Flood Risk Assessment

Arlington Works, Arlington Road, St Margarets, Twickenham, TW1 2BB

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Contents

1 INTRODUCTION 2
1.1 EXISTING SITE 2
1.2 PROPOSED DEVELOPMENT 2
1.3 REQUIREMENTS FOR A FLOOD RISK ASSESSMENT (FRA) 3
1.3.1 National Planning Policy Framework (NPPF) 3
1.3.2 National Planning Practice Guidance (NPPG) 4
1.3.3 Environment Agency Guidance 4
1.3.4 The SFRA 5
1.3.5 Lead Local Flood Authority 5
1.4 REPORT STRUCTURE 5
2 FLOOD RISK 6
2.1 FLUVIAL FLOODING 6
2.1.1 Sources of Fluvial Flooding 6
2.1.2 Flood Defences 6
2.1.3 Flooding History 6
2.1.4 Flood Extents and Levels 7
2.1.5 Breach or Failure of the defences 7
2.2 OTHER SOURCES OF FLOODING 8
2.3 IMPLICATIONS FOR THE PROPOSED DEVELOPMENT 9
2.3.1 Floor Levels 9
2.3.2 Flood Resistance or Resilience Measures 9
2.3.3 Safe Escape 9
2.3.4 Buffer Zone 9
2.3.5 Volume of Displacement 9
3 SITE RUNOFF 10
3.1 EXISTING SITE 10
3.2 GREENFIELD SITE 11
3.3 DEVELOPED SITE RUNOFF WITHOUT SUDS 11
4 SUDS 13
4.1 SOURCE CONTROL SYSTEMS 13
4.1.1 Soakaways 13
4.1.2 Rainwater Harvesting 13
4.1.3 Green Roofs 14
4.2 PERMEABLE CONVEYANCE 15
4.3 PASSIVE TREATMENT 15
4.4 OUTLINE DRAINAGE STRATEGY 17
5 PLANNING POLICY GUIDANCE 18
5.1 APPROPRIATE DEVELOPMENT 18
5.2 THE SEQUENTIAL TEST 18
6 CONCLUSIONS 19

Figures

1 INTRODUCTION

1.1 Existing Site

The existing site is located at Arlington Works on Arlington Road, St Margaret's in Twickenham (Figure 1.1). The site is currently occupied by Sharpes's Recycle Oil Ltd, a family business established in 1965, which provides a recycling facility to produce recycled fuel oil (RFO). The plant is located on the north west side of the central spine road and includes tanks, bunding and offices (Figure 1.2). The other tenants on the site include car body repairs, carpentry, upholstery, recording and practising of music, metal fabrication, office and storage facilities on the east side of the site and these occupy low rise industrial buildings and two Victorian terraced buildings. The shared facilities include the site access and spine road; vehicle parking and toilets.

The site is irregular in shape approximately 77m long by 40m wide narrowing to 20m wide at the southern boundary and covers 2,965m^2 (0.30ha). This includes 1270m^2 of buildings, 1695m^2 of impermeable hard standing areas such as roads and parking areas (Table 1.1) and with no green garden or landscaped areas as shown on an aerial photograph of the site (Figure 1.3).

Table 1.1 Land Use of Existing Site (m^2)

Area of Site	Buildings	Ground Level Impermeable	Green	Total
Buildings	1270			
Hard Standing		1695		
Gardens			0	
Total	**1270**	**1695**	**0**	**2965**

A topographical survey (Figure 1.4) shows a ground level of 5.6m OD on Arlington Road and the site is relatively flat and falls from 5.85m OD in the north to 5.53m to the south. Runoff from the existing buildings and hard standing areas is collected in an on-site drainage network which leads to the local storm sewer network in Arlington Road.

1.2 Proposed Development

The proposals are to provide 7 two storey business units and 24 residential units in a combination of 1, 2 and 3 bedrooms (Table 1.2) with associated roads, parking, footpaths and landscaping (Figure 1.5).

Table 1.2 Accommodation Schedule

Bedrooms	No Units	Persons per Unit	Occupants
1	5	2	10
2	3	3	9
2	9	4	36
3	7	4	28
Total	**24**		**83**

The proposed development will provide 1255m^2 of buildings, 1137m^2 of impermeable hard standing roads and parking areas and with 573m^2 of green or landscaped garden areas (Table 1.3).

Table 1.3 Land Use of Proposed Development Site (m^2)

Area of Site	Buildings	Ground Level Impermeable	Green	Total
Dwellings	690			
Busness Units	565			
Parking/Access		1137		
Green			573	
Total	**1255**	**1137**	**573**	**2695**

Runoff from the new buildings and hard standing areas will be collected in a new on-site drainage network which will drain to the same local storm sewer network as existing with SUDS measures as required.

1.3 Requirements for a Flood Risk Assessment (FRA)

A Flood Risk Assessment (FRA) is often required as part of a planning application depending on the nature of a development, its size and the anticipated flood risk as defined by the Environment Agency's flood risk zones. In England flood risk is divided into three zones:

- Zone 1 areas have low or no risk with an annual probability of tidal and fluvial flooding of less than 0.1% per year, above the 1000 year flood level.
- Zone 2 areas have a fluvial risk of flooding of between 0.1% and 1% a year, between the 100 year and 1000 year flood extents, and
- Zone 3 areas are at high risk of fluvial flooding with risk of greater than 1% a year, inside the 100 year flood extent.

The Environment Agency's flood map (Figure 1.6) shows the site is located in Flood Zone 1 and at a low risk of fluvial flooding. The nearest watercourse is the River Thames 600m to the north east at Richmond upon Thames but the flood map shows this west bank of the Thames is protected by raised flood defences alongside the river. The EAs flood map shows the undefended case and the flood extent in the absence of such defences and hence represents a worst case of the defences having failed. Even so the 100 year and 1000 year flood would not reach the site (Figure 1.7). As the site lies in Flood Zone 1 a Flood Risk Assessment (FRA) is not usually required unless (a) the site is larger than 1ha, or (b) it could be at risk from sources of flooding other than rivers or the sea and the latter is assumed. A Zone 1 FRA should therefore accompany the planning application where the content is dictated by the National Planning Policy Framework (NPPF), the National Planning Practice Guidance (NPPG), the Environment Agency's guidelines and the local Strategic Flood Risk Assessment (SFRA). The requirements of these documents are summarised below.

1.3.1 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) details the requirements for FRA and the required content was defined by the NPPF Technical Guidance, which has been superseded by NPPG as detailed below. This requires local planning authorities to consider developments in flood risk areas appropriate only where the application is supported by a site-specific FRA. A comparison of

NPPF and the earlier PPS25 reveals the technical approach to a FRA is largely unchanged with the main requirements for a FRA retained from PPS25 and its Practice Guide. The management of residual risk based on flood risk management and mitigation, including flood resistance and resilience measures, allows for development opportunities in Flood Zones 2 and 3, as long as flood ingress, impact, rate of onset etc are understood and mitigated. A FRA is not usually required for sites in Flood Zone 1.

1.3.2 National Planning Practice Guidance (NPPG)

In March 2014 the Department for Communities and Local Government (DCLG) launched a web-based National Planning Practice Guidance (NPPG). This was accompanied by a Written Ministerial Statement with a list of previous planning practice guidance documents now cancelled and this included PPS25, the PPS25 Practice Guide and the NPPF Technical Guide. The objectives of a site-specific FRA are to establish whether a proposed development is likely to be affected by current or future flooding from any source or will increase flood risk elsewhere and that any measures proposed to deal with these effects and risks are appropriate. The FRA should also consider the Sequential Test and show that the development will be safe and pass the Exception Test, if these are applicable.

1.3.3 Environment Agency Guidance

The Environment Agency has produced Standing Advice and Guidance which aims to simplify the requirements for a FRA according to the nature of the development and the relevant flood zone and this is referred to by NPPG. This indicates that a FRA should be based on the EAs guidance "Flood Risk Assessments in Flood Zone 1 and Critical Drainage Areas" which was updated in February 2017 and this requires a FRA to provide minimum information (Table 1.4).

Table 1.4 Environment Agency's Requirements for a FRA in Flood Zone 1

Item	Description
Plans	• A location plan with street names, any rivers, streams, ponds, wetlands, other bodies of water and geographical features. • A plan of the existing site. • A plan of the development proposals. • Any structures that could affect water flow, eg bridges, embankments.
Surveys	• A topo survey showing the existing site levels. • The levels of the proposed development, if different. • All site levels to be stated to Ordnance Datum.
Flood risk	• The risk to the development if there was a river flood. • Consider flooding from other sources (eg surface water, groundwater). • Consider climate change.
Surface water runoff	• Estimate how much surface water runoff the development will generate compared to the existing site. • Existing methods for managing surface water runoff, eg drainage to a sewer. • Plans for managing surface water to ensure no increase in the peak flow and volume of runoff in line with the LPAs SFRA, the LLFA and based on SUDS.
Sites near rivers	• For developments on or within 8m of a main river an Environment Agency flood defence consent or environmental permit will be required.

