LBR 2.61.3

LONDON BOROUGH OF REDBRIDGE
STRATEGIC FLOOD RISK ASSESSMENT
LEVEL 2 (ADDENDUM)

V1.2 – APRIL 2016

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EXECUTIVE SUMMARY

BACKGROUND

A Strategic Flood Risk Assessment (SFRA) is a study carried out to assess the flood risk to an area from all sources, now and in the future. It takes into account the impacts of climate change and assesses the impact that land use changes and development in the area will have on flood risk. The Level 1 SFRA for the London Borough of Redbridge (LBR) was completed in early 2015. It identified that that land outside flood risk areas could not appropriately accommodate all the necessary development and so a Level 2 SFRA was required.

A Level 2 SFRA considers the detailed nature of the flood characteristics within a Flood Zone, assesses existing flood defence infrastructure and the impacts of climate change with respect to specifically selected potential development sites. This document is an addendum of the Level 2 SFRA produced in September 2015. It delivers detailed assessments of two major potential development sites; **Billet Road** and the Guide Dog Training School, **Manor Road**. This Level 2 SFRA Addendum document has been developed in line with the National Planning Policy Framework (NPPF), the accompanying National Planning Practice Guidance (NPPG) and the LBR's own knowledge and policies.

KEY CHALLENGES – FLOODING IN REDBRIDGE

Fluvial and Tidal

The River Roding, the Cranbrook and the Seven Kings Water are the main sources of fluvial flood risk in the LBR. The River Roding is also affected by the tidal influence from the River Thames downstream from Ilford. Fluvial flood risk is relatively well confined to remain alongside the channels. Areas affected by the predicted fluvial flood extent include Woodford, Wanstead, Redbridge, Cranbrook, Ilford, Little Heath, Seven Kings and Loxford.

Surface Water and Ordinary Watercourses

Surface water flood risk is caused by overland flow which cannot drain away through drainage systems or soak into the ground and therefore lies on or flows over the ground instead. As surface water flooding is most affected by topography, geology and urban development, it can be variable in extent. The surface water flood risk in the LBR is mostly located in close proximity to the watercourses as this is where land is the lowest and natural drainage directs overland flow to these areas.

Sewer

Sewer flood risk is usually caused by blockages or capacity exceedance in the sewers which results in water being unable to enter the system or it surcharges from the sewers back onto the surface. Thames Water Utilities Ltd (TWUL) are responsible for maintenance and operation public sewers in the LBR. TWUL records show that sewer flooding has occurred at some point in most areas within the borough.

Groundwater

Groundwater is water which is found underground, held in the soil or in pores and crevices in rock. Groundwater flooding occurs when water levels in the ground rise above surface levels or into subterranean property such as basements. Areas susceptible to groundwater flooding in LBR are generally associated with alluvial geological deposits along the river corridors.

Artificial

The failure of a reservoir has the potential to cause catastrophic damage due to the sudden release of large volumes of water. Should a large reservoir fail, small areas of the LBR alongside watercourses would be affected, such as Wanstead, Ilford and Fairlop.

KEY SITE ASSESSMENTS

Billet Road

Flood Risk Assessment:

Source	Flood Risk	Source	Flood Risk	Source	Flood Risk
Fluvial	Very low	**Groundwater**	Uncertain but potential	**Sewer**	Medium
Surface water	Low - medium	**Artificial**	Very low	**Residual**	Very low

Planning Considerations:

- Sequential and Exception Tests are not required as site is located within Flood Zone 1.
- Site layout must accommodate overland flow paths.
- Sufficient SuDS infrastructure should be provided to achieve better than Greenfield runoff rates.

Manor Road

Flood Risk Assessment:

Source	Flood Risk	Source	Flood Risk	Source	Flood Risk
Fluvial	Low	**Groundwater**	Uncertain but potential	**Sewer**	Low
Surface water	Low	**Artificial**	Very low	**Residual**	Very low

Planning Considerations:

- Sequential and Exception Tests are not required as site is located within Flood Zone 1.
- Site layout must accommodate overland flow paths.
- Sufficient SuDS infrastructure should be provided to achieve better than Greenfield runoff

ABBREVIATIONS

Abbreviation	Definition
EA	Environment Agency
FRA	Flood Risk Assessment
LBR	London Borough of Redbridge
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection
SuDS	Sustainable Drainage System
TWUL	Thames Water Utilities Ltd
WFD	Water Framework Directive

GLOSSARY

Term	Definition
Climate Change	This refers to any change in climate over time. On Earth, the temperatures are rising causing an increase in sea levels and rainfall. This is usually accounted for in models by applying a potential change percentage to the current 1 in 100 year return period rainfall.
Environment Agency	The Environment Agency is a non-departmental public body, established in 1996 and sponsored by the government's Department for Environment, Food and Rural Affairs (Defra). Its responsibilities relate to the protection and enhancement of the environment in England.
Exception Test	This is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactory, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.
Flood Map for Planning (Rivers and Sea)	This map shows the assessment of the likelihood of flooding from rivers and the sea at any location. It takes into account the presence and effect of all flood defences, predicted flood levels, and ground levels.
Floodplain	A floodplain is the area that would naturally be affected by flooding if a river rises above its banks.
Flood Risk	For the purpose of applying the National Planning Policy Framework (NPPF), 'flood risk' is a combination of the probability and the potential consequences of flooding from all sources – 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, lakes and other artificial sources.
Flood Risk Vulnerability Classification	This classification categorises different types of property uses and development according to their vulnerability to flood risk.
Flood Zones	These show areas of land that could flood from rivers and/or the sea. They identify the extents over which flooding could occur, if the flooding is not constrained by flood defences.
Flood Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Flood Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Flood Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding or land having a 1 in 200 or greater annual probability of sea flooding.
Flood Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

Term	Definition
Fluvial	Of a river. For example, fluvial flooding is caused by river water.
Lead Local Flood Authority	The unitary authorities or county councils responsible for managing local flood risk, including from surface water, ground water and ordinary watercourses, and for preparing the local flood risk management strategy.
Local Flood Risk	Flood risk from surface runoff, groundwater and Ordinary Watercourses.
Main River	As marked on a main river map, these are larger watercourses which the EA have powers to carry out flood defence work on.
Ordinary Watercourse	This refers to every watercourse through which water flows and which does not form part of a Main River.
Sequential Approach	The sequential, risk-based approach to the location of development is a general approach designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. Application of the sequential approach in the plan-making process, in particular application of the Sequential Test, will help ensure that development can be safely and sustainably delivered.
Sequential Test	This method ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new development to Flood Zone 1 (areas with the lowest probability of flooding) and only considering sites outside of this zone when there are no reasonably available sites. If this is the case, Flood Zone 2 should be considered ahead of Flood Zone 3. Local Planning Authorities should take account of flood vulnerability of land uses when considering locations outside of Flood Zone 1, applying the Exception Test if required.
Site-Specific Flood Risk Assessment	This is to be carried out by (or on behalf of) a developer to assess the flood risk to and from a development site. Where necessary, the assessment should accompany a planning application submitted to the Local Planning Authority. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users.
SFRA	This is a study carried out by one or more Local Planning Authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that land use changes and development in the area will have on a flood risk.
SuDS	Sustainable Drainage Systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. They also provide opportunities to reduce the causes and impacts of flooding, remove pollutants from urban run-off at source and combine water management with green space with benefits for amenity, recreation and wildlife.
Surface Water	This refers to the water which ponds or flows on the surface following rainfall whereby water cannot drain away or soak into the ground fast enough.
Surface Water Flood Extent	The name given to the layer generated using the 1 in 100 year event layer from the Flood Map for Surface Water to represent the areas at risk of flooding due to surface water.

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1. KEY SITE ASSESSMENT – BILLET ROAD

1.1. SUMMARY

Flood Risk Assessment:

Source	Flood Risk	Source	Flood Risk	Source	Flood Risk
Fluvial	Very low	**Groundwater**	Uncertain but potential	**Sewer**	Medium
Surface water	Low - medium	**Artificial**	Very low	**Residual**	Very low

Additional considerations:

Consideration	Implication to Flood Risk
Climate change	Probable increase in surface water, groundwater and sewer flood risk. Potential for Flood Zones to extend to reach the site.
Greenbelt designation	Site is currently designated as a Greenbelt site, therefore there are development restrictions in place. There is potential for the site to be removed from this designation.
Landfill site	The north-east section of the site is recorded to be a historic landfill site (Hainault House Farm). Historic landfill sites are places with records of waste being received to be buried but are now closed or covered.
Safeguarded for minerals	*'Since minerals are a non-renewable resource, minerals safeguarding is the process of ensuring that non-minerals development does not needlessly prevent the future extraction of mineral resources, of local and national importance'* (NPPG, 2012).
Historic flooding	Surface water flooding has frequently occurred on Billet Road itself, Hainault Road and the junction with the A12. The school has also been flooded due to culverts with a lack of capacity.

Planning Considerations:

- Sequential and Exception Tests are not required as site is located within Flood Zone 1.
- Site layout must accommodate overland flow paths.
- Sufficient SuDS infrastructure should be provided to achieve better than Greenfield runoff rates.

1.2. SITE DESCRIPTION

The Billet Road site is 21.6ha and is located in the east of the borough in Romford (see *Figure 1.1*).

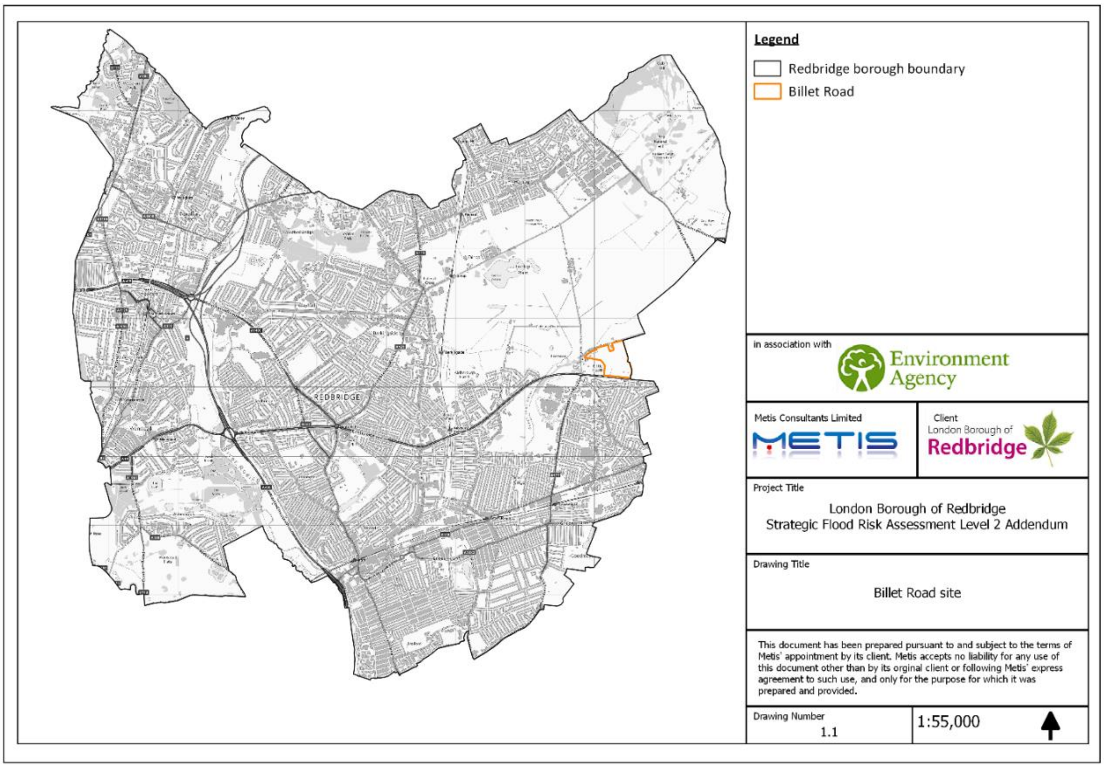

Figure 1-1. Billet Road site.

It is bordered by Eastern Avenue (A12) to the south, a residential development to the east and residential properties and rural land to the north and west. There is a Lawn Tennis Club and a school situated between the site and Hainault Road. There is a scout camp site to the north-west and a kennel & cattery to the north. An ordinary watercourse runs along the western border of the Billet Road site (south to west). This becomes part of the Seven Kings Water (SKW).

There is little elevation variety over the site with the higher points located in the north-east and south-west. The lower point is in the north-west, where the Ordinary Watercourse is located. There is also a drop in the south-east corner. This means that most water will flow from the site to the Ordinary Watercourse, except any which lands in the south-east which will flow downhill towards Padnall Lake.

1.3. PLANNING CONTEXT

The Billet Road site is currently designated as a Greenbelt site, resulting in development restrictions. There is potential for the site to be removed from this designation and therefore it is being included within this Level 2 SFRA Addendum. It has also been recognised that the Billet Road site has been safeguarded for minerals. The NPPG (DCLG, 2015) explains that sites are safeguarded for the following reason: '*Since minerals are a non-renewable resource, minerals safeguarding is the process of ensuring that non-minerals development does not needlessly prevent the future extraction of mineral resources, of local and national importance*'. Further details can be found within the LBR's Minerals Local Plan (LBR 2012).

The Billet Road site does not contain any areas within the Environment Agency Flood Zones (risk of flooding from the river and sea) and there are no building restrictions due to this. There are small patches of surface water flood risk and under the London Plan (Greater London Authority, 2015), all developments are to achieve Greenfield runoff rates post-development so this would need to be factored into the designs.

An additional consideration is that the north-east section of the site is recorded to be a historic landfill site (Hainault House Farm). The EA's *Landfill* maps (EA, 2015) states that historic landfill sites are places where records of waste being received to be buried are now closed or covered. Details of this will need to be further explored to determine what type of flood alleviation measures would be appropriate.

1.4. RISK ASSESSMENT

1.4.1. FLUVIAL AND TIDAL

The Billet Road site is about 250m east of the SKW (see Figure *1.2* and *Figure A1* in *Appendix A)*. There are Ordinary Watercourses which run from the south of the site to the west where they exit. These are tributaries of the SKW but are not included within the fluvial and tidal risk assessment. The SKW is surrounded by the Flood Zones but these do not reach the Billet Road site. Flood Zone 2 is less than 200m away from the site boundary.

