

8 Hydrology and Flood Risk

Introduction

- 8.1 This Chapter reports the likely significance of effects of the Proposed Development on the environment in terms of Water Resources, Flood Risk and Drainage. Where appropriate it also identifies proposed mitigation measures to prevent, minimise or control likely negative impacts arising from the Proposed Development and the subsequent anticipated residual effects.
- 8.2 This Chapter should be read together with the Introductory Chapters and Chapter 7: Geology, Hydrogeology and Ground Conditions which discusses the status and potential impacts to contamination and groundwater resources. Further information on the policy and legislative framework for this chapter is provided in Appendix 8.1.
- 8.3 A Flood Risk Assessment (FRA) and Outline Drainage Strategy have been produced to support the planning application and can be found in Appendix 8.2. Information from both the FRA and Outline Drainage Strategy, have informed this chapter.

Assessment Methodology

- 8.4 This assessment identifies the potential effects of the Proposed Development on drainage and flood risk. It determines the significance of the identified effects for the construction and operation phases. The methods used to identify key issues and assess the impact of the Development are as follows:
- Review data that is available for the Site and study area;
 - Undertake a Site visit to clearly understand the Site constraints and opportunities;
 - Review of Reading Borough Council's (RBC) Strategic Flood Risk Assessment (SFRA) (Jacobs, 2009) (Ref 8.1);
 - Review of Core Strategy (Reading Borough Council, 2015) (Ref 8.2);
 - Review of existing sewerage plans (Thames Water 2018) (Ref 8.3);
 - Review of the British Geological Survey (BGS) solid and drift geology map 268 (BGS, 2000) (Ref 8.4);
 - Review of groundwater vulnerability map (Magic map, 2018) (Ref 8.5);
 - Review and address the comments received in the EIA Scoping Opinion (Appendix 4.2);
 - Review consultations with RBC, the Environment Agency (EA) and Thames Water (TW) to ascertain the opportunities and constraints with regard to water resources on the Site;
- 8.5 An FRA has been completed for the development to assess the risk of flooding to the development and the impact the development has on flood risk in the area. The FRA has also assessed the

impact climate changes may have in terms of flood risk to the development and surrounding area. The FRA is presented in Appendix 8.2.

- 8.6 A drainage strategy that manages surface water accumulated on-site has been developed as part of the FRA. This considered potential pollutants and propose solutions which mitigate potential contamination. Water quality issues related to groundwater are discussed in Chapter 7: Geology, Hydrogeology and Ground Conditions

Legislation and Planning Policy Context

- 8.7 Details of the relevant legislation, policy and guidance are provided in Appendix 8.1. The applicable legislative framework is summarised as follows:

- European Commission, (2000). The Water Framework Directive (2000/60/EC). Luxembourg: Publications Office of the European Union;
- England and Wales. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. London: The Stationery Office;
- England and Wales. The Water Resources Act 1991. London: The Stationery Office;
- England and Wales. The Environment Act 1995. London: The Stationery Office;
- England and Wales. The Water Act 2003. London: The Stationery Office;
- England and Wales. The Water Act 2014. London: The Stationery Office;
- England and Wales. The Anti-Pollution Works Regulations 1999. London: The Stationery Office;
- England and Wales. The Water Industry Act 1999. London: The Stationery Office;
- England and Wales. Land Drainage Act 1991. London: The Stationery Office;
- England and Wales. Land Drainage Act 1994. London: The Stationery Office;
- Department for Environment, Food & Rural Affairs, 1981. Land Drainage Bylaws. London: The Stationery Office;
- England and Wales. Flood and Water Management Act 2010, London: The Stationery Office;
- England. The Environmental Damage (Prevention and Remediation) (England) Regulations 2015. London: The Stationery Office;
- England and Wales. Environmental Permitting (England and Wales) (Amendment) (No. 2) Regulations 2016. London: The Stationery Office;
- England and Wales. The Flood Risk Regulations 2009. London: The Stationery Office;

- National Planning Policy Framework (Ministry of Housing, Communities and Local Government 2018) (Ref: 8.6);
- Planning Practice (Guidance Ministry of Housing, Communities and Local Government 2016) (Ref: 8.7);
- Core Strategy (Reading Borough Council 2009) (Ref: 8.2);
- SFRA (Reading Borough Council 2009) (Ref: 8.1);
- Environment Agency, (2009). Thames Catchment Flood Management Plan. Reading: Environment Agency;
- Environment Agency, (2015). Thames River Basin Management Plan. Updated December 2015. Reading: Environment Agency;