1.3.4 The SFRA

Richmond Borough Councils Strategic Flood Risk Assessment (SFRA), March 2016 update, indicates that where the risk of flooding is low (e.g. Zone 1) rather than assessing the risk to life and property due to fluvial flooding a FRA should mainly ensure that runoff from the site does not increase flood risk elsewhere and that the site is not affected by other sources of flooding

The SFRA requires that for sites greater than 1ha a FRA and/or Sustainable Drainage Strategy must be prepared to assess the impact of the development due to the addition of hard surfaces, the effect of the new development on surface water runoff and the potential to increase flood risk elsewhere. This should include details of any proposed SuDS measures to ensure that runoff from the developed site does not exceed the greenfield runoff rate. The risk from other sources of flooding (e.g. urban drainage, sewers, groundwater etc) must also be considered. For smaller development proposals less than 1ha a FRA should consider whether the site is at risk from other sources of flooding.

1.3.5 Lead Local Flood Authority

As from April 2015 the Lead Local Flood Authority (LLFA) are consulted on ‘major’ planning applications and require details of the proposed drainage strategy and outline SUDS designs. As the proposals are for more than 10 dwellings this is considered a ‘major development’ and hence the LLFA requirements are valid.

The above documents have therefore been used to guide the content of this FRA which is intended to confirm whether the development proposals, with mitigation measures, are acceptable to the Environment Agency and the Local Planning Authority in terms of flood risk. This FRA provides an assessment of the flood risk to and from the proposed development based on the plans provided but does not include detailed drainage designs which is the subject of a separate report. It identifies potential SUDS measures for taking forward to the detailed design stage.

1.4 Report Structure

For this FRA the site details and flooding history are given in Section 2, details of site runoff are given in Section 3 with control measures using SuDS given in Section 4. The interpretation of planning policy guidance is given in Section 5 and the conclusions presented in Section 6.

2 FLOOD RISK

2.1 Fluvial Flooding

2.1.1 Sources of Fluvial Flooding

The EAs flood map (Figure 1.7) shows the site is located in Flood Zone 1 and that the nearest watercourse and source of flooding is the River Thames 600m to the north east at Richmond Bridge. There are no other watercourses or water bodies in the local area that pose a potential flood risk to the site.

2.1.2 Flood Defences

This area of St Margarets is protected against river and tidal flooding by the Thames Tidal Defence (TTD) system which provides a combination of raised defences and the Thames Barrie to protect much of riverside London. At this location the flood defence walls alongside the Thames were constructed in the late 1970s and early 1980s and together with the Thames Barrier provide protection against the 1000 year combined tidal and fluvial event downstream of Richmond and to the 100 year event upstream between Richmond and Teddington. Even without these defences the EAs flood map shows the site would not be affected by the 100 and the 1000 year flood.

The EA have plans for a future River Thames Flood Alleviation Scheme which will further reduce the risk of flooding to properties between Datchet and Teddington. The measures will include the construction of three flood diversion channels, the widening of Desborough Cut and improvements to Sunbury Weir, Molesey Weir and Teddington Lock. However these plans are not far advanced and the benefits of this scheme are not included in this FRA.

2.1.3 Flooding History

Flow records are available at an EA gauge at Kingston upon Thames 5km upstream which has flow records from 1883 to 2016 (133 years). These records show that the largest floods in this period occurred in 1894, 1947 and 1968 (Table 2.1).

Table 2.1 Largest Flood Flows on the Thames at Kingston

Rank	Date	Flow (m^3/s)
1	18 Nov 1894	806.0
2	20-Mar-1947	714.2
3	17-Sep-1968	600.1
4	05-Jan-1915	585.1
5	23-Nov-1974	559.0

The 1947 flood affected parts of Kingston and smaller events in 1968, 2003 and 2014 are known to have flooded parts of Hampton Wick but no properties in St Margarets or Richmond were affected (Figure 2.1). The British Hydrological Society's "Chronology of British Hydrological Events" also provides evidence of historical flood events at Kingston and Richmond (Table 2.2) but there are no direct records that the site or St Margarets flooded on these occasions.

Table 2.2 Flood Records at Kingston and Richmond from BHS Database

Year	Month	Quotation
1774	03	At Kingston the water reached the Town Hall and spread over the Town so that the Market did not open and a great deal of damage was done. It undermined the Church and damaged the graveyard. At Teddington the water rose in the Church to a considerable height. At Twickenham the flood was one foot higher than 115 years ago which at that time was higher than ever known before. At Richmond the Brewer had all his backs tore up and sustained very considerable damage. At Isleworth the water was so high that they could not get to the church without boats. This flood on the River Thames was at least two feet higher than in 1768. No later inundation seems to have approached the 1774 floods in magnitude until those of Nov 1894.
1852	11	The heavy rains produced wide-spread destruction and loss of life. The waters meeting the high tide flooded areas on the banks. At Kingston, Egham, and Windsor the waters extended over an immense surface.
1882	10	The flow of the tide usually ends at Kingston upon Thames Lock and Weir but now and then the rise is sufficiently high to force the river back as far as Kingston, or even further, turning the weir the reverse way. This happened on 28 October 1882 and several other tides that year were nearly as high.
1894	11	A large area of land along the valley of the Thames from Abingdon to Kingston was flooded. These floods will long be remembered as the most disastrous experienced for some 40 or 50 years. At Kingston the principal streets were flooded some to 5 ft. deep.
1928	01	The floods brought 20 fully laden barges careering down the Thames at Kingston upon Thames and threatened Richmond with flooding. The barges outstripped their moorings which couldn't take the strain of the floodwaters.

There are no records of the site or areas of St Margarets flooding on any of these dates or major flood events as recorded in the SFRA, the EA gauge, BHS records or elsewhere.

2.1.4 Flood Extents and Levels

The EA flood maps show the local area is defended Flood Zone 3 (Figure 1.6) but that the 100 year and 1000 year flood would not reach the site (Figure 1.7) even if the defences were not present and this confirms the site is in Zone 1.

2.1.5 Breach or Failure of the defences

As part of the TE2100 study (March 2015) the EA carried out hydraulic modelling of the tidal Thames downstream of Teddington Lock to consider the path of flood water should a failure of the defences occur. The results, under 2100 climate change conditions, show (Figure 2.2) that based on the breach locations considered that flood water would not reach the site and this support the EAs (defended) flood map extents. The risk of fluvial flooding of the site, with or without defences, is therefore low.

2.2 *Other Sources of Flooding*

NPPF and NPPG emphasise the need to consider all other potential sources of flooding when planning a development as these could affect the site and may be important considerations for managing flood risk. For this site these other sources may include:

- Storm Water Flooding. This can occur when excess water runs off the surface of a site particularly during short but intense storms. Flooding occurs because the ground is unable to absorb the high volume of rain water or because the amount of water arriving on a site is greater than the capacity of the drainage system to take it away and this can particularly occur on developed impermeable sites such as concrete, tarmac or large buildings. The SFRA indicates no reported surface water flooding in the vicinity of the site and the EAs surface water flood maps (Figure 2.3) show that flooding from the 30 year and 100 year storm events will be constrained to a small area in the west part of the site and to limited depth and velocity. The proposals are to install a new drainage system on the site to handle extreme storm events and with raised floor levels the risk of flooding from this source will be managed. Any overland flows will be intercepted by the local drainage system and no significant flooding from this source is anticipated.

- Road flooding can occur when an intense rain storm occurs on a road surface and the amount of water arriving is greater than the capacity of the local drainage network to take it away. Exceptional rainfall, a road being in a low lying area, changes in runoff from adjacent land can lead to road flooding even when the drainage system is in a good working order particularly if drains become blocked. The site entrance from Arlington Road has a slightly raised elevation hence road runoff is unlikely to enter the site and affect the buildings. The raised floor levels of the new buildings also indicates the risk of flooding from this source will be low.

- Sewer flooding can occur when a storm sewer or combined sewer network becomes overwhelmed and its capacity is exceeded. Higher flows occur during periods of prolonged rainfall, the autumn and winter months, when the capacity of the sewer system is most likely to be reached. The Water Companies maintain a register of areas and properties which are at risk of flooding from sewers and the SFRA indicates no recorded incidents of sewer flooding in the vicinity of the site and no significant flooding from sewers is therefore anticipated. With raised floor levels the risk from this source can be managed.

- Tidal flooding. The elevation of the site and presence of the Thames Barrier and the river side defences indicates that the risk of tidal flooding is low.

- Flooding from Impounded Water Bodies. The potential risk associated with artificial sources of flooding has been investigated by the EA and their mapping indicates there are reservoirs and/or water storage facilities upstream that may potentially pose a flood risk to the site (Figure 2.4). The Environment Agency has responsibility for the safety of these reservoirs under the Reservoirs Act 1975 and ensure that these are operated safely and are properly managed. The risk of failure of these reservoirs is extremely low and this should not be regarded as a constraint for future development on this site. The risk of flooding from this source is therefore considered to be low.

- Groundwater flooding is most likely in low-lying areas underlain by permeable rocks (e.g. Chalk or Sandstone) and occurs as water rises up through the underlying rocks or from water flowing from abnormal springs after long periods of sustained high rainfall which can cause the water table to rise above normal levels. This site is underlain by London Clay with a surface layer of

Kempton river sands and gravels and there are no recorded incidents of groundwater flooding in the area. The groundwater susceptibility map (Figure 2.5) highlights that there is the potential for groundwater flooding to occur at the ground surface presumably due to a perched water table in the terrace gravels. However it is likely that if groundwater does reach the ground surface any water would drain to the local storm sewer network and with raised floor levels the risk of internal flooding to the dwellings is considered to be low.