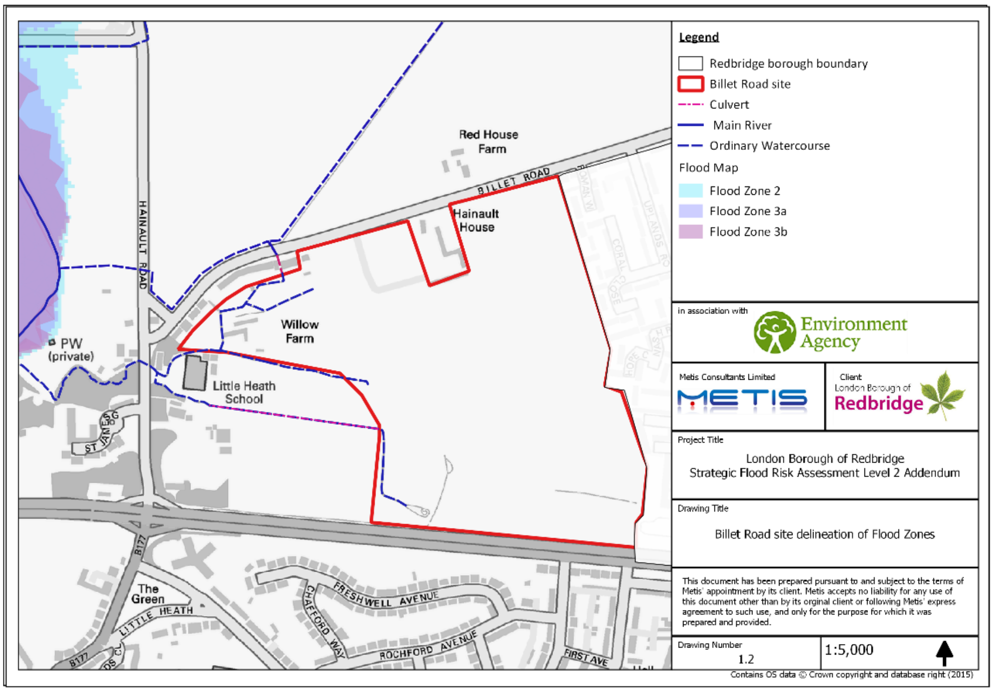

Figure 1-2. Billet Road site fluvial flood risk outlined by the Flood Zones.

1.4.2. SURFACE WATER AND ORDINARY WATERCOURSES

There is very little surface water flood risk within the Billet Road site. Low lying land around the Ordinary Watercourses to the north-west is predicted to reach depths between 0.15m and 0.60m due to the 1 in 100-year event. Small patches of land to the south of the site are also estimated to be susceptible to similar depths, as seen in *Figure 1-3* below (and *Figure A2* in *Appendix A*).

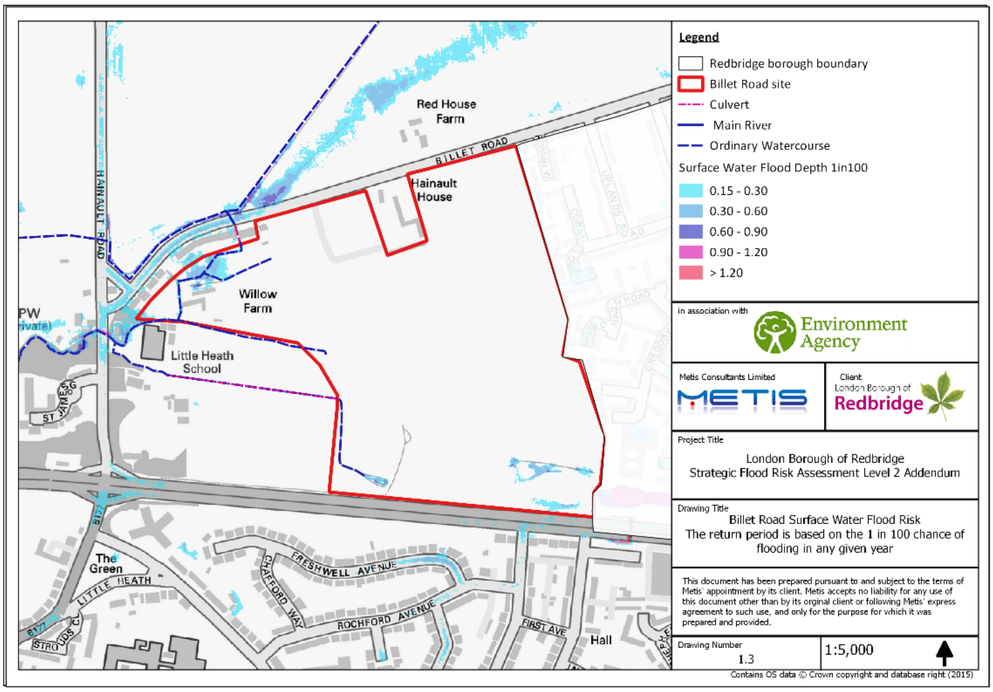

Figure 1-3. Billet Road site surface water flood map (depth)

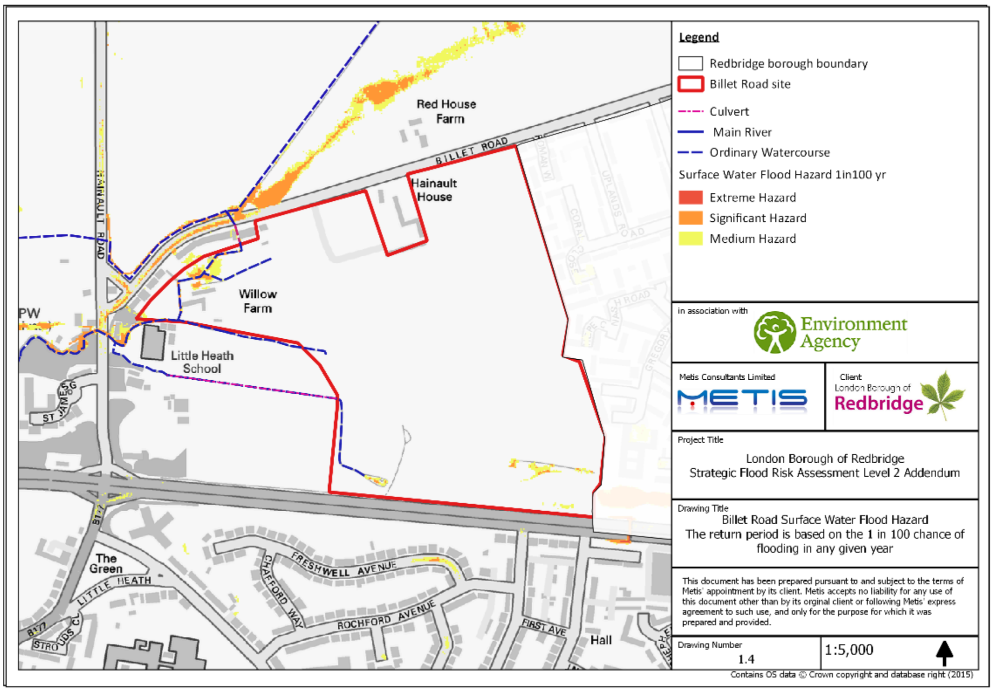

Figure 1-4. Billet Road site surface water flood map (hazard)

The velocity of the surface water is estimated to reach up to 0.25m/s in the southern area and anywhere between 0 and 2m/s in the north-west (although the majority of this area can expect to reach 0.5m/s). Billet Road itself is predicted to be at risk of surface water flooding, reaching velocities up to 2m/s which should be considered for safe access and egress routes. The hazard modelling predicts that the areas which may encounter surface water flooding would have a medium to significant hazard (see *Figure 1.4* or *Figure A3* in *Appendix A*).

Padnall Lake, just outside of the site to the east, is estimated to reach flood depths of up to 1.2m and to be an extreme hazard. Due to the close proximity to the site, the lake should be considered in the designs.

As previously mentioned, there are Ordinary Watercourses within the Billet Road Site. Whilst within the site boundary they are all open channels, one of them becomes culverted for a short stretch once it leaves. These channels merge just outside of the site and then join the SKW shortly downstream. The overland flow paths of surface water reaching the channels should be considered.

1.4.3. SEWER

The Billet Road site falls within the RM6 5 postcode. The TWUL DG5 register shows that there are 10 properties at risk of sewer flooding within this area. This is the fourth highest area at risk within the LBR. There is no data on the time to inundation and duration of flood available so the flood risk would need to be assessed in detail should any development progress.

There are surface water sewers serving Billet Road and Hainault Road. There is a small section of the network which serves the south-east area of the site and flows into Padnall Lake. There are no surface water or foul sewers running through the site. Foul sewers serve the developments around the site and flow in the same direction as (but not within) the Ordinary Watercourses.

1.4.4. GROUNDWATER

Groundwater flooding is most likely to occur in areas underlain by permeable rocks, areas known as aquifers. The majority of the Billet Road site is located above a superficial secondary aquifer, see *Figure 1.5* (and *Figure A4* in *Appendix A*). Superficial aquifers have permeable layers capable of supporting water supplies at a local level and in some cases they form an important source of base flow to rivers. In comparison to an area not situated above an aquifer, the Billet Road site has an increased level of groundwater flood risk.

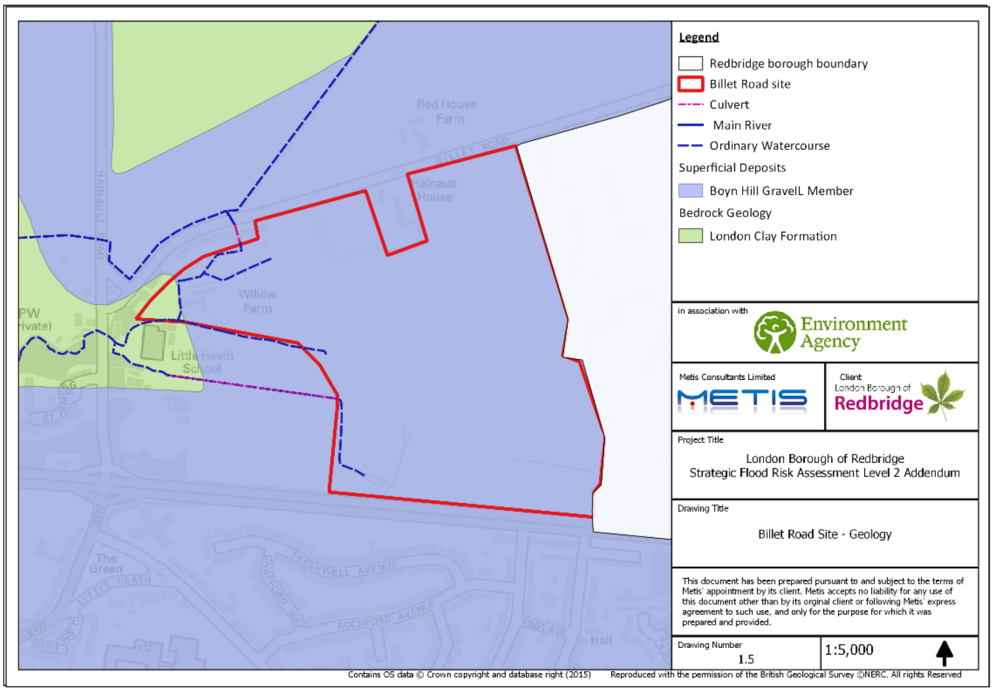

Figure 1-5. Billet Road groundwater flood risk (geology)

The bedrock geology is London Clay. A large percentage of the site is overlain by superficial deposits, Boyn Hill Gravel Formation (*Figure 1.6* and *Figure A5* in *Appendix A*). There is an increased potential for elevated groundwater in areas underlain by permeable superficial deposits. Information on flood extent, level of risk, time to inundation and duration of potential flooding is not available.

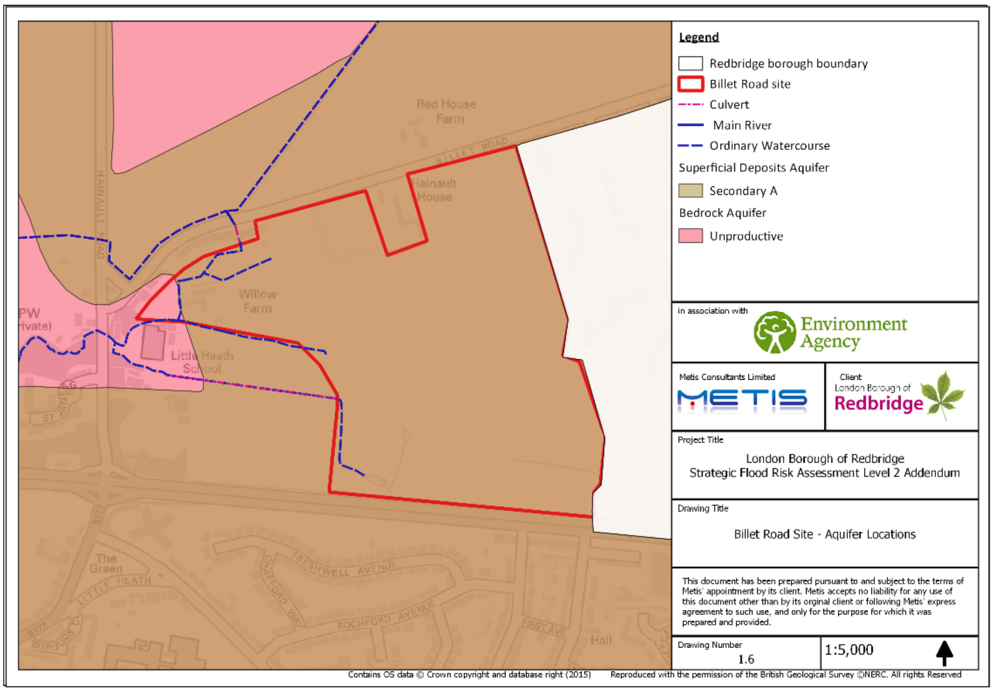

Figure 1-6. Billet Road groundwater flood risk (aquifers)

1.4.5. ARTIFICIAL

The Environment Agency's (EA) website states that reservoir flooding is extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. Their Risk of Flooding from Reservoirs map indicates that the Billet Road site is not at risk of flooding due to a reservoir breach, although there is a risk associated with the SKW, approximately 250m away. Should a breach occur, water from the Hainault Forest Lake is predicted to follow along the route of the SKW, flooding the land immediately alongside the watercourse, but not the Billet Road site.

