# A FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY FOR MAPLE CROSS, RICKMANSWORTH

## ISSUE 1.6

**T/17/1999/FRA**

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# EXECUTIVE SUMMARY

This Flood Risk Assessment demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The site should not therefore be precluded on the grounds of flood risk.

The majority of the site is located within Flood Zone 1 and therefore has a 'low probability' of fluvial flooding, with less than a 1 in 1000 annual probability of river or sea flooding in any year (<0.1%), while the southern and eastern boundary of the site is partially located within Flood Zone 2 and therefore has a 'medium probability' of fluvial flooding, with between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) in any year. It should be noted that the proposed buildings will be wholly located within Flood Zone 1.

It is understood that the access road has flooded in the past as a result of poor road design which will be improved as part of the proposed development. To mitigate future flooding the access road will be positively drained into the proposed drainage network. As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

The 1 in 1000 year event has a modelled water level of 42.38mAOD. By comparison, the ground levels at the site are generally between 42.00 and 43.00mAOD. Therefore, the risk of flooding from fluvial flooding is considered to be of low significance. A number of secondary flooding sources have been identified which may pose a low significant risk to the site. These are:

- Groundwater Flooding
- Surface Water Flooding
- Sewer Flooding

It is recommended that generally (with the exception of the main entrance ramped access) all buildings are located above the back of footway of the adjacent car park by 150mm to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zones 1 and 2. The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

The flood risk areas shown within the site boundary is extremely small and there are neighbouring parts of the site where the land will not be raised to facilitate piling which will more than compensate for the lost area without first floodwater being displaced onto neighbouring sites. This will ensure no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. There will be no increase in the flood water levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

In conclusion, the flood risk to the site can be considered to be limited, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

The development proposals should be considered by the LPA to satisfy the Sequential Test as set out in the NPPF. Applications for 'less vulnerable' uses located within Flood Zones 1 and 2 are not subject to the Exception Test.

Development of the site will take place with separate systems for foul and surface water drainage. The site will discharge foul water to the public foul sewer to the north of the site. There is an existing 600mm diameter foul public sewer which crosses the site, this is to be abandoned and grouted.

The SuDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The proposed drainage layout is shown in Appendix E. In order to limit the rate and volume of surface water runoff that is discharged, it will be necessary to include a flow control device.

The surface water runoff from the site will be attenuated to 6.50l/s, which is the greenfield QBAR runoff rate for the site (i.e. they will be same as existing runoff rates), for all events up to and including the 1 in 100 year (+30%) rainfall event before discharge to the Maplelodge Ditch. As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be incorporated into the site layout. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change. The half drain times during the 1 in 1 year, 1 in 30 year events are a maximum of 8 minutes and during the 1 in 100 year (+30%) event are a maximum of 11 minutes.

At this stage, it is anticipated that the attenuation storage will be provided in the form of cellular storage before discharge to the Maplelodge Ditch. Permeable paving of the car parking areas will also be used, this will be tanked using a 1mm thick impermeable membrane. The permeable paving will not be located within Flood Zone 2, the 1 in 1000 year event has a modelled water level of 42.38mAOD, which is equivalent to Flood Zone 2, and the permeable paving has a minimum ground level of 42.47mAOD.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream. As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

The flooding sources will be managed on the site by using a number of mitigation strategies to manage and reduce the overall flood risk at the site and will ensure the development will be safe. Measures used:

**Minimum Floor Level** – There is no minimum finished floor level proposed as a result of flooding. However, it is recommended that generally (with the exception of the main entrance ramped access) all buildings are located above the back of footway of the adjacent car park by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

**Flood Resilience and Resistance** - The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed. Relatively simple measures such as raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from properties can be easily and economically incorporated into the development of the site. To make the buildings / structures more resistant to seepage the following measures will be incorporated. The buildings will be constructed from hard wearing materials and will be sealed against water ingress. The floors of the buildings will be constructed from concrete.

**Access and Egress** - The majority of the site and surrounding area is located within Flood Zone 1. The Three Rivers District Council SFRA for Flood Risk Sites confirms that access to Maple Lodge Close to the south and the road at the northern corner of the site remains clear during the 1 in 100 year (plus climate change) event. The road at the northern corner of the site remains clear during the 1 in 1000 year event. Therefore, a permanently safe and dry access can be maintained.

**Buffer Strip/Easement** - An 8.00m buffer strip adjacent to the top of the watercourse on the western boundary of the site will need to be retained for maintenance purposes. This will be free of built development and is required by the Environment Agency. The buffer strip will also mitigate the impact of flooding from the watercourse should it overtop its banks. As part of the planning permission a Maintenance Plan will be submitted and agreed with the LPA and will be secured by a planning condition (see Planning Condition C6).

# 1. INTRODUCTION

## 1.1. Background

This Flood Risk Assessment and Drainage Strategy (FRA) has been prepared by Tier Consult to accompany an application for full planning permission being submitted by the Applicant, BCL (Maple Cross) LLP*, to Three Rivers District Council (TRDC). Planning permission is sought for the following development:

*'Comprehensive redevelopment to provide 2 no. warehouse Class B1c/B2/B8 units comprising a total of 16,115 sqm including 1,882 sqm ancillary B1a office space, access, landscaping and associated works.'*

This application follows the refusal of planning application ref. 19/1179/FUL 'the 'refused application') in November 2019, dismissed at appeal in June 2020 for a similar development. This report comprises a revision of the report which accompanied the refused application and is submitted in support of this revised scheme. It considers the amendments in the context of the scheme as a whole and relevant clarifications provided through the determination of the refused scheme.

For full details of the proposed development see the Design and Access Statement prepared by C4. For details in in terms of how this application relates to the refused scheme see the Planning Statement prepared by Avison Young.

