0.0	244.4	3120
7200 min Summer	0.438	0.0	258.0	3824
8640 min Summer	0.382	0.0	269.3	4576
10080 min Summer	0.340	0.0	278.6	5248
15 min Winter	30.705	0.0	34.4	18

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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	16-037 Hornsey Town Hall Hornsey Catchment D : PLANNING	
Date 12 July 2017	Designed by IL	
File 16-037SRC_Catchment D_P1 - 1y...	Checked by GV	
XP Solutions		Source Control 2015.1

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	52.111	0.111	0.2	1.8	2.0	45.5	O K
60 min Winter	52.135	0.135	0.2	2.0	2.2	55.4	O K
120 min Winter	52.160	0.160	0.2	2.2	2.4	65.6	O K
180 min Winter	52.173	0.173	0.2	2.3	2.5	70.9	O K
240 min Winter	52.180	0.180	0.2	2.4	2.6	73.9	O K
360 min Winter	52.189	0.189	0.2	2.4	2.6	77.4	O K
480 min Winter	52.193	0.193	0.2	2.5	2.7	79.4	O K
600 min Winter	52.195	0.195	0.2	2.5	2.7	80.2	O K
720 min Winter	52.195	0.195	0.2	2.5	2.7	80.2	O K
960 min Winter	52.190	0.190	0.2	2.5	2.6	78.2	O K
1440 min Winter	52.176	0.176	0.2	2.4	2.5	72.4	O K
2160 min Winter	52.154	0.154	0.2	2.2	2.4	63.3	O K
2880 min Winter	52.135	0.135	0.2	2.0	2.2	55.4	O K
4320 min Winter	52.103	0.103	0.2	1.7	1.9	42.3	O K
5760 min Winter	52.083	0.083	0.2	1.4	1.6	34.1	O K
7200 min Winter	52.072	0.072	0.2	1.2	1.4	29.7	O K
8640 min Winter	52.065	0.065	0.2	1.1	1.3	26.9	O K
10080 min Winter	52.060	0.060	0.2	1.0	1.1	24.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	19.312	0.0	43.8	33
60 min Winter	12.146	0.0	58.5	62
120 min Winter	7.639	0.0	73.8	118
180 min Winter	5.824	0.0	84.5	174
240 min Winter	4.805	0.0	93.0	226
360 min Winter	3.663	0.0	106.4	282
480 min Winter	3.022	0.0	117.0	360
600 min Winter	2.603	0.0	126.0	436
720 min Winter	2.304	0.0	133.7	512
960 min Winter	1.885	0.0	145.8	662
1440 min Winter	1.421	0.0	164.3	940
2160 min Winter	1.071	0.0	188.9	1344
2880 min Winter	0.877	0.0	205.9	1728
4320 min Winter	0.645	0.0	226.2	2464
5760 min Winter	0.519	0.0	244.4	3168
7200 min Winter	0.438	0.0	258.0	3824
8640 min Winter	0.382	0.0	269.4	4584
10080 min Winter	0.340	0.0	278.8	5304

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Date 12 July 2017	Designed by IL	
File 16-037SRC_Catchment D_P1 - 1y...	Checked by GV	
XP Solutions	Source Control 2015.1	

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	1	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.531

Time (mins) Area

From: To: (ha)

0 4 0.531

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	1369.0	1369.0	0.500	1369.0	1443.0	0.600	0.0	1443.0

Orifice Outflow Control

Diameter (m) 0.054 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions		Source Control 2015.1

Summary of Results for 30 year Return Period

Half Drain Time : 364 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.282	0.282	0.0	0.7	0.8	21.6	O K
30 min Summer	52.328	0.328	0.0	0.8	0.8	25.2	O K
60 min Summer	52.377	0.377	0.0	0.9	0.9	29.0	O K
120 min Summer	52.422	0.422	0.0	0.9	0.9	32.4	O K
180 min Summer	52.442	0.442	0.0	0.9	1.0	33.9	O K
240 min Summer	52.450	0.450	0.0	0.9	1.0	34.5	O K
360 min Summer	52.455	0.455	0.0	0.9	1.0	34.9	O K
480 min Summer	52.456	0.456	0.0	0.9	1.0	35.0	O K
600 min Summer	52.454	0.454	0.0	0.9	1.0	34.9	O K
720 min Summer	52.451	0.451	0.0	0.9	1.0	34.6	O K
960 min Summer	52.436	0.436	0.0	0.9	1.0	33.4	O K
1440 min Summer	52.402	0.402	0.0	0.9	0.9	30.9	O K
2160 min Summer	52.356	0.356	0.0	0.8	0.9	27.4	O K
2880 min Summer	52.317	0.317	0.0	0.8	0.8	24.4	O K
4320 min Summer	52.248	0.248	0.0	0.7	0.7	19.0	O K
5760 min Summer	52.200	0.200	0.0	0.6	0.6	15.3	O K
7200 min Summer	52.165	0.165	0.0	0.5	0.6	12.6	O K
8640 min Summer	52.138	0.138	0.0	0.5	0.5	10.6	O K
10080 min Summer	52.118	0.118	0.0	0.5	0.5	9.1	O K
15 min Winter	52.282	0.282	0.0	0.7	0.8	21.6	O K
30 min Winter	52.328	0.328	0.0	0.8	0.8	25.2	O K
60 min Winter	52.378	0.378	0.0	0.9	0.9	29.0	O K
120 min Winter	52.423	0.423	0.0	0.9	0.9	32.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.337	0.0	21.8	19
30 min Summer	62.923	0.0	25.8	33
60 min Summer	37.233	0.0	30.9	62
120 min Summer	22.032	0.0	36.6	122
180 min Summer	16.209	0.0	40.4	180
240 min Summer	13.037	0.0	43.3	240
360 min Summer	9.591	0.0	47.8	296
480 min Summer	7.714	0.0	51.2	358
600 min Summer	6.515	0.0	54.1	424
720 min Summer	5.675	0.0	56.5	492
960 min Summer	4.528	0.0	60.1	628
1440 min Summer	3.294	0.0	65.5	908
2160 min Summer	2.396	0.0	71.8	1300
2880 min Summer	1.912	0.0	76.3	1700
4320 min Summer	1.357	0.0	81.2	2424
5760 min Summer	1.064	0.0	85.0	3168
7200 min Summer	0.881	0.0	88.0	3888
8640 min Summer	0.755	0.0	90.5	4584
10080 min Summer	0.663	0.0	92.6	5344
15 min Winter	106.337	0.0	21.8	18
30 min Winter	62.923	0.0	25.8	33
60 min Winter	37.233	0.0	30.9	62
120 min Winter	22.032	0.0	36.6	120

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XP Solutions		Source Control 2015.1

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	52.444	0.444	0.0	0.9	1.0	34.1	O K
240 min Winter	52.453	0.453	0.0	0.9	1.0	34.8	O K
360 min Winter	52.455	0.455	0.0	0.9	1.0	35.0	O K
480 min Winter	52.454	0.454	0.0	0.9	1.0	34.9	O K
600 min Winter	52.450	0.450	0.0	0.9	1.0	34.6	O K
720 min Winter	52.443	0.443	0.0	0.9	1.0	34.0	O K
960 min Winter	52.421	0.421	0.0	0.9	0.9	32.3	O K
1440 min Winter	52.374	0.374	0.0	0.8	0.9	28.8	O K
2160 min Winter	52.314	0.314	0.0	0.8	0.8	24.1	O K
2880 min Winter	52.265	0.265	0.0	0.7	0.7	20.3	O K
4320 min Winter	52.187	0.187	0.0	0.6	0.6	14.4	O K
5760 min Winter	52.138	0.138	0.0	0.5	0.5	10.6	O K
7200 min Winter	52.106	0.106	0.0	0.4	0.5	8.2	O K
8640 min Winter	52.085	0.085	0.0	0.4	0.4	6.5	O K
10080 min Winter	52.069	0.069	0.0	0.3	0.4	5.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	16.209	0.0	40.4	176
240 min Winter	13.037	0.0	43.3	232
360 min Winter	9.591	0.0	47.8	328
480 min Winter	7.714	0.0	51.2	372
600 min Winter	6.515	0.0	54.1	450
720 min Winter	5.675	0.0	56.5	528
960 min Winter	4.528	0.0	60.1	676
1440 min Winter	3.294	0.0	65.5	966
2160 min Winter	2.396	0.0	71.8	1384
2880 min Winter	1.912	0.0	76.3	1764
4320 min Winter	1.357	0.0	81.2	2512
5760 min Winter	1.064	0.0	85.0	3232
7200 min Winter	0.881	0.0	88.0	3960
8640 min Winter	0.755	0.0	90.5	4664
10080 min Winter	0.663	0.0	92.6	5344

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	30	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.090

Time (mins) Area
From: To: (ha)

0 4 0.090

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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	256.0	256.0	0.600	0.0	288.0
0.500	256.0	288.0			

Orifice Outflow Control

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions		Source Control 2015.1

Summary of Results for 30 year Return Period

Half Drain Time : 464 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.271	0.271	0.1	1.9	2.1	73.2	O K
30 min Summer	52.317	0.317	0.1	2.1	2.2	85.6	O K
60 min Summer	52.367	0.367	0.1	2.3	2.4	99.0	O K
120 min Summer	52.416	0.416	0.1	2.4	2.5	112.3	O K
180 min Summer	52.440	0.440	0.1	2.5	2.6	118.8	O K
240 min Summer	52.453	0.453	0.1	2.5	2.7	122.4	O K
360 min Summer	52.463	0.463	0.1	2.6	2.7	125.0	O K
480 min Summer	52.467	0.467	0.1	2.6	2.7	126.1	O K
600 min Summer	52.468	0.468	0.1	2.6	2.7	126.4	O K
720 min Summer	52.468	0.468	0.1	2.6	2.7	126.3	O K
960 min Summer	52.459	0.459	0.1	2.6	2.7	123.9	O K
1440 min Summer	52.435	0.435	0.1	2.5	2.6	117.5	O K
2160 min Summer	52.397	0.397	0.1	2.4	2.5	107.2	O K
2880 min Summer	52.362	0.362	0.1	2.3	2.4	97.8	O K
4320 min Summer	52.294	0.294	0.1	2.0	2.1	79.5	O K
5760 min Summer	52.245	0.245	0.1	1.8	2.0	66.2	O K
7200 min Summer	52.208	0.208	0.1	1.7	1.8	56.1	O K
8640 min Summer	52.179	0.179	0.1	1.5	1.7	48.3	O K
10080 min Summer	52.156	0.156	0.1	1.4	1.5	42.1	O K
15 min Winter	52.271	0.271	0.1	1.9	2.1	73.2	O K
30 min Winter	52.317	0.317	0.1	2.1	2.2	85.6	O K
60 min Winter	52.367	0.367	0.1	2.3	2.4	99.1	O K
120 min Winter	52.417	0.417	0.1	2.4	2.6	112.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.337	0.0	71.4	19
30 min Summer	62.923	0.0	84.6	33
60 min Summer	37.233	0.0	103.5	62
120 min Summer	22.032	0.0	122.5	122
180 min Summer	16.209	0.0	135.2	182
240 min Summer	13.037	0.0	144.9	240
360 min Summer	9.591	0.0	159.9	332
480 min Summer	7.714	0.0	171.4	388
600 min Summer	6.515	0.0	180.9	452
720 min Summer	5.675	0.0	189.0	516
960 min Summer	4.528	0.0	200.8	654
1440 min Summer	3.294	0.0	218.2	924
2160 min Summer	2.396	0.0	241.4	1340
2880 min Summer	1.912	0.0	256.6	1732
4320 min Summer	1.357	0.0	272.6	2504
5760 min Summer	1.064	0.0	286.2	3232
7200 min Summer	0.881	0.0	296.3	3968
8640 min Summer	0.755	0.0	304.6	4672
10080 min Summer	0.663	0.0	311.3	5440
15 min Winter	106.337	0.0	71.4	19
30 min Winter	62.923	0.0	84.6	33
60 min Winter	37.233	0.0	103.5	62
120 min Winter	22.032	0.0	122.5	120

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XP Solutions		Source Control 2015.1