Relevant Guidance

- Department for Environment, Food & Rural Affairs, (2015). Sustainable drainage systems non-statutory technical standards for sustainable drainage systems. [viewed 18 October 2018]. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf;
- Department for Environment, Food & Rural Affairs, (2008). Future Water – The Government's Water Strategy for England. London: The Stationary Office.
- CIRIA, (2015). The SuDS Manual CIRIA report 753. London: CIRIA.
- CIRIA, (2001). CIRIA 532 – Control of Water Pollution from Construction Sites. London: CIRIA.
- Water Research Centre, (2012). Sewers for Adoption. 7th Edition. Swindon: Water Research Centre.
- Thames Water, (2015). Thames Water: Final Water Resources Management Plan ('WRMP') 2015-2040. London: Thames Water.
- Department for Environment, Food & Rural Affairs, (2016). Business and the environment. [viewed 18 October 2018]. <https://www.gov.uk/business-and-industry/business-and-the-environment>.

Study Area

- 8.8 The Site is approximately 1.962 ha in size and located within the administrative area of the Reading Borough Council. The extent of the study area is indicated in Green and covers the River Thames to the north and River Kennet to the south, the Site planning boundary is shown outlined in Red in Figure 8.1.

Baseline Methodology

8.9 The following sources are used to inform the baseline:

- Online flood mapping database (EA 2018) (Ref: 8.8);
- Flood levels and modelling information (EA 2015) (Ref: 8.9);
- BSG mapping (BSG 2018) (Ref: 8.4);
- Foul and surface water sewer records (Thames Water 2018) (Ref: 8.3);
- Topographical Survey of the site, (Ref: 8.10);
- Reading RMG Flooding Modelling Report, (Edenvale Young, 2011) (Ref: 8.11);
- Reading RMG FRA, (Ove Arup & Partners Ltd, 2010) (Ref: 8.12);
- Reading RMG Drainage Management Plan, (Waterman Transport and Development Ltd, 2010) (Ref: 8.13);
- Reading RMG Assessment of floodplain storage, (Waterman Transport and Development Ltd 2010) (Ref: 8.14);
- Groundwater level information, (Tony Bedford Site Investigation Drilling, 2010) (Ref: 8.15); and
- Chapter 7: Geology, Hydrogeology and Ground Conditions of this ES.

Consultation

8.10 A summary of the consultation activities undertaken in preparation of this chapter through the scoping exercise and other consultation is provide in Table 8.1 below.

Table 8.1: Consultation Responses Relevant to this Chapter

Date	Consultee and Issues Raised	How/ Where Addressed
12 th February 2018	The EA were contacted for flood information in relation to the fluvial flood risk in the area.	The EA provided flood maps, flood levels, flows for the River Thames which is potential source of any fluvial flooding and they proposed extents of historic flood events in the area. This information has been in the FRA in Appendix 8.2 to assess the impact of flooding on the proposed development.
29 th March 2018	Reading Borough Council A request for a scoping opinion and the EA made the following comments. An FRA will be required for the development	A full FRA has been produced and is included in Appendix 8.2

Date	Consultee and Issues Raised	How/ Where Addressed
	Floodplain storage should be considered to ensure no detrimental impact on third parties is made, they also recommended the following: <i>"The Proposals should be designed to the recommendations for floodplain storage, floor levels, basements and a safe route of access and egress recommended in the level 2 SFRA assessment (site AB004: NORTH OF THE STATION (Local Plan Ref: CR11e)".</i> Climate change allowances based on: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances should be factored into the flooding assessment in the FRA	The FRA Appendix 8.2 has considered the impact the development has on the floodplain storage and confirm there is no loss of storage or determinantal impact on the surrounding area. Also the recommendations in the SFRA have been used in the FRA for assessing storage, floor levels and safe access, and where necessary mitigation measures have been recommended in the FRA to ensure the development is safe and won't increase the risk of flooding in the area. The current climate change allowances have been included in the assessment of flooding in the FRA in Appendix 8.2, which is also as recommended in RBC SFRA level 2 assessment of the application site.
29 th March 2018	Network Rail provided comments to RBC as part of the request for a scoping opinion. They requested that any drainage should fall away from Network Rails land. They also stated that in the interest of stability any soakaway or attenuation tanks should be 20 m away from any Network Rail boundary.	The site has been designed so that ground falls away from Network Rail Land. The drainage strategy for the development with the FRA in Appendix 8.2 has been prepared on the basis that all attenuation tanks are located a minimum of 20 m from the Network Rail boundary.
19 th October 2018	Thames Water (sewage) were contact for details of any existing sewers within the site that be may affected.	Thames Water confirmed they do not have any sewers within the site, they also confirmed they do not own or manage the culvert running through the site.