1.4.6. RESIDUAL (DEFENCE FAILURE/OVERTOPPING)

By EA definition, an area benefits from a flood defence if it has a Standard of Protection (SoP) against the 1 in 100-year event. There are no areas within the LBR which benefit from defences under this definition. There are also no formal flood defences within the Billet Road site. In light of this information, there is no residual risk due to defence failure or overtopping.

1.4.7. IMPACTS OF CLIMATE CHANGE

Climate change could result in an increase of flood risk. The following paragraphs outline how climate change may impact the Billet Road site.

FLUVIAL / TIDAL FLOOD RISK

The potential increase in river levels and time to inundation caused by an increase in rainfall as a result of climate change may result in the current Flood Zones expanding. This could mean that the Flood Zones surrounding the SKW could expand to cover parts of the Billet road site.

SURFACE WATER AND ORDINARY WATERCOURSE FLOOD RISK

To account for climate change, the LBR decided to map surface water flood risk as a result of rainfall with an annual probability of 1% (1 in 100) rather than the 0.33% (1 in 30 year). This comparison can be seen in *Figure 1.7* below *(*and *Figure A6* in *Appendix A*).

The Flood Map for Surface Water shows that for an event with an annual probability of 0.33% (1 in 30-year), the surface water flooding predicted to occur around the Ordinary Watercourses affects less land and has a shallower depth compared to that estimated for the 1 in 100-year event. The smaller patches of land affected in the south of the site are still predicted to be at risk, but with a reduced extent. This comparison shows that the risk of surface water flooding should be considered to increase with climate change.

An increase in groundwater levels and surface water runoff due to climate change means that intermittent watercourses can be found to contain a flow or an increased flow which heightens the flood risk. This could affect the Ordinary Watercourses within the Billet Road site, resulting in flooding. As an additional consequence, the SKW may experience an increase in flow and river levels, increasing the fluvial flood risk.

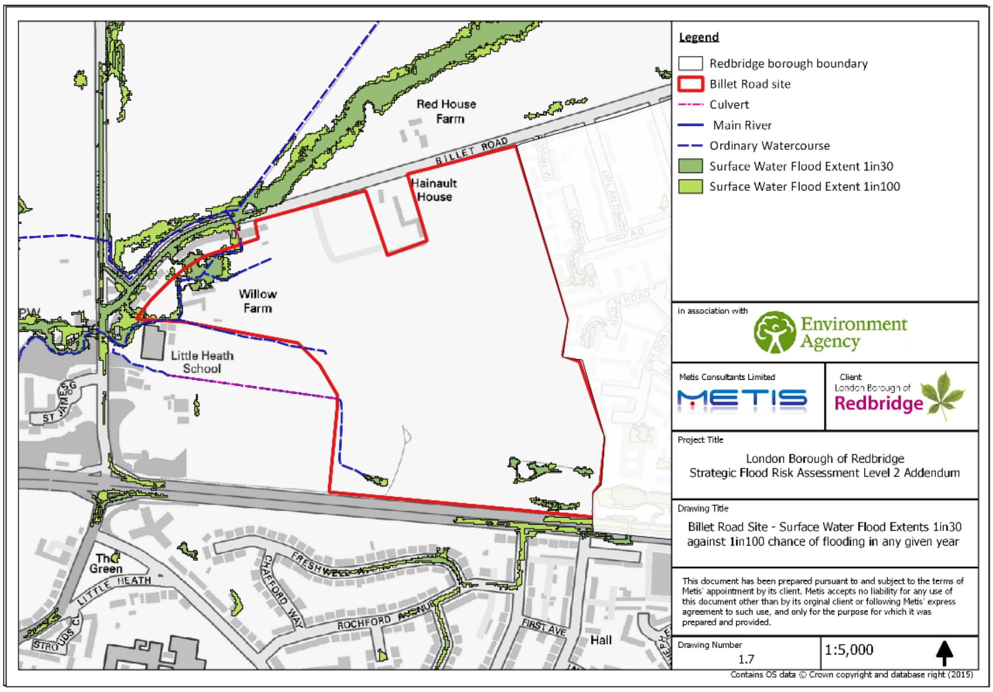

Figure 1-7. Billet Road site surface water flood risk comparison (1 in 30-year vs 1 in 100 year events)

SEWER FLOOD RISK

Climate change is expected to increase the frequency and intensity of rainfall events. This will decrease the level of service provided by the sewer system over time and the risk of sewer flooding will increase where capacity is not increased in line with these changes.

GROUNDWATER FLOOD RISK

It is predicted that the effects of climate change may increase groundwater flood risk. An increase in rainfall can result in aquifers becoming fully recharged more frequently, resulting in excess water rising back to the surface in the form of springs. Subsequently, intermittent watercourses can be found to contain a permanent flow. These effects can also be caused by higher sea levels which can cause an increase in the water table resulting in groundwater being found closer to the surface. Both the Ordinary Watercourses within the site and the aquifers located below it could experience an increase in water levels and therefore the groundwater flood risk can be expected to increase.

ARTIFICIAL FLOOD RISK

The increased rate and volume of rainfall associated with climate change could increase reservoir flood risk. Although this has not been modelled, the frequency in which overtopping occurs could increase, as could the risk of subsequent breaches. An increase in water volume could extend the reservoir flood extent to the Billet Road site.

The Environment Agency has recently (February 2016) published revised guidance on climate change allowances for flood risk assessment. The guidance provides allowances for a range of time periods specifically related to river basin districts for river flows, rainfall intensities for urban catchments and sea level rise. Allowances are split into upper end, higher central and central bands. This issued guidance provides detailed direction on how these should be applied to development scenarios.

For more information, please refer to 'Flood risk assessments: climate change allowances - https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Note that modelled climate change scenarios for flooding in line with new guidance were not available at time of writing and the user should consult with EA to determine when new data will be available.

The EA has also provided an updated version of ‘Adapting to Climate Change: Advice for Flood & Coastal Erosion Risk Management Authorities’. It has been updated in line with best available scientific evidence to help ensure flood and coastal erosion risk management schemes and plans take into account the most up to date scientific evidence.

For more information, please refer to ‘Adapting to climate change: guidance for risk management authorities - https://www.gov.uk/government/publications/adapting-to-climate-change-for-risk-management-authorities

1.4.8. HISTORIC FLOOD ISSUES

The EA’s historic flood map does not show any fluvial flood events having occurred in the Billet Road site. Anecdotal evidence provided by LBR officers tells that although there is little evidence of flooding on site, there have been issues surrounding it. There are a number of pipes and ditches in a network around the site, passing under the highways and properties. The pipes under Billet Road have been known to block easily and have a lack of capacity. This resulted in overland flow running off onto Billet Road and on to its junction with Hainault Road. There is often flooding at the junction, as shown in the photo below and in severe conditions access to the school in Hainault Road would be limited.

Junction of Hainault Road with Billet Road. Supplied by John Martin (LBR, 2015).

There are a number of culverted ditches which meet under the school which have caused some of the school buildings to flood in the past. It is thought that a gas main flowing across the highway limits the capacity of the sewer network. Additionally, during heavy rain, the junction of the A12 with Barley Lane and Hainault Road floods. The surface water sewer in Hainault Road is known to surcharge, resulting in water spilling out of the gullies.

Gullies outside the school on Hainault Road. Supplied by John Martin (LBR, 2015).

Approximately 10 years ago (est. 2004), the LBR constructed a ditch network to take water from the fields above Billet Road, down to the Hainault Road junction, under the highway and into the SKW. Although this has not totally removed the flooding issue at the junction of Billet Road with Hainault Road, it has reduced the frequency and severity of the problems. There are still flooding issues on the A12 and in Hainault Road. It is recommended that any development on this site must limit surface water runoff.

1.5. POTENTIAL MANAGEMENT MEASURES

1.5.1. FLUVIAL AND TIDAL

The Billet Road site is not directly at risk of flooding from any Main Rivers or the sea. However, the site is located to the north-east of the Goodmayes site which has historically experienced flooding. If surface water runoff can be reduced from the Billet Road site, downstream fluvial flooding issues could be reduced. Additionally, with the potential risks associated with climate change, attenuating water on site could reduce the risk of fluvial flooding and prevent the Flood Zones from expanding.

Sustainable Drainage Systems (SuDS) should be utilised to achieve better than Greenfield runoff rates post-development and attenuation methods should be used to delay water from leaving the site and increase the time it takes for it to reach the watercourses.

1.5.2. SURFACE WATER AND SEWER

The Billet Road site has a low to medium risk of surface water flooding. The majority of the areas at risk are alongside the Ordinary Watercourses and so development would need to consider the combined risk. 'Highly vulnerable' developments should not be located within the predicted flood extent. The sequential approach should be utilised to locate 'essential infrastructure' or 'more vulnerable' developments outside the risk areas. Finished floor levels must be at least 150mm above the predicted 1 in 100-year flood depth or the adjacent ground level – whichever is the greater.

SuDS features should be used on-site to mitigate the surface water flood risk and to reduce runoff to aid in mitigating flood risk elsewhere. Attenuation methods should be used to delay surface water from leaving the site. The London Plan states that developments should aim to achieve Greenfield runoff rates as a minimum. It would be beneficial for the Billet Road site to seek to achieve better than Greenfield runoff rates to mitigate downstream flood risk on the SKW. Site ground conditions should be tested to determine the potential for disposal of surface water via infiltration. This approach will also mitigate the impact of the development on sewer flooding.

1.5.3. GROUNDWATER

The risk of flooding from groundwater is uncertain and the developer should investigate this issue further. If investigations show that there is a flood risk, basements should not be permitted and the use of infiltration based SuDS will need to be reviewed.

1.5.4. ARTIFICIAL

The Billet Road site has a very low risk of flooding from artificial sources. There are no associated management measures proposed.

1.5.5. EMERGENCY PLANNING

Access and egress routes should be designed so that should a flood event occur, residents can safely leave the area and the emergency services can navigate as required. The 1 in 100-year flood risk should be considered when planning these routes. The surface water flood map and historic events indicates that the western sections of Billet Road could be flooded, therefore emergency routes should avoid this area.

1.5.6. USE OF SUDS

VOLUMES AND RATES

The use of SuDS maintains natural drainage flows and contributes to the reduction of flood risk. To provide an approximation of the surface water runoff rates and volumes expected at the Billet Road site, HR Wallingford's UK Sustainable Drainage Guidance and Tools website has been used. The 'Greenfield runoff estimate' and the 'Stormwater storage analysis' tools have been utilised. Information on how these tools work can be found on the website.

A summary of the estimated Greenfield runoff rate is in *Table 1.1* and estimated storage volumes in *Table 1.2.* The full reports generated by the SuDS tool can be found in *Appendix A* (*Figures A8* and *A9*). Estimates have been made based on two different percentages of impermeable area to provide a range of how this changes depending on the density of the development.

Table 1-1. Predicted Greenfield runoff rates for the Billet Road site

Return Period	Peak Runoff Rate	Return Period	Peak Runoff Rate
Qbar*	83.69 l/s	**1 in 30 years**	192.48 l/s
1 in 1 year	71.13 l/s	**1 in 100 years**	299.96 l/s

*the mean annual flood

Table 1-2. Predicted surface water storage requirements for the Billet Road site

Storage Type	50% impermeable area	66.6% impermeable area
	Storage Volume	
Interception storage	430 m^3	575 m^3
Attenuation storage	7,500 m^3	10,500 m^3
Long term storage	0	850 m^3
Treatment storage	1,300 m^3	1,700 m^3
Total storage	**8,000 m^3**	**12,000 m^3**

Where surface water runoff contributes to flood risk, the LBR expects the runoff to be reduced post-development. This applies to the Billet Road site and the values in the above tables should be treated as the minimum targets and a higher retention volume is expected. A minimum 5 l/s peak discharge rate should remain to prevent the blocking of any channels or culverts.

CHOICE OF SUDS

There is a wide range of different SuDS and not all will be suitable for every sites. There will be opportunities and constraints with different locations and SuDS should be chosen accordingly. The

SuDS Selection chapter of The SuDS Manual (CIRIA C697, 2007) contains a Design Information Checklist and a step-by-step approach to selecting SuDS. It uses a selection criterion which assesses SuDS features based upon the following headings:

- Land use characteristics
- Site characteristics
- Catchment characteristics
- Quantity and quality performance requirements
- Amenity and environmental requirements

An assessment for the Billet Road site has been made using the SuDS selection criteria in *Table 1.3*. A number of assumptions have been made for this high level assessment. The site developer should satisfy themselves that they are appropriate or propose alternatives. The assumptions are as follows:

- **Land use:** Assuming the development will comprise of medium density residential units, some commercial units, local roads and open space areas and the site is considered to be possibly contaminated due to the historic landfill records.
- **Site characteristics:** Based on the sites geology, the site has been considered as permeable; due to its size, the area draining to a single SuDS component could be either 0-2 ha or >2 ha; the minimum depth to the water table is less than 1m due to the proximity of the SKW, the site slope is less than 5% and available space could be both high or low depending on the unit density.

Table 1-3. Initial SuDS assessment for the Billet Road site.