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	52.441	0.441	0.1	2.5	2.6	119.2	O K
240 min Winter	52.455	0.455	0.1	2.5	2.7	122.9	O K
360 min Winter	52.466	0.466	0.1	2.6	2.7	125.9	O K
480 min Winter	52.467	0.467	0.1	2.6	2.7	126.0	O K
600 min Winter	52.467	0.467	0.1	2.6	2.7	126.0	O K
720 min Winter	52.464	0.464	0.1	2.6	2.7	125.3	O K
960 min Winter	52.450	0.450	0.1	2.5	2.7	121.4	O K
1440 min Winter	52.415	0.415	0.1	2.4	2.5	112.0	O K
2160 min Winter	52.363	0.363	0.1	2.3	2.4	97.9	O K
2880 min Winter	52.317	0.317	0.1	2.1	2.2	85.6	O K
4320 min Winter	52.238	0.238	0.1	1.8	1.9	64.1	O K
5760 min Winter	52.184	0.184	0.1	1.6	1.7	49.7	O K
7200 min Winter	52.146	0.146	0.1	1.4	1.5	39.6	O K
8640 min Winter	52.120	0.120	0.1	1.2	1.3	32.3	O K
10080 min Winter	52.100	0.100	0.1	1.1	1.2	27.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	16.209	0.0	135.2	178
240 min Winter	13.037	0.0	144.9	234
360 min Winter	9.591	0.0	159.9	342
480 min Winter	7.714	0.0	171.4	400
600 min Winter	6.515	0.0	180.9	468
720 min Winter	5.675	0.0	189.0	544
960 min Winter	4.528	0.0	200.8	700
1440 min Winter	3.294	0.0	218.3	996
2160 min Winter	2.396	0.0	241.4	1424
2880 min Winter	1.912	0.0	256.6	1820
4320 min Winter	1.357	0.0	272.7	2596
5760 min Winter	1.064	0.0	286.2	3344
7200 min Winter	0.881	0.0	296.3	4040
8640 min Winter	0.755	0.0	304.6	4760
10080 min Winter	0.663	0.0	311.4	5448

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	30	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.303

Time (mins)	Area
From:	To: (ha)

0	4	0.303
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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	0.600	0.0	960.0
0.500	900.0	960.0			

Orifice Outflow Control

Diameter (m) 0.043 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 30 year Return Period

Half Drain Time : 353 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.227	0.227	0.1	1.4	1.5	42.5	O K
30 min Summer	52.265	0.265	0.1	1.6	1.7	49.6	O K
60 min Summer	52.304	0.304	0.1	1.7	1.8	57.0	O K
120 min Summer	52.341	0.341	0.1	1.8	1.9	63.9	O K
180 min Summer	52.356	0.356	0.1	1.8	1.9	66.8	O K
240 min Summer	52.363	0.363	0.1	1.9	1.9	68.0	O K
360 min Summer	52.368	0.368	0.1	1.9	2.0	68.9	O K
480 min Summer	52.369	0.369	0.1	1.9	2.0	69.2	O K
600 min Summer	52.368	0.368	0.1	1.9	2.0	69.0	O K
720 min Summer	52.366	0.366	0.1	1.9	2.0	68.5	O K
960 min Summer	52.354	0.354	0.1	1.8	1.9	66.3	O K
1440 min Summer	52.327	0.327	0.1	1.8	1.8	61.4	O K
2160 min Summer	52.290	0.290	0.1	1.7	1.7	54.4	O K
2880 min Summer	52.258	0.258	0.1	1.6	1.6	48.4	O K
4320 min Summer	52.202	0.202	0.1	1.4	1.4	38.0	O K
5760 min Summer	52.164	0.164	0.1	1.2	1.3	30.7	O K
7200 min Summer	52.136	0.136	0.1	1.1	1.2	25.5	O K
8640 min Summer	52.115	0.115	0.1	1.0	1.1	21.6	O K
10080 min Summer	52.099	0.099	0.1	0.9	1.0	18.6	O K
15 min Winter	52.227	0.227	0.1	1.4	1.5	42.5	O K
30 min Winter	52.265	0.265	0.1	1.6	1.7	49.6	O K
60 min Winter	52.304	0.304	0.1	1.7	1.8	57.1	O K
120 min Winter	52.341	0.341	0.1	1.8	1.9	64.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.337	0.0	42.2	19
30 min Summer	62.923	0.0	50.0	33
60 min Summer	37.233	0.0	60.6	62
120 min Summer	22.032	0.0	71.7	122
180 min Summer	16.209	0.0	79.2	180
240 min Summer	13.037	0.0	84.9	238
360 min Summer	9.591	0.0	93.7	292
480 min Summer	7.714	0.0	100.4	354
600 min Summer	6.515	0.0	106.0	422
720 min Summer	5.675	0.0	110.8	492
960 min Summer	4.528	0.0	117.8	626
1440 min Summer	3.294	0.0	128.3	898
2160 min Summer	2.396	0.0	141.1	1300
2880 min Summer	1.912	0.0	150.0	1676
4320 min Summer	1.357	0.0	159.4	2424
5760 min Summer	1.064	0.0	167.2	3168
7200 min Summer	0.881	0.0	173.1	3888
8640 min Summer	0.755	0.0	177.9	4584
10080 min Summer	0.663	0.0	181.9	5336
15 min Winter	106.337	0.0	42.2	18
30 min Winter	62.923	0.0	50.0	33
60 min Winter	37.233	0.0	60.6	62
120 min Winter	22.032	0.0	71.7	120

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XP Solutions		Source Control 2015.1

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	52.358	0.358	0.1	1.8	1.9	67.1	O K
240 min Winter	52.365	0.365	0.1	1.9	2.0	68.5	O K
360 min Winter	52.367	0.367	0.1	1.9	2.0	68.9	O K
480 min Winter	52.367	0.367	0.1	1.9	2.0	68.9	O K
600 min Winter	52.364	0.364	0.1	1.9	1.9	68.2	O K
720 min Winter	52.358	0.358	0.1	1.8	1.9	67.2	O K
960 min Winter	52.341	0.341	0.1	1.8	1.9	63.9	O K
1440 min Winter	52.304	0.304	0.1	1.7	1.8	56.9	O K
2160 min Winter	52.254	0.254	0.1	1.5	1.6	47.7	O K
2880 min Winter	52.215	0.215	0.1	1.4	1.5	40.3	O K
4320 min Winter	52.153	0.153	0.1	1.2	1.2	28.7	O K
5760 min Winter	52.115	0.115	0.1	1.0	1.1	21.5	O K
7200 min Winter	52.090	0.090	0.1	0.8	0.9	16.8	O K
8640 min Winter	52.073	0.073	0.1	0.7	0.8	13.7	O K
10080 min Winter	52.061	0.061	0.1	0.6	0.7	11.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	16.209	0.0	79.2	176
240 min Winter	13.037	0.0	84.9	230
360 min Winter	9.591	0.0	93.7	302
480 min Winter	7.714	0.0	100.4	370
600 min Winter	6.515	0.0	106.0	448
720 min Winter	5.675	0.0	110.8	526
960 min Winter	4.528	0.0	117.8	674
1440 min Winter	3.294	0.0	128.3	964
2160 min Winter	2.396	0.0	141.1	1368
2880 min Winter	1.912	0.0	150.0	1760
4320 min Winter	1.357	0.0	159.4	2508
5760 min Winter	1.064	0.0	167.2	3232
7200 min Winter	0.881	0.0	173.1	3960
8640 min Winter	0.755	0.0	177.9	4664
10080 min Winter	0.663	0.0	182.0	5344

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	30	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.177

Time (mins)	Area
From:	To: (ha)

0	4	0.177
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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	625.0	625.0	0.600	0.0	675.0
0.500	625.0	675.0			

Orifice Outflow Control

Diameter (m) 0.039 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 30 year Return Period

Half Drain Time : 287 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.310	0.310	0.2	5.4	5.6	127.1	O K
30 min Summer	52.360	0.360	0.2	5.8	6.0	147.9	O K
60 min Summer	52.412	0.412	0.2	6.3	6.5	169.0	O K
120 min Summer	52.456	0.456	0.2	6.6	6.8	187.2	O K
180 min Summer	52.472	0.472	0.2	6.8	6.9	193.8	O K
240 min Summer	52.478	0.478	0.2	6.8	7.0	196.1	O K
360 min Summer	52.483	0.483	0.2	6.8	7.0	198.5	O K
480 min Summer	52.483	0.483	0.2	6.8	7.0	198.5	O K
600 min Summer	52.480	0.480	0.2	6.8	7.0	197.0	O K
720 min Summer	52.474	0.474	0.2	6.8	7.0	194.5	O K
960 min Summer	52.454	0.454	0.2	6.6	6.8	186.4	O K
1440 min Summer	52.413	0.413	0.2	6.3	6.5	169.5	O K
2160 min Summer	52.358	0.358	0.2	5.8	6.0	147.0	O K
2880 min Summer	52.314	0.314	0.2	5.4	5.6	128.8	O K
4320 min Summer	52.241	0.241	0.2	4.6	4.8	98.9	O K
5760 min Summer	52.193	0.193	0.2	4.1	4.3	79.3	O K
7200 min Summer	52.160	0.160	0.2	3.6	3.8	65.8	O K
8640 min Summer	52.137	0.137	0.2	3.3	3.5	56.1	O K
10080 min Summer	52.119	0.119	0.2	3.0	3.2	49.1	O K
15 min Winter	52.310	0.310	0.2	5.4	5.6	127.2	O K
30 min Winter	52.360	0.360	0.2	5.8	6.0	147.9	O K
60 min Winter	52.412	0.412	0.2	6.3	6.5	169.2	O K
120 min Winter	52.457	0.457	0.2	6.6	6.8	187.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.337	0.0	126.4	19
30 min Summer	62.923	0.0	150.0	33
60 min Summer	37.233	0.0	181.6	62
120 min Summer	22.032	0.0	215.1	122
180 min Summer	16.209	0.0	237.4	180
240 min Summer	13.037	0.0	254.6	208
360 min Summer	9.591	0.0	281.0	270
480 min Summer	7.714	0.0	301.3	338
600 min Summer	6.515	0.0	318.1	406
720 min Summer	5.675	0.0	332.5	476
960 min Summer	4.528	0.0	353.5	610
1440 min Summer	3.294	0.0	385.0	880
2160 min Summer	2.396	0.0	423.1	1276
2880 min Summer	1.912	0.0	449.9	1644
4320 min Summer	1.357	0.0	477.9	2380
5760 min Summer	1.064	0.0	501.6	3112
7200 min Summer	0.881	0.0	519.2	3816
8640 min Summer	0.755	0.0	533.7	4504
10080 min Summer	0.663	0.0	545.5	5240
15 min Winter	106.337	0.0	126.4	18
30 min Winter	62.923	0.0	150.0	33
60 min Winter	37.233	0.0	181.6	62
120 min Winter	22.032	0.0	215.1	118

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XP Solutions		Source Control 2015.1

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	52.474	0.474	0.2	6.8	7.0	194.9	O K
240 min Winter	52.480	0.480	0.2	6.8	7.0	197.0	O K
360 min Winter	52.481	0.481	0.2	6.8	7.0	197.5	O K
480 min Winter	52.477	0.477	0.2	6.8	7.0	195.9	O K
600 min Winter	52.468	0.468	0.2	6.7	6.9	192.4	O K
720 min Winter	52.458	0.458	0.2	6.7	6.8	187.9	O K
960 min Winter	52.428	0.428	0.2	6.4	6.6	175.9	O K
1440 min Winter	52.372	0.372	0.2	5.9	6.1	152.8	O K
2160 min Winter	52.303	0.303	0.2	5.3	5.5	124.4	O K
2880 min Winter	52.251	0.251	0.2	4.8	4.9	103.0	O K
4320 min Winter	52.175	0.175	0.2	3.8	4.0	71.9	O K
5760 min Winter	52.132	0.132	0.2	3.2	3.4	54.2	O K
7200 min Winter	52.106	0.106	0.2	2.7	2.9	43.6	O K
8640 min Winter	52.093	0.093	0.2	2.4	2.6	38.3	O K
10080 min Winter	52.085	0.085	0.2	2.1	2.3	34.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	16.209	0.0	237.4	174
240 min Winter	13.037	0.0	254.6	226
360 min Winter	9.591	0.0	281.0	282
480 min Winter	7.714	0.0	301.3	358
600 min Winter	6.515	0.0	318.1	434
720 min Winter	5.675	0.0	332.5	508
960 min Winter	4.528	0.0	353.5	654
1440 min Winter	3.294	0.0	385.0	936
2160 min Winter	2.396	0.0	423.1	1336
2880 min Winter	1.912	0.0	449.9	1704
4320 min Winter	1.357	0.0	478.0	2424
5760 min Winter	1.064	0.0	501.6	3120
7200 min Winter	0.881	0.0	519.2	3816
8640 min Winter	0.755	0.0	533.8	4496
10080 min Winter	0.663	0.0	545.7	5240