Assessment Criteria and Assignment of Significance

- 8.11 The assessment of potential effects, as a result of the Proposed Development, has taken into account both the Construction and Operational stages of the development. Magnitude of effect and sensitivity of the affected receptor have been assessed adapting the relevant tables within the Design Manual for Roads and Bridges (DMRB) Vol 11,2,5, (Department of Transport, 2008) (Ref: 8.16) and TAG Unit A3 Environmental Impact Assessment, (Department of Transport 2015) (Ref: 8.17).
- 8.12 Although the above documents were prepared to provide guidance for assessing the impact road schemes may have on the water environment they provide a general framework which can be used to assess the impact of the development proposals on the water environment.

8.13 Table 8.2 below provides the general criteria used to assess the sensitivity of the water receptors as part of this assessment

Table 8.2: Sensitivity of Water Receptors

Sensitivity	Criteria
Very High	Very high importance and rarity, international scale and very limited potential for substitution. Examples include: • Principal Aquifer providing potable water to a large population (groundwater) • Important fish population (surface water) Floodplain or defence protecting more than 100 residential properties (flood risk)
High	High importance and rarity, national scale, and limited potential for substitution. Examples include: • Water Framework Directive (WFD) high status water body (surface water) • Aquifer in source protection zone (SPZ) 1 providing potable water to a small population (groundwater) • Notable fish population (surface water) • Floodplain or defence protecting up to 100 residential properties or industrial premises (flood risk) • Increasing surface water discharges from the site such that the risk of on and off-site flooding is likely to threaten life and/or damage infrastructure (flood risk)
Medium	High or medium importance and rarity, regional scale, limited potential for substitution. Examples include: • WFD good status water body (surface water) • Aquifer not in SPZ 1 providing abstraction water for agricultural or industrial use (ground water) • Floodplain or defence protecting up to 10 industrial premises (flood risk) • Increasing surface water discharges from the site such that the risk of on and off-site flooding is likely to damage infrastructure but not threaten life (flood risk)
Low	Low or medium importance and rarity, local scale. Examples Include: • WFD less than good status (surface water) • Unproductive strata (ground water) • Floodplain with limited existing development (flood risk) • Increasing surface water discharges from the site such that the risk of local flooding is likely to damage property but not threaten life (flood risk)
Negligible	Very low importance and rarity, local scale. Examples include: • Surface water sewers (surface water) • Agriculture drainage ditches (surface Water) • Floodplain not affecting existing development (flood risk)

8.14 The criteria for determining the magnitude of impact is detailed in Table 8.3

Table 8.3: Classification of Magnitude

Magnitude	Typical Descriptors
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse). Examples Include: • Loss or significant change of important fishery • Negative change in WFD classification of river reach • Loss of flood storage and or significant increase in fluvial flood risk affecting receptors with a high probability such that the risk of major flooding is likely to threaten life and/or damage key infrastructure • Increase in surface water discharge from the development that might cause flooding with a high probability that could threaten life and key infrastructure • Pollution of potable source of abstraction
	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial). Examples Include: • Gain or significant change of important fishery • Positive change in WFD classification of river reach • Increase of flood storage and or significant reduction in fluvial flood risk affecting receptors with a high probability such that the risk of major flooding is likely to reduce the threat to life and/or damage to key infrastructure • reduction in surface water discharge from the development that might reduce flooding with a high probability that could reduce threat to life and key infrastructure
Medium	Loss of resource, but not adversely affecting the integrity; partial loss of/damage to key characteristics, features or elements (Adverse). Examples Include: • Loss of productivity of a fishery • Contribution of the site effluent towards receiving river but insufficient to change WFD classification • Loss of flood storage and or increase in fluvial flood risk affecting receptors with a high probability such that the risk of flooding is likely to damage infrastructure but not threaten life • Increase in surface water discharge from the development that might cause flooding of the site with a high probability that could threaten property but no loss of life
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial). Examples Include: • Gain in productivity of a fishery • Reduction of the site effluent towards receiving river but insufficient to change WFD classification • Increase of flood storage and or reduction in fluvial flood risk affecting receptors with a high probability such that the risk of flooding to infrastructure is reduced • Reduction in surface water discharge from the development that might reduce flooding of the site with a high probability that could threaten property