## 1.2. National Planning Policy Framework (NPPF)

One of the key aims of the NPPF is to ensure that flood risk is taken into account at all stages of the planning process; to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. It advises that where new development is exceptionally necessary in areas of higher risk, this should be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall. A risk based approach is adopted at stages of the planning process, applying a source pathway receptor model to planning and flood risk. To demonstrate this, an FRA is required and should include:

- whether a proposed development is likely to be affected by current or future flooding from all sources;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- if necessary, provide the evidence to the Local Planning Authority (LPA) that the Sequential Test can be applied; and
- whether the development will be safe and pass part c) of the Exception Test if this is appropriate.

## 1.3. Local Policy

The Three Rivers Local Plan 2011 – 2026 consists of three documents: the Core Strategy (2011), Development Management Policies Local Development Document (2013) and Site Allocations Local Development Document (2014). The 2011 Core Strategy sets out the Strategic Objective (S3) of the Council to allocate and approve development in areas of lower flood risk, and to consider the impacts

of climate change on decision-making: *'reduce impacts on the environment by…promoting the…conservation of water resources and …designing development to take into account future changes to the climate'.*

The following policies provide guidance with regards to flooding and drainage.

Policy CP1 Overarching Policy on Sustainable Development

*'All development in Three Rivers will contribute to the sustainability of the District. This means taking into account the need to:*

*a) Tackle climate change by reducing carbon emissions, increasing energy and water efficiency of buildings, promoting the use of renewable energy systems, and using other natural resources wisely, including through the use of sustainable building materials*

*b) Avoid development in areas at risk from flooding*

*c) Minimising flood risk through the use of Sustainable Drainage Systems'*

Policy CP12 Design of Development

*'In seeking a high standard of design, the Council will expect all development proposals to:*

*e) Build resilience into a site's design taking into account climate change (for example flood resistant design).'*

## 1.4. Report Structure

This FRA has the following report structure:

- Section 2 details the sources of information that have been consulted;
- Section 3 describes the location area and the existing and proposed development;
- Section 4 outlines the flood risk to the existing and proposed development;
- Section 5 details the sequential and exception tests;
- Section 6 outlines the proposed foul water drainage for the site;
- Section 7 details the proposed surface water drainage for the site and assesses the potential impacts of the proposed development on surface water drainage;
- Section 8 describes the risk management methods used to mitigate all sources of flood risk; and
- Section 9 presents a summary and conclusions.

# 2. SOURCES OF INFORMATION

## 2.1. Discussion with Regulators

Consultation and discussions with the relevant regulators have been undertaken during this FRA including the Environment Agency, the Local Planning Authority (LPA), the Lead Local Flood Authority (LLFA) and Sewerage Undertakers.

### Environment Agency

The Flood and Water Management Act 2010 gives the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is the statutory consultee with regards to flood risk and planning. Information regarding the current flood risk at the application site, local flood defences and flood risk has been obtained from the Environment Agency (see Appendix B).

### Three Rivers District Council

The Three Rivers District Council is the LPA. Planning guidance written by Three Rivers District Council regarding flood risk was consulted to assess the mitigation policies in place. The Three Rivers District Council afford Council Preliminary Flood Risk Assessment (PFRA) which covers the site has been reviewed.

### Hertfordshire County Council

Hertfordshire County Council is the LLFA and has responsibilities for 'local flood risk', which includes surface runoff, groundwater and ordinary watercourses. Planning guidance written by Hertfordshire County Council regarding flood risk was consulted to assess the mitigation policies in place. The Hertfordshire County Council Preliminary Flood Risk Assessment (PFRA) which covers the site has been reviewed.

### Thames Water

Thames Water is responsible for the disposal of wastewater for this area. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.

# 3. LOCATION & DESCRIPTION

## 3.1. Site Location

The site is located in Maple Cross within the south west of the administrative area of Three Rivers District Council (TRDC), the Local Planning Authority (LPA) (see Drawing T/17/1999/FRA/1). The site is located immediately to the east of the existing employment uses of the Maple Cross/Maple Lodge Employment area in the secondary centre of Maple Cross.

It is bound to the north/northwest by the Rivers Office Park and Hertford Place (subject to implemented planning permission); to the south by open space (cricket pitch); to the east by the access road leading to the Thames Water site to the south; and west by the multi-storey car park of Maple Cross House (offices) and residential properties of Longmore Close.

## 3.2. Existing Development

The site comprises an irregular shaped parcel of undeveloped greenfield land of approximately 3.40 hectares. It is currently unoccupied in nil use. The majority of the land is covered by grass with a mixture of shrubs and mature trees situated along the boundaries, some of which are protected. The site is accessed via an existing access road leading from the A412 (Denham Way).

## 3.3. Proposed Development

It is understood that the planning application is for a comprehensive redevelopment to provide 2 no. warehouse Class B1c/B2/B8 units comprising a total of 16,115 sqm including 1,882 sqm ancillary B1a office space, access, landscaping and associated works (see Appendix C).

## 3.4. Ground Levels

The topography is relatively flat with average elevations in the range of approximately 42 meters above Ordnance Survey (mAOD) to 43 mAOD (see Appendix D).

## 3.5. Catchment Hydrology / Drainage

The main drainage feature for the area is the River Colne which is located approximately 200m to the east of the site where it flows in a southerly direction. In general, this stretch of the River Colne flows adjacent to many lakes which mark the locations of former sand and gravel quarries in the floodplain of the river. Springwell Lake is located on the opposite (eastern) bank of the River Colne and another lake is located approximately 160m to the south of the site as part of the Maple Lodge Nature Reserve.

The land to the west of the site rises to a higher elevation associated with the Chalk downland and surface water runoff generated from this area would be expected to flow towards the site. However, the routing of this water is likely to be affected by the presence of the A412 which separates the catchment to the west from the site to the east. There are no culverts or drainage ditches associated with this road marked on the OS maps. The absence of significant thicknesses of low permeability superficial deposits and the Chalk solid geology in the upstream catchment would indicate that natural drainage to ground in the catchment is likely to be good and therefore runoff is likely to be low.