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	30	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.531

Time (mins) Area
From: To: (ha)

0 4 0.531

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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	1369.0	1369.0	0.600	0.0	1443.0
0.500	1369.0	1443.0			

Orifice Outflow Control

Diameter (m) 0.070 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Half Drain Time : 389 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.445	0.445	0.0	0.6	0.6	34.1	O K
30 min Summer	52.511	0.511	0.0	0.7	0.7	39.2	O K
60 min Summer	55.001	3.001	0.0	1.6	1.6	44.0	FLOOD
120 min Summer	55.004	3.004	0.0	1.6	1.6	47.8	FLOOD
180 min Summer	55.006	3.006	0.0	1.6	1.6	49.2	FLOOD
240 min Summer	55.006	3.006	0.0	1.6	1.6	49.7	FLOOD
360 min Summer	55.007	3.007	0.0	1.6	1.6	50.3	FLOOD
480 min Summer	55.007	3.007	0.0	1.6	1.6	50.5	FLOOD
600 min Summer	55.007	3.007	0.0	1.6	1.6	50.4	FLOOD
720 min Summer	55.007	3.007	0.0	1.6	1.6	50.0	FLOOD
960 min Summer	55.005	3.005	0.0	1.6	1.6	48.6	FLOOD
1440 min Summer	55.002	3.002	0.0	1.6	1.6	45.7	FLOOD
2160 min Summer	54.649	2.649	0.0	1.5	1.5	43.0	O K
2880 min Summer	53.583	1.583	0.0	1.2	1.2	41.9	O K
4320 min Summer	52.489	0.489	0.0	0.6	0.7	37.5	O K
5760 min Summer	52.414	0.414	0.0	0.6	0.6	31.8	O K
7200 min Summer	52.356	0.356	0.0	0.5	0.6	27.4	O K
8640 min Summer	52.310	0.310	0.0	0.5	0.5	23.8	O K
10080 min Summer	52.272	0.272	0.0	0.5	0.5	20.9	O K
15 min Winter	52.445	0.445	0.0	0.6	0.6	34.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	166.149	0.0	33.1	19
30 min Summer	96.184	0.0	37.5	34
60 min Summer	55.682	3.0	46.2	62
120 min Summer	32.234	6.8	53.4	122
180 min Summer	23.413	8.2	58.2	180
240 min Summer	18.661	8.7	61.9	214
360 min Summer	13.554	9.3	67.4	274
480 min Summer	10.803	9.5	71.6	338
600 min Summer	9.060	9.4	75.0	408
720 min Summer	7.846	9.1	78.0	476
960 min Summer	6.204	7.6	82.0	608
1440 min Summer	4.455	4.7	87.5	866
2160 min Summer	3.199	0.0	95.8	1252
2880 min Summer	2.529	0.0	101.0	1672
4320 min Summer	1.773	0.0	106.0	2592
5760 min Summer	1.378	0.0	110.1	3344
7200 min Summer	1.133	0.0	113.1	4104
8640 min Summer	0.966	0.0	115.7	4840
10080 min Summer	0.844	0.0	117.8	5552
15 min Winter	166.149	0.0	33.1	19

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XP Solutions		Source Control 2015.1

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	52.512	0.512	0.0	0.7	0.7	39.2	O K
60 min Winter	55.001	3.001	0.0	1.6	1.6	44.1	FLOOD
120 min Winter	55.005	3.005	0.0	1.6	1.6	48.1	FLOOD
180 min Winter	55.006	3.006	0.0	1.6	1.6	49.8	FLOOD
240 min Winter	55.007	3.007	0.0	1.6	1.6	50.4	FLOOD
360 min Winter	55.007	3.007	0.0	1.6	1.6	50.7	FLOOD
480 min Winter	55.007	3.007	0.0	1.6	1.6	50.6	FLOOD
600 min Winter	55.007	3.007	0.0	1.6	1.6	50.1	FLOOD
720 min Winter	55.006	3.006	0.0	1.6	1.6	49.4	FLOOD
960 min Winter	55.004	3.004	0.0	1.6	1.6	47.3	FLOOD
1440 min Winter	55.001	3.001	0.0	1.6	1.6	43.9	FLOOD
2160 min Winter	53.756	1.756	0.0	1.2	1.3	42.1	O K
2880 min Winter	52.740	0.740	0.0	0.8	0.8	41.1	O K
4320 min Winter	52.422	0.422	0.0	0.6	0.6	32.4	O K
5760 min Winter	52.336	0.336	0.0	0.5	0.6	25.8	O K
7200 min Winter	52.272	0.272	0.0	0.5	0.5	20.9	O K
8640 min Winter	52.224	0.224	0.0	0.4	0.5	17.2	O K
10080 min Winter	52.186	0.186	0.0	0.4	0.4	14.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	96.184	0.0	37.5	33
60 min Winter	55.682	3.1	46.2	62
120 min Winter	32.234	7.2	53.4	118
180 min Winter	23.413	8.8	58.2	174
240 min Winter	18.661	9.4	61.9	228
360 min Winter	13.554	9.7	67.4	284
480 min Winter	10.803	9.6	71.6	360
600 min Winter	9.060	9.1	75.0	434
720 min Winter	7.846	8.4	78.0	508
960 min Winter	6.204	6.3	82.0	646
1440 min Winter	4.455	2.9	87.4	906
2160 min Winter	3.199	0.0	95.8	1324
2880 min Winter	2.529	0.0	101.0	1848
4320 min Winter	1.773	0.0	106.0	2724
5760 min Winter	1.378	0.0	110.1	3512
7200 min Winter	1.133	0.0	113.1	4248
8640 min Winter	0.966	0.0	115.7	5008
10080 min Winter	0.844	0.0	117.8	5656

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.090

Time (mins) Area
From: To: (ha)

0 4 0.090

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	256.0	256.0	0.500	256.0	288.0	0.600	0.0	288.0

Orifice Outflow Control

Diameter (m) 0.021 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 438 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	55.002	3.002	0.1	6.1	6.2	148.8	FLOOD
30 min Summer	55.023	3.023	0.1	6.1	6.2	169.3	FLOOD
60 min Summer	55.044	3.044	0.1	6.1	6.2	190.6	FLOOD
120 min Summer	55.063	3.063	0.1	6.1	6.2	209.7	FLOOD
180 min Summer	55.071	3.071	0.1	6.1	6.3	217.5	FLOOD
240 min Summer	55.074	3.074	0.1	6.1	6.3	220.2	FLOOD
360 min Summer	55.076	3.076	0.1	6.1	6.3	222.2	FLOOD
480 min Summer	55.076	3.076	0.1	6.1	6.3	222.6	FLOOD
600 min Summer	55.076	3.076	0.1	6.1	6.3	222.0	FLOOD
720 min Summer	55.074	3.074	0.1	6.1	6.3	220.3	FLOOD
960 min Summer	55.067	3.067	0.1	6.1	6.2	213.3	FLOOD
1440 min Summer	55.051	3.051	0.1	6.1	6.2	197.6	FLOOD
2160 min Summer	55.029	3.029	0.1	6.1	6.2	175.6	FLOOD
2880 min Summer	55.012	3.012	0.1	6.1	6.2	158.8	FLOOD
4320 min Summer	54.248	2.248	0.1	5.2	5.4	145.6	O K
5760 min Summer	52.763	0.763	0.1	3.0	3.1	144.2	O K
7200 min Summer	52.468	0.468	0.1	2.3	2.5	126.4	O K
8640 min Summer	52.410	0.410	0.1	2.2	2.3	110.7	O K
10080 min Summer	52.362	0.362	0.1	2.0	2.2	97.7	O K
15 min Winter	55.002	3.002	0.1	6.1	6.2	148.9	FLOOD
30 min Winter	55.023	3.023	0.1	6.1	6.2	169.6	FLOOD
60 min Winter	55.045	3.045	0.1	6.1	6.2	191.3	FLOOD
120 min Winter	55.064	3.064	0.1	6.1	6.2	210.6	FLOOD

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	215.994	4.8	141.8	19
30 min Summer	125.040	25.3	163.7	33
60 min Summer	72.386	46.6	201.4	62
120 min Summer	41.905	65.7	233.3	122
180 min Summer	30.437	73.5	254.1	180
240 min Summer	24.259	76.2	270.1	236
360 min Summer	17.620	78.2	294.2	290
480 min Summer	14.043	78.6	312.5	352
600 min Summer	11.777	78.0	327.4	418
720 min Summer	10.200	76.3	340.1	486
960 min Summer	8.065	69.3	358.0	620
1440 min Summer	5.791	53.6	382.5	882
2160 min Summer	4.159	31.6	419.1	1256
2880 min Summer	3.288	14.8	441.6	1612
4320 min Summer	2.305	0.0	463.0	2332
5760 min Summer	1.791	0.0	481.7	3280
7200 min Summer	1.473	0.0	495.2	4112
8640 min Summer	1.255	0.0	506.2	4840
10080 min Summer	1.097	0.0	515.2	5552
15 min Winter	215.994	4.9	141.8	18
30 min Winter	125.040	25.6	163.7	33
60 min Winter	72.386	47.3	201.4	62
120 min Winter	41.905	66.6	233.3	120

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XP Solutions		Source Control 2015.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	55.073	3.073	0.1	6.1	6.3	219.0	FLOOD
240 min Winter	55.076	3.076	0.1	6.1	6.3	222.4	FLOOD
360 min Winter	55.076	3.076	0.1	6.1	6.3	222.4	FLOOD
480 min Winter	55.075	3.075	0.1	6.1	6.3	221.7	FLOOD
600 min Winter	55.073	3.073	0.1	6.1	6.3	219.3	FLOOD
720 min Winter	55.069	3.069	0.1	6.1	6.3	215.6	FLOOD
960 min Winter	55.058	3.058	0.1	6.1	6.2	204.6	FLOOD
1440 min Winter	55.036	3.036	0.1	6.1	6.2	182.3	FLOOD
2160 min Winter	55.010	3.010	0.1	6.1	6.2	156.4	FLOOD
2880 min Winter	54.795	2.795	0.1	5.8	6.0	146.2	Flood Risk
4320 min Winter	52.876	0.876	0.1	3.2	3.4	144.3	O K
5760 min Winter	52.445	0.445	0.1	2.3	2.4	120.1	O K
7200 min Winter	52.364	0.364	0.1	2.1	2.2	98.4	O K
8640 min Winter	52.303	0.303	0.1	1.9	2.0	81.8	O K
10080 min Winter	52.255	0.255	0.1	1.7	1.8	68.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	30.437	75.0	254.1	176
240 min Winter	24.259	78.4	270.1	230
360 min Winter	17.620	78.4	294.2	298
480 min Winter	14.043	77.7	312.5	368
600 min Winter	11.777	75.3	327.4	446
720 min Winter	10.200	71.6	340.1	520
960 min Winter	8.065	60.6	358.0	664
1440 min Winter	5.791	38.3	382.6	936
2160 min Winter	4.159	12.4	419.1	1276
2880 min Winter	3.288	0.0	441.5	1560
4320 min Winter	2.305	0.0	462.8	2592
5760 min Winter	1.791	0.0	481.7	3520
7200 min Winter	1.473	0.0	495.2	4256
8640 min Winter	1.255	0.0	506.2	5016
10080 min Winter	1.097	0.0	515.3	5744

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.303

Time (mins) Area
From: To: (ha)

0 4 0.303

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XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	0.600	0.0	960.0
0.500	900.0	960.0			