Magnitude	Typical Descriptors
Low	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (Adverse). Examples Include: - Minimal increase in the likelihood or magnitude of flooding as a consequence of the development - Limited increase in discharge flow from the site which would cause a small/barely noticeable change in the probability or magnitude of flooding.
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial). Examples Include: - Minimal decrease in the likelihood or magnitude of flooding as a consequence of the development - Limited reduction in discharge flow from the site which would cause a small/barely noticeable improvement in the probability or magnitude of flooding.
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse). Examples Include: The development is unlikely to affect the integrity of the water environment and have a significant impact on flooding
	Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial). Examples Include: The development is likely to have a minimal benefit on the integrity of the water environment and flooding
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

- 8.15 Both sensitivity/value and magnitude must be taken into account in determining the significance of effect. The section should define significance based on (as appropriate):

Significance of Effects

- 8.16 The significance level attributed to each effect has been assessed based on the magnitude of change due to the Proposed Development and the sensitivity of the affected receptor/receiving environment to change. The assessment of potential effects, as a result of the Proposed Development, has considered both the Demolition and Construction and Operational stages.
- 8.17 Magnitude of change of the affected receptor/receiving environment is assessed on a scale of high, medium, low, negligible and no change, the sensitivity of the affected receptor/receiving environment is assessed on a scale of very high, high, medium, low and negligible (as shown in Chapter 4: Approach to the Assessment).

8.18 A summary of the significance matrix can be seen in Table 8.3

Table 8.3: Assessment Matrix of Significance of Effects

Sensitivity	Magnitude of Impact				
	No Change	Negligible	Low	Medium	High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major or Substantial
Very high	No change	Minor	Moderate or Major	Major or Substantial	Substantial

8.19 The following terms have been used to define the significance of the effects identified.

- Substantial: where the proposed development could be expected to have a very major effect (either positive or negative) on flood risk or drainage at a regional or national level.
- Major: where the proposed development could be expected to have a very significant effect (either positive or negative) on flood risk or drainage in the area.
- Moderate: where the proposed development could be expected to have a noticeable effect (either positive or negative) on flood risk or drainage in the area.
- Minor: where the proposed development could be expected to have a very minimal effect (either positive or negative) on flood risk or drainage in the area.
- Negligible: where the proposed development could be expected to have no discernible effect (either positive or negative) on flood risk or drainage in the area.

8.20 In terms of effect significance, substantial, major and moderate effects are considered to be 'significant'. Effects that are minor and negligible are not considered significant. Effects are also described as permanent or temporary and by their timescale short, medium or long. Short term being a matter of months up to one year, medium term more than one year up to five years and long term greater than five years.

Limitations of the Assessment

8.21 The assessments within this chapter have been carried out for the outline planning application. Therefore, assumptions have been made where necessary and the worst case scenario considered. For example, assumptions have been made regarding the proposed drainage layout for the development, while the Sustainable Drainage System (SuDS) and attenuation have been designed to suit the proposals the network of pipes may need to be adjusting once the final form of development has been decided.

8.22 The culvert running through the site needs CCTV survey to confirm the condition and size assumed in this assessment, the size may need to be adjusted if there is any variance to that assumed in this assessment.

- 8.23 The assessment of storage volumes and floor levels are based on modelling information provided by the EA, which is assumed to be correct. The methodology used is as recommended in RBC SFRA and the EA confirmed this is the correct method for assessing the flood implications at the site.

Baseline Environment

Surface Water

- 8.24 The Site is comprised of buildings and impermeable surfaces, there is limited landscaping across the site. The existing runoff generated from the existing site is high due the level of impermeable surfaces, the current discharge rate has been estimated at 152 l/s for the 1 in 1 year event.
- 8.25 A culvert is known to run through the middle of the site and it has been confirmed by TW that it is not a surface water sewer and therefore it is considered to be an ordinary watercourse. The culvert commences to the west of the site, passes under the railway bridge over Caversham Road and runs down Caversham Road before turning left into the site. It passes through the site crosses under Kings Meadow Road and outfalls into a ditch alongside the River Thames. The ditch flows for approximately 100m and outfalls in to the River Thames downstream from the Caversham Lock.
- 8.26 The culvert was originally built of brick but sections have been replaced with precast concrete units. The size of the culvert starts as a 600 mm diameter pipe which increases to 1500 mm by 750 mm through the majority of the site. A survey in 2008 found the culvert to be in serviceable conditions, however it identified in places the flow was hindered by silt that has slightly reduced the cross section.
- 8.27 There are no existing surface water sewers on or in the vicinity of the site that could receive runoff from the site. The nearest sewers are located in Caversham Road.

Existing Discharge Consents

- 8.28 There are no records of any discharge consents on the site, but there are 5 current discharge consents within 1 km of the Site. The nearest being Reading Transport Ltd, approximately 370 m away from the Site. The other listed discharge consents of interest are treated sewage discharges into the River Thames over 400 m away and treated effluent discharge into the overlying alluvium layer over 700 m away from the Site.