A small drainage ditch known as the Maplelodge Ditch starts immediately north of the site and runs along the western boundary of the site and this appears to connect with the lake to the south of the site. It was also noted that the channel appears to be open (3.00m wide and 1.00m deep) and unrestricted within the site, but may require maintenance downstream of the site, water depths are 0.50m to 1.00m within the channel.

Along the eastern boundary of the site is an access road. The road has associated drainage, but this requires maintenance. Historic maps show a potential drainage feature along the line of the road which may have been culverted or infilled and diverted to the west of the site.

There is an existing 600mm diameter foul public sewer which crosses the site. There does not appear to be any other drainage infrastructure at the site.

## 3.6. Ground Conditions

The British Geological Survey (BGS) map shows the superficial deposits that underlay the site consist of Alluvium - clay, silt, sand and gravel. Superficial deposits formed up to 2 million years ago in the Quaternary Period in a local environment previously dominated by rivers (U). The bedrock deposits that underlay the site consist of the Lewes Nodular Chalk Formation - chalk. Sedimentary bedrock formed approximately 86 to 94 million years ago in the Cretaceous Period in a local environment previously dominated by warm chalk seas. Soil at the site is freely draining very acid sandy and loamy soil which has high permeability.

This has been confirmed by the site investigation carried out by ESI in May 2014[1] which showed Made Ground/topsoil overlying alluvium, beneath which were river terrace deposits and then Chalk.

## 3.7. Permeability/Infiltration Rate

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. Due to the site ground conditions infiltration methods are unlikely to be feasible at the site. Soakaway tests carried out as part of the site investigations has confirmed the option to use a conventional soakaway is therefore unlikely to be feasible at this site due to the high water table and the narrow unsaturated zone associated with it preventing effective operation over the full seasonal cycle. Therefore, it will not be possible to discharge surface water runoff from the site via infiltration methods.

[1] ESI Ltd (ESI 2014b). Site Investigation and Geo-Environmental Assessment Repot, 62409R1.

# 4. FLOOD RISK

## 4.1. Sources of Flooding

All sources of flooding have been considered, these are; Fluvial (river) Flooding, Tidal (coastal) Flooding, Groundwater Flooding, Surface Water (pluvial) Flooding, Sewer Flooding and Flooding from Artificial Drainage Systems/Infrastructure Failure.

## 4.2. Historic Flooding

The Environment Agency has confirmed that the site has not historically flooded. There are no records of anecdotal information of flooding at the site including within the British Hydrological Society "Chronology of British Hydrological Events[4]". It is understood that the access road has flooded in the past as a result of poor road design which will be improved as part of the proposed development. Investigations have shown that the road drainage is too flat and high to effectively drain into Springwell Lake. The access road floods at its lowest level. To mitigate future flooding the access road will be positively drained into the proposed drainage network.

As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

## 4.3. Existing and Planned Flood Defence Measures

The Environment Agency has confirmed that the site is protected against fluvial flooding by existing flood defences measures, these take the form of brick walls and earth embankments. The Three Rivers District Council SFRA for Flood Risk Sites states that *'these defences give in general a standard of protection of 100 years to the site'*. Further risk management measures will be used to protect the site from flooding these are discussed in Section 8.0.

## 4.4. Environment Agency Flood Zones

A review of the Environment Agency's flood map indicates that the majority of the site is located within Flood Zone 1 and therefore has a 'low probability' of fluvial flooding, as shown in Drawing T/17/1999/FRA/2, with less than a 1 in 1000 annual probability of river or sea flooding in any year (<0.1%), while the southern and eastern boundary of the site is partially located within Flood Zone 2 and therefore has a 'medium probability' of fluvial flooding, with between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) in any year. It should be noted that the proposed buildings will be wholly located within Flood Zone 1.

The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development. The Environment Agency Flood Zones and acceptable development types are explained in Table 4.1. Table 4.1 shows that all development types are acceptable in Flood Zone 1.

In the Planning Practice Guidance to the NPPF (Table 1) appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in Table 2 and 3 of the Planning Practice Guidance to the NPPF, the proposed development is classified as 'less vulnerable'. Tables 4.1 and 4.2 of this report and Table 3 of the Planning Practice Guidance to the NPPF states that 'less vulnerable' uses are appropriate within Flood Zones 1 and 2.

**Table 4.1 - Environment Agency Flood Zones and Appropriate Land Use**

| Flood Zone | Probability | Explanation | Appropriate Land Use |
|---|---|---|---|
| Zone 1 | Low | Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%) | All development types generally acceptable |
| Zone 2 | Medium | Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year | Most development type are generally acceptable |
| Zone 3a | High | A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year | Some development types not acceptable |
| Zone 3b | 'Functional Floodplain' | Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes) | Some development types not acceptable |

**Table 4.2 - Flood Risk Vulnerability and Flood Zone 'Compatibility' as identified in the Planning Practice Guidance to the NPPF**

| Flood Risk Vulnerability Classification | Essential Infrastructure | Water Compatible | Highly Vulnerable | More Vulnerable | Less Vulnerable |
|---|---|---|---|---|---|
| Zone 1 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Zone 2 | ✓ | ✓ | Exception test required | ✓ | ✓ |
| Zone 3a | Exception test required | ✓ | × | Exception test required | ✓ |
| Zone 3b 'Functional Floodplain' | Exception test required | ✓ | × | × | × |

Key: ✓: Development is appropriate, ×: Development should not be permitted.