SuDS Group	Technique	Land use				Site characteristics							
		Residential	Commercial	Local Roads	Contaminated land	Permeable soil	0-2 ha draining to a single SuDS	>2ha draining to a single SuDS	Min depth to water table 0-1m	Site slope 0-5%	Available head 0-1m	Low available space	High available space
Retention	Retention pond	Y	Y[2]	Y[1]	Y[2]	Y[3]	Y	Y[5]	Y	Y	Y	N	Y
	Subsurface storage	Y	Y	Y	Y[3]	Y	Y	Y[5]	Y	Y	Y	Y	Y
Wetland	Shallow wetland	Y	Y[2]	Y[1]	N	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Extended detention wetland	Y	Y[2]	Y[1]	N	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Pond/wetland	Y	Y[2]	Y[1]	N	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Pocket wetland	Y	Y[2]	Y[1]	N	Y[4]	Y[4]	N	Y[7]	Y	Y	Y	Y
	Submerged gravel wetland	Y	Y[2]	Y[1]	N	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
	Wetland channel	Y	Y[2]	Y[1]	N	Y[4]	Y[4]	Y[6]	Y[7]	Y	Y	N	Y
Infiltration	Infiltration trench	Y	Y[2]	Y[1]	N	Y	Y	N	N	Y	Y	Y	Y
	Infiltration basin	Y	Y[2]	Y[1]	N	Y	Y	Y[5]	N	Y	Y	N	Y
	Soakaway	Y	Y[2]	Y[1]	N	Y	Y	N	N	Y	Y	Y	Y
Filtration	Surface sand filter	Y	Y[2]	Y[1]	N	Y	Y	Y[5]	N	Y	N	N	Y
	Sub-surface sand filter	Y	Y[2]	Y[1]	N	Y	Y	N	N	Y	N	Y	Y
	Perimeter sand filter	N	Y[2]	Y[1]	N	Y	Y	N	N	Y	Y	Y	Y
	Bioretention/filter strip	Y	Y[2]	Y[1]	N	Y	Y	N	N	Y	Y	N	Y
	Filter trench	Y	Y[2]	Y[1]	N	Y[3]	Y	N	N	Y	Y	Y	Y
Detention	Detention basin	Y	Y[2]	Y[1]	Y[3]	Y[3]	Y	Y[5]	N	Y	N	N	Y
Open channels	Conveyance swale	Y	Y[2]	Y[1]	Y[3]	Y	Y	N	N	Y	Y	N	Y
	Enhanced dry swale	Y	Y[2]	Y[1]	Y[3]	Y	Y	N	N	Y	Y	N	Y
	Enhanced wet swale	Y	Y[2]	Y[1]	Y[3]	Y[4]	Y	N	Y	Y	Y	N	Y
Source control	Green roof	Y	Y[2]	N	N	Y	Y	N	Y	Y	Y	Y	Y
	Rain water harvesting	Y	Y[2]	N	N	Y	Y	N	Y	Y	Y		
	Permeable pavements	Y	Y[2]	N	N	Y	Y	Y	N	Y	Y	Y	Y

Y = Yes N = No

[1] = may require two treatment train stages depending on type/intensity of road use and receiving water sensitivity.

[2] = may require three treatment trains depending on receiving watercourse sensitivity

[3] = with liner

[4] = with liner and constant surface baseflow, or high ground water table

[5] = possible but not recommended (implies appropriate management train not in place)

[6] = where high flows are diverted around SuDS component

[7] = with surface baseflow

The catchment characteristics assessment section helps to determine how many components of the SuDS treatment train is required to lower the risk of poor water quality and whether there are any regulatory criteria which may restrict or preclude the use of a SuDS technique. As the receiving water sensitivity increases, the number of treatment train components increase. This is relevant to the Billet Road site as a contributor to the SKW. Under the Water Framework Directive (WFD), the SKW currently has a moderate ecological status. Action should be taken to prevent the deterioration of water quality and then to improve it. The following questions should be asked and answered as part of a full assessment of the Billet Road site:

- Are aquifers used for public water supply?
- Is the SKW used as formal recreational/amenity facilities?
- Are there any local habitat requirements?
- Would any of the water discharge into the sewerage network?
- Are there opportunities to improve the ecological status of the SKW?

SuDS which are going to collect water from the residential roads and commercial areas should be made up of three components and those collecting water from roofs should be made up of one. Ideally, SuDS techniques with a high potential to produce better quality water should be used. To account for the flood risk associated with the SKW, techniques with high potential for runoff volume reduction and with high potential of hydraulic control for the 1 in 100-year event should be used.

Part of the SuDS selection process should focus on the community and environment requirements at the site. In order to maximise the benefits from SuDS, they need to be maintained. Some techniques require more maintenance than others. It is important that the adopter of the proposed drainage system is involved in the planning process in the early stages so that the most appropriate SuDS are chosen based upon the initial cost and the available maintenance commitment.

SuDS techniques should also be chosen based on how acceptable they are to the community. A resident may not want a swale in their garden although a feature in a recreation ground would be acceptable. Equally, they need to be safe and the public should not be concerned. Lastly, SuDS can help to improve wildlife habitat and in turn have ecological benefits.

The following SuDS techniques are recommended for the Billet Road site (although, as mentioned, a number of site investigations would need to be carried out to confirm this):

- Retention ponds - retention ponds would be ideal where the topography is low and water collects.
- Wetlands - the Ordinary Watercourses could be developed into wetlands if the land is not found to be contaminated.
- Infiltration methods (trench/basin/soakaway) – where the water table is deeper than 1m and there are no contamination issues.
- All swale types - where less than 2ha is being drained and the water table is deeper than 1m
- Green roof - not roads and only where less than 2ha is being drained
- Rainwater harvesting - not roads and only where less than 2ha is being drained
- Pervious pavements - roads, parking and paved outside areas where less than 2ha is drained

MAINTENANCE

The EA document *Cost estimation for SuDS – summary of evidence*, provides indicative costs and maintenance guidance for SuDS and other drainage infrastructure. *Table 1.4* below describes the typical works and frequencies for the SuDS most suitable for the Billet Road site.

Table 1-4. Typical works and frequencies for the SuDS most suitable for the Billet Road site

SuDS Technique	Annual or sub annual maintenance	Intermittent	Design life estimates
Retention pond	No information available		20-50 years
Constructed wetlands	Monthly - litter & debris removal, grass cutting of landscaped areas Half yearly - grass cutting of meadow grass Annual - manage vegetation including cut of submerged & emergent aquatic plants & bank vegetation removal	Remove sediment. Repair of erosion or other damage. Repair/rehabilitation of inlets, outlets & overflows. Supplement plants if establishment not complete.	20-50 years. Sediment disposal after 10-15 years
Infiltration trench	Monthly - litter and debris removal. Annual - weed/root management. Removal & washing of exposed stones. Removal or sediment from pre-treatment devices.	Replacement of filter material (20-25 years)	Unlimited design life. 10-15 years before replacement of filter material.

SuDS Technique	Annual or sub annual maintenance	Intermittent	Design life estimates
Infiltration basin	Monthly - litter & debris removal, grass cutting of landscaped areas. Half yearly - grass cutting of meadow grass and around basin. Annual - manage vegetation & remove nuisance plants.	Re-seed areas of poor vegetation growth. Prune % trim trees. Remove sediment when 50% full. Repair of erosion or other damage. Repair/rehabilitation of inlets, outlets & overflows. Re-level uneven surfaces & reinstate design levels.	Unlimited design life. 10-15 years before tilling required & replacement of infiltration surface.
Soakaway	Remove sediment and debris. Clean gutters and filters. Trim roots that cause blockage.		No information available.
Swales	Monthly - litter and debris removal, grass cutting. Annual - manage vegetation and remove nuisance plants. Checks for poor vegetation growth and re-seed.	Repair erosion or damage, re-level uneven surfaces. Remove sediment and/or oils.	Unlimited design life. 5-10 years before tilling required & replacement of infiltration surface.
Green roof	6 monthly - remove debris and litter. Remove weeds. Mow grass (if applicable)		Unlimited design life.
Rainwater harvesting	**Simple:** Annual - cleaning inlets, outlets, gutters & tanks. **Advanced:** 3-6 monthly - self-cleaning & coarse filter checks & clean. 6-12 monthly - check & clean roof & gutters. UV unit operation checks. Annual - pump operation checks.		Unlimited design life.
Pervious pavements	4 monthly - brushing and vacuuming	Stabilise & mow contributing areas, removal of weeds. Remedial work to any depressions or broken blocks. Rehabilitation of surface & upper sub-structure where significant clogging occurs. Replacement of filter material (20-25 years).	Unlimited design life. 20-25 years before replacement of filter material.

INDICATIVE COSTS

The EA document *Cost estimation for SuDS – summary of evidence* contains information on calculating whole life costs, which include the following:

- Procurement and design costs
- Capital construction costs
- Operation and maintenance costs
- Monitoring costs
- Replacement or decommissioning costs

Using this information, *Table 1.5* provides an initial estimations of the costs associated with the most suitable SuDS components for the Billet Road site as identified in the above section. Note that there are a number of factors which may affect the costs outlined below and a site-specific estimate should be compiled by the developer to demonstrate that the recommended SuDS approach is cost effective (or to demonstrate an alternative approach provides a more cost effective solution).

Table 1-5. Indicative prices for the most suitable SuDS components for the Billet Road site.

SuDS Technique	Capital Indicative Costs	Annual Maintenance Costs
Retention pond	£15-£25/m³ treated volume (CIRIA 2007) £80,000/5000m³ pond (£16/m³) (SNIFFER, 2007)	£0.5 - £1.5/m² of pond surface area (HR Wallingford, 2004). £0.1 - £2/m³ of pond vol (Ellis, 2003)
Constructed wetlands	£25-£30 per m3 treated volume (CIRIA, 2007)	£0.1 / m² of wetland surface area. (HR Wallingford, 2004). Annual maintenance of £200-250/yr for first 5 years (declining to £80 - £100/yr after 3 years). (Ellis, 2003)
Infiltration trench	£55-£65/m³ stored volume (CIRIA, 2007) £74-£99/m length (Stovin & Swan 2007) £60/m² (EA, 2007)	£0.2 - £1/m² of filter surface area (HR Wallingford, 2004)
Infiltration basin	£10-£15/m³ stored volume (CIRIA, 2007)	£0.1 - £0.3/m² of basin area £0.25 - £1/m³ of detention volume (HR Wallingford, 2004)
Soakaway	>£100/m³ stored volume (CIRIA, 2007) £454 -£552/soakaway (Stovin & Swan 2007)	£0.1/m² of treated area (HR Wallingford, 2004)
Swales	£10-£15/m² swale area (CIRIA, 2007) £18-£20/m length using an excavator (Stovin & Swan 2007) £12.5/m² (EA, 2007)	£0.1/m² of swale surface area (HR Wallingford, 2004) £350/year (Ellis, 2003)
Green roof	£90/m² - covered roof with sedum mat (Bamfield, 2005) £80/m² - biodiverse roof (varied covering of plants, growing medium & aggregates) (Bamfield, 2005)	£2,500/year for first 2 years for covered roof with sedum mat, £600/ year after. £1,250/year for first 2 years for covered roof with biodiverse roof, £150/year after (Bamfield, 2005)
Rainwater harvesting	**Simple:** £100 - £243/property (includes installation & connection pipe) (Stovin & Swan 2007) **Advanced:** £2,100 - £2,400/residential property (Woking Borough Council) £2,500 - £6,000/residential property (EA, 2007) £2,600 - £3,700/residential property (RainCycle, 2005) £6,300 - £21,000/ commercial/industrial property (RainCycle, 2005) £45/m² for residential properties (EA, 2007) £9/m² for non-residential properties (EA, 2007)	**Simple:** Negligible **Advanced:** £250 per year/property for external maintenance contract (RainCycle)
Pervious pavements	£30-£40/m² of permeable surface (CIRIA, 2007) £27/m² of replacement surface (Stovin & Swan 2007) £54/m² (EA, 2007)	£0.5 - £1/m³ of storage volume (HR Wallingford, 2004)

1.6. DEVELOPABLE AREA

By analysing the various sources of flood risk, the development site can be split into areas determined by what type of development would be suitable. This is based upon the vulnerability classifications. *Figure 1.8* (and *Figure A7* in *Appendix A*) displays this information. It shows that a very large percentage of the Billet Road site is considered to be low risk andsuitable for all types of development.

There are no areas of extreme risk and only small areas considered at moderate or high risk. Highly vulnerable developments should not be developed within moderate risk areas. Only less vulnerable or water compatible developments should be developed within high risks areas, with more vulnerable and essential infrastructure only permitted if the principles of the Exception Test are passed. Emergency access and egress routes should avoid using routes considered to be at moderate or high risk.

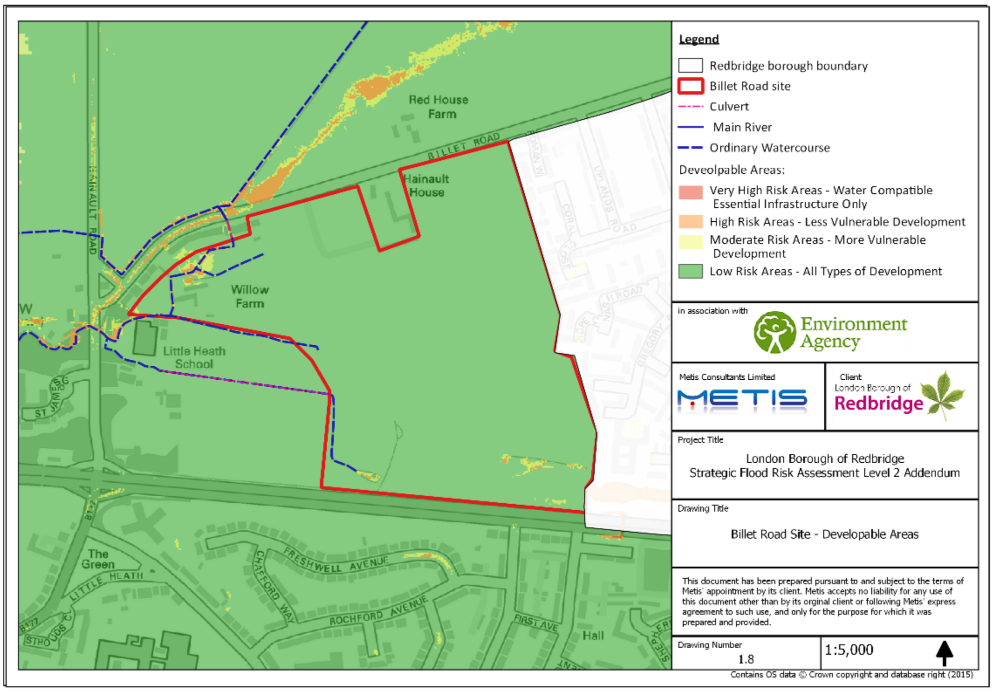

Figure 1-8. Developable area within the Billet Road site based upon flood risk and development vulnerability

1.7. SITE SPECIFIC FLOOD RISK ASSESSMENT REQUIREMENTS

A site-specific flood risk assessment (FRA) must investigate all sources of flood risk at a local level and show that flooding can be managed on site without increasing flood risk elsewhere. Where data has not been available for assessment within this SFRA, additional investigations should be carried out.