2.3 Implications for the Proposed Development

2.3.1 Floor Levels

To reduce the potential damage to property and injury of persons due to flooding the preferred method of mitigation is to have floor levels raised above the maximum likely fluvial or pluvial flood water level. In Flood Zone 1 this can usually be accommodated in the building design with a minimal raising of floor levels to mitigate against storm water rather than fluvial flooding. For a residential dwelling floor levels should be 300mm above the local ground level or 300mm above the 100 year + CC flood level whichever is the greater. As the site is in Zone 1 a lower freeboard of 150mm above the local ground level could be used to prevent pluvial flooding but to still allow disabled access.

2.3.2 Flood Resistance or Resilience Measures

Flood resistance measures aim to prevent flood waters from entering a building by creating barriers and walls to divert or prevent flood water entering a building. This is principally achieved by having raised floors, door cills and thresholds and ensuring all windows, services and other openings are protected to the same level. Flood resilience measures aim to reduce the consequences of flooding and allow flood water to enter a building but to not cause significant damage. Providing floor levels are raised above local ground level as this site is in Flood Zone 1 then additional flood resilience and resistance measures will not be required.

2.3.3 Safe Escape

Safe access and egress is required to enable the evacuation of people from the development and to provide the emergency services with access to the development during a flood. A 'Safe' access or escape routes is defined as one that can be used by occupiers without the intervention of the emergency services or others and which ideally should be dry. The proposed escape route from the site is to the east and onto Arlington Road which is in Flood Zone 1 and hence would be dry. This road leads to an area outside of the flood plain where services and facilities exist.

2.3.4 Buffer Zone

The site is not within 8m of a main river hence there is no requirement for a buffer zone and an EA flood defence consent is not required.

2.3.5 Volume of Displacement

As this site is in Flood Zone 1 there will be no loss of flood plain storage and hence flood plain storage compensation measures are not required.

3 SITE RUNOFF

Under NPPF/NPPG a sustainable drainage system is required to ensure the rate of surface water runoff from a developed site does not exceed the existing rate so as not to increase flood risk to others. The SFRA requires a return to the greenfield rate as far as possible but there are different standards:

- The London Plan (Policy 5.13) states that developers should aim for a greenfield runoff rate.
- The London Plan SPG states (3.4.10) that all developments on greenfield sites must maintain greenfield runoff rates but on previously developed sites, runoff rates should not be more than three times the greenfield rate.
- DEFRA Non Technical Guidance on SUDS states (Policy S3) that for developments which were previously developed the peak runoff rate to any drain, sewer or surface water body for the 1 year and the 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event, i.e. existing rate.
- NPPF/NPPG require no increase in site runoff to avoid increasing flood risk to others which implies the existing rate.

This therefore requires a comparison of the existing, the greenfield and the developed site peak flows and volumes to determine what SUDS measures would be the most appropriate to achieve the required standards. These are considered below.

3.1 Existing Site

The CIRIA guidance on SUDS (CIRIA C697) recommends the use of IH124 for site runoff calculations on sites less than 50ha. However the area of this site is small (0.30ha) and far below the lower limit of the IH124 method (110ha) and for roofed buildings and car parks such as this where the generation of runoff does not involve a watercourse or soils, IH124, which is based on measured flows on streams and rivers, is not valid. The EAs recent R&D report (SC090031) recommended that IH124 should no longer be used for site runoff calculations and this is included in the EAs latest Flood Estimation (FEH) Guidelines.

The Wallingford or Rational method and FEH rainfall are therefore used to provide peak flows and volumes based on the impermeable drainage area, the runoff characteristics (percentage runoff) and the rainfall intensity for a range of storms durations and return periods. The impermeable areas on the existing site covers 2,965m^2 with an assumed urban percentage runoff of 70%. Rainfall totals are given by the Flood Estimation Handbook (FEH)[1] and for the present day rainfall is not increased to account for climate change.

[1] *Flood Estimation Handbook, Centre for Ecology and Hydrology 1999*

This shows that the 100 year 1 hour storm on the existing site will provide a peak flow of 29.0 l/s and a volume of 104m^3 whilst the 100 year 6 hour storm a peak flow of 7.2 l/s and volume of 155m^3 (Table 3.1).

Table 3.1 Existing Site Peak Flows and Volumes

Return Period (yrs)	1 hour		3 hour		6 hour	
	Peak Flow (l/s)	Volume (m3)	Peak Flow (l/s)	Volume (m3)	Peak Flow (l/s)	Volume (m3)
2	7.1	25.5	3.4	36.8	2.1	46.3
5	10.9	39.0	5.0	54.2	3.1	66.7
10	13.9	50.0	6.3	68.0	3.8	82.5
30	19.9	71.6	8.7	94.3	5.2	112.2
50	23.4	84.0	10.1	109.2	6.0	128.8
100	29.0	104.2	12.3	132.9	7.2	155.0

3.2 Greenfield Site

The greenfield site covers the same site area as the developed site and is taken as of 2,965m^2 with an assumed SPRHOST percentage runoff of 18.6%. The peak flows (Table 3.2) suggests a 100 year 1 hour storm will provide a peak flow of 7.7 l/s and a volume of 28m^3 whilst the 100 year 6 hour storm the peak flow is 1.9 l/s and volume is 41m^3.

Table 3.2 Greenfield Site Peak Flows and Volumes

Return Period (yrs)	1 hour		3 hour		6 hour	
	Peak Flow (l/s)	Volume (m3)	Peak Flow (l/s)	Volume (m3)	Peak Flow (l/s)	Volume (m3)
2	1.9	6.8	0.9	9.8	0.6	12.3
5	2.9	10.4	1.3	14.4	0.8	17.7
10	3.7	13.3	1.7	18.1	1.0	21.9
30	5.3	19.0	2.3	25.1	1.4	29.8
50	6.2	22.3	2.7	29.0	1.6	34.3
100	7.7	27.7	3.3	35.3	1.9	41.2

The greenfield peak flows and volumes are 75% of the existing rate due to the difference in the percentage runoff.

3.3 Developed Site Runoff without SUDS

The developed site will include buildings and hard standing area an impermeable area of 2392m^2 with an assumed urban percentage runoff of 70% and permeable areas of 573m^2 which will drain at the SPRHOST rate of 18.6%. The SUDS designs should also consider the impact of climate change and the EAs latest guidance (February 2016) suggests for a residential development, with an assumed design life of 100 years, the rainfall totals should be increased by 40%. The peak flows from the developed site without SUDS (Table 3.3) suggests a 100 year 1 hour storm will provide a peak flow of 34.8 l/s and a volume of 125m^3 whilst the 100 year 6 hour storm peak flow is 8.6 l/s and volume is 186m^3.

Table 3.3 Developed Site Peak Flows and Volumes with Climate Change

Return Period (yrs)	1 hour		3 hour		6 hour	
	Peak Flow (l/s)	Volume (m3)	Peak Flow (l/s)	Volume (m3)	Peak Flow (l/s)	Volume (m3)
2	8.5	30.7	4.1	44.2	2.6	55.6
5	13.0	46.9	6.0	65.1	3.7	80.1
10	16.7	60.1	7.6	81.7	4.6	99.1
30	23.9	86.0	10.5	113.3	6.2	134.8
50	28.1	100.9	12.2	131.2	7.2	154.8
100	34.8	125.2	14.8	159.7	8.6	186.2

This 20% increase in peak flows and volumes above the existing rate (Table 3.3) is due to the 40% increase in rainfall from climate change and as the impermeable area is slightly larger than the existing site. The use of SUDS to reduce the developed site peak flows and volumes to the existing or greenfield rate is considered in Section 4.

4 SUDS

Sustainable Urban Drainage Systems (SUDS) fall into three broad groups;

- Source Control Techniques. These aim to reduce the quantity of runoff at source and include porous pavements, soakaways, rainwater harvesting and/or green roofs;
- Permeable Conveyance Systems. These slow the velocity of runoff between a source and a disposal point to allow infiltration and can include infiltration trenches or swales; and
- Passive Treatment Systems. These provide treatment to collected surface water before discharge into a watercourse and include basins, ponds and wetlands or on smaller sites tanks and storm cells.

The usual approach is to consider the "SUDS train" where each of the above are considered in turn until a suitable solution is found. Thus source control techniques if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds. The options are considered below.

4.1 Source Control Systems

4.1.1 Soakaways

Source control systems can include soakaways where water is dispersed into the ground providing there are permeable strata below a site. The British Geological Survey (BGS) maps show the site lies on the impermeable London Clay (Figure 4.1) with a drift cover of Kempton river sands and gravel drift deposits (Figure 4.2) which are more permeable. The site is not in a groundwater Source Protection Zone. BGS records show there are 1 borehole in the local area (Figure 4.3) which extends to 9.45m depth (Table 4.1).

Table 4.1 BGS Boreholes near Site

Reference	Name	Length (m)	Easting	Northing
TQ17SE109	THAMES FLOOD PREVENTION R3	9.45	517050	174390

The borehole log (Figure 4.4) shows a 1.1m layer of top soil and sandy clay over 8m of sand and gravel with the top of the London Clay close to the base of the boreholes at 9.45m below ground. Groundwater levels are not available but would be expected to be close to the level of the local watercourse and/or perched in the gravel above the top of the London Clay aquiclude. This thick layer of sand and gravel may be suitable for the disposal of surface runoff depending in the level of the groundwater below the site. However due to the former industrial use of the site soakaways are discounted as a drainage disposal option.