Flood Risk and Defences

- 8.29 The site is located between the River Kennet approximately 650 m to the south and the River Thames to 230 m to the north. They are designated as main river and as consequence, the EA are responsible for operating and maintaining them. The Site is considered to be in flood zone 2 with a probability of flooding of between 1.0% & 0.1%, it is not offered any form of protection by raised (formal or informal) defences. The source of flooding is the River Thames in the north, the site is not at risk of flooding from the River Kennet.
- 8.30 The EA flood modelling for the River Thames and their flood maps show that the site lies within flood zone 2. RBC SFRA also shows the site to be in flood zone 2, a level 2 SFRA has been prepared by RBC which provides design recommendation for development of the site.

8.31 The level 2 SFRA considered it was feasible to design the site in such a way that it remains safe throughout the lifetime of development. It sets out important design recommendations to be considered when planning the redevelopment of the site as follows:

- Floor levels within the site should be situated a minimum of 300 mm above the 1 in 100 annual probability plus allowance for climate change, in this instance +25%, assuming a 100 year lifetime for residential development;
- Flood storage should be analysed to show that the proposed building footprint of the development will not cause a detriment to the available storage during the 1 in 100 annual probability +25% climate change allowance flood event. The presence of a significant existing building footprint suggest that floodplain storage capacity could be improved through effective design measures;
- Where appropriate, buildings should adopt resilient design techniques to minimise the damage and disruption sustained by businesses and/or residents following a flooding event. Further guidance can be found in BRE Digest DG523 'Flood Resilient Building', the Department for Communities and Local Government document 'Improving the Flood Performance of New Buildings – Flood Resilient Construction' (Ref 8.6), and Section 12.4 of the Level 1 SFRA';
- SuDS should be incorporated into the site design, aiming to achieve greenfield runoff rates, if feasible, in accordance with Section 13.4 of the Level 1 SFRA. It is important that SuDS are designed with due consideration to soil and groundwater conditions. Infiltration techniques should be sought wherever possible, however are likely to be unsuitable in areas of shallow groundwater and/or impermeable soils. Further guidance on designing for groundwater is provided in Section 6.5 of the Level 1 SFRA. Buildings and landscaping should be designed within the site to avoid locking overland flow routes;
- Safe access is available in the current 1 in 100 annual probability flood event and would therefore meet the requirements of Section 3.4 of the L2 SFRA provided a 'Flood Management and Evacuation Plan' (FMPE) is prepared to consider the impacts in the climate change scenarios. Future tenants/residents within the site should be made aware of the potential risks of flooding, and should be actively encouraged to sign up to the Environment Agency's Flood Information Service to receive flood alerts, flood warnings and severe flood warnings well in advance of an event;
- It is essential to ensure that all basement areas within flood affected areas of the site are watertight, and the entrance point is situated above the 1 in 100 annual probability +25% allowance for climate change flood level. Basements should not be used to provide habitable areas in locations classified at Flood Zone 2 'Medium Probability';
- Residual risk to the development should be investigated against the 1 in 100 annual probability +35% allowance for climate change flood event.

- 8.32 The EA had previously agreed that the existing buildings on site, including the sorting office, office building etc. are currently impermeable structures and could be made flood resilient to the 1 in 100 year plus climate change flood level and as such, would not flood in the baseline condition.

Sewer Flooding

- 8.33 RBC SFRA indicates there have been 21-50 incidents of sewer flooding in the area, the site has no recorded history of being subject to flooding. There are no public sewers present within the site, the nearest sewers run along Caversham Road and Vastern Road. Any flooding from these sewers are likely travel east away from the site along Vastern Road the probability of sewer flooding is considered low.

Groundwater Conditions

- 8.34 The presence of river terrace deposits is indicated in boreholes around the site and are likely to extend into some or all areas on site. The upper aquifer is assumed to be form of the river terrace deposits. Borehole logs for the surrounding areas also indicate localised shallow perched water within the Made Ground.
- 8.35 An intrusive investigation was carried out on site in December 2010. This investigation indicated that the groundwater level was within the Terrace Sands and Gravels. Further details of the site investigation findings are listed below:
- Based on the topographical survey, the ground level elevation for both borehole locations was 38.0 m above ordnance datum (AOD). The boreholes were close together in the car park next to the sorting office, borehole 2 is slightly north west (nearest the sorting office) of borehole 1.
 - Borehole 1 - Groundwater encountered at 35.5 m AOD rising to 35.75 m AOD (2.25 m depth below ground).
 - Borehole 2 - Groundwater encountered at 35.8 m AOD rising to 36 m AOD (2.0 m depth below ground).
 - The groundwater flow was recorded as slow and it is interpreted that there is very little gradient (and therefore flow) of groundwater across the site.