The assessment of groundwater flood risk showed that the Billet Road site is situated above secondary aquifers, overlain by permeable superficial deposits. This could result in a risk of groundwater flooding. A FRA should investigate the depth of the water table level and the soil permeability. The outcome of this will outline whether basements are suitable and whether infiltration SuDS would be appropriate.

Where it is proposed that surface water flows into Ordinary Watercourses or Padnall Lake, evidence should be provided that sufficient water treatment has taken place.

1.8. DRAINAGE STRATEGY REQUIREMENTS

A drainage strategy must demonstrate that surface water runoff can be managed on site. Development must strive to achieve less than Greenfield runoff rates, or the Greenfield rate as a minimum. If it is not reasonable to achieve this, a clear justification must be provided.

The strategy should outline which SuDS will be utilised within the development and explain the selection process. This decision process should have used the London Plan drainage hierarchy. A justification must be provided where options further down the hierarchy have been chosen over those higher up.

London Plan Policy 5.13 drainage hierarchy:
1. Store rainwater for later use
2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer

It should be clear whether SuDS will attenuate surface water (if so, how much), indicating whether there will be a positive effect of flood risk downstream. Treatment trains should be in place to ensure that clean water discharges from site, preventing a negative effect on water quality and the ecological status.

Where SuDS are to be utilised, the drainage strategy should outline who owns the assets, who will be responsible for their maintenance and how this will be paid for. There should be an accompanying maintenance strategy to cover the life of the development.

1.9. PLANNING CONSIDERATIONS

Would the development be at risk of flooding?
The assessment of flood risk shows that the Billet Road site has a low risk. Modelling predicts some areas may be susceptible to surface water flooding and there are Ordinary Watercourses to consider. TWUL have records of sewer flooding. Practical measures are available to mitigate the risks to as necessary.

Will the development increase flood risk elsewhere?
Potentially – the Ordinary Watercourses within the site contribute to the SKW and a small section of the site drains into Padnall Lake. The LBR should ensure that development does not increase the surface water runoff rates and volumes which could increase flood risk elsewhere.

How can the development reduce flood risk overall?
The site has potential to retain surface water and mitigate flood risk further downstream in the SKW catchment. The use of SuDS can do this whilst improving the water quality, amenity and biodiversity.

How can the development be made safe?
Safe access and egress routes can be designed to avoid areas at risk of flooding. Finished floor levels can be designed to be above any predicted flood depths. Basements should be avoided where there is a groundwater flood risk and inappropriate development should be steered away from flood risk areas.

Is there a reasonable prospect of compliance with flood risk aspects of the Exception Test?
Yes – the site is located in Flood Zone 1 and at low to medium risk of surface water flooding that is practically manageable within the development footprint.

Are there any additional benefits that could be achieved through effective development planning?
The SKW currently has a moderate ecological status. Treatment of surface water through SuDS and attenuation could to improve the water quality. Additionally, the development of wetlands could provide biodiversity and amenity benefits.

1.10. CONCLUSIONS

An assessment of flood risk identifies that the Billet Road site is not at risk of fluvial flooding and the Exception Test is not required. It has a low to medium risk of surface water flooding and there is a potential for groundwater flooding although further investigation will need to be carried out.

The site layout must accommodate overland flow paths and vulnerable land uses should not be located in any areas at risk. Sufficient SuDS infrastructure will be required to achieve better than Greenfield runoff rates in order to mitigate flood risk downstream in the SKW and to reduce surface water flooding to the surrounding areas. Additional considerations such as the site being safeguarded for minerals and potentially being a contaminated site will need to be incorporated into any development designs.

2. KEY SITE ASSESSMENT – GUIDE DOG TRAINING SCHOOL, MANOR ROAD

2.1. SUMMARY

Flood Risk Assessment:

Source	Flood Risk	Source	Flood Risk	Source	Flood Risk
Fluvial	Low	**Groundwater**	Uncertain but potential risk	**Sewer**	Low
Surface water	Low	**Artificial**	Very low	**Residual**	Very low

Additional considerations:

Consideration	Implication to Flood Risk
Climate change	Probable increase in surface water, groundwater and sewer flood risk
Greenbelt designation	Site is currently designated as a Greenbelt site, therefore there are development restrictions in place. There is potential for the site to be removed from this designation.
Historic flooding	No records of on-site flooding but Manor Pond experiences flooding due to sewer capacity issues.

Planning Considerations:

- Sequential and Exception Tests are not required as site is located within Flood Zone 1.
- Site layout must accommodate overland flow paths.

Sufficient SuDS infrastructure should be provided to achieve better than Greenfield runoff

2.2. SITE DESCRIPTION

The Guide Dog Training School, Manor Road (referred to as the 'Manor Road' site) is located in the north of the LBR, in Woodford Green. The site is 1.89ha, currently comprising of buildings, car parks and green space. The surrounding area is made up of residential urban areas, woodland and green spaces. Repton Park Cricket Ground is located to the east and there are a number of restaurants and hotels amongst the current developments. The site's location can be seen below in *Figure 2.1*.

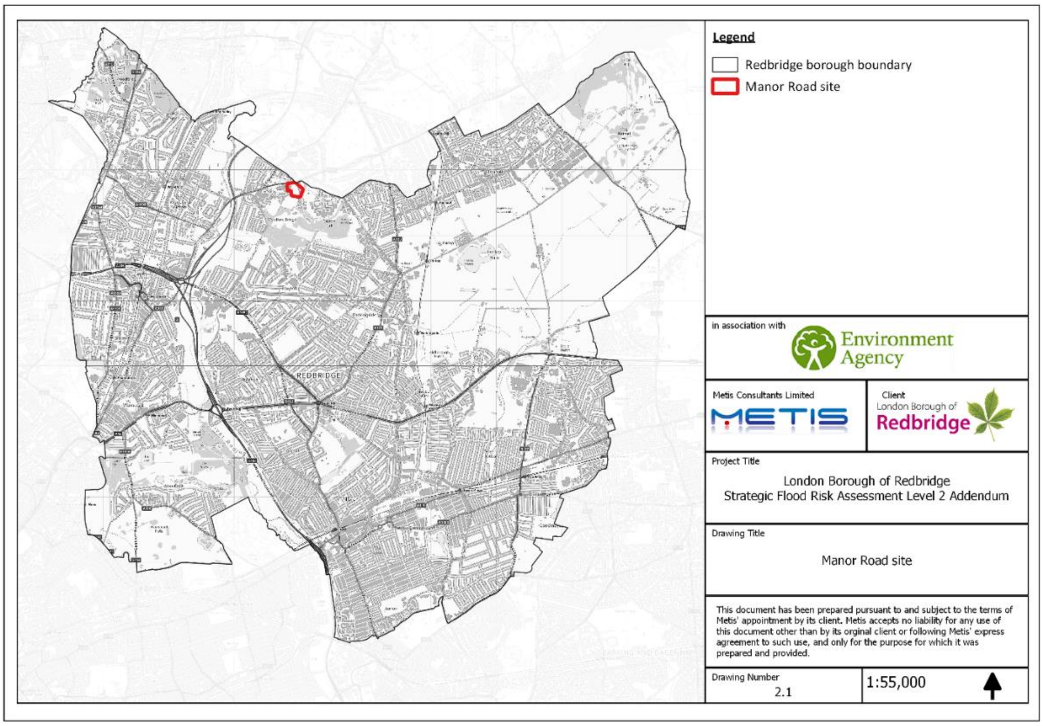

Figure 2-1. Manor Road site.

The topography of the Manor Road site slopes from south-east (high) to north-west (low). This indicates the direction of overland flow. Over the 270m length of the site, the elevation changes by approximately 12m (4.4%).

2.3. PLANNING CONTEXT

The Manor Road site is currently designated as a Greenbelt site, meaning that there are development restrictions in place. There is potential for the site to be removed from this designation and it has been included within this Level 2 SFRA Addendum.

The Manor Road site does not contain any areas within the Environment Agency Flood Zones (risk of flooding from the river and sea) and there are no building restrictions due to this. There are small areas of surface water flood risk and under the London Plan (Greater London Authority, 2015), all developments are to aim to achieve Greenfield runoff rates post-development.

2.4. RISK ASSESSMENT

2.4.1. FLUVIAL AND TIDAL

The EA's Flood Map shows that the Manor Road site is not at risk from fluvial or tidal flooding (see *Figure 2.2* and *Figure B1* in *Appendix* B). The nearest Main River is the River Roding, just under a kilometre to the west of the site. Flood Zone 2 associated with the River Roding is approximately 600m away. The topography indicates that rainwater falling on the Manor Road site will flow towards the Roding via sewers and overland flow routes.

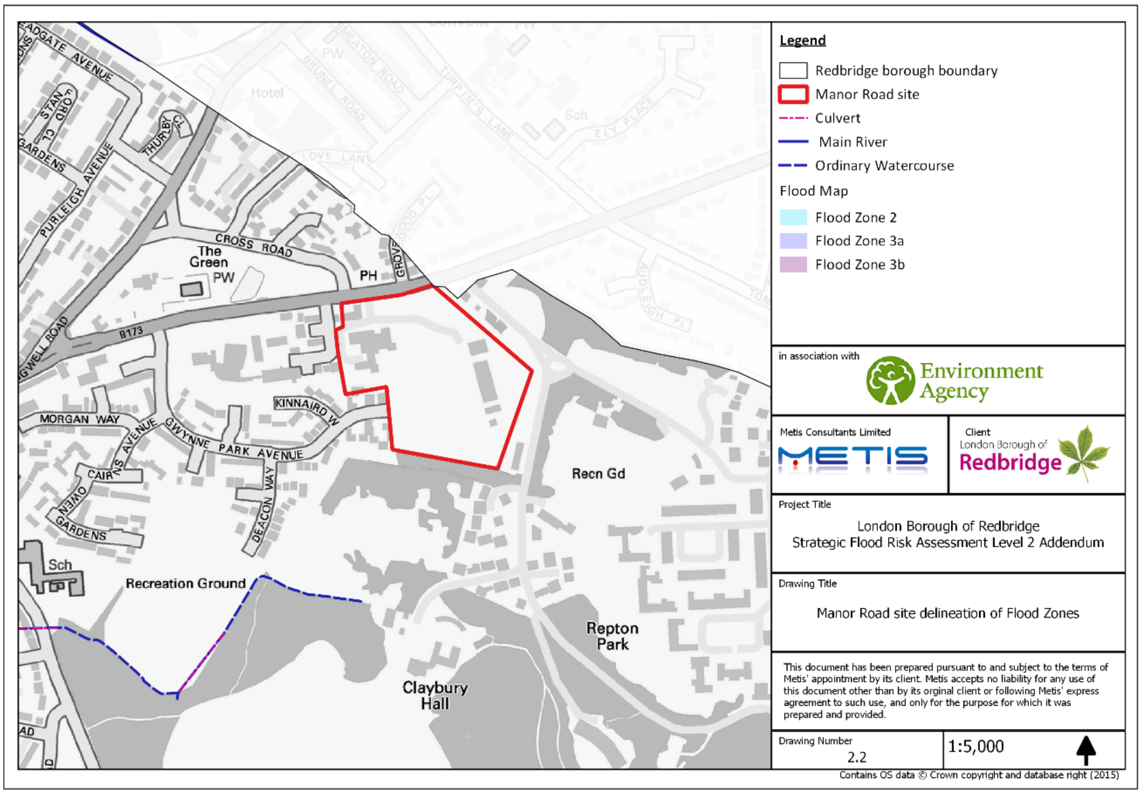

Figure 2-2. Manor Road site fluvial flood risk outlined by the Flood Zones.

2.4.2. SURFACE WATER AND ORDINARY WATERCOURSES

The surface water flood map indicates that the Manor Road site has a low risk of surface water flooding. There are small areas of flooding predicted around the buildings to the north west and the east of the site (due to the 1 in 100-year flood event). The depths are estimated to reach a maximum of 0.3m, with a very small area reaching 0.6m. A small area towards the centre of the site, in the green space, is predicted to flood to a depth of 0.3m. This is shown in *Figure 2.3* (and *Figure B2* in *Appendix B*).

Modelling indicates that the areas which would experience surface water flooding would encounter water with a velocity of 0 to 0.25m/s. A very small section of the flooding around the north-west building could encounter a velocity of up to 1m/s. Hazard modelling predicts that the small sections of the site at risk of surface water flooding have a medium hazard rating. A very small section is considered to be a significant hazard, as shown in *Figure 2.4* (and *Figure B3* in *Appendix B*).