Orifice Outflow Control

Diameter (m) 0.041 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Half Drain Time : 783 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.360	0.360	0.1	0.6	0.7	67.5	O K
30 min Summer	52.415	0.415	0.1	0.6	0.7	77.8	O K
60 min Summer	52.476	0.476	0.1	0.7	0.8	89.3	O K
120 min Summer	54.019	2.019	0.1	1.4	1.5	101.4	O K
180 min Summer	55.004	3.004	0.1	1.7	1.8	106.6	FLOOD
240 min Summer	55.007	3.007	0.1	1.7	1.8	109.6	FLOOD
360 min Summer	55.010	3.010	0.1	1.7	1.8	112.7	FLOOD
480 min Summer	55.011	3.011	0.1	1.7	1.8	113.8	FLOOD
600 min Summer	55.012	3.012	0.1	1.8	1.8	114.6	FLOOD
720 min Summer	55.013	3.013	0.1	1.8	1.8	115.2	FLOOD
960 min Summer	55.012	3.012	0.1	1.8	1.8	114.7	FLOOD
1440 min Summer	55.010	3.010	0.1	1.7	1.8	112.6	FLOOD
2160 min Summer	55.006	3.006	0.1	1.7	1.8	108.4	FLOOD
2880 min Summer	55.002	3.002	0.1	1.7	1.8	104.5	FLOOD
4320 min Summer	53.446	1.446	0.1	1.2	1.3	100.8	O K
5760 min Summer	52.502	0.502	0.1	0.7	0.8	94.0	O K
7200 min Summer	52.454	0.454	0.1	0.7	0.8	85.2	O K
8640 min Summer	52.414	0.414	0.1	0.6	0.7	77.6	O K
10080 min Summer	52.379	0.379	0.1	0.6	0.7	71.0	O K
15 min Winter	52.360	0.360	0.1	0.6	0.7	67.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	166.149	0.0	47.2	19
30 min Summer	96.184	0.0	51.2	34
60 min Summer	55.682	0.0	86.4	64
120 min Summer	32.234	0.0	96.9	122
180 min Summer	23.413	6.6	104.6	182
240 min Summer	18.661	9.6	110.1	242
360 min Summer	13.554	12.7	118.1	360
480 min Summer	10.803	13.8	123.7	430
600 min Summer	9.060	14.6	127.9	488
720 min Summer	7.846	15.2	131.1	550
960 min Summer	6.204	14.7	134.7	674
1440 min Summer	4.455	12.6	134.9	950
2160 min Summer	3.199	8.4	186.9	1344
2880 min Summer	2.529	4.5	195.3	1732
4320 min Summer	1.773	0.0	189.3	2596
5760 min Summer	1.378	0.0	216.4	3576
7200 min Summer	1.133	0.0	222.4	4392
8640 min Summer	0.966	0.0	227.2	5184
10080 min Summer	0.844	0.0	231.1	5952
15 min Winter	166.149	0.0	47.2	19

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XP Solutions		Source Control 2015.1

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	52.415	0.415	0.1	0.6	0.7	77.8	O K
60 min Winter	52.476	0.476	0.1	0.7	0.8	89.3	O K
120 min Winter	54.049	2.049	0.1	1.4	1.5	101.4	O K
180 min Winter	55.004	3.004	0.1	1.7	1.8	106.9	FLOOD
240 min Winter	55.008	3.008	0.1	1.7	1.8	110.3	FLOOD
360 min Winter	55.012	3.012	0.1	1.8	1.8	114.1	FLOOD
480 min Winter	55.013	3.013	0.1	1.8	1.8	115.5	FLOOD
600 min Winter	55.013	3.013	0.1	1.8	1.8	115.7	FLOOD
720 min Winter	55.014	3.014	0.1	1.8	1.8	116.2	FLOOD
960 min Winter	55.013	3.013	0.1	1.8	1.8	115.3	FLOOD
1440 min Winter	55.009	3.009	0.1	1.7	1.8	111.8	FLOOD
2160 min Winter	55.004	3.004	0.1	1.7	1.8	106.0	FLOOD
2880 min Winter	54.939	2.939	0.1	1.7	1.8	102.3	Flood Risk
4320 min Winter	52.548	0.548	0.1	0.7	0.8	99.1	O K
5760 min Winter	52.460	0.460	0.1	0.7	0.8	86.3	O K
7200 min Winter	52.402	0.402	0.1	0.6	0.7	75.4	O K
8640 min Winter	52.354	0.354	0.1	0.6	0.7	66.3	O K
10080 min Winter	52.312	0.312	0.1	0.6	0.6	58.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	96.184	0.0	51.2	34
60 min Winter	55.682	0.0	86.4	64
120 min Winter	32.234	0.0	97.0	120
180 min Winter	23.413	6.9	104.6	178
240 min Winter	18.661	10.3	110.1	236
360 min Winter	13.554	14.1	118.0	348
480 min Winter	10.803	15.5	123.5	454
600 min Winter	9.060	15.7	127.7	506
720 min Winter	7.846	16.2	130.9	564
960 min Winter	6.204	15.3	134.4	714
1440 min Winter	4.455	11.8	135.4	1010
2160 min Winter	3.199	6.0	186.9	1428
2880 min Winter	2.529	0.0	195.1	1812
4320 min Winter	1.773	0.0	187.8	2980
5760 min Winter	1.378	0.0	216.4	3808
7200 min Winter	1.133	0.0	222.4	4616
8640 min Winter	0.966	0.0	227.2	5448
10080 min Winter	0.844	0.0	231.1	6248

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.177

Time (mins) Area
From: To: (ha)

0 4 0.177

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	625.0	625.0	0.500	625.0	675.0	0.600	0.0	675.0

Orifice Outflow Control

Diameter (m) 0.022 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Half Drain Time : 338 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.490	0.490	0.2	4.1	4.3	201.2	O K
30 min Summer	55.007	3.007	0.2	10.5	10.7	228.7	FLOOD
60 min Summer	55.033	3.033	0.2	10.6	10.7	254.5	FLOOD
120 min Summer	55.054	3.054	0.2	10.6	10.8	275.7	FLOOD
180 min Summer	55.061	3.061	0.2	10.6	10.8	282.0	FLOOD
240 min Summer	55.063	3.063	0.2	10.6	10.8	284.7	FLOOD
360 min Summer	55.066	3.066	0.2	10.6	10.8	287.8	FLOOD
480 min Summer	55.066	3.066	0.2	10.6	10.8	287.5	FLOOD
600 min Summer	55.064	3.064	0.2	10.6	10.8	285.2	FLOOD
720 min Summer	55.061	3.061	0.2	10.6	10.8	282.0	FLOOD
960 min Summer	55.050	3.050	0.2	10.6	10.8	271.0	FLOOD
1440 min Summer	55.028	3.028	0.2	10.5	10.7	249.4	FLOOD
2160 min Summer	55.005	3.005	0.2	10.5	10.7	226.6	FLOOD
2880 min Summer	54.327	2.327	0.2	9.2	9.4	220.8	O K
4320 min Summer	52.503	0.503	0.2	4.2	4.4	206.4	O K
5760 min Summer	52.422	0.422	0.2	3.8	4.0	173.2	O K
7200 min Summer	52.360	0.360	0.2	3.5	3.7	147.8	O K
8640 min Summer	52.311	0.311	0.2	3.2	3.4	127.8	O K
10080 min Summer	52.272	0.272	0.2	3.0	3.2	111.7	O K
15 min Winter	52.490	0.490	0.2	4.1	4.3	201.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	166.149	0.0	193.7	19
30 min Summer	96.184	9.6	223.8	33
60 min Summer	55.682	35.5	271.2	62
120 min Summer	32.234	56.6	314.2	120
180 min Summer	23.413	63.0	342.3	176
240 min Summer	18.661	65.7	363.8	202
360 min Summer	13.554	68.7	396.3	262
480 min Summer	10.803	68.4	421.1	330
600 min Summer	9.060	66.2	441.3	398
720 min Summer	7.846	63.0	458.4	464
960 min Summer	6.204	52.0	482.4	598
1440 min Summer	4.455	30.3	516.8	852
2160 min Summer	3.199	7.6	564.8	1208
2880 min Summer	2.529	0.0	595.0	1584
4320 min Summer	1.773	0.0	623.9	2548
5760 min Summer	1.378	0.0	649.4	3288
7200 min Summer	1.133	0.0	667.4	4032
8640 min Summer	0.966	0.0	682.2	4760
10080 min Summer	0.844	0.0	693.9	5456
15 min Winter	166.149	0.0	193.7	19

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	55.007	3.007	0.2	10.5	10.7	228.8	FLOOD
60 min Winter	55.034	3.034	0.2	10.6	10.7	255.3	FLOOD
120 min Winter	55.056	3.056	0.2	10.6	10.8	277.9	FLOOD
180 min Winter	55.064	3.064	0.2	10.6	10.8	285.5	FLOOD
240 min Winter	55.066	3.066	0.2	10.6	10.8	287.3	FLOOD
360 min Winter	55.066	3.066	0.2	10.6	10.8	287.9	FLOOD
480 min Winter	55.064	3.064	0.2	10.6	10.8	285.1	FLOOD
600 min Winter	55.059	3.059	0.2	10.6	10.8	280.0	FLOOD
720 min Winter	55.052	3.052	0.2	10.6	10.8	273.8	FLOOD
960 min Winter	55.037	3.037	0.2	10.6	10.7	258.0	FLOOD
1440 min Winter	55.011	3.011	0.2	10.5	10.7	232.1	FLOOD
2160 min Winter	54.259	2.259	0.2	9.1	9.3	220.7	O K
2880 min Winter	52.982	0.982	0.2	5.9	6.1	219.4	O K
4320 min Winter	52.423	0.423	0.2	3.8	4.0	173.6	O K
5760 min Winter	52.332	0.332	0.2	3.4	3.6	136.3	O K
7200 min Winter	52.267	0.267	0.2	3.0	3.2	109.5	O K
8640 min Winter	52.219	0.219	0.2	2.7	2.9	89.8	O K
10080 min Winter	52.183	0.183	0.2	2.4	2.6	75.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	96.184	9.8	223.8	32
60 min Winter	55.682	36.3	271.2	62
120 min Winter	32.234	58.9	314.1	118
180 min Winter	23.413	66.5	342.3	174
240 min Winter	18.661	68.3	363.8	222
360 min Winter	13.554	68.8	396.3	276
480 min Winter	10.803	66.0	421.1	352
600 min Winter	9.060	61.0	441.3	426
720 min Winter	7.846	54.8	458.4	498
960 min Winter	6.204	38.9	482.4	634
1440 min Winter	4.455	13.0	516.6	878
2160 min Winter	3.199	0.0	564.8	1232
2880 min Winter	2.529	0.0	595.0	1756
4320 min Winter	1.773	0.0	623.9	2676
5760 min Winter	1.378	0.0	649.4	3408
7200 min Winter	1.133	0.0	667.4	4176
8640 min Winter	0.966	0.0	682.2	4848
10080 min Winter	0.844	0.0	694.2	5552

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.531

Time (mins) Area
From: To: (ha)

0 4 0.531

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	1369.0	1369.0	0.500	1369.0	1443.0	0.600	0.0	1443.0

Orifice Outflow Control

Diameter (m) 0.054 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 405 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	55.001	3.001	0.0	1.9	1.9	44.1	FLOOD
30 min Summer	55.007	3.007	0.0	1.9	1.9	50.1	FLOOD
60 min Summer	55.013	3.013	0.0	1.9	1.9	56.3	FLOOD
120 min Summer	55.018	3.018	0.0	1.9	2.0	61.7	FLOOD
180 min Summer	55.020	3.020	0.0	1.9	2.0	63.8	FLOOD
240 min Summer	55.021	3.021	0.0	1.9	2.0	64.4	FLOOD
360 min Summer	55.022	3.022	0.0	1.9	2.0	64.9	FLOOD
480 min Summer	55.022	3.022	0.0	1.9	2.0	64.9	FLOOD
600 min Summer	55.021	3.021	0.0	1.9	2.0	64.5	FLOOD
720 min Summer	55.020	3.020	0.0	1.9	2.0	63.9	FLOOD
960 min Summer	55.018	3.018	0.0	1.9	2.0	61.5	FLOOD
1440 min Summer	55.013	3.013	0.0	1.9	1.9	56.4	FLOOD
2160 min Summer	55.006	3.006	0.0	1.9	1.9	49.6	FLOOD
2880 min Summer	55.002	3.002	0.0	1.9	1.9	45.0	FLOOD
4320 min Summer	53.654	1.654	0.0	1.4	1.5	42.0	O K
5760 min Summer	52.532	0.532	0.0	0.8	0.8	40.2	O K
7200 min Summer	52.449	0.449	0.0	0.7	0.8	34.4	O K
8640 min Summer	52.389	0.389	0.0	0.7	0.7	29.9	O K
10080 min Summer	52.341	0.341	0.0	0.6	0.7	26.2	O K
15 min Winter	55.001	3.001	0.0	1.9	1.9	44.1	FLOOD