4.1.2 Rainwater Harvesting

Rainwater harvesting is the collection of runoff from roofs and other surfaces that would otherwise be directed to the local drainage system. Once collected and stored it can be used to replace mains water for non-potable purposes such as toilet flushing and this can reduce storm runoff without the need for treatment or oil separators as the risk of contamination is low. Such a facility could be practical for residential buildings depending on the available water volumes and the water demand. The collected water is held in roof level or underground storage tanks and over the course of a year will reduce the volume of water entering the storm water system.

The BS8515:2009[2] intermediate approach is based on the average annual rainfall (SAAR) of 600mm and assuming a roof area of 645m^2 for the residential blocks and330m2 for each of the two areas of business units to give a total runoff volume of 387m^3 and 198m^{3}per year respectively (Table 4.2). A drainage coefficient (DC) of 0.8 accounts for losses to overflowing gutters and evaporation and only 90% of the water flowing into the system is retained hence the available water volume is 279m^3/yr and 143m^3/yr. BS8515 suggests the installed tank size should be 5% of the annual supply and the storage volume of 13.9m^3 and 7.91^3 which are very large and impractical.

Table 4.2 Rainwater Harvesting Volumes

Units	Roof Area (m2)	SAAR (mm)	Gross Runoff (m3/yr)	Net Runoff (m3/yr)	Tank Size (m3)
Residential	645	600	387	279	13.9
Business	330	600	198	143	7.1

As water is collected from roof gutters and down pipes an underground rather than roof level tank of this size is preferred from which a pump would take water to roof level header tank where a gravity feed would distribute water to the building for flushing WCs etc. This will require an overflow from the storage tank to discharge excess runoff. Assuming 90 persons in the residential units (Table 1.2) and a WC use of 25 l/day a 13.9m^3 tank would provide a supply for around 6 days (Table 4.3). The business units with 20 occupants would have a supply of around 14 days. These tanks would run dry if there was no rainfall in this period and hence this will not provide a suitable or economically viable option

Table 4.3 Water Demand

Item	Residential	Business Units
Stored Volume (m3_	13.9	7.1
No Occupants	90	20
Total Water Demand (25 l/p/d)	2250	500
Total Water Demand (m3/day)	2.25	0.5
No Days Supply	6.2	14.3

In addition as a RWH tank is used to provide a water supply the aim would be to keep it as near as full as possible to ensure a reliable supply. It cannot be guaranteed that there would be any spare capacity at the start of an extreme rainfall event and hence RWH tanks are not considered suitable for runoff control.

4.1.3 Green Roofs

A green roof is a multi-layered system that covers the top of a building with vegetation and soils. These can be extensive roofs which are a low maintenance 25-125 mm soil layer in which a variety of hardy drought tolerant low plants are grown, or intensive roofs with trees and planters which

[2] *British Standard 8515:2009* Rainwater Harvesting Systems – Code of Practice *(BS 8515)*

impose a greater load on the roof structure but are more suitable in certain circumstances. As the roofs will be pitched and a green roof will not be suitable.

4.2 Permeable Conveyance

Permeable conveyance systems take the form of swales or infiltration trenches where surface runoff from roads, parking areas and roof drainage can be directed. These allow for attenuation and storage whilst water is transported from source to a disposal point. Swales are open wide trapezoidal channels across a site or along road margins but there is insufficient space for a long swale system and these are not considered suitable for surface water disposal on this site.

An infiltration trench is a linear underground permeable conveyance system which is gravel filled and hence will have a high storage volume to provide attenuation and allow gradual infiltration into the surrounding soil. They require relatively permeable strata and a suitable depth to groundwater below a site to allow percolation into the ground. For the same reasons as above these infiltration methods are not considered suitable on this site and are discounted.

4.3 Passive Treatment

An alternative to source control or permeable conveyance is to use passive treatment systems based on storage and attenuation. For larger sites these can include a pond, wetland or a basin and on smaller sites an underground tank, an oversized drainage network or sub-surface attenuation structures such as Storm cells.

Preliminary routing calculations have been undertaken to assess the required size of a storage facility based on maintaining the developed site runoff at the existing rate with any excess water taken into storage for late gradual release. This suggests (Table 4.6) that to maintain the existing site runoff a storage facility of 4.6m^3 would be required for the 1 hour and 6.8m^3 for the 6 hour storm. This storage volume arises due to the 40% increase in rainfall due to climate change and the smaller impermeable area. The existing and developed site hydrographs and storage are provided for the 1 hour storm (Figure 4.5).

Table 4.6 Storage to Reduce Runoff to the Existing Rate - 100 yr storm

Storm (hrs)	Peak Flow (l/s)		Storage Volume Reqd (m^3)
	Existing	Developed	
1	29.0	34.8	4.6
3	12.3	14.8	5.8
6	7.2	8.6	6.8

To achieve the greenfield rate as required by the SFRA suggests (Table 4.7) that a far larger storage facility of 59m^3 would be required for the 1 hour and 88m^3 for the 6 hour storm and this is due to the far smaller greenfield runoff rate compared to the existing rate. The greenfield and developed site hydrographs and storage are provided for the 1 hour storm (Figure 4.6).

Table 4.7 Storage to Reduce Runoff to the Existing Rate - 100 yr storm

Storm (hrs)	Peak Flow (l/s)			Storage Volume Reqd (m^3)	
	Existing	Green Field	3 * Greenfield	Green Field	3 * Greenfield
1	29.0	7.7	23.1	59.0	14.2
3	12.3	3.3	9.8	75.3	18.1
6	7.2	1.9	5.7	87.8	21.1

The London Plan SPG requires that runoff from an existing developed site should be restricted to 3 times the greenfield rate and the same routing calculations show a storage facility of 14.2m^3 would be required for the 1 hour and 21.1m^3 for the 6 hour storm

The storage requirements are therefore variable depending on the allowable discharge rate and for the 6 hour storm vary from 7m^3, 21m^3 or 88m^3. The options to achieve these volumes would require:

- A 10m^3 underground tank is too large and impractical.

- A drainage system provided by 200m of 150mm storm water pipes will give a storage volume of 3.53m^3 and increasing this to 400m of 250mm diameter pipe will provide 12.5m^3 of storage which is sufficient to provide the storage requirements and may provide a possible or partial option.

- Sub-surface structures such as a Storm-Cells can provide the required attenuation and storage volume. A typical storm-cell is 1.2m wide by 2.4m long and 0.52m deep and with 95% void space can provide 1.42m^3 of storage. To maintain runoff at the existing rate for the 6 hour storm would require 5 storm cells over a surface area of 15m^2 (Table 4.7) and this could be achieved under the hard standing area with an overflow to the existing drainage network as existing. To achieve the greenfield rate would require 62 storm cells over large area of 180m^2 this is impractical and prohibitively expensive.

Table 4.7 Storm Cells to Reduce Runoff to the Existing Rate - 100 yr 6 hour storm

Release Rate	Storage Volume Reqd (m^3)	No Storm Cells required	Surface Area (m^2)
Existing	6.8	5	14.4
Greenfield	87.8	62	178.6
3 * Greenfield	21.1	15	43.2

The above review of SUDS options indicates that a combination of an oversized drainage network and storm cells can be used to ensure that site runoff does not exceed the existing rate. As such, flood risk to others off the site will not be increased and this will meet the requirements of NPPF, NPPG, the EA and the LLFA. To achieve the greenfield rate would be impractical and this requirement should the subject of further discussion with the LPA. These outline considerations should be the subject of further assessment at the detailed design stage.

4.4 Outline Drainage Strategy

The preferred SUDS measures are therefore based on the provision of an oversized drainage network and storm cells to reduce the developed site runoff with increased rainfall due to climate change to the existing rate. The storm cells can include a flow control such as a hydro-brake to restrict off site flows to the local drainage network. The detailed drainage designs and final scheme drawings will be submitted prior to construction and can be covered by a condition and this would show the dimensions of the proposed SuDS features and demonstrate how this will link into the same storm sewer network as existing.

The flow routes in the event of a system failure or the storage facility being full, will be as existing which is down gradient towards the local storm sewer. As the ground floor slabs of the new buildings, and all access and service entrances, will be raised above the local ground level then flooding of these parts of the site will not occur in the event of local drainage system failure, whether by extreme rainfall or a lack of maintenance.

The proposed SUDS system will require arrangements for ongoing maintenance based on the manufacturers recommendations for the surface and subsurface components of the installed SUDS system. This will consider access required to undertake any necessary works over the life-time of the development including system monitoring, inspection, routine and remedial maintenance. The maintenance of the proposed SUDS will also be covered by a condition with confirmation of who will be undertaking this maintenance for the lifetime of the development. This can be pre-commencement to fit in with the detailed drainage design drawing conditions detailed above.

5 PLANNING POLICY GUIDANCE

5.1 Appropriate Development

NPPG divides land use into five categories based on the likely impacts in the event of flooding (Table 5.1) where the proposed dwellings are a "more vulnerable" and the business units a "less vulnerable" form of development.

Table 5.1 NPPF Appropriate Land Use by Flood Zone

Classification	Zone			
	1	2	3a	3b
Essential Infrastructure	Appropriate	Appropriate	Exception test	Exception test
Highly Vulnerable	Appropriate	Exception test	Not permitted	Not permitted
More Vulnerable	Appropriate	Appropriate	Exception test	Not permitted
Less Vulnerable	Appropriate	Appropriate	Appropriate	Not permitted
Water Compatible	Appropriate	Appropriate	Appropriate	If it has to be there

The EA's flood map shows the site is located in Flood Zone 1 where the proposed "more vulnerable" and "less vulnerable" developments are appropriate and the Exception Test is not required.