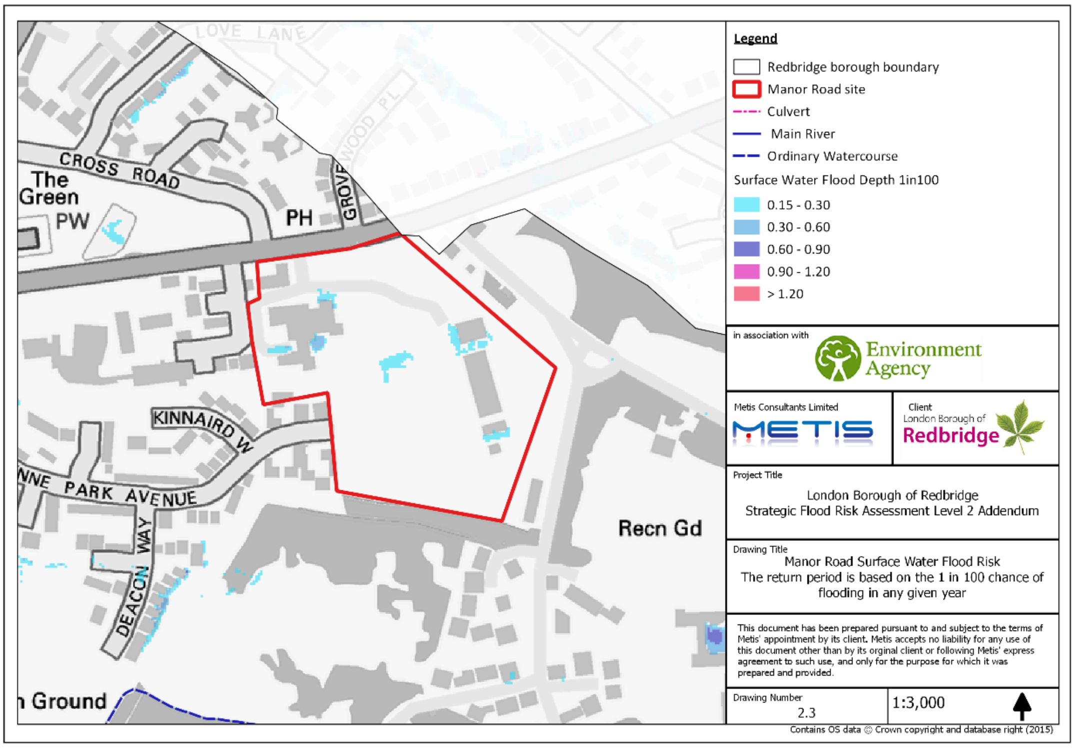

Figure 2-3. Manor Road site surface water flood map (depth)

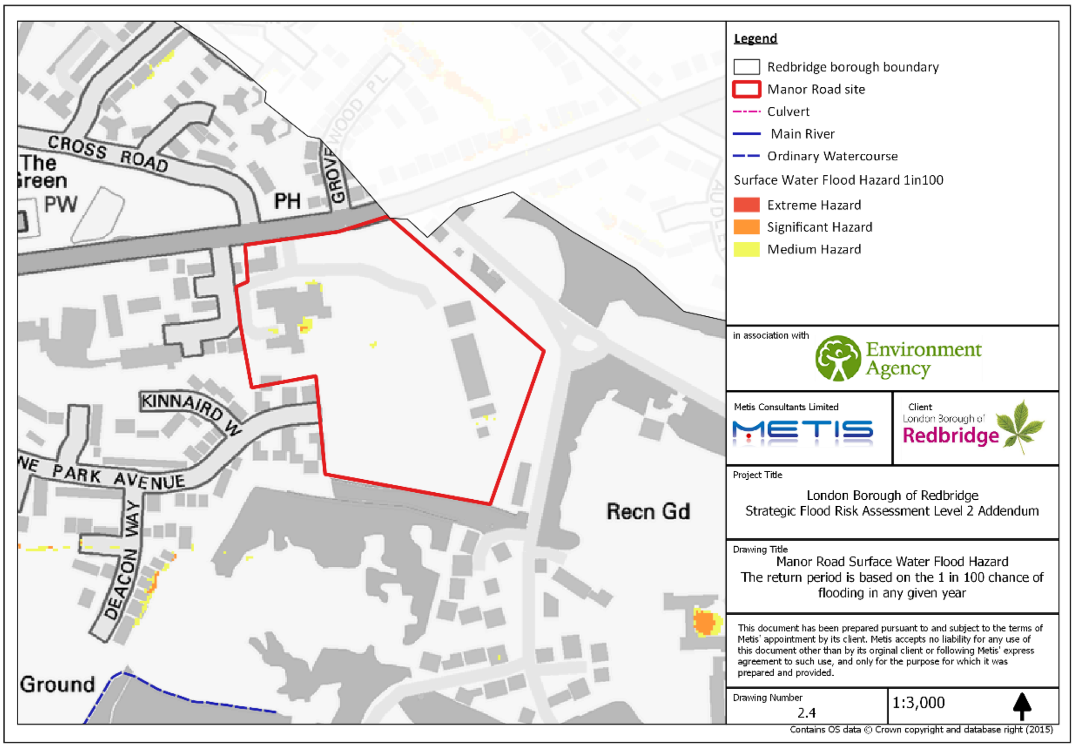

Figure 2-4. Manor Road site surface water flood map (hazard)

There are no Ordinary Watercourse within the Manor Road site. The nearest one is 200m to the south of the site, which feeds into the River Roding further downstream. Topography information indicates that the Manor Road site would not contribute to this watercourse.

2.4.3. SEWER

The Manor Road site falls within the IG8 8 postcode. The TWUL DG5 register shows that there are three properties at risk of sewer flooding within this area. There is no information on the time to inundation and duration of flood available. TWUL's records also show that the site is not currently served by a public sewer network. The roads around the site are served by both foul and surface water sewers. The sewer flood risk of the surrounding roads would need to be assessed in order to design safe access and egress routes. If the site was to be connected to the existing sewer, capacity checks would need to be made to ensure that there would not be an increased risk of flooding as a result.

2.4.4. GROUNDWATER

The bedrock geology is London Clay. There are areas of this overlain by superficial deposits (Woodford Gravel Formation), as shown in *Figure 2.5* (and *Figure B4* in *Appendix B)*.

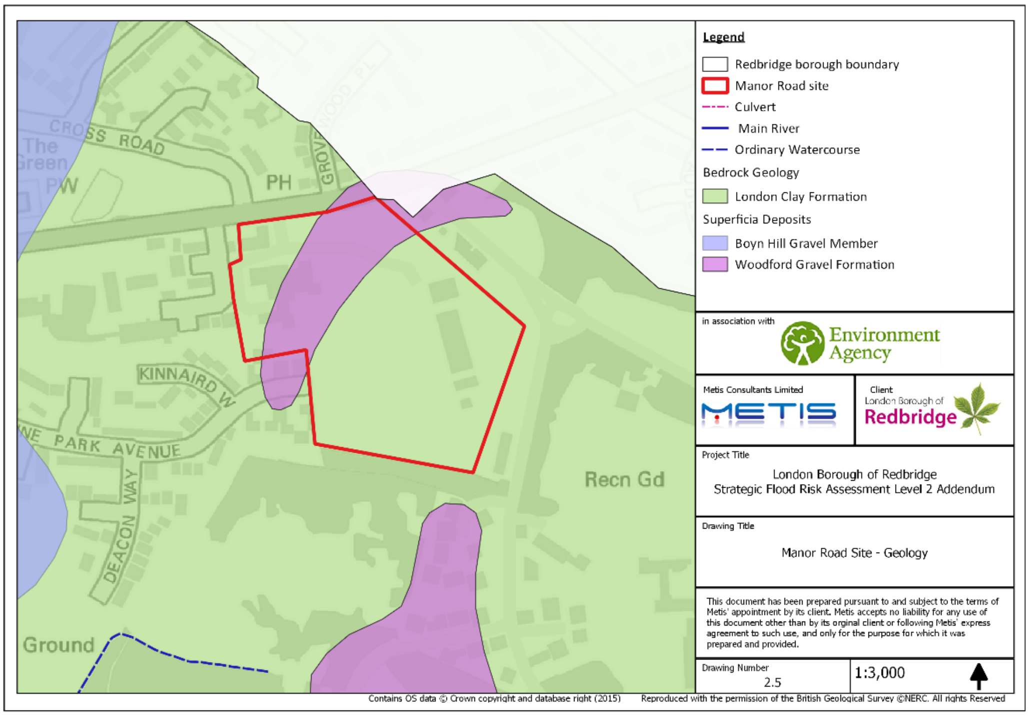

Figure 2-5. Manor Road groundwater flood risk (geology)

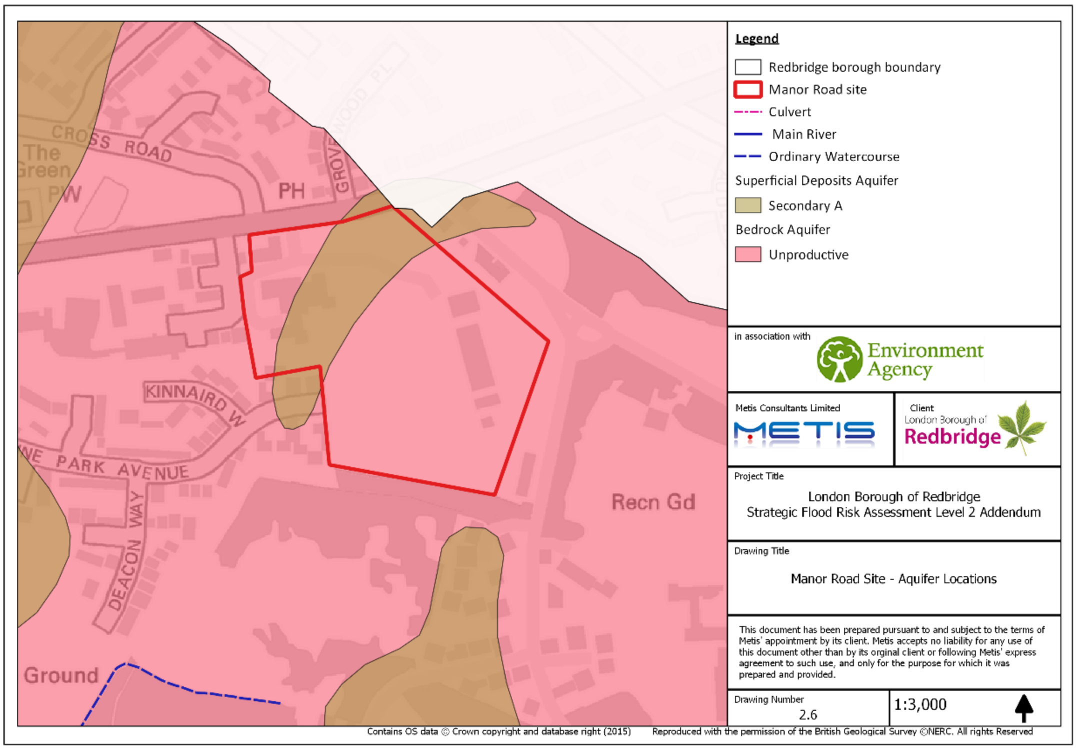

Figure 2-6. Manor Road groundwater flood risk (aquifers)

Groundwater flooding is most likely to occur in areas underlain by permeable rocks, known as aquifers. The Manor Road site is located above a superficial secondary aquifer, as shown in *Figure 2.6* (and *Figures* B5 in *Appendix B*). These have permeable layers capable of supporting water supplies at a local level and in some cases they form an important source of base flow to rivers. In comparison to an area not situated above an aquifer, the Manor Road site has an increased level of groundwater flood risk. Information on flood extent, level of risk, time to inundation and duration of potential flooding is not available.

2.4.5. ARTIFICIAL

The EA's Reservoir Inundation mapping shows that the Manor Road site is not at risk of flooding due to a reservoir breach.

2.4.6. RESIDUAL (DEFENCE FAILURE/OVERTOPPING)

By EA definition, an area benefits from a flood defence if it has a SoP against the 1 in 100-year event. There are no areas within the LBR which benefit from defences under this definition. There are defences along the River Roding, but as the Flood Zones do not consider defences and the extents do not cover the Manor Road site, it can be assumed that there is no residual risk to the site.

2.4.7. IMPACTS OF CLIMATE CHANGE

Climate change could result in an increase of flood risk (refer to section 1.4.7). The following paragraphs outline how climate change may impact the Manor Road site.

FLUVIAL / TIDAL FLOOD RISK

The potential increase in river levels and time to inundation caused by an increase in rainfall as a result of climate change may lead to the current Flood Zones expanding. Despite this, and due to the distance between the site and the River Roding, it is unlikely that climate change will result in a change in fluvial or tidal flood risk to the Manor Road site.

SURFACE WATER AND ORDINARY WATERCOURSE FLOOD RISK

Surface water flood risk as has been assessed as a result of rainfall with an annual probability of 1% (1 in 100) to account for climate change. The Flood Map for Surface Water shows that for an event with an annual probability of 0.33% (1 in 30 year), the surface water flooding predicted to occur within the Manor Road site is minimal. Two small areas are estimated to flood, one towards the centre of the site and the other around the building to the north-west. This comparison shows that the risk of surface water flooding should be considered to increase with climate change, as shown in *Figure 2.7* (and *Figure B6* in *Appendix B*).

Due to the increase in groundwater levels and surface water runoff associated with climate change, intermittent watercourses can be found to contain a flow or an increased flow which heightens the flood risk. The Ordinary Watercourse to the south of the Manor Road site could encounter increased volumes and flows. Due to the topography, it is unlikely that this would affect the Manor Road site.

SEWER FLOOD RISK

Climate change is expected to increase the frequency and intensity of rainfall events. This will decrease the level of service provided by the sewer network over time and the risk of sewer flooding will increase where capacity is not increased in line with these changes. Where the network appears to have existing capacity issues, climate change could result in more frequent and severe flooding.

GROUNDWATER FLOOD RISK

It is predicted that the effects of climate change may increase groundwater flood risk. More rainfall could result in aquifers becoming fully recharged more frequently resulting in excess water rising to the surface in the form of springs. Subsequently, intermittent watercourses can be found to contain a permanent flow. The aquifers located below the Manor Road site could experience an increase in water levels and the groundwater flood risk can be expected to increase.

ARTIFICIAL FLOOD RISK

The increased rate and volume of rainfall associated with climate change could increase reservoir flood risk. Although this has not been modelled, the frequency in which overtopping occurs could increase, as could the risk of subsequent breaches. An increase in water volume could extend reservoir flood risk extent although it is unlikely that this would affect the Manor Road site.