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	215.994	3.1	43.6	19
30 min Summer	125.040	9.2	50.3	33
60 min Summer	72.386	15.4	60.1	62
120 min Summer	41.905	20.8	69.6	122
180 min Summer	30.437	22.8	75.8	180
240 min Summer	24.259	23.5	80.6	228
360 min Summer	17.620	23.9	87.8	284
480 min Summer	14.043	23.9	93.3	346
600 min Summer	11.777	23.5	97.7	414
720 min Summer	10.200	22.9	101.6	484
960 min Summer	8.065	20.5	107.0	616
1440 min Summer	5.791	15.4	114.8	880
2160 min Summer	4.159	8.7	124.6	1252
2880 min Summer	3.288	4.0	131.3	1588
4320 min Summer	2.305	0.0	137.9	2376
5760 min Summer	1.791	0.0	143.1	3344
7200 min Summer	1.473	0.0	147.1	4104
8640 min Summer	1.255	0.0	150.4	4840
10080 min Summer	1.097	0.0	153.2	5544
15 min Winter	215.994	3.2	43.6	18

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XP Solutions		Source Control 2015.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	55.007	3.007	0.0	1.9	1.9	50.2	FLOOD
60 min Winter	55.013	3.013	0.0	1.9	1.9	56.5	FLOOD
120 min Winter	55.019	3.019	0.0	1.9	2.0	62.0	FLOOD
180 min Winter	55.021	3.021	0.0	1.9	2.0	64.3	FLOOD
240 min Winter	55.022	3.022	0.0	1.9	2.0	65.1	FLOOD
360 min Winter	55.022	3.022	0.0	1.9	2.0	64.9	FLOOD
480 min Winter	55.021	3.021	0.0	1.9	2.0	64.5	FLOOD
600 min Winter	55.020	3.020	0.0	1.9	2.0	63.5	FLOOD
720 min Winter	55.019	3.019	0.0	1.9	2.0	62.2	FLOOD
960 min Winter	55.015	3.015	0.0	1.9	1.9	58.6	FLOOD
1440 min Winter	55.008	3.008	0.0	1.9	1.9	51.7	FLOOD
2160 min Winter	55.001	3.001	0.0	1.9	1.9	44.4	FLOOD
2880 min Winter	54.180	2.180	0.0	1.6	1.7	42.5	O K
4320 min Winter	52.553	0.553	0.0	0.8	0.8	40.7	O K
5760 min Winter	52.421	0.421	0.0	0.7	0.7	32.3	O K
7200 min Winter	52.340	0.340	0.0	0.6	0.7	26.1	O K
8640 min Winter	52.279	0.279	0.0	0.6	0.6	21.4	O K
10080 min Winter	52.232	0.232	0.0	0.5	0.6	17.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	125.040	9.3	50.3	33
60 min Winter	72.386	15.5	60.1	62
120 min Winter	41.905	21.1	69.6	118
180 min Winter	30.437	23.3	75.8	176
240 min Winter	24.259	24.1	80.6	230
360 min Winter	17.620	23.9	87.8	290
480 min Winter	14.043	23.5	93.3	364
600 min Winter	11.777	22.6	97.7	440
720 min Winter	10.200	21.3	101.6	514
960 min Winter	8.065	17.7	107.0	656
1440 min Winter	5.791	10.7	114.9	922
2160 min Winter	4.159	3.4	124.6	1256
2880 min Winter	3.288	0.0	131.3	1616
4320 min Winter	2.305	0.0	137.9	2684
5760 min Winter	1.791	0.0	143.1	3464
7200 min Winter	1.473	0.0	147.1	4248
8640 min Winter	1.255	0.0	150.4	4936
10080 min Winter	1.097	0.0	153.2	5648

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.090

Time (mins) Area
From: To: (ha)

0 4 0.090

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	256.0	256.0	0.500	256.0	288.0	0.600	0.0	288.0

Orifice Outflow Control

Diameter (m) 0.023 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Half Drain Time : 436 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.426	0.426	0.1	1.8	1.9	115.1	O K
30 min Summer	52.490	0.490	0.1	2.0	2.1	132.2	O K
60 min Summer	55.003	3.003	0.1	4.9	5.1	149.4	FLOOD
120 min Summer	55.016	3.016	0.1	4.9	5.1	162.9	FLOOD
180 min Summer	55.022	3.022	0.1	5.0	5.1	168.6	FLOOD
240 min Summer	55.024	3.024	0.1	5.0	5.1	170.7	FLOOD
360 min Summer	55.027	3.027	0.1	5.0	5.1	173.1	FLOOD
480 min Summer	55.028	3.028	0.1	5.0	5.1	174.2	FLOOD
600 min Summer	55.028	3.028	0.1	5.0	5.1	174.2	FLOOD
720 min Summer	55.027	3.027	0.1	5.0	5.1	173.6	FLOOD
960 min Summer	55.023	3.023	0.1	5.0	5.1	169.5	FLOOD
1440 min Summer	55.014	3.014	0.1	4.9	5.1	160.5	FLOOD
2160 min Summer	55.003	3.003	0.1	4.9	5.1	149.5	FLOOD
2880 min Summer	54.342	2.342	0.1	4.4	4.5	145.7	O K
4320 min Summer	52.506	0.506	0.1	2.0	2.1	136.6	O K
5760 min Summer	52.435	0.435	0.1	1.8	2.0	117.4	O K
7200 min Summer	52.378	0.378	0.1	1.7	1.8	102.1	O K
8640 min Summer	52.332	0.332	0.1	1.6	1.7	89.7	O K
10080 min Summer	52.295	0.295	0.1	1.5	1.6	79.5	O K
15 min Winter	52.426	0.426	0.1	1.8	1.9	115.1	O K
30 min Winter	52.490	0.490	0.1	2.0	2.1	132.3	O K
60 min Winter	55.003	3.003	0.1	4.9	5.1	149.5	FLOOD
120 min Winter	55.018	3.018	0.1	4.9	5.1	163.9	FLOOD

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	166.149	0.0	106.6	19
30 min Summer	96.184	0.0	120.0	34
60 min Summer	55.682	5.4	154.3	62
120 min Summer	32.234	18.9	178.7	122
180 min Summer	23.413	24.6	194.7	180
240 min Summer	18.661	26.7	206.9	228
360 min Summer	13.554	29.1	225.3	284
480 min Summer	10.803	30.2	239.2	346
600 min Summer	9.060	30.2	250.6	412
720 min Summer	7.846	29.6	260.1	482
960 min Summer	6.204	25.5	272.9	616
1440 min Summer	4.455	16.5	287.5	880
2160 min Summer	3.199	5.5	322.1	1252
2880 min Summer	2.529	0.0	339.3	1640
4320 min Summer	1.773	0.0	355.2	2596
5760 min Summer	1.378	0.0	370.5	3400
7200 min Summer	1.133	0.0	380.8	4112
8640 min Summer	0.966	0.0	389.3	4848
10080 min Summer	0.844	0.0	396.0	5640
15 min Winter	166.149	0.0	106.6	19
30 min Winter	96.184	0.0	120.0	33
60 min Winter	55.682	5.5	154.3	62
120 min Winter	32.234	19.9	178.7	118

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
180 min Winter	55.024	3.024	0.1	5.0	5.1	170.4	FLOOD
240 min Winter	55.027	3.027	0.1	5.0	5.1	173.2	FLOOD
360 min Winter	55.028	3.028	0.1	5.0	5.1	174.4	FLOOD
480 min Winter	55.028	3.028	0.1	5.0	5.1	174.8	FLOOD
600 min Winter	55.027	3.027	0.1	5.0	5.1	173.9	FLOOD
720 min Winter	55.026	3.026	0.1	5.0	5.1	172.0	FLOOD
960 min Winter	55.019	3.019	0.1	5.0	5.1	165.7	FLOOD
1440 min Winter	55.007	3.007	0.1	4.9	5.1	153.9	FLOOD
2160 min Winter	54.543	2.543	0.1	4.5	4.7	145.9	O K
2880 min Winter	53.213	1.213	0.1	3.1	3.2	144.6	O K
4320 min Winter	52.446	0.446	0.1	1.9	2.0	120.5	O K
5760 min Winter	52.362	0.362	0.1	1.7	1.8	97.8	O K
7200 min Winter	52.299	0.299	0.1	1.5	1.6	80.6	O K
8640 min Winter	52.249	0.249	0.1	1.4	1.5	67.4	O K
10080 min Winter	52.211	0.211	0.1	1.3	1.4	57.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
180 min Winter	23.413	26.4	194.7	176
240 min Winter	18.661	29.2	206.9	230
360 min Winter	13.554	30.4	225.3	290
480 min Winter	10.803	30.8	239.2	364
600 min Winter	9.060	29.9	250.6	440
720 min Winter	7.846	28.0	260.1	514
960 min Winter	6.204	21.7	272.9	656
1440 min Winter	4.455	9.9	287.3	922
2160 min Winter	3.199	0.0	322.1	1296
2880 min Winter	2.529	0.0	339.2	1788
4320 min Winter	1.773	0.0	355.2	2764
5760 min Winter	1.378	0.0	370.5	3568
7200 min Winter	1.133	0.0	380.9	4320
8640 min Winter	0.966	0.0	389.3	5024
10080 min Winter	0.844	0.0	396.2	5752

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+0
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.303

Time (mins)	Area
From:	To: (ha)

0	4	0.303
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1st Floor Neville House 55 Eden Street Kingston KT1 1BW	16-037 Hornsey Town Hall Hornsey Catchment B : PLANNING	
Date 12 July 2017 File 16-037SRC_Catchment B_P1 - ...	Designed by IL Checked by GV	
XP Solutions		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	0.600	0.0	960.0
0.500	900.0	960.0			

Orifice Outflow Control

Diameter (m) 0.037 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 701 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	52.468	0.468	0.1	1.0	1.0	87.7	O K
30 min Summer	53.481	1.481	0.1	1.7	1.8	100.9	O K
60 min Summer	55.012	3.012	0.1	2.4	2.5	114.0	FLOOD
120 min Summer	55.025	3.025	0.1	2.4	2.5	127.4	FLOOD
180 min Summer	55.032	3.032	0.1	2.5	2.5	134.3	FLOOD
240 min Summer	55.036	3.036	0.1	2.5	2.5	138.3	FLOOD
360 min Summer	55.039	3.039	0.1	2.5	2.5	141.7	FLOOD
480 min Summer	55.040	3.040	0.1	2.5	2.5	142.7	FLOOD
600 min Summer	55.041	3.041	0.1	2.5	2.5	143.3	FLOOD
720 min Summer	55.041	3.041	0.1	2.5	2.5	143.5	FLOOD
960 min Summer	55.039	3.039	0.1	2.5	2.5	141.8	FLOOD
1440 min Summer	55.034	3.034	0.1	2.5	2.5	136.6	FLOOD
2160 min Summer	55.025	3.025	0.1	2.4	2.5	127.6	FLOOD
2880 min Summer	55.017	3.017	0.1	2.4	2.5	118.9	FLOOD
4320 min Summer	55.002	3.002	0.1	2.4	2.5	104.4	FLOOD
5760 min Summer	53.881	1.881	0.1	1.9	2.0	101.3	O K
7200 min Summer	52.586	0.586	0.1	1.1	1.2	100.0	O K
8640 min Summer	52.483	0.483	0.1	1.0	1.1	90.5	O K
10080 min Summer	52.438	0.438	0.1	0.9	1.0	82.1	O K
15 min Winter	52.468	0.468	0.1	1.0	1.0	87.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	215.994	0.0	67.8	19
30 min Summer	125.040	0.0	74.4	34
60 min Summer	72.386	14.0	116.2	64
120 min Summer	41.905	27.4	134.2	122
180 min Summer	30.437	34.3	145.9	182
240 min Summer	24.259	38.3	154.6	242
360 min Summer	17.620	41.7	167.3	360
480 min Summer	14.043	42.7	176.2	414
600 min Summer	11.777	43.3	183.0	476
720 min Summer	10.200	43.5	188.3	536
960 min Summer	8.065	41.8	194.7	666
1440 min Summer	5.791	36.6	201.1	938
2160 min Summer	4.159	27.6	244.4	1340
2880 min Summer	3.288	18.9	257.2	1728
4320 min Summer	2.305	4.4	265.3	2420
5760 min Summer	1.791	0.0	281.4	3224
7200 min Summer	1.473	0.0	289.2	4256
8640 min Summer	1.255	0.0	295.6	5096
10080 min Summer	1.097	0.0	300.9	5848
15 min Winter	215.994	0.0	67.8	19