5.2 The Sequential Test

The objectives of the Sequential Test are to consider if there are any reasonably available alternative sites in the LPA area at a lower flood risk on which the proposed development could take place instead. However as this site is in Flood Zone 1 there will be no reasonably available alternative sites at a lower flood risk and hence the Sequential Test is not required.

6 CONCLUSIONS

- The existing site is located at Arlington Works on Arlington Road, St Margaret's in Twickenham and is currently occupied by Sharpes's Recycle Oil Ltd who produces recycled fuel oil (RFO). Other tenants on the site include car body repairs, carpentry, upholstery, recording and practising of music, metal fabrication, offices and storage facilities and these occupy low rise industrial and two Victorian terraced buildings.

- The site covers 2965m^2 (0.30ha) and includes 1270m^2 of buildings, 1695m^2 of impermeable hard standing areas such as roads and parking areas with no green garden or landscaped areas. Ground levels are 5.5m OD on Arlington Road and the site, which is relatively flat, is at a similar elevation. Runoff from the existing buildings and hard standing areas is collected in an on-site drainage network which leads to the local storm sewer network on Arlington Road.

- The proposals are to provide 7 two storey business units and 24 residential units in a combination of 1, 2 and 3 bedrooms with associated roads, parking, footpaths and landscaping. The proposed development will provide 1255m^2 of buildings, 1137m^2 of impermeable hard standing roads and parking areas and with 573m^2 of green garden areas. Runoff from the buildings and hard standing areas will be collected in a new on-site drainage network which will drain to the same local storm sewer network as existing with SUDS measures as required.

- The Environment Agency's flood map shows the site is located in Flood Zone 1 at a low risk of fluvial flooding. The nearest watercourse is the River Thames 600m to the north east at Richmond upon Thames but this area is protected by raised flood defences alongside the river. The EAs flood map is for the undefended case and shows the 100 year and 1000 year flood would not reach the site even if the defences were not present. The EA proposed River Thames Flood Alleviation Scheme is not considered in this FRA. The risk of fluvial flooding of the site, with or without defences, is therefore low.

- As the site lies in Flood Zone 1 and less than 1ha a FRA is not usually required unless it could be at risk from sources of flooding other than rivers or the sea which may be the case. This Zone 1 FRA should therefore accompany the planning application and the content is dictated by the National Planning Policy Framework (NPPF), the National Planning Practice Guidance (NPPG), the Environment Agency's guidelines and the local Strategic Flood Risk Assessment (SFRA). The requirements of these documents are considered in this FRA.

- Flow records from the EA gauge at Kingston upon Thames 5km upstream, with flow records from 1883 to 2016, show that the largest floods in the last 133 years occurred in 1894, 1947 and 1968. The 1947 flood affected parts of Kingston and smaller events in 1968, 2003 and 2014 flooded parts of Hampton Wick but no properties in St Margarets were affected. The SFRA and the British Hydrological Society's "Chronology of British Hydrological Events" provides no evidence of historical flood events in St Margarets.

- Other potential sources of flooding have been considered but the risk from storm water, roads, sewers, tides, failure of impounded water bodies and groundwater are considered to be low. With raised floor levels the risk of flooding from these sources will be managed and intercepted by the local drainage system and no significant flooding from these sources is anticipated. The raised floor levels will protect the buildings from pluvial and other sources of flooding and additional flood resistance or resilience measures are not required.

- The proposed escape route from the site is onto Arlington Road which is in Flood Zone 1 and would be dry and this road leads to an area outside of the flood plain where services and facilities exist. As this site is in Flood Zone 1 there will be no loss of flood plain storage and flood plain storage compensation measures are not required.

- Under NPPF/NPPG a sustainable drainage system is required to ensure surface water runoff from a developed site does not exceed the existing rate so as not to increase flood risk to others. The SFRA and the London Plan require a return to the greenfield rate, whilst the London Plan SPG to three times the greenfield rate. The greenfield peak flows and volumes are 75% of the existing rate due to the lower percentage runoff whilst the developed site will increase peak flows and volumes by 20% above the existing rate due to the 40% increase in rainfall from climate change and as the impermeable area is slightly less than the existing site.

- A review of SUDS options suggests that infiltration methods such as soakaways, trenches, permeable pavements and swales will not be suitable due to the industrial uses on the site and the potential for contamination to be present. Rainwater harvesting and a green roof have been discounted as being impractical. Storage and attenuation offer the most suitable option and to achieve the existing rate will require storage of 6.8m^3 for the 6 hour storm or to achieve the greenfield rate a larger storage facility of 88m^3. The London Plan SPG criteria of 3 times the greenfield rate suggests a storage facility of 21m^3. These storage requirements are therefore variable depending on the allowable discharge rate. An underground tank is too large and impractical but an oversized drainage network or storm cells could be used. To maintain runoff at the existing rate would require 5 storm cells over 15m^2, to achieve the greenfield rate 62 storm cells over 180m^2 but this is considered impractical and prohibitively expensive.

- A combination of an oversized drainage network and storm cells can be used to ensure that site runoff does not exceed the existing rate and this will meet the requirements of NPPF, NPPG, the EA and the LLFA. To achieve the greenfield rate would be impractical and this requirement should the subject of further discussion with the LPA. These outline considerations should be the subject of further assessment at the detailed design stage and covered by a condition.

- The preferred SUDS measures would include a flow control device to restrict off site flows to the local drainage network. The flow routes in the event of a system failure or the storage facility being full will be as existing which is down gradient to the local storm sewer. As the ground floor slabs of the new buildings, and all access and service entrances, will be raised above the local ground level then flooding of these parts of the site will not occur in the event of local drainage system failure, whether by extreme rainfall or a lack of maintenance. The proposed SUDS system will require arrangements for ongoing maintenance based on the manufacturers recommendations for the surface and subsurface components of the installed SUDS system.

- Under NPPG the proposed dwellings are a "more vulnerable" and the business units a "less vulnerable" form of development which are appropriate in Flood Zone 1 and the Exception Test is not required. As the site is in Flood Zone 1 there will be no reasonably available alternative sites at a lower flood risk and hence the Sequential Test is not required.