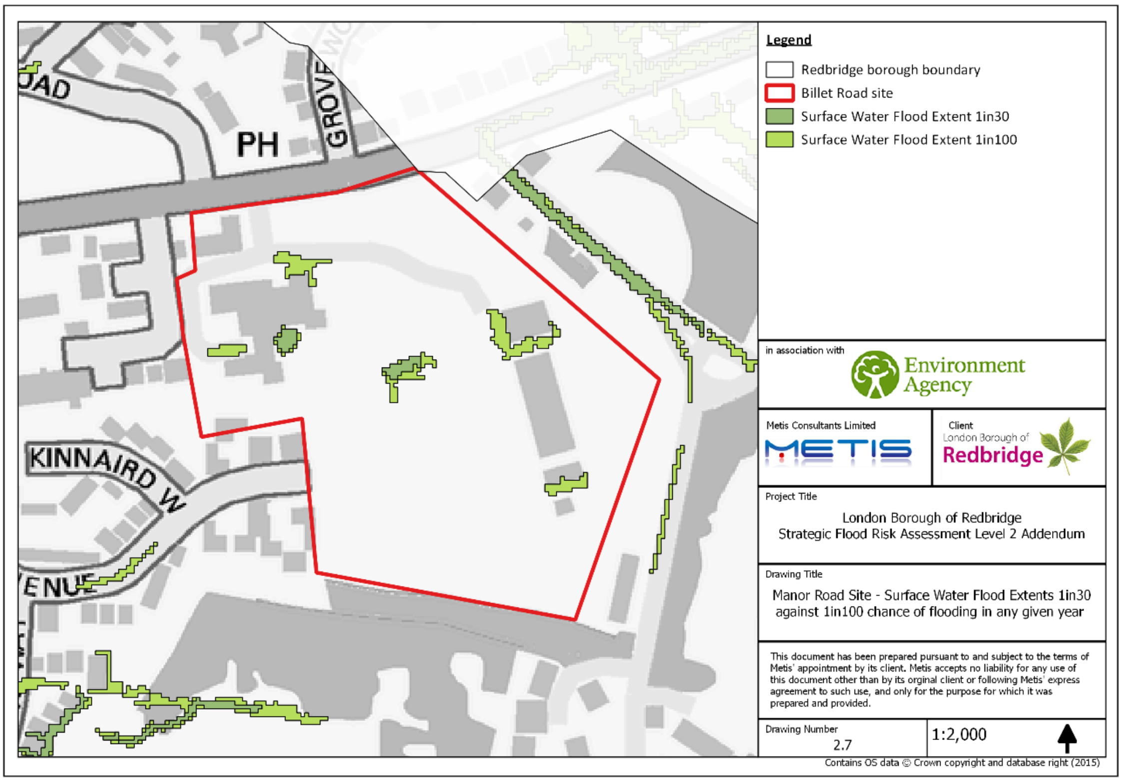

Figure 2-7. Manor Road surface water flood risk comparison (1 in 30-year vs 1 in 100-year events)

2.4.8. HISTORIC FLOOD ISSUES

The EA's historic flood map does not show that any fluvial flood events have occurred in the Manor Road site. Anecdotal evidence provided by an LBR officer suggests that Manor Pond, within the green space opposite the site on Manor Road, is used as a balancing pond by the surface water sewer. The pond has overtopped on a number of occasions, flooding the adjacent church and shops in Chigwell Road. The main causes appear to be a blocked outflow from the pond, a blocked sewer downstream of the pond or possibly lack of capacity in the sewer downstream of the pond. Due to this, it is recommended that flow from the Manor Road site is restricted to reduce flood risk. There are records of Ashton Playing Fields flooding in 2000 although this was largely attributed to the height of the River Roding and not surface water.

2.5. POTENTIAL MANAGEMENT MEASURES

2.5.1. FLUVIAL AND TIDAL

As outlined in *section 2.4.*1, the Manor Road site is not at risk of fluvial flooding. However, the site is located to the west of the River Roding and the topography suggests that it sits within the rivers catchment. If surface water runoff can be reduced from the Manor Road site, downstream fluvial flood risk could be mitigated. With the potential risk associated with climate change, attenuating water on site could prevent the Flood Zones from expanding. SuDS should be utilised to achieve Greenfield runoff rates as a minimum post-development and attenuation methods should be used to delay water from leaving the site and increase the time it takes for it to reach the watercourses.

2.5.2. SURFACE WATER AND SEWER

The Manor Road site has a low risk of surface water flooding. There are small areas predicted to be at risk. When developing the site, 'highly vulnerable' developments should not be located within the predicted surface water flood extent. The sequential approach should be utilised to locate any 'essential infrastructure' or 'more vulnerable' developments outside the predicted surface water flood extent. Finished floor levels must be set at least 150mm above the predicted 1 in 100-year surface water flood level or the adjacent ground level – whichever is the greater.

The Manor Road site should be developed in a way in which storm water is attenuated (on-site SuDS) and reducing the watercourses and sewer networks from receiving as much runoff as currently. This would benefit downstream locations at risk of flooding, such as Manor Pond. The London Plan states that developments should aim to achieve Greenfield runoff rates as a minimum and LBR expect the any future developer to exceed this minimum requirement. Site ground conditions should be tested to determine the potential for infiltration SuDS.

2.5.3. GROUNDWATER

The risk of flooding from groundwater is uncertain and should be investigated by the developer. If investigations show that there is a groundwater flood risk, basements should not be permitted and the use of infiltration based SuDS will need to be reviewed.

2.5.4. ARTIFICIAL

The Manor Road site has a very low risk of flooding from artificial sources. There are no associated management measures proposed.

2.5.5. EMERGENCY PLANNING

Access and egress routes should be designed so that should a flood event occur, residents can safely leave the area and the emergency services can navigate as required. The 1 in 100-year flood should be considered when planning these routes. The knowledge of historic events should be utilised and therefore the highway along Manor Road may not be suitable.

2.5.6. USE OF SUDS

VOLUMES AND RATES

The use of SuDS maintains natural drainage flows and contributes to reduction of flood risk elsewhere. To provide an approximation of the surface water runoff rates and volumes expected at the Manor Road site, HR Wallingford's UK Sustainable Drainage Guidance and Tools website has been used. The 'Greenfield runoff estimate' and the 'Stormwater storage analysis' tools have been utilised. Information on how these tools work can be found on the website.

A summary of the estimated Greenfield runoff rates can be found in *Table 2.1* and estimated storage volumes in *Table 2.2.* The full reports generated by the SuDS tool can be found in *Appendix B* (*Figures B8* and B9). Estimates have been made based on two different percentages of impermeable area to provide a range of how this changes depending on the density of the development.

Table 2-1. Predicted Greenfield runoff rates for the Manor Road site

Return Period	Peak Runoff Rate	Return Period	Peak Runoff Rate
Qbar*	7.69 l/s	**1 in 30 years**	17.69 l/s
1 in 1 year	6.54 l/s	**1 in 100 years**	24.54 l/s

*the mean annual flood

Table 2-2. Predicted surface water storage requirements for the Manor site

Storage Type	50% impermeable area	66.6% impermeable area
	Storage Volume	
Interception storage	40 m^3	50 m^3
Attenuation storage	650 m^3	900 m^3
Long term storage	0	75 m^3
Treatment storage	110 m^3	150 m^3
Total storage	**700 m^3**	**1,000 m^3**

Due to the known flooding issues surrounding the Manor Road site, the LBR expects for surface water runoff to be reduced through development to better than Greenfield rate or to a minimum of the Greenfield rates. The values in the above tables should be treated as minimum targets and the potential to retain greater volumes is explored. A minimum 5 l/s peak discharge rate should remain to prevent any blockages.

CHOICE OF SUDS

There is a wide range of different SuDS but not all will be suitable for all sites. There will be opportunities and constraints with each development location and SuDS should be duly selected.

The SuDS Selection chapter of The SuDS Manual (CIRIA C697, 2007) contains a Design Information Checklist and a step-by-step approach to selecting SuDS. It uses a SuDS selection criteria which assesses SuDS features based upon the following headings:

- Land use characteristics
- Site characteristics
- Catchment characteristics
- Quantity and quality performance requirements
- Amenity and environmental requirements

An assessment for the Manor Road site has been made using the SuDS selection criteria. This can be seen below in *Table 2*.3. A number of assumptions have been made for this high level assessment. The site developer should satisfy themselves that they are appropriate or propose alternatives if needed. The following assumptions have been made:

- **Land use:** Based upon the potential development comprising of low density residential, local roads and open space areas.
- **Site characteristics:** Based on the sites geology, both the areas underlain and not underlain by superficial deposits are permeable; the area draining to a single SuDS component can only be 0-2 ha; the minimum depth to the water table is greater than 1m due to the site's topography and the distance from the River Roding and the Ordinary Watercourse, the site slope is less than 5% and the available space could be both high or low depending on the density decision.

Table 2-3. Initial SuDS assessment for the Manor Road site.

SuDS Group	Technique	Land use		Site characteristics						
		Residential	Local Roads	Permeable soil	0-2 ha draining to a single SuDS	Min depth to water table >1m	Site slope 0-5%	Available head 0-1m	Low available space	High available space
Retention	Retention pond	Y	Y[1]	Y[3]	Y	Y	Y	Y	N	Y
	Subsurface storage	Y	Y	Y	Y	Y	Y	Y	Y	Y
Wetland	Shallow wetland	Y	Y[1]	Y[4]	Y[4]	Y[7]	Y	Y	N	Y
	Extended detention wetland	Y	Y[1]	Y[4]	Y[4]	Y[7]	Y	Y	N	Y
	Pond/wetland	Y	Y[1]	Y[4]	Y[4]	Y[7]	Y	Y	N	Y
	Pocket wetland	Y	Y[1]	Y[4]	Y[4]	Y[7]	Y	Y	Y	Y
	Submerged gravel wetland	Y	Y[1]	Y[4]	Y[4]	Y[7]	Y	Y	N	Y
	Wetland channel	Y	Y[1]	Y[4]	Y[4]	Y[7]	Y	Y	N	Y
Infiltration	Infiltration trench	Y	Y[1]	Y	Y	Y	Y	Y	Y	Y
	Infiltration basin	Y	Y[1]	Y	Y	Y	Y	Y	N	Y
	Soakaway	Y	Y[1]	Y	Y	Y	Y	Y	Y	Y
Filtration	Surface sand filter	Y	Y[1]	Y	Y	Y	Y	N	N	Y
	Sub-surface sand filter	Y	Y[1]	Y	Y	Y	Y	N	Y	Y
	Perimeter sand filter	N	Y[1]	Y	Y	Y	Y	Y	Y	Y
	Bioretention/filter strip	Y	Y[1]	Y	Y	Y	Y	Y	N	Y

SuDS Group	Technique	Land use		Site characteristics						
		Residential	Local Roads	Permeable soil	0-2 ha draining to a single SuDS	Min depth to water table >1m	Site slope 0-5%	Available head 0-1m	Low available space	High available space
	Filter trench	Y	Y[1]	Y[3]	Y	Y	Y	Y	Y	Y
Detention	Detention basin	Y	Y[1]	Y[3]	Y	Y	Y	N	N	Y
Open channels	Conveyance swale	Y	Y[1]	Y	Y	Y	Y	Y	N	Y
	Enhanced dry swale	Y	Y[1]	Y	Y	Y	Y	Y	N	Y
	Enhanced wet swale	Y	Y[1]	Y[4]	Y	Y	Y	Y	N	Y
Source control	Green roof	Y	N	Y	Y	Y	Y	Y	Y	Y
	Rain water harvesting	Y	N	Y	Y	Y	Y	Y		
	Permeable pavements	Y	N	Y	Y	Y	Y	Y	Y	Y

Y = Yes, N = No
[1] = may require two treatment train stages depending on type and intensity of road use and receiving water sensitivity.
[2] = may require three treatment trains depending on receiving watercourse sensitivity
[3] = with liner
[4] = with liner and constant surface baseflow, or high ground water table
[5] = possible but not recommended (implies appropriate management train not in place)
[6] = where high flows are diverted around SuDS component
[7] = with surface baseflow

The catchment characteristics assessment section helps to determine how many components of the SuDS treatment train is required to lower the risk of poor water quality and whether there are any regulatory criteria which may restrict or preclude the use of a SuDS technique. As the receiving water sensitivity increases, the number of treatment train components increase. This is relevant to the Manor Road site as water flows to the River Roding. Under the WFD, the Roding currently has a poor ecological status. Action should be taken to firstly prevent deterioration of water quality and then to improve it. The following questions should be asked and answered as part of a full assessment:

- Are aquifers used for public water supply?
- Is the River Roding used as formal recreational/amenity facilities?
- Are there any local habitat requirements?
- Would any of the water discharge into the sewerage network?
- Are there opportunities to improve the ecological status of the River Roding?

SuDS which will collect water from residential roads and commercial areas should be made up of three components and those collecting water from roofs should be made up of one. SuDS with a high potential to produce better quality water should be used. To account for the flood risk associated with roads and building surrounding the Manor Road site, techniques with the potential to reduce a high volume of runoff and with high potential of hydraulic control for the 1 in 100-year event should be used.

Part of the SuDS selection process should focus on the community and environmental requirements at the site. In order to maximise the benefits from SuDS, they need to be maintained. Some techniques require more maintenance than others. It is important that the adopter of the proposed drainage system is involved in the planning process in the early stages so that the most appropriate SuDS are chosen based upon the initial cost and the available maintenance commitment.

SuDS techniques should also be chosen based on how acceptable they are to the community. Equally, they need to be safe and the public should not be concerned. Lastly, SuDS can also improve wildlife habitat and in turn have ecological benefits.

The following SuDS techniques are recommended for the Manor Road site (although, as mentioned, a number of site investigations would need to be carried out to confirm this):

- Pocket wetland - where space is available
- Infiltration methods (trench/soakaway) – where the water table is deeper than 1m
- All swale types - where less than 2ha is being drained, the water table is deeper than 1m and space allows
- Green roof - not roads and only where less than 2ha is being drained
- Rainwater harvesting - not roads and only where less than 2ha is being drained
- Pervious pavements - roads, parking and paved outside areas where less than 2ha is drained

MAINTENANCE

The EA document *Cost estimation for SuDS – summary of evidence*, provides indicative costs and maintenance guidance for SuDS and other drainage infrastructure. *Table 7.4* below describes the typical works and frequencies for the SuDS most suitable for the Manor Road site.