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XP Solutions		Source Control 2015.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	53.503	1.503	0.1	1.7	1.8	100.9	O K
60 min Winter	55.012	3.012	0.1	2.4	2.5	114.3	FLOOD
120 min Winter	55.025	3.025	0.1	2.4	2.5	127.9	FLOOD
180 min Winter	55.033	3.033	0.1	2.5	2.5	135.0	FLOOD
240 min Winter	55.037	3.037	0.1	2.5	2.5	139.3	FLOOD
360 min Winter	55.041	3.041	0.1	2.5	2.5	143.2	FLOOD
480 min Winter	55.042	3.042	0.1	2.5	2.5	143.9	FLOOD
600 min Winter	55.041	3.041	0.1	2.5	2.5	143.7	FLOOD
720 min Winter	55.041	3.041	0.1	2.5	2.5	143.5	FLOOD
960 min Winter	55.038	3.038	0.1	2.5	2.5	140.6	FLOOD
1440 min Winter	55.030	3.030	0.1	2.5	2.5	132.6	FLOOD
2160 min Winter	55.018	3.018	0.1	2.4	2.5	120.0	FLOOD
2880 min Winter	55.007	3.007	0.1	2.4	2.5	109.7	FLOOD
4320 min Winter	54.134	2.134	0.1	2.1	2.1	101.5	O K
5760 min Winter	52.576	0.576	0.1	1.1	1.1	99.9	O K
7200 min Winter	52.460	0.460	0.1	0.9	1.0	86.2	O K
8640 min Winter	52.399	0.399	0.1	0.9	1.0	74.7	O K
10080 min Winter	52.348	0.348	0.1	0.8	0.9	65.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	125.040	0.0	74.4	33
60 min Winter	72.386	14.3	116.2	62
120 min Winter	41.905	27.9	134.2	120
180 min Winter	30.437	35.0	145.9	178
240 min Winter	24.259	39.3	154.6	236
360 min Winter	17.620	43.2	167.3	346
480 min Winter	14.043	43.9	176.2	450
600 min Winter	11.777	43.7	182.9	484
720 min Winter	10.200	43.5	188.2	556
960 min Winter	8.065	40.6	194.6	710
1440 min Winter	5.791	32.6	201.2	998
2160 min Winter	4.159	20.0	244.4	1404
2880 min Winter	3.288	9.7	257.1	1760
4320 min Winter	2.305	0.0	264.1	2504
5760 min Winter	1.791	0.0	281.4	3696
7200 min Winter	1.473	0.0	289.2	4536
8640 min Winter	1.255	0.0	295.7	5280
10080 min Winter	1.097	0.0	300.9	6056

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.177

Time (mins) Area
From: To: (ha)

0 4 0.177

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	625.0	625.0	0.500	625.0	675.0	0.600	0.0	675.0

Orifice Outflow Control

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 52.000

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XP Solutions	Source Control 2015.1	

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 332 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	55.037	3.037	0.2	13.5	13.7	258.3	FLOOD
30 min Summer	55.072	3.072	0.2	13.5	13.7	293.1	FLOOD
60 min Summer	55.106	3.106	0.2	13.6	13.8	327.7	FLOOD
120 min Summer	55.133	3.133	0.2	13.7	13.9	354.1	FLOOD
180 min Summer	55.141	3.141	0.2	13.7	13.9	362.1	FLOOD
240 min Summer	55.143	3.143	0.2	13.7	13.9	364.1	FLOOD
360 min Summer	55.144	3.144	0.2	13.7	13.9	365.5	FLOOD
480 min Summer	55.142	3.142	0.2	13.7	13.9	363.4	FLOOD
600 min Summer	55.137	3.137	0.2	13.7	13.9	358.8	FLOOD
720 min Summer	55.131	3.131	0.2	13.7	13.9	352.6	FLOOD
960 min Summer	55.113	3.113	0.2	13.6	13.8	334.4	FLOOD
1440 min Summer	55.077	3.077	0.2	13.6	13.7	298.5	FLOOD
2160 min Summer	55.034	3.034	0.2	13.5	13.7	255.6	FLOOD
2880 min Summer	55.008	3.008	0.2	13.4	13.6	229.6	FLOOD
4320 min Summer	53.617	1.617	0.2	9.8	10.0	220.1	O K
5760 min Summer	52.501	0.501	0.2	5.3	5.5	205.8	O K
7200 min Summer	52.423	0.423	0.2	4.9	5.1	173.9	O K
8640 min Summer	52.363	0.363	0.2	4.5	4.7	149.2	O K
10080 min Summer	52.316	0.316	0.2	4.1	4.3	129.7	O K
15 min Winter	55.037	3.037	0.2	13.5	13.7	258.5	FLOOD

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	215.994	39.2	256.9	18
30 min Summer	125.040	74.1	297.9	33
60 min Summer	72.386	108.7	353.6	62
120 min Summer	41.905	135.0	409.6	122
180 min Summer	30.437	143.0	446.3	176
240 min Summer	24.259	145.1	474.3	202
360 min Summer	17.620	146.5	516.7	264
480 min Summer	14.043	144.4	549.0	330
600 min Summer	11.777	139.8	575.5	398
720 min Summer	10.200	133.5	598.0	466
960 min Summer	8.065	115.4	629.9	598
1440 min Summer	5.791	79.5	676.7	852
2160 min Summer	4.159	36.6	734.7	1212
2880 min Summer	3.288	10.6	774.2	1532
4320 min Summer	2.305	0.0	812.3	2292
5760 min Summer	1.791	0.0	844.3	3280
7200 min Summer	1.473	0.0	867.7	3968
8640 min Summer	1.255	0.0	887.1	4752
10080 min Summer	1.097	0.0	902.8	5448
15 min Winter	215.994	39.4	256.9	18

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XP Solutions		Source Control 2015.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	55.072	3.072	0.2	13.5	13.7	293.8	FLOOD
60 min Winter	55.107	3.107	0.2	13.6	13.8	328.2	FLOOD
120 min Winter	55.135	3.135	0.2	13.7	13.9	356.6	FLOOD
180 min Winter	55.143	3.143	0.2	13.7	13.9	364.6	FLOOD
240 min Winter	55.144	3.144	0.2	13.7	13.9	365.1	FLOOD
360 min Winter	55.142	3.142	0.2	13.7	13.9	363.1	FLOOD
480 min Winter	55.135	3.135	0.2	13.7	13.9	356.4	FLOOD
600 min Winter	55.125	3.125	0.2	13.7	13.9	346.6	FLOOD
720 min Winter	55.114	3.114	0.2	13.6	13.8	335.6	FLOOD
960 min Winter	55.087	3.087	0.2	13.6	13.8	308.8	FLOOD
1440 min Winter	55.040	3.040	0.2	13.5	13.7	261.8	FLOOD
2160 min Winter	55.001	3.001	0.2	13.4	13.6	222.4	FLOOD
2880 min Winter	53.866	1.866	0.2	10.5	10.7	220.3	O K
4320 min Winter	52.497	0.497	0.2	5.3	5.5	204.3	O K
5760 min Winter	52.384	0.384	0.2	4.6	4.8	157.8	O K
7200 min Winter	52.305	0.305	0.2	4.1	4.3	125.3	O K
8640 min Winter	52.248	0.248	0.2	3.6	3.8	101.9	O K
10080 min Winter	52.206	0.206	0.2	3.3	3.4	84.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	125.040	74.8	297.9	32
60 min Winter	72.386	109.1	353.6	62
120 min Winter	41.905	137.5	409.6	118
180 min Winter	30.437	145.6	446.3	174
240 min Winter	24.259	146.0	474.3	222
360 min Winter	17.620	144.1	516.7	276
480 min Winter	14.043	137.4	549.1	352
600 min Winter	11.777	127.5	575.5	428
720 min Winter	10.200	116.6	598.0	498
960 min Winter	8.065	89.8	629.9	636
1440 min Winter	5.791	42.7	676.7	880
2160 min Winter	4.159	3.4	734.6	1152
2880 min Winter	3.288	0.0	774.1	1552
4320 min Winter	2.305	0.0	812.4	2636
5760 min Winter	1.791	0.0	844.3	3392
7200 min Winter	1.473	0.0	867.8	4104
8640 min Winter	1.255	0.0	887.1	4840
10080 min Winter	1.097	0.0	903.0	5544

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XP Solutions		Source Control 2015.1

Rainfall Details

Rainfall Model	FEH	D3 (1km)	0.243	Cv (Winter)	0.925
Return Period (years)	100	E (1km)	0.331	Shortest Storm (mins)	15
Site Location		F (1km)	2.497	Longest Storm (mins)	10080
C (1km)	-0.026	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.331	Winter Storms	Yes		
D2 (1km)	0.303	Cv (Summer)	0.925		

Time Area Diagram

Total Area (ha) 0.531

Time (mins) Area
From: To: (ha)

0 4 0.531

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XP Solutions	Source Control 2015.1	

Model Details

Storage is Online Cover Level (m) 55.000

Cellular Storage Structure

Invert Level (m) 52.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.30
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	1369.0	1369.0	0.500	1369.0	1443.0	0.600	0.0	1443.0

Orifice Outflow Control

Diameter (m) 0.061 Discharge Coefficient 0.600 Invert Level (m) 52.000

Appendix D

Haringey SuDS Flows and Volumes Proforma

SuDS Flows and Volumes – LLFA Technical Assessment Proforma

This form identifies the information required by Haringey LLFA to enable technical assessment of flows and volumes determined as part of drainage / SuDS calculations.

Note : * means delete as appropriate; Numbers in brackets refer to accompanying notes.

SITE DETAILS

- 1.1 Planning application reference
- 1.2 Site name Hornsey Town Hall
- 1.3 Total application site area ⁽¹⁾ 13,300 m² 1.33 ha
- 1.4 Is the site located in a CDA or LFRZ Y/N
- 1.5 Is the site located in a SPZ X/N

VOLUME AND FLOW DESIGN INPUTS

- 2.1 Site area which is positively drained by SuDS ⁽²⁾ 11,014 m²
- 2.2 Impermeable area drained pre development ⁽³⁾ 11,300 m²
- 2.3 Impermeable area drained post development ⁽³⁾ 11,014 m²
- 2.4 Additional impermeable area (2.3 minus 2.2) -286 m²
- 2.5 Predevelopment use ⁽⁴⁾ Greenfield / Brownfield / Mixed*
- 2.6 Method of discharge ⁽⁵⁾ Infiltration / waterbody / storm sewer / combined sewer*
- 2.7 Infiltration rate (where applicable) 0.001 m/hr
- 2.8 Influencing factors on infiltration London City
- 2.9 Depth to highest known ground water table approx 1.5m bgl MAOD
- 2.10 Coefficient of runoff (Cv) ⁽⁶⁾ 0.90 Pavement, 0.95 Roof
- 2.11 Justification for Cv used L84 Guidance
- 2.12 FEH rainfall data used (Note that FSR is no longer the preferred rainfall calculation method) Y/N
- 2.13 Will storage be subject to surcharge by elevated water levels in watercourse / sewer Y/N
- 2.14 Invert level at outlet (invert level of final flow control) mAOD
- 2.15 Design level used for surcharge water level at point of discharge ⁽¹⁴⁾ mAOD

SuDS Flows and Volumes – LLFA Technical Assessment Proforma

CALCULATION OUTPUTS

Sections 3 and 4 refer to site where storage is provided by attenuation and / or partial infiltration. Where all flows are infiltrated to ground omit Sections 3 -5 and complete Section 6.