## 4.5. Fluvial (river) Flooding

The primary flood risk posed to the site is fluvial flooding from the River Colne. The Environment Agency modelled flood outlines show that the site will not be inundated with floodwater for all events up to and including the 1 in 100 year (+20%) event. The site will be flood free during the 1 in 100 year (+20%) event. The Environment Agency modelled flood outlines show that the majority of the site will not be inundated with floodwater during the 1 in 1000 year event. Small areas of the site situated along the southern and eastern boundaries of the site are shown to be inundated with floodwater during the 1 in 1000 year event.

The Environment Agency have been contacted to obtain the modelled flood levels in the vicinity of the site. The 1 in 1000 year event has a modelled water level of 42.38mAOD. By comparison, the ground levels at the site are generally between 42.00 and 43.00mAOD.

The Three Rivers District Council SFRA for Flood Risk Sites states that *'under the effects of climate change the 1 in 100 year event will still not reach the proposed site. For this event, there is therefore no hazard, flood depths or flow velocities that reach the site'*. Furthermore, the Three Rivers District Council SFRA for Flood Risk Sites states that *'the effect of a breach of the River Colne embankment to the east of the site (for the 1 in 100 year plus climate change run taking account of defences) results in flooding of*

*sufficiently low depths and velocity that there is only a little 'danger for some' hazard (coloured in yellow) along the site border'* (see Figure 4.1).

An assessment of the residual flood risk of blockage (complete or partial) of the watercourses located on the site has been undertaken. Blockage of such a feature can occur through a number of different mechanisms:

*Large debris in watercourse*

If large pieces of rubbish or natural debris are allowed to collect in the channel these can be washed downstream during episodes of high flow and then become lodged in the watercourse or culverts. This in itself will reduce the channel capacity, but would also allow smaller pieces of debris to become trapped and then further reduce the channel capacity.

The potential for this mechanism to be realised depends upon the availability of debris and the frequency with which the watercourse is cleared. In this case there is limited availability of suitable sized debris is limited due to the nature of the catchment. Given this there is limited potential for a blockage of this type to occur.

*Sedimentation*

Over long periods of natural sedimentation along with additional sediment loading and other geomorphological changes caused by human actions can result in siltation which will then reduce the channel capacity. The catchment of the watercourse upstream of the site is however predominantly rural and there is no reason to expect significant sediment loading. It should also be noted that such problems typically impact smaller channels and it is unlikely that sedimentation will significantly impact conveyance in this case.

*Channel collapse*

A collapse of the channel would block flows and could lead to water backing up and flooding areas of the site. If a partial blockage or failure of the channel were to occur the capacity of the channel would be exceeded and localised flooding may occur. However, this will be of a minor nature due to the low flows and topography of the area.

If the capacity of the channel is exceeded, the water then spills from the channel and follows the contours of the surrounding area. Given the above the likelihood of a channel blockage occurring due to any kind of debris/sedimentation in the channel is currently minimal and the probability of a channel blockage is very low. Therefore, the risk of flooding from fluvial flooding is considered to be of low significance. The risk from this source will be further mitigated by using a number of risk management measures (see Section 8.0). In addition, as part of the planning permission a Maintenance Plan will be submitted and agreed with the LPA and will be secured by a planning condition (see Planning Condition C6).