Figures

Figure 1.1 Site Location

Figure 1.2 Existing Site Layout

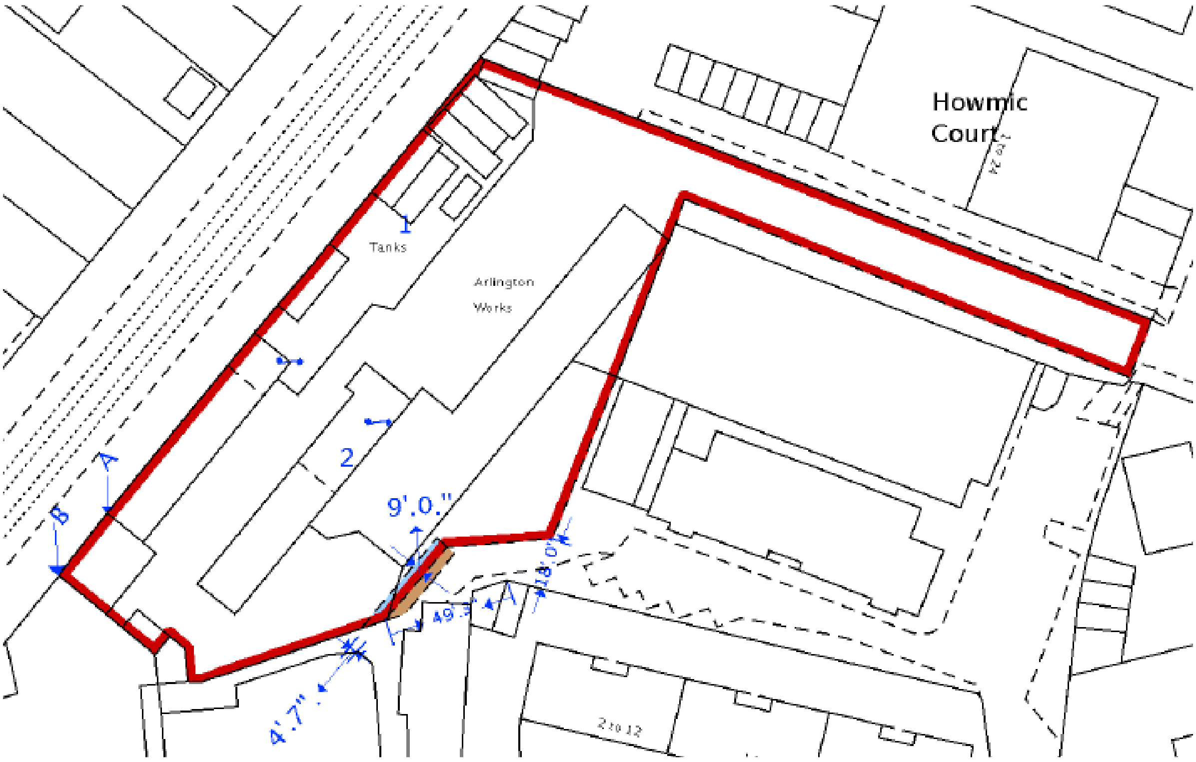

Figure 1.3 Aerial Photograph

Figure 1.4 Topographical Survey

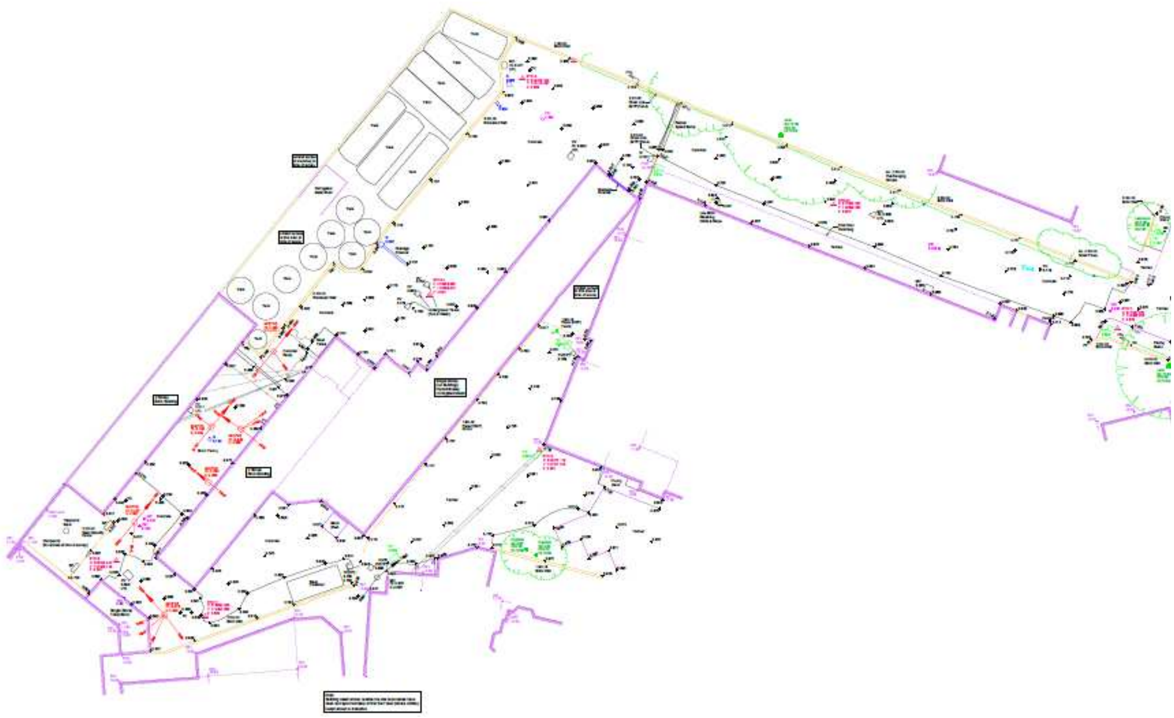

Figure 1.5 Proposed Development Layout

Figure 1.6 EA Flood Map

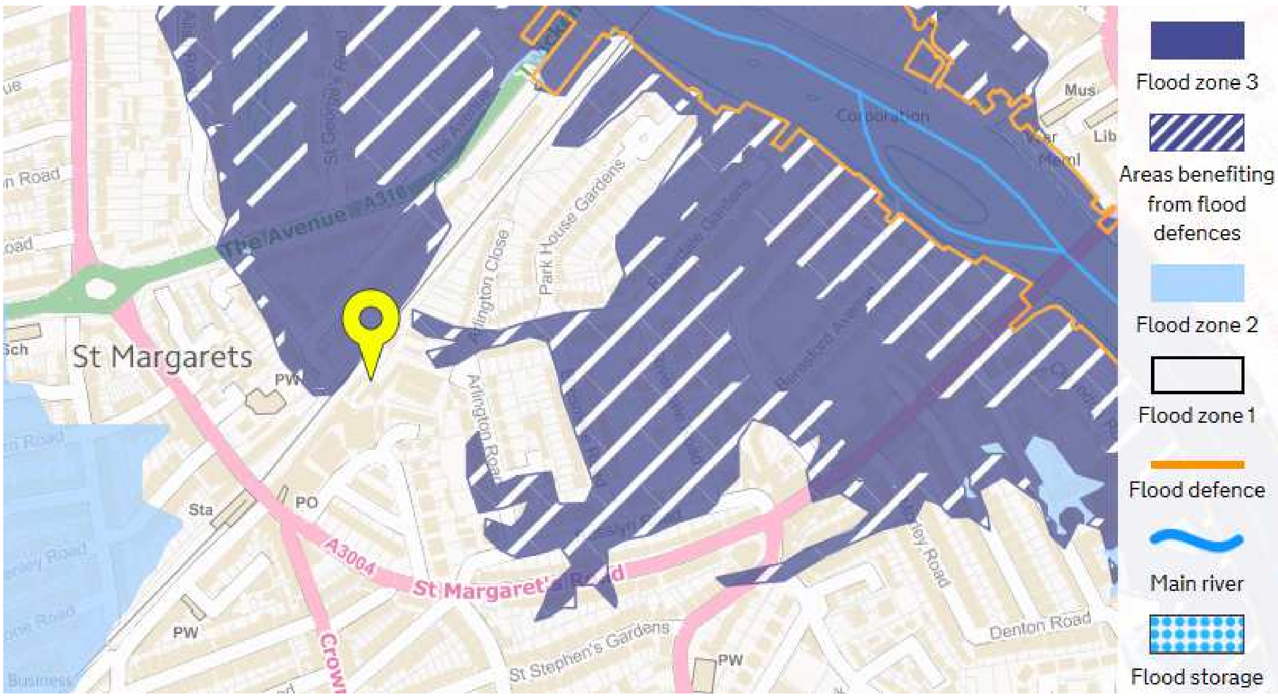

Figure 1.7 EA Flood Map - detail

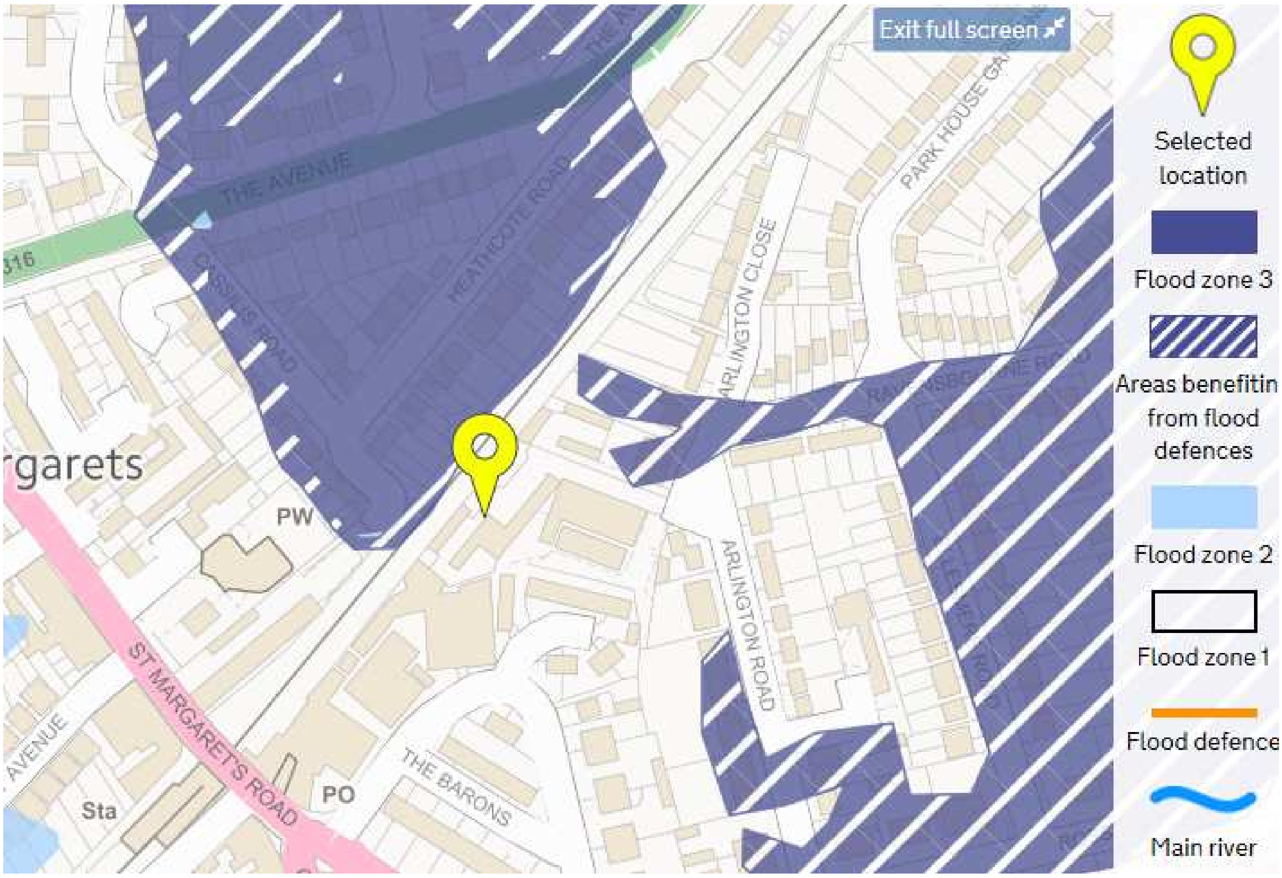

Figure 2.1 Historical Flood Records

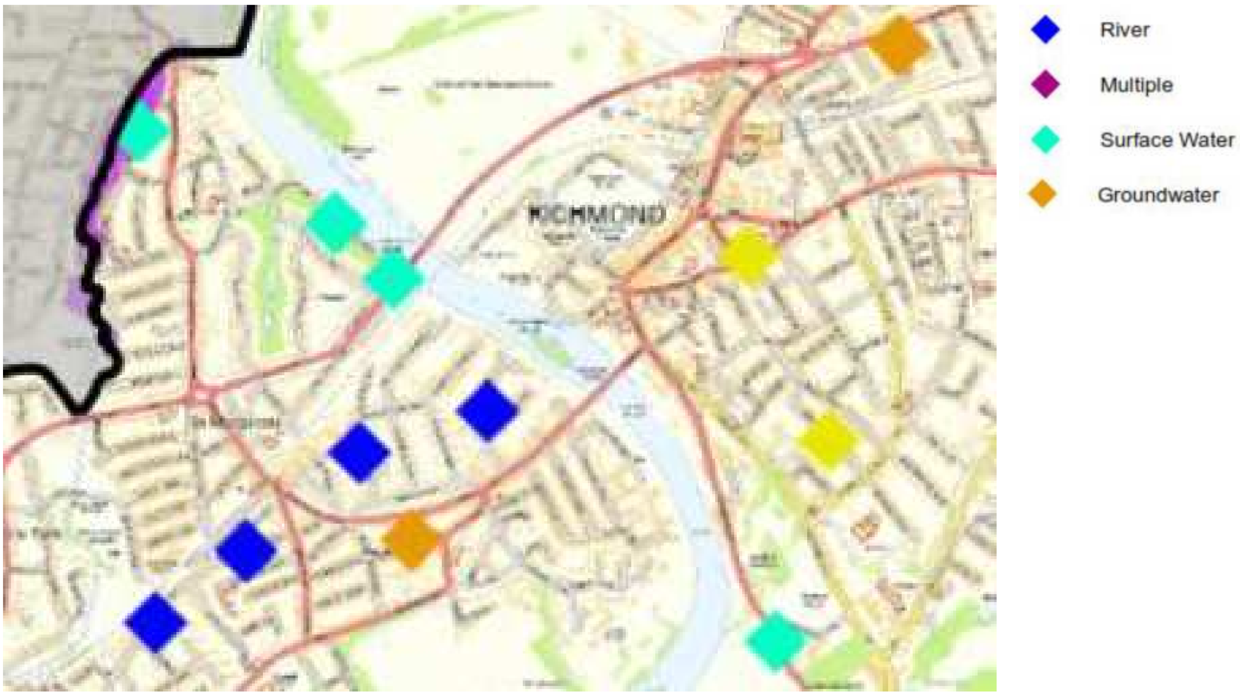

Figure 2.2 Flood Hazard due to a Breach of the Defences

Figure 2.3 EA Pluvial Flood Risk

Figure 2.4 Risk of Flooding Due to Reservoir Failure

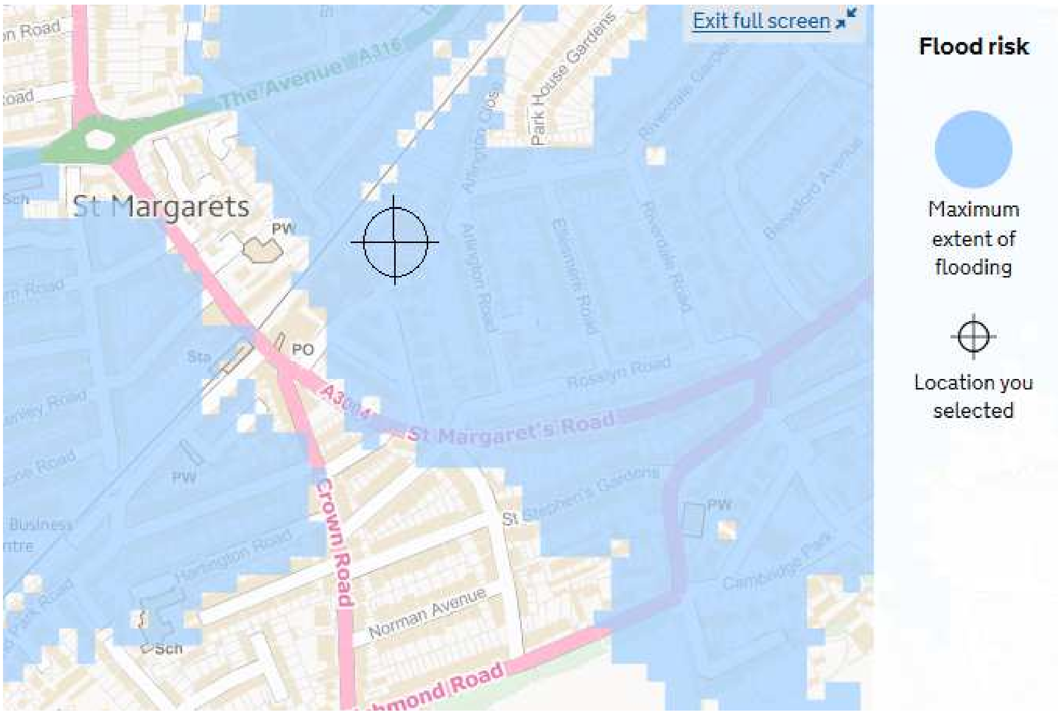

Figure 2.5 Susceptibility to Groundwater Flooding

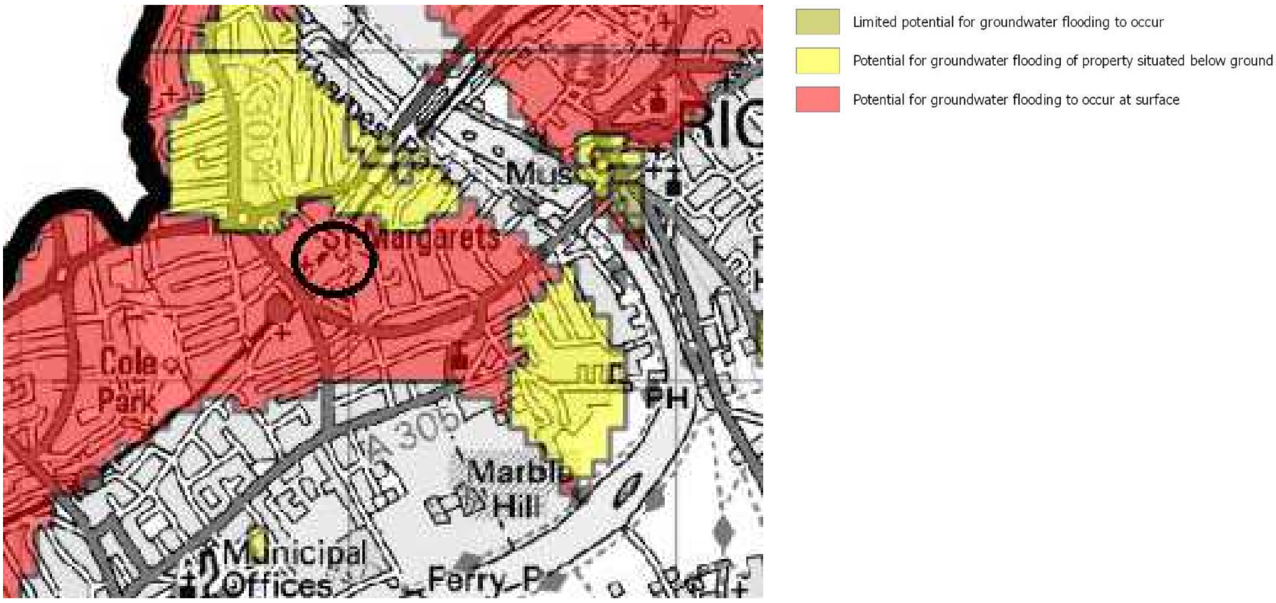

Figure 4.1 Bed Rock Geology

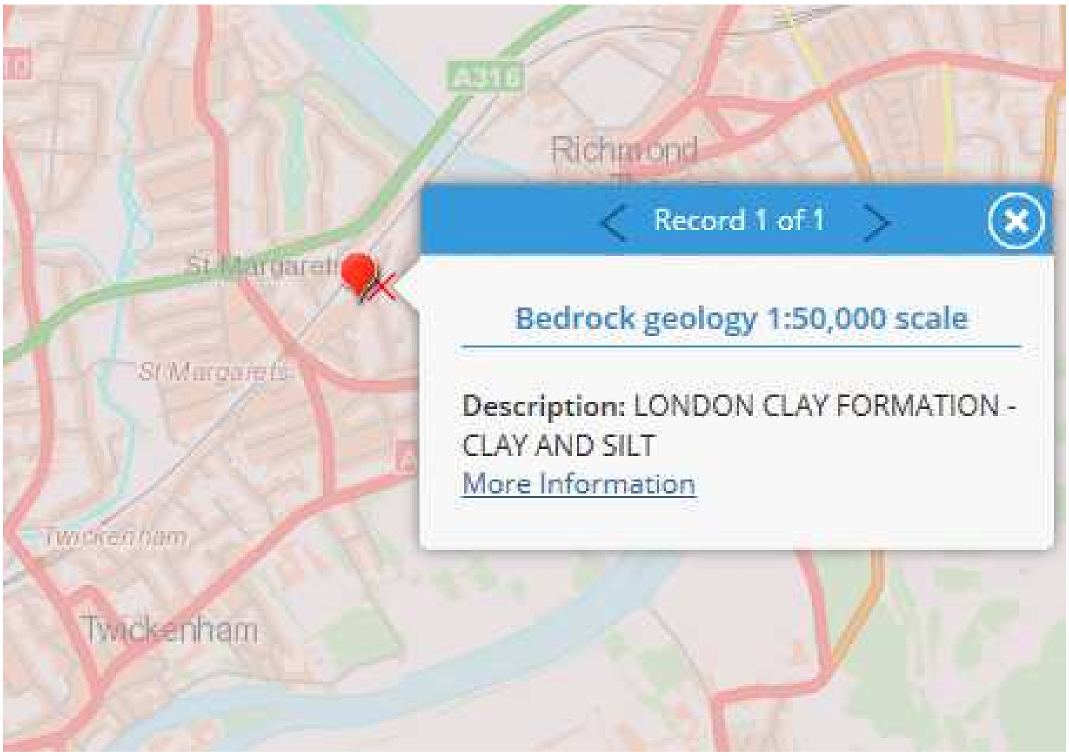

Figure 4.2 Drift Geology

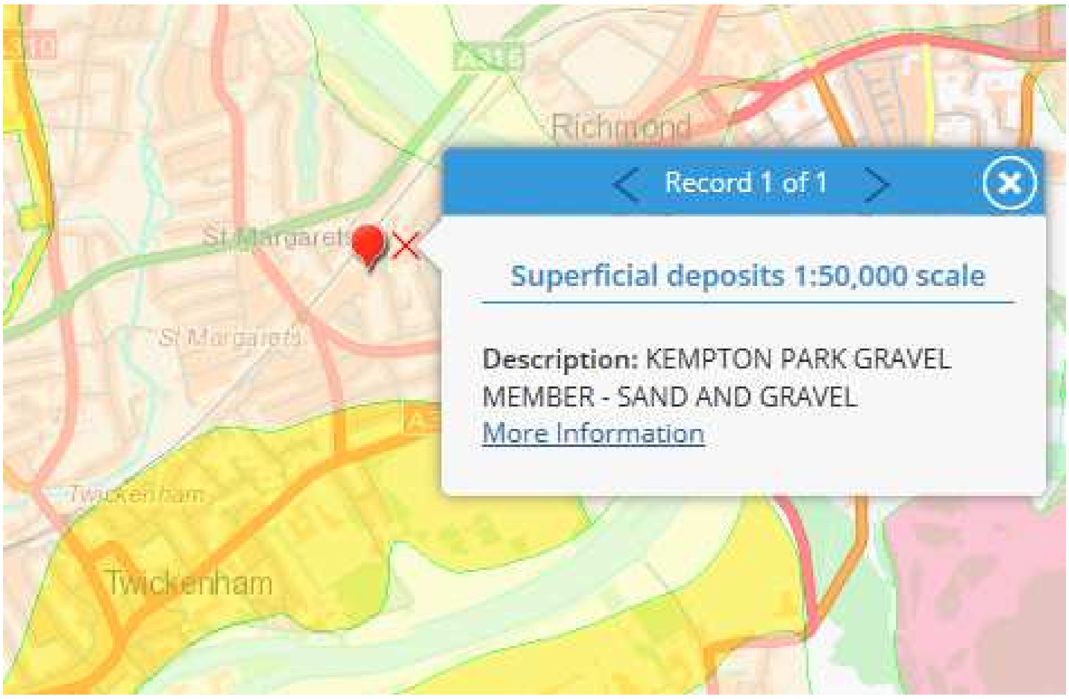

Figure 4.3 BGS Boreholes

Figure 4.4 BGS Borehole Log at TQ17SE109