Table 2-4. Typical works and frequencies for the SuDS most suitable for the Manor Road site

SuDS Technique	Annual or sub annual maintenance	Intermittent	Design life estimates
Constructed wetland	Monthly – litter & debris removal, grass cutting of landscaped areas. Half yearly – grass cutting of meadow grass. Annual – manage vegetation including cut of submerged & emergent aquatic plants & bank vegetation removal.	Remove sediment. Repair of erosion or other damage. Repair/rehabilitation of inlets, outlets & overflows. Supplement plants if establishment not complete.	20-50 years. Sediment disposal after 10-15 years.
Infiltration trench	Monthly - litter and debris removal. Annual - weed/root management. Removal & washing of exposed stones. Removal or sediment from pre-treatment devices.	Replacement of filter material (20-25 years)	Unlimited design life. 10-15 years before replacement of filter material.
Soakaway	Remove sediment and debris. Clean gutters and filters. Trim roots that cause blockage.		No information available.
Swales	Monthly - litter and debris removal, grass cutting. Annual - manage vegetation and remove nuisance plants. Checks for poor vegetation growth and re-seed.	Repair erosion or damage, re-level uneven surfaces. Remove sediment and/or oils.	Unlimited design life. 5-10 years before tilling required & replacement of infiltration surface.
Green roof	6 monthly - remove debris and litter. Remove weeds. Mow grass (if applicable)		Unlimited design life.
Rainwater harvesting	**Simple:** Annual - cleaning inlets, outlets, gutters & tanks. **Advanced:** 3-6 monthly - self-cleaning & coarse filter checks & clean. 6-12 monthly - check & clean roof & gutters. UV unit operation checks. Annual - pump operation checks.		Unlimited design life.
Permeable pavements	4 monthly - brushing and vacuuming	Stabilise & mow contributing areas, removal of weeds. Remedial work to any depressions or broken blocks. Rehabilitation of surface & upper sub-structure where significant clogging occurs. Replacement of filter material (20-25 years).	Unlimited design life. 20-25 years before replacement of filter material.

INDICATIVE COSTS

The EA document *Cost estimation for SuDS – summary of evidence* contains information on calculating whole life costs, which include the following:

- Procurement and design costs
- Capital construction costs
- Operation and maintenance costs
- Monitoring costs
- Replacement or decommissioning costs

Using this information, *Table 2.5* provides initial estimations of the costs associated with the most suitable SuDS components for the Manor Road site as identified in the above section. Note that there are a number of factors which may affect the costs outlined below and a site-specific estimate should be compiled by the developer to demonstrate that the recommended SuDS approach is cost effective (or to demonstrate an alternative approach provides a more cost effective solution).

Table 2-5. Indicative prices for the most suitable SuDS components for the Manor Road site.

SuDS Technique	Capital Indicative Costs	Annual Maintenance Costs
Constructed wetland	£25-30 per m^3 treated volume	£0.1/m^2 of wetland surface area (HR Wallingford, 2004) Annual maintenance of £200-250/year for first 5 years (declining to £80-100/year after 3 years) (Ellis, 2003)
Infiltration trench	£55-£65/m^3 stored volume (CIRIA, 2007) £74-£99/m length (Stovin & Swan 2007) £60/m^2 (EA, 2007)	£0.2 - £1/m^2 of filter surface area (HR Wallingford, 2004)
Soakaway	>£100/m^3 stored volume (CIRIA, 2007) £454 -£552/soakaway (Stovin & Swan 2007)	£0.1/m^2 of treated area (HR Wallingford, 2004)
Swales	£10-£15/m^2 swale area (CIRIA, 2007) £18-£20/m length using an excavator (Stovin & Swan 2007) £12.5/m^2 (EA, 2007)	£0.1/m^2 of swale surface area (HR Wallingford, 2004) £350/year (Ellis, 2003)
Green roof	£90/m^2 - covered roof with sedum mat (Bamfield, 2005) £80/m^2 - biodiverse roof (varied covering of plants, growing medium & aggregates) (Bamfield, 2005)	£2,500/year for first 2 years for covered roof with sedum mat, £600/ year after (Bamfield, 2005) £1,250/year for first 2 years for covered roof with biodiverse roof, £150/year after (Bamfield, 2005)
Rainwater harvesting	**Simple:** £100 - £243/property (includes installation & connection pipe) (Stovin & Swan 2007) **Advanced:** £2,100 - £2,400/residential property (Woking Borough Council) £2,500 - £6,000/residential property (EA, 2007) £2,600 - £3,700/residential property (RainCycle, 2005) £6,300 - £21,000/ commercial/industrial property (RainCycle, 2005) £45/m^2 for residential properties (EA, 2007) £9/m^2 for non-residential properties (EA, 2007)	**Simple:** Negligible **Advanced:** £250 per year/property for external maintenance contract (RainCycle)
Permeable pavements	£30-£40/m^2 of permeable Surface (CIRIA, 2007) £27/m^2 of replacement surface (Stovin & Swan 2007) £54/m^2 (EA, 2007)	£0.5 - £1/m^3 of storage volume (HR Wallingford, 2004)

2.6. DEVELOPABLE AREA

From analysing the various sources of flood risk, the development site can be split into areas determined by what type of development would be suitable. This is based upon the vulnerability classifications. *Figure 2.8* (and *Figure B7* in *Appendix B*) displays this information. It shows that the majority of the Manor Road site is considered to be at a low risk and any type of development would be acceptable.

The small areas of land considered to be moderate to high risk areas should be developed according to the sequential method. 'Highly vulnerable' developments should not be permitted within moderate risk areas. Only 'less vulnerable' or 'water compatible' developments should be developed within high risks areas, with 'more vulnerable' and 'essential infrastructure' only permitted if the principles of the Exception Test are passed. Emergency access and egress routes should avoid using routes considered to be at moderate or high risk. With regards to the Manor Road site, caution should be taken in using Manor Road as an access/egress route due to the historic flood risk associated with Manor Pond.

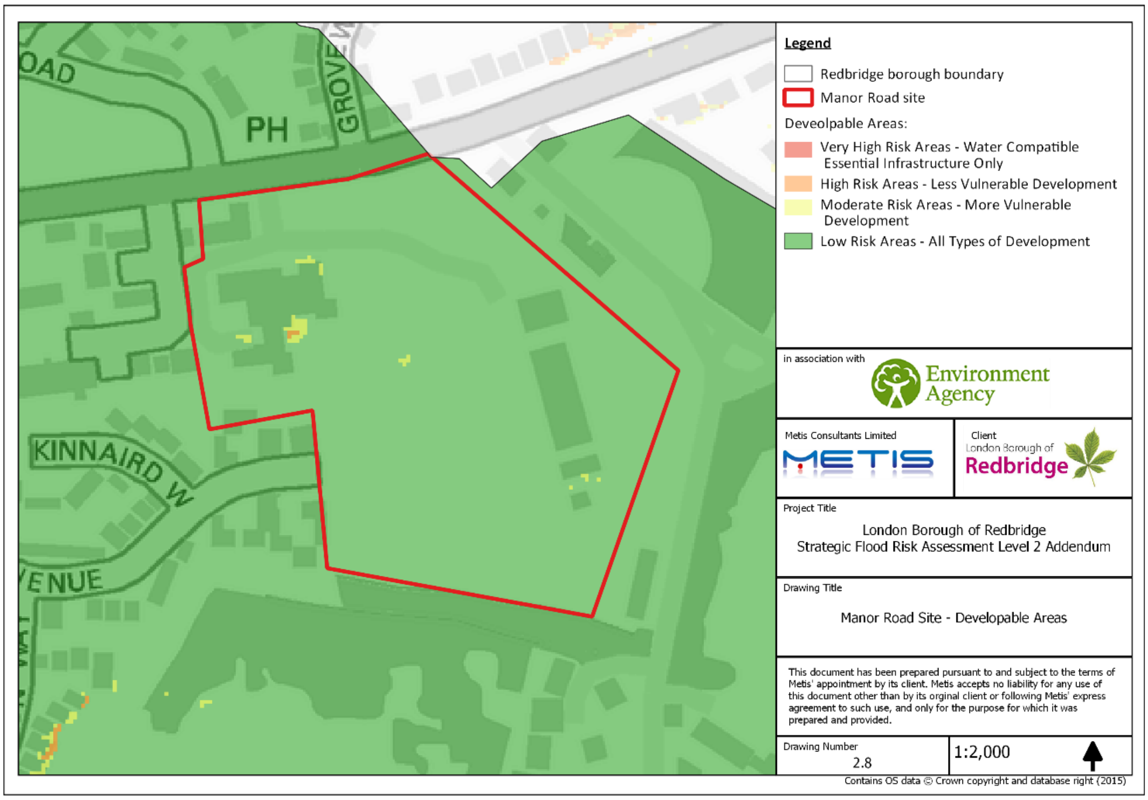

Figure 2-8. Developable area within the Manor Road site based upon flood risk and development vulnerability

2.7. SITE SPECIFIC FLOOD RISK ASSESSMENT REQUIREMENTS

A site-specific flood risk assessment (FRA) must investigate all sources of flood risk at a local level and show that flooding can be managed on site without increasing flood risk elsewhere. Where data has not been available for assessment within this SFRA, additional investigations should be carried out.

The assessment of groundwater flood risk showed that the Manor Road site is situated above secondary aquifers, overlain by permeable superficial deposits. This could result in a risk of groundwater flooding. A FRA should investigate the depth of the water table level and the soil permeability. The outcome of this will outline whether basements are suitable and whether infiltration SuDS would be appropriate.

Considering that surface water flows into Manor Pond and ultimately the River Roding, evidence should be provided that sufficient water treatment has taken place.

2.8. DRAINAGE STRATEGY REQUIREMENTS

The drainage strategy must demonstrate that surface water runoff can be managed on site and that the Greenfield Runoff rate is achieved as a minimum – better than Greenfield runoff rate should be targeted by ay developer. The strategy should outline which SuDS will be utilised within the development and why they have been selected, based upon the London Plan drainage hierarchy. A justification must be provided where options further down the hierarchy have been chosen over those higher up.

London Plan Policy 5.13 drainage hierarchy:
1. Store rainwater for later use
2. Use infiltration techniques, such as porous surfaces in non-clay areas
3. Attenuate rainwater in ponds or open water features for gradual release
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release
5. Discharge rainwater direct to a watercourse
6. Discharge rainwater to a surface water sewer/drain
7. Discharge rainwater to the combined sewer

It should be clear whether the SuDS will attenuate surface water and, if so, how much. This provides an indication as to whether there will be a positive effect of flood risk downstream of the catchment (sewer network and at the River Roding). There should be sufficient treatment trains in place to ensure that water discharging from the site is clean and will not be have a negative effect of water quality.

Where SuDS are to be utilised, the drainage strategy should outline who the future owners of the assets will be, who will be responsible for their maintenance and how this will be paid for. There should also be an accompanying maintenance strategy to cover the life of the development.

2.9. PLANNING CONSIDERATIONS

Would the development be at risk of flooding?
The assessment of flood risk shows that the Manor Road site has a low risk. Modelling predicts some small areas may be susceptible to surface water flooding and TWUL have records of sewer flooding. Practical measures are available to mitigate the risks to an appropriate level.

Will the development increase flood risk elsewhere?
There are existing drainage issues around Manor Pond so the LBR should ensure that development does not increase the surface water runoff rates and volumes which could increase flood risk elsewhere.

How can the development reduce flood risk overall?
The site could retain surface water and mitigate flood risk further downstream in the River Roding catchment. The use of SuDS can do this whilst improving the water quality, amenity and biodiversity.

How can the development be made safe?
Safe access and egress routes can be designed to avoid areas at risk of flooding. Finished floor levels can be designed to be above any predicted flood depths. Basements should be avoided where there is a groundwater flood risk and inappropriate development should be steered away from flood risk areas.

Is there a reasonable prospect of compliance with flood risk aspects of the Exception Test?
Yes – the site is located in Flood Zone 1 and has a low risk of surface water flooding that is practically manageable within the development footprint.

Are there any additional benefits that could be achieved through effective development planning?
The River Roding currently has a poor ecological status. Treatment of surface water through SuDS and attenuation could to improve the water quality. The development of wetlands could provide biodiversity and amenity benefits.

2.10. CONCLUSIONS

An assessment of flood risk identifies that the Manor Road site is not at risk of fluvial flooding, therefore the Exception Test is not required. It has a low risk of surface water flooding, but there is a potential for groundwater flooding although further investigation will need to be carried out.

The site layout must accommodate overland flow paths and vulnerable land uses should not be located in any of the small areas at risk. Sufficient SuDS infrastructure will be required to achieve better than Greenfield runoff rates or Greenfield runoff rates as a minimum in order to reduce flood risk in the surrounding areas.

3. REFERENCES

Greater London Authority (2015) *London Plan (FALP).* Available at: http://www.london.gov.uk/priorities/planning/london-plan. Accessed 15th October 2015

Department for Communities and Local Government (2015) National Planning Practice Guidance. Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/minerals/minerals-safeguarding/ Accessed 15th October 2015.

Photos supplied by LBD officer John Martin on the 17th October 2015.

London Borough of Redbridge (2012) Minerals Local Plan. Available at: http://www2.redbridge.gov.uk/cms/planning_land_and_buildings/planning_policy__regeneration/local_development_framework.aspx. Accessed 15th October 2015.

Environment Agency (2015) *Cost estimation for SuDS – summary of evidence*

Environment Agency (2015) *Landfill site map*, Available at: http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=waste&layerGroups=default&lang=_e&ep=map&scale=9&x=547034&y=189294. Accessed 21st October 2015.

CIRIA (2007) *The SuDS Manual (C697)*. Chapter 5.

APPENDICES

Appendix A –Billet Road Figures

Appendix B –Manor Road Figures

APPENDIX A –BILLET ROAD SITE FIGURES

Figure A1: Billet Road site delineation of Flood Zones

Figure A2: Billet Road Surface Water Flood Depth. The return period is based on the 1 in 100 chance of flooding in any given year.

Figure A3: Billet Road Surface Water Flood Hazard. The return period is based on the 1 in 100 chance of flooding in any given year.

Figure A4: Billet Road Site – Geology

Figure A5: Billet Road Site – Aquifer Locations

Figure A6: Billet Road Site – Surface Water Flood Extents 1in30 against 1in100 chance of flooding in any given year

Figure A7: Billet Road Site – Developable Areas

APPENDIX B –MANOR ROAD SITE FIGURES

Figure B1: Manor Road site delineation of Flood Zones

Figure B2: Manor Road Surface Water Flood Depth. The return period is based on the 1 in 100 chance of flooding in any given year.

Figure B3: Manor Road Surface Water Flood Hazard. The return period is based on the 1 in 100 chance of flooding in any given year.

Figure B4: Manor Road Site - Geology

Figure B5: Manor Road Site – Aquifer Locations

Figure B6: Manor Road Site – Surface Water Flood Extents 1in30 against 1in100 chance of flooding in any given year

Figure B7: Manor Road Site – Developable Areas