- 8.36 The hydrogeology of the Site has been determined using the stratigraphy profiles obtained from the records of previous boreholes. The aquifer designation data is based on geological mapping provided by the BGS. The maps display aquifer designations for principal aquifers, secondary aquifers and unproductive strata. The hydrogeology is covered in more detail in Chapter 7: Geology, Hydrogeology and Ground Conditions.

Future Baseline Conditions

- 8.37 The development proposals should be assessed against a 1.0% probability flood event. The flood level for the 1.0% event is likely to increase as a result of global climate change, the development therefore needs to assess against the 1.0% probability event with and without climate change.

8.38 The allowances to be included for climate change have been out by the EA in supporting information of PPG and in the level 2 SFRA. The proposed development includes a residential use so the development is considered to have life expectancy of 100 years, therefore the future baseline condition that need and have been considered are as follows:

- Building floor levels should be assessed based on the 1.0% probability flood level plus a climate change allowance of 25% increase in river flows;
- Flood compensation on site should be assessed based on the 1.0% probability flood level plus a climate change allowance of 25% increase in river flows;
- Access levels to basement car park should be assessed based on the 1.0% probability flood level plus a climate change allowance of 25% increase in river flows;
- Rainfall events should be assessed based on the 1.0% probability flood level plus a climate change allowance of 40% increase in rainfall intensities;
- Residual risk should be assessed based on the 1.0% probability flood level plus a climate change allowance of 35% increase in river flows;

Mitigation Measures Adopted as Part of the Project

8.39 The proposed development will have a smaller footprint when compared to the existing buildings on site. Mitigation measures are proposed to ensure that there will be no loss of flood storage volumes. This will involve providing space between and around the building to accommodate flood waters. The proposed ground levels across the site and around the buildings have been set to ensure the flood storage volumes at each 100 mm increment are maintained under the proposals to prevent an increase in flood risk to the area.

8.40 All residential building will be set 300 mm above the flood level for a 1.0% flood level including allowances for climate change, this mitigate against potential flooding and ensure they are free from flooding from such an events.

8.41 Safe access will be provided from all buildings to mitigate against potential flooding across the site to ensure a safe access can be provided during flood conditions, all evacuation routes will be above the 1.0% flood probability event as recommended in RBC Level 2 SFRA.

8.42 SuDS techniques will be employed for the disposal of runoff from the development, these will ensure the runoff from the development will be reduced compared to the existing situation. Underground attenuation tanks will also be used to mitigate the volume of runoff from the development to ensure the rate of discharge is closer to greenfield rates then the current discharge rate.

8.43 The SuDS will provide a level of treatment to the runoff from the development ensuring the quality of water reaching the surface water network meets current quality standards. The runoff from roads and hard standings that are do not receive treatment via SuDS will pass through petrol inceptors and silt traps before entering the surface water network.

- 8.44 Over pumping of the water in the culvert will be required when the connection of the new culvert is made to the existing, to mitigate any potential flooding the pumps will be sized to the maximum capacity of the culvert upstream. Construction activities will not be undertaken when there is a high probability of intense rainfall to reduce the risk of flooding.
- 8.45 A FMEP will be produced prior to occupation of the Proposed Development and will be made available to residents to make them aware of the flood risks in the area, what measures should can be implemented the procedures to be followed during a flood incident and how they can sign up to flooding waring system offered by the EA. The FMEP will be prepared by the developer and they will maintain the plan and update it when circumstances dictate or there is a change to the flood risk to the area.
- 8.46 A Code of Construction Practice (CoCP) has been prepared, Chapter 2 of this ES set outs the measures to be implemented during the construction stage of development. This will include local flood prevention measures, flood warning / evacuation procedures, management and storage of materials etc in line with best practice and policy. Temporary facilities for the management of surface water runoff has also been included to accommodate the diversion of the culvert until the permanent solutions are incorporated, All discharges would be controlled via the use of suitable settlement tanks and interceptors to control the quality of water entering the culvert, any discharge form construction activities such as dewatering would obtain the necessary environmental permits to allow discharge to the water course.
- 8.47 The CoCP will introduce safe methods of working to prevent trafficking over the culvert, loading adjacent to or near the culvert and only allow permitted excavations in the vicinity of the culvert that have been assessed not to impact on the structural integrity of the culvert, this should ensure the stability of the culvert and prevent any collapse.
- 8.48 The CoCP will also set out pollution prevention measures that are to be used during the construction phase to prevent contamination reaching the culvert, these will be in accordance with best practice and the guidance still available on the governments website.