NGR 1705 7439
OD + 5.57

TQ 17 / 55
TQ17SE /109

17/5

soil mechanics department

BOREHOLE No. 1

CONTRACT Thames Flood Prevention: Barrier/Barrage Project

REPORT No. 7707/C

Bored for G.L.C. Dept., of Public Health Engineering

Ground Level 18.27 O.D.

Site Address Arlington Road, Twickenham

Boring Commenced 27.2.70
Boring Completed 27.2.70

Type and Dia. of Boring Shell and Auger (8 ins. diameter) (4 ft. x 3 ft. Pit to 3'6")

Water Strikes	Water Levels Recorded During Boring								
1. 8'6"	Hole Depth								
2.	Casing Depth								
3.	Water Level								

Remarks

Description	Depth (Scale 1 inch = 5 ft.)	Ref. No.	Type	Depth	N blows/ft
Topsoil Soft brown sandy clay with occasional stones	1'0"	6076	J	1'0"	
		6077	J	2'6"	
Gravel and brown sand [FPG]	3'6"	6078	J	3'6"	
		6079	D	3'6"	
		6080	J	5'6"	
		6081	D	5'6"	
		6082	J	7'6"	
		6083	D	7'6"	
KP		6085	J	9'6"	
		6086	D	9'6"	
		6087	J	11'6"	
		6088	D	11'6"	
		6089	J	13'6"	
		6090	D	13'6"	
		6091	J	15'6"	