3.0 Defining rate of runoff from the site

- 3.2 Max. discharge for 1 in 1 year rainfall 3.578 l/s/ha, ... 4.83 l/s for the site
- 3.2 Max. discharge for Q_{med} rainfall 3.704 l/s/ha, ... 5.00 l/s for the site
- 3.3 Max. discharge for 1 in 30 year rainfall 9.674 l/s/ha, ... 13.06 l/s for the site
- 3.4 Max. discharge for 1 in 100 year rainfall 15.422 l/s/ha, ... 18.12 l/s for the site
- 3.5 Max. discharge for 1 in 100 year plus 30%CC 17.407 l/s/ha, ... 23.50 l/s for the site

4.0 Attenuation storage to manage peak runoff rates from the site

- 4.1 Storage - 1 in 1 year Max. 178 m³ 0.013 m³/m² (of developed impermeable area)
- 4.2 Storage - 1 in 30 year ⁽⁷⁾ Max. 439 m³ 0.033 m³/m²
- 4.3 Storage - 1 in 100 year ⁽⁸⁾ Max. 754 m³ 0.056 m³/m²
- 4.4 Storage - 1 in 100 year plus 30%CC ⁽⁹⁾ Max. 1090 m³ 0.081 m³/m²

5.0 Controlling volume of runoff from the site

- 5.1 Pre development runoff volume⁽¹⁰⁾ 748.50 m³ for the site
- 5.2 Post development runoff volume (unmitigated) ⁽¹⁰⁾ 620.70 m³ for the site
- 5.3 Volume to be controlled/does not leave site ^(5.2 - 5.1) -127.80 m³ for the site
- 5.4 Volume control provided by
- Interception losses⁽¹¹⁾ 44 m³
 - Rain harvesting⁽¹²⁾ 0 m³
 - Infiltration (even at very low rates) m³
 - Separate area designated as long term storage⁽¹³⁾ 0 m³
- 5.5 Total volume control (sum of inputs for 5.4) 44 m³ ⁽¹⁵⁾

6.0 Site storage volumes (full infiltration only)

- 6.1 Storage - 1 in 30 year ⁽⁷⁾ m³ m³/m² (of developed impermeable area)
- 6.2 Storage - 1 in 100 year plus CC ⁽⁹⁾ m³ m³/m²

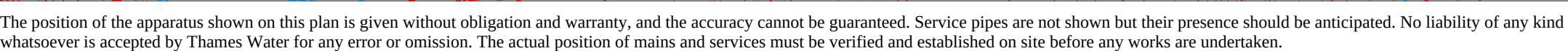
SuDS Flows and Volumes – LLFA Technical Assessment Proforma

Notes

1. All area with the proposed application site boundary to be included.
2. The site area which is positively drained includes all green areas which drain to the SuDS system and area of surface SuDS features. It excludes large open green spaces which do not drain to the SuDS system.
3. Impermeable area should be measured pre and post development. Impermeable surfaces includes, roofs, pavements, driveways and paths where runoff is conveyed to the drainage system.
4. Predevelopment use may impact on the allowable discharge rate. The LLFA will seek for reduction in flow rates to GF status in all instances. The design statement and drawings explain / demonstrate how flows will be managed from the site.
5. Runoff may be discharge via one or a number of means.
6. Sewers for Adoption 6th Edition recommends a Cv of 100% when designing drainage for impermeable area (assumes no loss of runoff from impermeable surfaces) and 0% for permeable areas. Where lower Cv's are used the application should justify the selection of Cv.
7. Storage for the 1 in 30 year must be fully contained within the SuDS components. Note that standing water within SuDS components such as ponds, basins and swales is not classified as flooding. Storage should be calculated for the critical duration rainfall event.
8. Runoff generated from rainfall events up to the 1 in 100 year will not be allowed to leave the site in an uncontrolled way. Temporary flooding of specified areas to shallow depths (150-300mm) may be permitted in agreement with the LLFA.
9. Climate change is specified as 30% increase to rainfall intensity, unless otherwise agreed with the LLFA / EA.
10. To be determined using the 100 year return period 6 hour duration rainfall event.
11. Where Source Control is provided Interception losses will occur. An allowance of 5mm rainfall depth can be subtracted from the net inflow to the storage calculation where interception losses are demonstrated. The Applicant should demonstrate use of subcatchments and source control techniques.
12. Please refer to Rain harvesting BS for guidance on available storage.
13. Flow diverted to Long term storage areas should be infiltrated to the ground, or where this is not possible, discharged to the receiving water at slow flow rates (maximum 2 l/s/ha). LT storage would not be allowed to empty directly back into attenuation storage and would be expected to drain away over 5-10 days. Typically LT storage may be provided on multi-functional open space or sacrificial car parking areas.
14. Careful consideration should be used for calculations where flow control / storage is likely to be influenced by surcharged sewer or peak levels within a watercourse. Storm sewers are designed for pipe full capacity for 1 in 1 to 1 in 5year return period. Beyond this, the pipe network will usually be in conditions of surcharge. Where information cannot be gathered from Thames Water, engineering judgement should be used to evaluate potential impact (using sensitivity analysis for example).
15. In controlling the volume of runoff the total volume from mitigation measures should be greater than or equal to the additional volume generated.

Appendix E

Thames Water Public record plans



EAGLE hardcopy facility - Normal Map.

The plot is centred on (530206 , 188316), which is in TQ3088SW. Printed on 14 January 2009 at 13:17:07 by JLISKOVA.

Comments:
SEWER

Printbox (529956,188066) -> (530456,188566)
Central Mapsheet : TQ3088SW
User : JLISKOVA
Time : Wed Jan 14 13:17:16 2009

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

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates no survey information is available.

At (530179,188089)	there is a MANHOLE with SHORT NUMBER=1003	COVER=	55.57	INVERT=	52.88
At (530183,188089)	there is a MANHOLE with SHORT NUMBER=1004	COVER=	55.68	INVERT=	50.95
At (530195,188089)	there is a MANHOLE with SHORT NUMBER=1005	COVER=	55.91	INVERT=	53.44
At (530186,188083)	there is a MANHOLE with SHORT NUMBER=1006	COVER=	56.03	INVERT=	51.23
At (530188,188223)	there is a MANHOLE with SHORT NUMBER=1207	COVER=	49.54	INVERT=	45.72
At (530192,188497)	there is a MANHOLE with SHORT NUMBER=1408	COVER=	43.56	INVERT=	41.15
At (530192,188494)	there is a MANHOLE with SHORT NUMBER=1409	COVER=	43.59	INVERT=	41.80
At (530191,188445)	there is a MANHOLE with SHORT NUMBER=1412	COVER=	44.52	INVERT=	42.87
At (530193,188443)	there is a MANHOLE with SHORT NUMBER=1413	COVER=	44.50	INVERT=	42.47
At (530198,188553)	there is a MANHOLE with SHORT NUMBER=1506	COVER=	42.81	INVERT=	40.42
At (530252,188178)	there is a MANHOLE with SHORT NUMBER=2101	COVER=	52.01	INVERT=	50.46
At (530251,188177)	there is a MANHOLE with SHORT NUMBER=2102	COVER=	52.00	INVERT=	49.87
At (530241,188111)	there is a MANHOLE with SHORT NUMBER=2103	COVER=	56.26	INVERT=	53.49
At (530225,188243)	there is a MANHOLE with SHORT NUMBER=2201	COVER=	49.14	INVERT=	47.87
At (530225,188239)	there is a MANHOLE with SHORT NUMBER=2202	COVER=	49.32	INVERT=	45.01
At (530297,188270)	there is a MANHOLE with SHORT NUMBER=2204	COVER=	48.93	INVERT=	43.45
At (530242,188396)	there is a MANHOLE with SHORT NUMBER=2301	COVER=	44.42	INVERT=	41.75
At (530228,188496)	there is a MANHOLE with SHORT NUMBER=2401	COVER=	43.54	INVERT=	41.72
At (530231,188495)	there is a MANHOLE with SHORT NUMBER=2402	COVER=	43.51	INVERT=	41.16
At (530215,188406)	there is a MANHOLE with SHORT NUMBER=2403	COVER=	44.83	INVERT=	-9999.00
At (530230,188547)	there is a MANHOLE with SHORT NUMBER=2508	COVER=	42.62	INVERT=	40.23
At (530232,188547)	there is a MANHOLE with SHORT NUMBER=2509	COVER=	42.63	INVERT=	41.31
At (530259,188549)	there is a MANHOLE with SHORT NUMBER=2510	COVER=	42.10	INVERT=	40.78
At (530261,188549)	there is a MANHOLE with SHORT NUMBER=2511	COVER=	42.18	INVERT=	39.85
At (530216,188528)	there is a MANHOLE with SHORT NUMBER=2512	COVER=	43.05	INVERT=	40.13
At (530216,188525)	there is a MANHOLE with SHORT NUMBER=2513	COVER=	43.11	INVERT=	41.15
At (530225,188520)	there is a MANHOLE with SHORT NUMBER=2514	COVER=	43.13	INVERT=	41.10
At (530227,188520)	there is a MANHOLE with SHORT NUMBER=2515	COVER=	43.09	INVERT=	40.11
At (530277,188526)	there is a MANHOLE with SHORT NUMBER=2516	COVER=	42.13	INVERT=	39.82
At (530278,188523)	there is a MANHOLE with SHORT NUMBER=2517	COVER=	42.17	INVERT=	40.62
At (530326,188141)	there is a MANHOLE with SHORT NUMBER=3102	COVER=	56.98	INVERT=	54.10
At (530380,188308)	there is a MANHOLE with SHORT NUMBER=3301	COVER=	47.61	INVERT=	45.88
At (530384,188307)	there is a MANHOLE with SHORT NUMBER=3302	COVER=	47.55	INVERT=	41.73
At (530322,188428)	there is a MANHOLE with SHORT NUMBER=3401	COVER=	42.95	INVERT=	39.22
At (530397,188526)	there is a MANHOLE with SHORT NUMBER=3503	COVER=	40.66	INVERT=	38.69
At (530397,188522)	there is a MANHOLE with SHORT NUMBER=3504	COVER=	40.65	INVERT=	38.45
At (530439,188090)	there is a MANHOLE with SHORT NUMBER=4001	COVER=	61.13	INVERT=	58.52
At (530442,188088)	there is a MANHOLE with SHORT NUMBER=4002	COVER=	61.50	INVERT=	59.22
At (530442,188083)	there is a MANHOLE with SHORT NUMBER=4003	COVER=	61.26	INVERT=	58.52
At (530413,188172)	there is a MANHOLE with SHORT NUMBER=4101	COVER=	55.79	INVERT=	54.29
At (530421,188174)	there is a MANHOLE with SHORT NUMBER=4102	COVER=	55.56	INVERT=	53.12
At (530429,188175)	there is a MANHOLE with SHORT NUMBER=4103	COVER=	55.30	INVERT=	53.78
At (530411,188242)	there is a MANHOLE with SHORT NUMBER=4202	COVER=	50.56	INVERT=	48.05
At (530403,188315)	there is a MANHOLE with SHORT NUMBER=4301	COVER=	46.69	INVERT=	41.48
At (530417,188323)	there is a MANHOLE with SHORT NUMBER=4303	COVER=	45.61	INVERT=	41.37
At (530442,188337)	there is a MANHOLE with SHORT NUMBER=4304	COVER=	43.47	INVERT=	42.25
At (530444,188337)	there is a MANHOLE with SHORT NUMBER=4305	COVER=	43.50	INVERT=	41.24
At (530444,188334)	there is a MANHOLE with SHORT NUMBER=4306	COVER=	43.68	INVERT=	40.13
At (530420,188465)	there is a MANHOLE with SHORT NUMBER=4401	COVER=	40.98	INVERT=	37.14
At (530422,188463)	there is a MANHOLE with SHORT NUMBER=4402	COVER=	40.92	INVERT=	38.18
At (530082,188065)	there is a MANHOLE with SHORT NUMBER=0002	COVER=	59.60	INVERT=	56.46
At (530032,188165)	there is a MANHOLE with SHORT NUMBER=0101	COVER=	52.75	INVERT=	50.99
At (530087,188295)	there is a MANHOLE with SHORT NUMBER=0202	COVER=	47.33	INVERT=	-9999.00
At (530091,188277)	there is a MANHOLE with SHORT NUMBER=0203	COVER=	47.94	INVERT=	43.37
At (530078,188245)	there is a MANHOLE with SHORT NUMBER=0204	COVER=	48.79	INVERT=	47.49
At (530078,188239)	there is a MANHOLE with SHORT NUMBER=0205	COVER=	48.92	INVERT=	47.68
At (530050,188217)	there is a MANHOLE with SHORT NUMBER=0206	COVER=	50.10	INVERT=	49.29
At (530043,188205)	there is a MANHOLE with SHORT NUMBER=0207	COVER=	50.68	INVERT=	47.61
At (530055,188205)	there is a MANHOLE with SHORT NUMBER=0208	COVER=	50.47	INVERT=	49.24
At (530100,188343)	there is a MANHOLE with SHORT NUMBER=0302	COVER=	46.33	INVERT=	42.96
At (530079,188482)	there is a MANHOLE with SHORT NUMBER=0403	COVER=	42.96	INVERT=	-9999.00
At (530092,188436)	there is a MANHOLE with SHORT NUMBER=0404	COVER=	44.22	INVERT=	-9999.00
At (530098,188427)	there is a MANHOLE with SHORT NUMBER=0405	COVER=	44.66	INVERT=	42.33
At (530004,188556)	there is a MANHOLE with SHORT NUMBER=0501	COVER=	40.86	INVERT=	37.54
At (530050,188526)	there is a MANHOLE with SHORT NUMBER=0502	COVER=	41.76	INVERT=	38.77
At (530084,188502)	there is a MANHOLE with SHORT NUMBER=0504	COVER=	42.73	INVERT=	40.03
At (530061,188567)	there is a MANHOLE with SHORT NUMBER=0506	COVER=	41.93	INVERT=	40.49
At (530123,188071)	there is a MANHOLE with SHORT NUMBER=1001	COVER=	58.23	INVERT=	55.51
At (530150,188076)	there is a MANHOLE with SHORT NUMBER=1002	COVER=	57.23	INVERT=	54.19
At (530131,188198)	there is a MANHOLE with SHORT NUMBER=1101	COVER=	50.25	INVERT=	46.69
At (530102,188283)	there is a MANHOLE with SHORT NUMBER=1201	COVER=	47.75	INVERT=	44.12
At (530112,188253)	there is a MANHOLE with SHORT NUMBER=1202	COVER=	48.65	INVERT=	45.05
At (530157,188293)	there is a MANHOLE with SHORT NUMBER=1203	COVER=	47.59	INVERT=	46.05
At (530161,188295)	there is a MANHOLE with SHORT NUMBER=1204	COVER=	47.62	INVERT=	46.43
At (530164,188274)	there is a MANHOLE with SHORT NUMBER=1205	COVER=	48.17	INVERT=	45.76
At (530174,188248)	there is a MANHOLE with SHORT NUMBER=1206	COVER=	48.95	INVERT=	46.42
At (530150,188312)	there is a MANHOLE with SHORT NUMBER=1301	COVER=	47.03	INVERT=	46.37
At (530107,188410)	there is a MANHOLE with SHORT NUMBER=1401	COVER=	45.22	INVERT=	42.52
At (530115,188430)	there is a MANHOLE with SHORT NUMBER=1402	COVER=	44.91	INVERT=	41.94