Assessment of Construction Effects

Effects on flood risk to construction works

- 8.49 The site is located in a flood risk zone 2 with a probability of between 1.0% to 0.1% risk of flooding. Construction activities such as stockpiling of material could reduce the flood storage volumes on site and increase the severity of flooding in the area. Construction workers could be at risk of flooding should there be an extreme event during the construction phase.
- 8.50 The site at present is entirely impermeable and as a result, the volumetric surface water runoff is not expected to increase as a consequence of any construction activities. The surface water culvert running through the site which collects runoff from the site will also be diverted. Failure to maintain drainage connection to the culvert during this phase could result in surface water flooding on site
- 8.51 Therefore, with the implementation of the CoCP and in light of the nature of the potential fluvial flood risk the and the risk of surface water flooding the magnitude of effect is considered to be low. The sensitivity of Construction Workers to the risk of flooding is considered medium. This is due to

their presence on site only during working hours, their awareness and training. Therefore, there is likely to be a direct, temporary, medium-term effect on construction workers of minor adverse significance. This is not considered to be significant in terms of the EIA Regulations.

Effects of flood risk to residents / users in the surrounding area

- 8.52 An increase in severity of fluvial flooding to the surrounding area could be caused by the loss of floodplain storage resulting from construction activities. Failure to manage surface water runoff during this phase could also result in localised surface water flooding. However, the effect off site reduces with distance from the site, only residential properties to the north of the site are likely to be impacted and the magnitude of effect is therefore considered to be negligible.
- 8.53 The sensitivity of residents and occupants of the surrounding area to flooding is considered to be high to very high. Therefore, their sensitivity to flood risk at the demolition and construction stage is very high.
- 8.54 The sensitivity of residents/users of the surrounding area is very high and the magnitude of impact with the CoCP is negligible. Therefore, there is likely to be a direct, temporary, medium-term effect on residents and occupants of minor adverse significance. This is not considered to be significant in terms of the EIA Regulations.

Surface water runoff

- 8.55 Runoff from the impermeable surfaces on site currently discharge to an existing culvert (ordinary water course). The ordinary water course is culverted and runs through the site it is to be diverted to the north of the site, the diversion is one of the first activities following demolition of the existing building. The majority of the diverted culvert will be constructed off-line and the existing retained until the new culvert is connected. The connection of the new culvert to the existing infrastructure could affect the flow in the culvert, with the over pumping of water in the culvert during connection of old to new the flow of surface water can be maintained. Failure to maintain the flow in the culvert could result in flooding.
- 8.56 Construction activities may change the nature of the impermeable areas, to prevent surface water flooding on site runoff will be managed on site in line with the CoCP and discharged to the culvert. When the culvert is diverted the existing connections from the site are to be extended or diverted to maintain the discharge to the culvert during this stage.
- 8.57 Demolition and construction activities have the potential to contaminate surface water run-off which could subsequently enter the river network 'River Thames', all construction activities will be comply with the CoCP. There is also the potential of contamination entering the water course and ultimately the River Thames during the connection of the new culvert to the existing, all construction activities would be undertaken in accordance with best practice to the CoCP.
- 8.58 There will be no surface water connections from the site to the public drainage network, therefore there is no impact on these networks.
- 8.59 The sensitivity of the Site, Ordinary Water Course / River Thames to flooding is considered to be low and the magnitude of impact is negligible Therefore, there is likely to be a direct, temporary,

medium-term effect of negligible adverse significance. This is not considered to be significant in terms of the EIA Regulations.

Groundwater

- 8.60 There is a potential to impact upon the groundwater during foundation and piling works. From the site investigations carried out, slow flowing groundwater is present approximately 2m below ground level within the Terrace Sands and Gravels, this and the impact on the quality of groundwater is assessed in Chapter 7: Geology, Hydrogeology and Ground Conditions.

Water quality

- 8.61 During this stage the surface water drainage regime will be maintained, the baseline site is developed and entirely impermeable the activities are not expected to significantly modify this in terms of volumetric and/or rate of discharge. Construction works would result in impermeable areas being exposed. During a rainfall event, sediment and other pollutants could be washed into the culvert on site which would temporarily impact on the water quality reaching the River Thames.
- 8.62 Construction activities will be completed in accordance with the CoCP. The sensitivity of the culverted watercourse is considered to be medium and the magnitude is low, therefore, there is likely to be a direct, temporary, medium-term effect of minor adverse significance. This is not considered to be significant in terms of the EIA Regulations.