		6092	D	15'6"	
		6093	J	17'6"	
		6094	D	17'6"	
		6095	J	19'6"	
		6096	D	19'6"	
		6097	J	21'6"	
		6098	D	21'6"	
		6099	J	23'6"	
		6100	D	23'6"	
		6201	J	25'6"	
		6202	D	25'6"	
		6203	J	27'6"	
		6204	D	27'6"	
		6205	J	29'6"	
Stiff grey-brown fissured London Clay [LC]	30'0"	6206	D	29'6"	-3.57
	31'0"	6207	J	31'0"	
		6084	W	(8'6")	

S.S.D.F. 12.5.70.

Code: U—Undisturbed Sample D—Large Disturbed Sample J—Jar Sample W—Water Sample

Note.—Unless classification tests have been made and the results are included in this Report, the descriptions of strata given above have been obtained by inspection ... with British Standard Code of Practice CP 2001 (1957) Site Investigations. To ensure agreement as to interpretation clients are requested to ...

Figure 4.5 Runoff and Storage Hydrographs to Achieve Existing Rate – 1 hour Storm

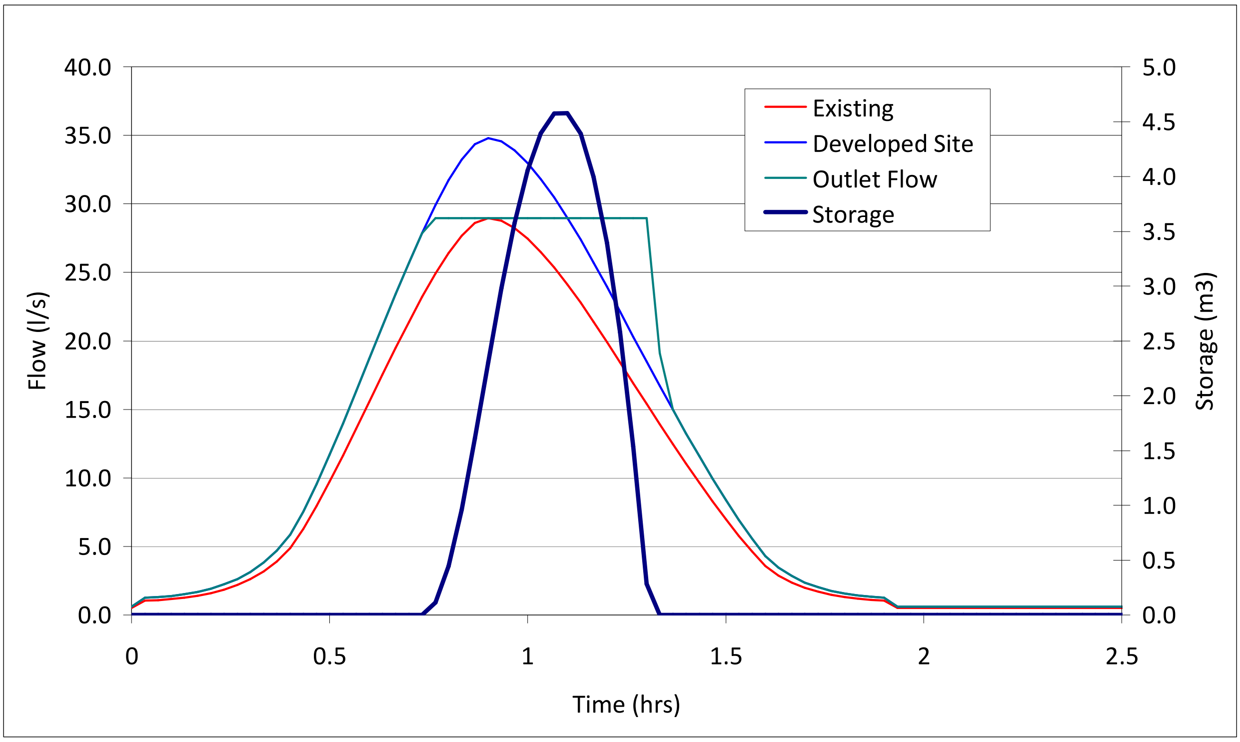

Figure 4.6 Runoff and Storage Hydrographs to Achieve Greenfield Rate– 1 hour Storm