Printbox (529956,188066) -> (530456,188566)
Central Mapsheet : TQ3088SW
User : JLISKOVA
Time : Wed Jan 14 13:17:16 2009

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NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates no survey information is available.

At (530122,188424)	there is a MANHOLE with SHORT NUMBER=1403	COVER=	45.03	INVERT=	43.15
At (530122,188432)	there is a MANHOLE with SHORT NUMBER=1404	COVER=	44.95	INVERT=	43.29
At (530130,188449)	there is a MANHOLE with SHORT NUMBER=1405	COVER=	44.69	INVERT=	43.52
At (530126,188458)	there is a MANHOLE with SHORT NUMBER=1406	COVER=	44.37	INVERT=	40.65
At (530148,188486)	there is a MANHOLE with SHORT NUMBER=1407	COVER=	44.03	INVERT=	41.27
At (530162,188452)	there is a MANHOLE with SHORT NUMBER=1410	COVER=	44.49	INVERT=	42.46
At (530160,188451)	there is a MANHOLE with SHORT NUMBER=1411	COVER=	44.52	INVERT=	42.46
At (530101,188553)	there is a MANHOLE with SHORT NUMBER=1501	COVER=	41.94	INVERT=	38.33
At (530109,188532)	there is a MANHOLE with SHORT NUMBER=1502	COVER=	42.54	INVERT=	39.67
At (530129,188527)	there is a MANHOLE with SHORT NUMBER=1503	COVER=	43.54	INVERT=	39.19
At (530135,188547)	there is a MANHOLE with SHORT NUMBER=1504	COVER=	43.16	INVERT=	40.80
At (530173,188525)	there is a MANHOLE with SHORT NUMBER=1505	COVER=	43.32	INVERT=	40.37
At (530302,188131)	there is a MANHOLE with SHORT NUMBER=3101	COVER=	56.82	INVERT=	52.28
At (530301,188276)	there is a MANHOLE with SHORT NUMBER=3201	COVER=	48.83	INVERT=	47.49
At (530322,188426)	there is a MANHOLE with SHORT NUMBER=3402	COVER=	42.94	INVERT=	40.09
At (530409,188241)	there is a MANHOLE with SHORT NUMBER=4201	COVER=	50.66	INVERT=	48.78
At (530404,188317)	there is a MANHOLE with SHORT NUMBER=4302	COVER=	46.57	INVERT=	44.82
At (530405,188353)	there is a MANHOLE with SHORT NUMBER=4309	COVER=	44.18	INVERT=	42.04
At (529956,188134)	there is a MANHOLE with SHORT NUMBER=9103	COVER=	57.85	INVERT=	54.76
At (529956,188269)	there is a MANHOLE with SHORT NUMBER=9205	COVER=	48.11	INVERT=	-9999.00
At (529993,188560)	there is a MANHOLE with SHORT NUMBER=9505	COVER=	40.72	INVERT=	-9999.00
At (530014,188135)	there is a MANHOLE with SHORT NUMBER=0102	COVER=	55.20	INVERT=	53.84
At (530008,188282)	there is a MANHOLE with SHORT NUMBER=0201	COVER=	48.59	INVERT=	44.38
At (530023,188385)	there is a MANHOLE with SHORT NUMBER=0301	COVER=	45.50	INVERT=	43.52
At (530018,188419)	there is a MANHOLE with SHORT NUMBER=0401	COVER=	44.76	INVERT=	42.73
At (530021,188417)	there is a MANHOLE with SHORT NUMBER=0402	COVER=	44.75	INVERT=	42.83
At (530261,188298)	there is a MANHOLE with SHORT NUMBER=2206	COVER=	-9999.00	INVERT=	-9999.00
At (530282,188270)	there is a MANHOLE with SHORT NUMBER=2207	COVER=	-9999.00	INVERT=	-9999.00
At (530263,188290)	there is a MANHOLE with SHORT NUMBER=2208	COVER=	-9999.00	INVERT=	-9999.00
At (529989,188088)	there is a MANHOLE with SHORT NUMBER=9001	COVER=	60.01	INVERT=	58.36
At (529976,188074)	there is a MANHOLE with SHORT NUMBER=9004	COVER=	61.41	INVERT=	59.65
At (529992,188066)	there is a MANHOLE with SHORT NUMBER=9005	COVER=	61.67	INVERT=	59.64
At (530000,188184)	there is a MANHOLE with SHORT NUMBER=9101	COVER=	52.04	INVERT=	50.06
At (529998,188182)	there is a MANHOLE with SHORT NUMBER=9102	COVER=	52.05	INVERT=	49.97
At (529988,188120)	there is a MANHOLE with SHORT NUMBER=9104	COVER=	57.14	INVERT=	56.26
At (529970,188210)	there is a MANHOLE with SHORT NUMBER=9206	COVER=	50.11	INVERT=	47.45
At (529963,188231)	there is a MANHOLE with SHORT NUMBER=9207	COVER=	49.25	INVERT=	47.22
At (529960,188232)	there is a MANHOLE with SHORT NUMBER=9208	COVER=	49.24	INVERT=	46.42
At (529972,188212)	there is a MANHOLE with SHORT NUMBER=9209	COVER=	50.06	INVERT=	48.25
At (529964,188342)	there is a MANHOLE with SHORT NUMBER=9303	COVER=	46.31	INVERT=	45.31
At (529962,188340)	there is a MANHOLE with SHORT NUMBER=9304	COVER=	46.33	INVERT=	44.66
At (529962,188312)	there is a MANHOLE with SHORT NUMBER=9305	COVER=	47.11	INVERT=	45.31
At (529960,188310)	there is a MANHOLE with SHORT NUMBER=9306	COVER=	47.05	INVERT=	45.40
At (529998,188471)	there is a MANHOLE with SHORT NUMBER=9401	COVER=	43.95	INVERT=	42.13
At (529997,188468)	there is a MANHOLE with SHORT NUMBER=9402	COVER=	43.95	INVERT=	42.04
At (529987,188237)	there is a MANHOLE with SHORT NUMBER=	COVER=	-9999.00	INVERT=	-9999.00
At (529987,188239)	there is a MANHOLE with SHORT NUMBER=	COVER=	-9999.00	INVERT=	-9999.00



ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

 **Foul:** A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

 **Surface Water:** A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

 **Combined:** A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

 Joint	 Trunk Foul
 Trunk Surface Water	 Trunk Combined
 Storm Relief	 Bio-solids (Sludge)
 Vent Pipe	 Trade Effluent
 Proposed Thames Surface Water Sewer	 Proposed Thames Water Foul Sewer
 Gallery	 Foul Rising Main
 Surface Water Rising Main	 Combined Rising Main
 Sludge Rising Main	 Proposed Thames Water Rising Main
 Vacuum	 Syphon

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

 AV Air Valve	 LH Lamp Hole
 BS Blind Shaft	 LS Lifting Shaft
 CP Catch Pit	 ME Meter
 DC Dam Chase	 RE Rodding Eye
 DF Double Flushing Tank / Chamber	 VC Vent Column
 SF Single Flushing Tank / Chamber	 VT Vent
 HB Hatch Box	 WO Washout
 Other (specified on plan)	

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

 BD Backdrop Manhole	 HY Hydrobrake
 BV Butterfly Valve	 PI Petrol Interceptor
 CL Clough	 PS Penstock
 DB Dam Board	 RV Reflux Valve
 DP Drop Pipe	 ST Step
 DS Drop Shaft	 SV Sluice Valve
 FL Flume	 TA Tank
 FV Flap Valve	 WW Weir
 HW Headwall	 Other (specified on plan)

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

 STW Effluent Discharge	 Undefined End
 SA /  SA Soakaway	 GU Gully
 Outfall	 Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

 /  /  Public/Private Pumping Station	
 Change of characteristic indicator (C.O.C.I.)	
 Sewage Treatment Works	
 IL Invert Level	 Summit

Areas

Lines denoting areas of underground surveys, etc.

 Building over Case (BOC No.) or Low Lying Land (LLL No.)	
 Sewage Treatment Works or Pumping Station	
 Area under Adoption Agreement	 Survey Area
 Drawing Area or chamber	 Licence Area
 Area pending Adoption Agreement	 Other Area (specified on plan)

Other Sewer Types (Not Operated or Maintained by Thames Water)

 Foul Sewer	 Surface Water Sewer
 Combined Sewer	 Highway Drain
 Culverted Watercourse	 Proposed
 Status Unknown	 Abandoned Sewer

Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plans are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
- 4) For symbols referred to as 'Other' on this key, please see the plan for further information.
- 5) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

6) -9999.00 or 0 on a manhole level indicates that data is unavailable.

7) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. When cover and invert levels appear on a plan they are clearly prefixed by 'CL' and 'IL'. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0118 925 1504.



Ardmore Construction Limited

Katy Venables
Whitecode Consulting
26-27 The Hill
Northfleet
Gravesend
Kent
DA11 2EU

16/10/2024

Dear Katy

Re: Hornsey Town Hall BREEAM Non-Domestic RFO 2014

With regards to the BREEAM Assessment for Town Hall and Hotel, we write to formally confirm the following:

Hea 01 and Pol 04

We can confirm that we have installed external lighting in accordance with Whitecode Consulting Ltd's drawings and specifications. Timers have been set to ensure that all external lighting, except safety and security lighting, is switched off between 23.00 and 7.00.

Tra 05

We confirm that we will be providing tenants with a copy of the Travel Plan prepared by TPHS, at handover.

Pol 03

We confirm that the drainage has been installed in accordance with Bradbrook Consulting's design. Additionally, the findings within their Flood Risk Assessment remain unchanged.

Should you have any queries, please do not hesitate to contact the undersigned.

Yours sincerely

Elliot Bacon

For and on behalf of Ardmore Construction



WHITECODE
CONSULTING

Hornsey Town Hall Average NOx Calculations

Calculations by Katy Venables, BREEAM Assessor

CHP Boiler

Rehema R-Gen 50/100

Nox emissions per unit of heat generated (mg/kWh_{heat}) = $A \times (B / (B + C))$

A = Nox emissions per unit of fuel input (mg/kWh _{fuel input})	40
B = Heat output, kW	100
C = Electrical output, kW	50
Nox associated with Heat Output	26.67 mg/kWh

Gas Boiler

Hoval Gas 900D

Nox	21 mg/kWh
Heat Output kW	834

Total Heat Output	934
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Average	CHP Nox	2.83 mg/kWh
	Gas Boiler Nox	18.57 mg/kWh
		21.40 mg/kWh

References

As Built Energy Centre Schematic ref 10687-M-04-BM-0007

R-Gen-50-100-Technical-Sheet

UltraGas900D_Tech_Sub_Jun21_hornsey