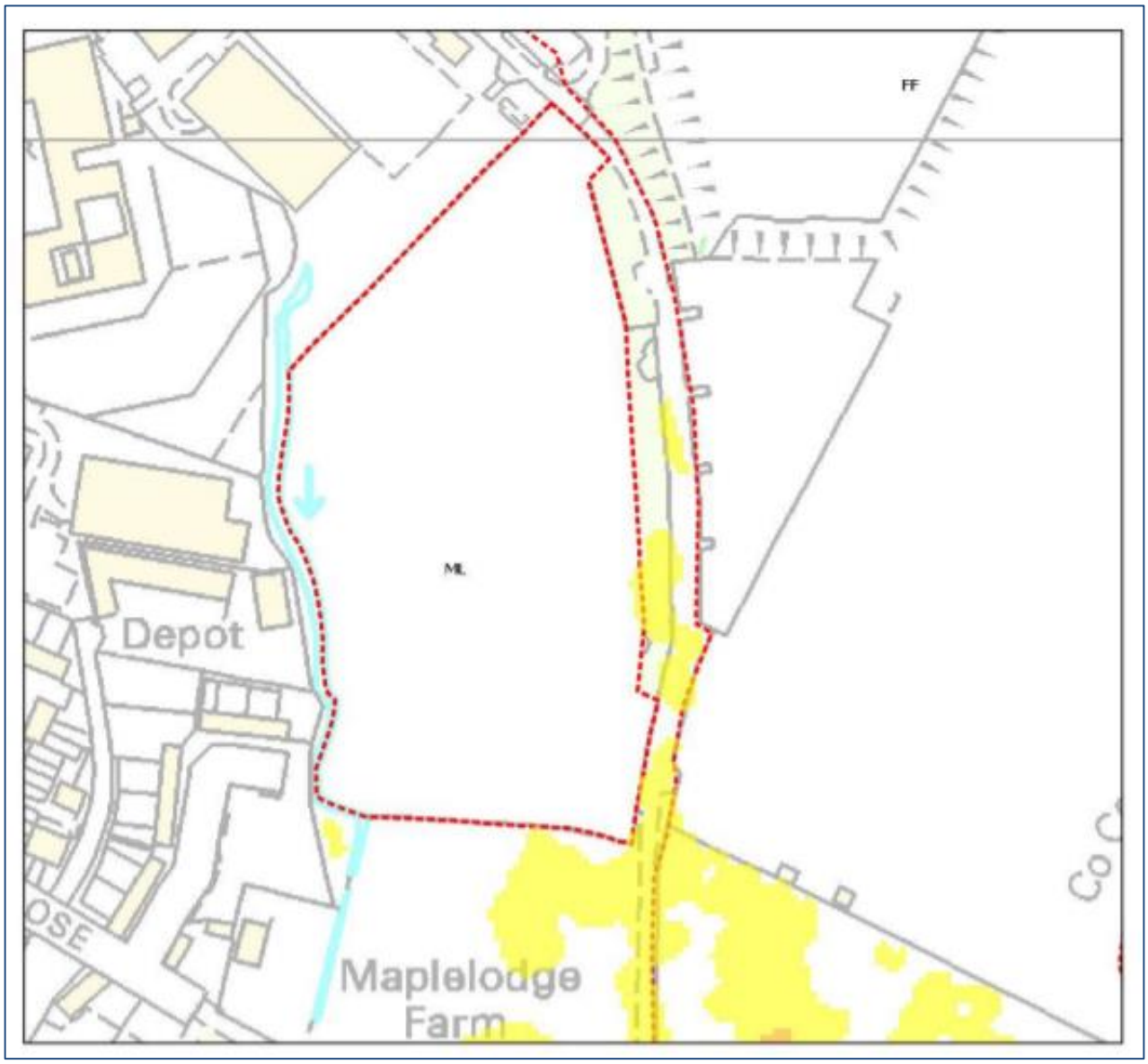


**Figure 4.1 - Three Rivers District Council SFRA for Flood Risk Sites Flood Hazard**

## 4.6. Tidal (coastal) Flooding

The site is not located within the vicinity of tidal flooding sources and the risk of tidal flooding is considered to be not significant. Therefore, flooding from this source has not been considered further within this FRA.

## 4.7. Groundwater Flooding

Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded. Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rocks (aquifers).

The BGS has identified the site as having the potential for groundwater flooding at the ground surface. According to ESI Groundwater Flooding Map (2014)[2], the risk of groundwater flooding at the site and within 250m of the site is considered to be high, this was also highlighted as part of the Three Rivers District Council SFRA for Flood Risk Sites.

Groundwater levels have also been recorded as part of the site investigation. Water levels were recorded from three positions sealed within the superficial River Terrace Deposits and from three positions within the underlying Chalk. The variance in head level between these different geological units was negligible suggesting direct hydraulic continuity with an average head level at 0.57m below ground level or 42.05mAOD in reference to an average ground level of 42.62mAOD.

The high-water table suggests that the site may have a low risk of groundwater flooding. However, it is likely that the measured groundwater levels represent close to a worst-case condition (i.e. high) as they follow a relatively wet period. The risk of flooding from groundwater flooding is considered to be of low significance. The risk from this source will be further mitigated by using a number of risk management measures (see Section 8.0).

## 4.8. Surface Water (pluvial) Flooding

The soil condition at the site and within the vicinity of the site and the topography of the site suggest that surface water flooding would not be expected to accumulate to any significant depths. Surface water flooding tends to occur sporadically in both location and time such surface water would tend to be confined to the roads to the south of the site.

Drawing T/17/1999/FRA/3 confirms that the site has a very low risk of surface water flooding with a chance of flooding of less than 1 in 1000 (0.1%) years. However, a very small proportion of the site has a low risk of surface water flooding with a chance of flooding of between 1 in 100 (1%) and 1 in 1000 (0.1%) years. Therefore, risk of flooding from surface water flooding is considered to be of low significance. The risk from this source will be further mitigated by using a number of risk management measures (see Section 8.0)

## 4.9. Sewer Flooding

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled. Sewer flooding tends to occur sporadically in both location and time such flood flows would tend to be confined to the streets around the development.

2 ESI Ltd (ESI), 2014. Groundwater flood risk map. Version 1. December 2013.

There are existing public sewers within the vicinity of the site. Sewers have a limited capacity so in extreme conditions there would be surcharges, which may in turn cause flooding. Flood flows could also be generated by burst water mains, but these would tend to be of a restricted and much lower volume than weather generated events and so can be discounted for the purposes of this assessment. Given the design parameters normally used for drainage design in recent times and allowing for some deterioration in the performance of the installed systems, which are likely to have been in place for many years, an appropriate flood risk probability from this source could be assumed to have a return period in the order of 1 in 10 to 1 in 30 years. The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers.

The provision of adequate level difference between the ground floors and adjacent ground level would reduce the annual probability of damage to property from this source to 1 in 100 years or less. Taking the above into consideration, the fact that there have been no infrastructure failure flooding events in the site area and the site's topography it can be concluded that the risk of flooding is low. The risk of flooding from sewer flooding is considered to be of low significance. The risk from this source will be mitigated by using a number of risk management measures (see Section 8.0).

## 4.10. Flooding from Artificial Drainage Systems/Infrastructure Failure

There are no other nearby artificial water bodies, water channels and artificial drainage systems that could be considered a flood risk to the site. The Environment Agency Reservoir flood map shows that the site is at risk of reservoir flooding (see Drawing T/17/1999/FRA/4). Reservoir flooding is extremely unlikely; reservoirs in the UK have a very good safety record. There has been no loss of life in the UK from reservoir flooding since 1925. Since then reservoir safety legislation has been introduced to make sure reservoirs are well maintained. The hazard is well managed through effective legislation and it is unlikely that the impact zone downstream of the reservoirs should preclude the proposed development. The risk of flooding from reservoir flooding is considered to be not significant. Therefore, flooding from these sources has not been considered further within this FRA.

## 4.11. Effects of the Development on Flood Risk

The flood risk areas shown within the site boundary is extremely small and there are neighbouring parts of the site where the land will not be raised to facilitate piling which will more than compensate for the lost area without first floodwater being displaced onto neighbouring sites. This will ensure no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. There will be no increase in the flood water levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

## 4.12. Site Specific Flood Risk Assessment

A summary of the sources of flooding and a review of the risk posed by each source at the site is shown in Table 4.3.

**Table 4.3 - Risk Posed by Flooding Sources**

| Sources of Flooding | Potential Flood Risk | Potential Source | Probability/Significance |
|---|---|---|---|
| Fluvial (river) Flooding | Yes | River Colne | Low |
| Tidal (coastal) Flooding | No | None Reported | Not significant |
| Groundwater Flooding | Yes | Groundwater | Low |
| Surface Water (pluvial) Flooding | Yes | Overland Flow | Low |
| Sewer Flooding | Yes | Local Sewers | Low |
| Flooding from Artificial Drainage Systems/Infrastructure Failure | No | None Reported | Not significant |

The majority of the site is located within Flood Zone 1 and therefore has a 'low probability' of fluvial flooding, with less than a 1 in 1000 annual probability of river or sea flooding in any year (<0.1%), while the southern and eastern boundary of the site is partially located within Flood Zone 2 and therefore has a 'medium probability' of fluvial flooding, with between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) in any year. It should be noted that the proposed buildings will be wholly located within Flood Zone 1.

It is understood that the access road has flooded in the past as a result of poor road design which will be improved as part of the proposed development. To mitigate future flooding the access road will be positively drained into the proposed drainage network. As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

The 1 in 1000 year event has a modelled water level of 42.38mAOD. By comparison, the ground levels at the site are generally between 42.00 and 43.00mAOD. Therefore, the risk of flooding from fluvial flooding is considered to be of low significance. A number of secondary flooding sources have been identified which may pose a low significant risk to the site. These are:

- Groundwater Flooding
- Surface Water Flooding
- Sewer Flooding

It is recommended that generally (with the exception of the main entrance ramped access) all buildings are located above the back of footway of the adjacent car park by 150mm to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zones 1 and 2. The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

The flood risk areas shown within the site boundary is extremely small and there are neighbouring parts of the site where the land will not be raised to facilitate piling which will more than compensate for the lost area without first floodwater being displaced onto neighbouring sites. This will ensure no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. There will be no increase in the flood water levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

In conclusion, the flood risk to the site can be considered to be limited, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

# 5. SEQUENTIAL APPROACH

## 5.1. Sequential Test

The risk-based sequential test in accordance with the NPPF aims to steer new development to areas at the lowest probability of flooding (i.e. Flood Zone 1). The proposed development site complies with the sequential approach which should be applied at all stages of planning. The site has been allocated for B1c/B2/B8 uses within the Three Rivers District Council Local Plan (site ref E(d)). As part of this allocation the sequential test has been undertaken and it was concluded within the Three Rivers District Council Local Development Framework Site Allocations Sequential Test Report[3], the study site is sequentially preferable in flood risk terms and may have a role to play in meeting the District's requirements for development. Therefore, as per paragraph 162 of the NPPF *'where planning applications come forward on sites allocated in the development plan through the sequential test, applications need not apply the sequential test again'*. The development proposals should therefore be considered by the LPA to satisfy the Sequential Test as set out in the NPPF.

## 5.2. Exception Test

Applications for 'less vulnerable' uses located within Flood Zones 1 and 2 are not subject to the Exception Test as confirmed within Table 4.2 of this report and Table 3 of the Planning Practice Guidance to the NPPF.

[3] Three Rivers District Council Local Development Framework Site Allocations Sequential Test Report November 2012.

# 6. PROPOSED FOUL WATER DRAINAGE

## 6.1. Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The site will discharge foul water to the public foul sewer to the north of the site (see Appendix E). There is an existing 600mm diameter foul public sewer which crosses the site, this is to be abandoned and grouted.

## 6.2. Conditions

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage can be connected/discharged to the public sewer.

At a last resort, highway drainage may be accepted under certain circumstances. If SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharge to the public sewer network may be permitted. In this event, the developer may be required to enter into a formal agreement with Thames Water under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

Foul water from kitchens and/or food preparation areas of any restaurants and/or canteens etc. must pass through a fat and grease trap of adequate design before any discharge to the public sewer network.

## 6.3. Adoption Agreements

Prospective adoptable sewers and pumping stations will be designed and in constructed in accordance with 'Sewers for Adoption' 7$^{th}$ Edition as supplemented by Thames Water requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site.

# 7. SURFACE WATER MANAGEMENT

## 7.1. Surface Water Management Overview

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

A SuDS Strategy for the site proposals has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The requirement for managing surface water runoff from developments depends on the pre-developed nature of the site. If it is an undeveloped greenfield site, then the impact of the development will need to be mitigated so that the runoff from the site replicates the natural drainage characteristics of the pre-developed site. In the case of brownfield sites, drainage proposals will be measured against the existing performance of the site, although it is preferable for solutions to provide runoff characteristics that are similar to greenfield behaviour.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development unless specific off-site arrangements are made and result in the same net effect.

It should be acknowledged that the satisfactory collection, control and discharge of surface water runoff are now a principle planning and design consideration. This is reflected in recently implemented guidance and released National Sustainable Drainage Systems (SuDS) Standards.

## 7.2. Opportunities for Discharge of Surface Water

There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations, this hierarchy is also promoted within the NPPF. Rainwater shall discharge to one of the following, listed in order of priority:

1. an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
2. a watercourse; or where that is not reasonably practicable,
3. a sewer.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

### Soakaway/Infiltration System

It has been concluded that the site is unsuitable for infiltration drainage due to the site ground conditions. Therefore, it will not be possible to discharge surface water runoff from the site via infiltration methods.

### Water Body

Should infiltration be found to be unsuitable, the next option is discharge to a water body. It is proposed that the surface water runoff from the site will discharge into the Maplelodge Ditch on the western boundary of the site. Discharge to the Maplelodge would be at greenfield runoff rates, greenfield runoff rates represent runoff from undeveloped land (i.e. they will be same as existing runoff rates).

By restricting runoff rates to Greenfield runoff rates the receiving watercourse will be protected from erosion and the resulting morphological, ecological damage and increasing flood risk. Due to the site ground levels the discharge will be pumped.

### Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse/water body is deemed unsuitable, then discharge to the public sewer would be possible. Where the developer proposes to discharge to a public sewer, prior approval from Thames Water Developer Services will be required, to ensure that the surface water discharge from the site shall not be detrimental to the existing sewerage system.

## 7.3. Proposed SuDS Strategy

The objective of this SuDS Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The proposed drainage layout is shown in Appendix E. In order to limit the rate and volume of surface water runoff that is discharged, it will be necessary to include a flow control device.

The surface water runoff from the site will be attenuated to 6.50l/s, which is the greenfield QBAR runoff rate for the site (i.e. they will be same as existing runoff rates), for all events up to and including the 1 in 100 year (+30%) rainfall event before discharge to the Maplelodge Ditch. As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be incorporated into the site layout. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change. The half drain times during the 1 in 1 year, 1 in 30 year events are a maximum of 8 minutes and during the 1 in 100 year (+30%) event are a maximum of 11 minutes.

At this stage, it is anticipated that the attenuation storage will be provided in the form of cellular storage before discharge to the Maplelodge Ditch. Permeable paving of the car parking areas will also be used, this will be tanked using a 1mm thick impermeable

membrane. The permeable paving will not be located within Flood Zone 2, the 1 in 1000 year event has a modelled water level of 42.38mAOD, which is equivalent to Flood Zone 2, and the permeable paving has a minimum ground level of 42.47mAOD.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream. As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

## 7.4. Designing for Local Drainage System Failure/Design Exceedance

When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SuDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it is not possible to completely remove the risk. This section of the FRA is therefore associated with the way the residual risk is managed.

As part of the SuDS Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground[4].

The attenuation requirements have been designed to accommodate the 1 in 100 year storm event plus climate change (+30%). The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the sewers, lateral drains connecting the properties to the underground storage areas. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the sewers would not affect the proposed buildings because the finished floor level will be raised above surrounding ground levels, ensuring any exceedance flooding would not affect the buildings. The gardens and driveways of the properties will be rise away from the highways so that any flows will not enter the property boundaries.

[4] CIRIA (2006) Designing for exceedance in urban drainage – good practice.

Exceedance flows would be contained within the highways within the site and adjacent to the site and would flow to the lower ground levels where the landscaped areas are located. In particular, the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+30%) event, there is safety factor for attenuation storage, even under the design event conditions. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this. If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure. Drainage gullies, manholes and pipework will provide additional water storage and provide betterment. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

The above manages and mitigates the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

Furthermore, a plan of routine inspection maintenance will be adopted and adhered to in order to prevent failure due to inadequate maintenance and will be maintained by the owner of the site. As part of the planning permission a Maintenance Plan will be submitted and agreed with the LPA and will be secured by a planning condition (see Planning Condition 6).

# 8. RISK MANAGEMENT

## 8.1. Introduction

The flood risk at this location is considered suitable for 'less vulnerable' developments within the NPPF. In this flood zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout, form of the development and the use of flood mitigation measures including SuDS techniques.

The flooding sources have been mitigated on the site by using a number of techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. This will ensure the development will be safe and there is:

- Minimal risk to life;
- Minimal disruption to people living and working in the area;
- Minimal potential damage to property;
- Minimal impact of the proposed development on flood risk generally; and;
- Minimal disruption to natural heritage.

## 8.2. Minimum Floor Level

There is no minimum finished floor level proposed as a result of flooding. However, it is recommended that generally (with the exception of the main entrance ramped access) all buildings are located above the back of footway of the adjacent car park by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

## 8.3. Flood Resilience and Resistance

The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed. Relatively simple measures such as raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from properties can be easily and economically incorporated into the development of the site. To make the buildings / structures more resistant to seepage the following measures will be incorporated. The buildings will be constructed from hard wearing materials and will be sealed against water ingress. The floors of the buildings will be constructed from concrete.

## 8.4. Access and Egress

The majority of the site and surrounding area is located within Flood Zone 1. The Three Rivers District Council SFRA for Flood Risk Sites confirms that access to Maple Lodge Close to the south and the road at the northern corner of the site remains clear during the 1 in 100 year (plus climate change) event. The road at the northern corner of the site remains clear during the 1 in 1000 year event. Therefore, a permanently safe and dry access can be maintained.

## 8.5. Buffer Strip/Easement

An 8.00m buffer strip adjacent to the top of the watercourse on the western boundary of the site will need to be retained for maintenance purposes. This will be free of built development and is required by the Environment Agency. The buffer strip will also mitigate the impact of flooding from the watercourse should it overtop its banks. As part of the planning permission a Maintenance Plan will be submitted and agreed with the LPA and will be secured by a planning condition (see Planning Condition C6).

## 8.6. Flooding Consequences

The mitigation measures detailed above show that the flood risk can be effectively managed and therefore the consequences of flooding are acceptable. In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1, with a low annual probability of flooding and from all sources.

# 9. SUMMARY AND CONCLUSIONS

## 9.1. Introduction

This report presents an FRA in accordance with the NPPF, Policies CP1 and CP12 of the Core Strategy for the proposed development at Maple Cross, Rickmansworth and includes an assessment of the existing and proposed surface and foul water drainage of the site. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

## 9.2. Flood Risk

The majority of the site is located within Flood Zone 1 and therefore has a 'low probability' of fluvial flooding, with less than a 1 in 1000 annual probability of river or sea flooding in any year (<0.1%), while the southern and eastern boundary of the site is partially located within Flood Zone 2 and therefore has a 'medium probability' of fluvial flooding, with between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) in any year. It should be noted that the proposed buildings will be wholly located within Flood Zone 1.

It is understood that the access road has flooded in the past as a result of poor road design which will be improved as part of the proposed development. To mitigate future flooding the access road will be positively drained into the proposed drainage network. As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

The 1 in 1000 year event has a modelled water level of 42.38mAOD. By comparison, the ground levels at the site are generally between 42.00 and 43.00mAOD. Therefore, the risk of flooding from fluvial flooding is considered to be of low significance. A number of secondary flooding sources have been identified which may pose a low significant risk to the site. These are:

- Groundwater Flooding
- Surface Water Flooding
- Sewer Flooding

It is recommended that generally (with the exception of the main entrance ramped access) all buildings are located above the back of footway of the adjacent car park by 150mm to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from all sources is considered to be low or not significant. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The proposed development is classified as 'less vulnerable', 'less vulnerable' uses are appropriate within Flood Zones 1 and 2. The flood risk at the site, will be further managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

The flood risk areas shown within the site boundary is extremely small and there are neighbouring parts of the site where the land will not be raised to facilitate piling which will more than compensate for the lost area without first floodwater being displaced onto neighbouring sites. This will ensure no detriment to the flood storage capacity of the site. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. There will be no increase in the flood water levels due to the proposed development. There will be no loss in flood storage capacity and no change in the on-site and off-site flood risk.

In conclusion, the flood risk to the site can be considered to be limited, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

## 9.3. Sequential Test

The development proposals should be considered by the LPA to satisfy the Sequential Test as set out in the NPPF. Applications for 'less vulnerable' uses located within Flood Zones 1 and 2 are not subject to the Exception Test.

## 9.4. Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The site will discharge foul water to the public foul sewer to the north of the site. There is an existing 600mm diameter foul public sewer which crosses the site, this is to be abandoned and grouted.

## 9.5. SuDS Strategy

The SuDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. The proposed drainage layout is shown in Appendix E. In order to limit the rate and volume of surface water runoff that is discharged, it will be necessary to include a flow control device.

The surface water runoff from the site will be attenuated to 6.50l/s, which is the greenfield QBAR runoff rate for the site (i.e. they will be same as existing runoff rates), for all events up to and including the 1 in 100 year (+30%) rainfall event before discharge to the Maplelodge Ditch. As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, attenuation storage will be incorporated into the site layout. The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change. The half drain times during the 1 in 1 year, 1 in 30 year events are a maximum of 8 minutes and during the 1 in 100 year (+30%) event are a maximum of 11 minutes.

At this stage, it is anticipated that the attenuation storage will be provided in the form of cellular storage before discharge to the Maplelodge Ditch. Permeable paving of the car parking areas will also be used, this will be tanked using a 1mm thick impermeable membrane. The permeable paving will not be located within Flood Zone 2, the 1 in 1000 year event has a modelled water level of 42.38mAOD, which is equivalent to Flood Zone 2, and the permeable paving has a minimum ground level of 42.47mAOD.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SuDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes. The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream. As part of the planning permission a final design of the drainage scheme will be submitted and agreed with the LPA this will include a Maintenance Plan and will be secured by a planning condition (see Planning Condition C6).

## 9.6. Risk Management

The flooding sources will be managed on the site by using a number of mitigation strategies to manage and reduce the overall flood risk at the site and will ensure the development will be safe. Measures used:

**Minimum Floor Level** – There is no minimum finished floor level proposed as a result of flooding. However, it is recommended that generally (with the exception of the main entrance ramped access) all buildings are located above the back of footway of the adjacent car park by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

**Flood Resilience and Resistance** - The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed. Relatively simple measures such as raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from properties can be easily and economically incorporated into the development of the site. To make the buildings / structures more resistant to seepage the following measures will be incorporated. The buildings will be constructed from hard wearing materials and will be sealed against water ingress. The floors of the buildings will be constructed from concrete.

**Access and Egress** - The majority of the site and surrounding area is located within Flood Zone 1. The Three Rivers District Council SFRA for Flood Risk Sites confirms that access to Maple Lodge Close to the south and the road at the northern corner of the site remains clear during the 1 in 100 year (plus climate change) event. The road at the northern corner of the site remains clear during the 1 in 1000 year event. Therefore, a permanently safe and dry access can be maintained.

**Buffer Strip/Easement** - An 8.00m buffer strip adjacent to the top of the watercourse on the western boundary of the site will need to be retained for maintenance purposes. This will be free of built development and is required by the Environment Agency. The buffer strip will also mitigate the impact of flooding from the watercourse should it overtop its banks. As part of the planning permission a Maintenance Plan will be submitted and agreed with the LPA and will be secured by a planning condition (see Planning Condition C6).

## 9.7. Conclusion

Table 9.1 summarises the probability and consequence of flooding for the site with and without mitigation measures. This FRA demonstrates that the site can be operated with minimal risk from flooding and will not increase flood risk elsewhere. The site should not therefore be precluded on the grounds of flood risk.

Further detailed information will be provided by way planning conditions. No development shall take place until the final design of the drainage scheme is completed and sent to the LPA for approval and will be secured by a planning condition (see Planning Condition C6).

**Table 9.1 - Probability and Consequences of all Sources of Flooding**

| Sources of Flooding | Potential Source | Probability | Consequence & Impact Without Mitigation | Consequence & Impact with Mitigation |
|---|---|---|---|---|
| Fluvial Flooding | River Colne | Low | Low | Negligible |
| Tidal Flooding | No | Not Significant | Negligible | Negligible |
| Groundwater Flooding | Groundwater | Low | Low | Negligible |
| Surface Water Flooding | Surface Water Runoff | Low | Low | Negligible |
| Sewer Flooding | Local Sewers | Low | Low | Negligible |
| Flooding from Artificial Drainage Systems/Infrastructure Failure | No | Not Significant | Negligible | Negligible |

# APPENDIX A - FIGURES AND DRAWINGS

# APPENDIX B – ENVIRONMENT AGENCY DATA

# APPENDIX C – PROPOSED SITE LAYOUT

# APPENDIX D – TOPOGRAPHICAL SURVEY

# APPENDIX E – PROPOSED DRAINAGE LAYOUT