Further Mitigation and Monitoring

- 8.63 With the mitigation measures adopted as part of the design of the Proposed Development it has been assessed that there would be no significant effects in relation to flood risk or water quality. Therefore, no further mitigation is required during construction and the residual effect on hydrology and flood risk would be as stated above. Monitoring of the water quality entering the River Thames should be monitored at regular intervals during the construction phase.

Accidents and/or Disasters

- 8.64 Construction activities that would occur over or in the vicinity of the culvert could result in its collapse causing flooding of the area. Construction activities in the area of the culvert will be managed to prevent damage to culvert.
- 8.65 A major oil or fuel spillage on site could result in pollution of ground and surface water. The measures outlined in the CoCP and subsequent CEMP and implementation of safe methods of working, for example ensuring any fuel deliveries are in an area where and spills can be easily contained before they are able to reach the ground or surface water networks.

Assessment of Operational Effects

Effects of fluvial flood risk to site occupants

- 8.66 The site has been shown to be in flood zone 2 with a probability of flooding of less than 1.0%, allowances for climate change have been considered in this assessment and the site could be subject to flooding as a result of climate change.

- 8.67 Flood compensation has been provided across the site on a level for level basis to ensure flood risk is not increased and there will be no loss of flood storage volumes compared to the current situation. The overall flood storage on site as a result of the development results in a slight increase over that currently available.
- 8.68 The development results in a net reduction in impermeable area across the site and SuDS techniques will be used within the development that will reduce the volume and discharge rate of runoff generated by the development, reducing the overall flood risk in the area.
- 8.69 A FMEP will be issued to residents to make them aware of the flood risks in the area and how to sign up to flooding warning system offered by the EA along with a procedure to follow in the event of a flood. A dry access above the 1.0% flood probability level is provided across the entire development in accordance with the recommendations in RBC level 2 SFRA in case of evacuation of the site during a flood event. A safe access can be provided from the buildings for flood events with a probability of 1.0% plus allowance for climate change should residents need to evacuate the site, or should emergency services need to access the development.
- 8.70 The sensitivity of Site occupants to the risk of flooding has been considered very high as there are residential properties on site providing sleeping accommodation. The sensitivity of other users of the development e.g. office works etc. are considered medium as they would be managed through office management operations.
- 8.71 The site would only be affected by an event in excess of the current 1.0% probability flood event. The mitigation measures outlined above; providing greater compensation for flood storage, SuDS to reduce the runoff impacts from the development, safe access to and from the site and raising floor levels, would reduce the overall flood risk in the area and ensure the site is safe for all events up to and including the 1.0% event with climate change allowances included. Therefore, the magnitude of impact in terms of flooding is considered to be negligible.
- 8.72 The sensitivity of occupants is very high and the magnitude of impact is negligible, therefore, there is likely to be a direct, permanent, long-term effect on site occupants of minor adverse significance. This is not considered to be significant in terms of the EIA Regulations.

Effects of fluvial flood risk to residents / users in the surrounding area

- 8.73 The proposed development would not affect the probability of flooding elsewhere. The proposals will increase the flood storage volumes on site when compared to the current situation and the proposed drainage strategy has incorporated SuDS techniques which will reduce the volume and rate of discharge of runoff from the site. The proposed development would provide a slight benefit to flood risk in the area although this is likely to be of negligible magnitude.
- 8.74 The sensitivity of residents and occupants of the surrounding area is very high and the magnitude of impact is negligible. Therefore, there is likely to be a direct, permanent, long-term effect on residents of the surrounding area of a minor beneficial significance. This is not considered to be significant in terms of the EIA Regulations.

Surface water runoff flood risk

- 8.75 The surface water from the Proposed Development would be collected and discharged into the diverted culvert which currently routes through the centre of the Site. The Proposed Development would reduce the area of impermeable surfaces compared to that currently on site and there is currently no attenuation of runoff on site. The proposed drainage strategy uses green roofs and rainwater harvesting, and all flows discharging from within the red line boundary would be attenuated on site to allow the discharge rate to be restricted back to greenfield rates.
- 8.76 The proposed development would result in a 10-fold reduction in the rate of discharge from the site. Which will substantially reduce the risk of surface water flooding to residents on site and in the surrounding area. The sensitivity of the impact on residents from surface water flooding is considered medium and the magnitude of impact is low. Therefore, there is likely to be a direct, permanent, long-term effect on surface water runoff of minor beneficial significance. This is not considered to be significant in terms of the EIA Regulations.

Water quality

- 8.77 The site currently discharges to the culverted ordinary water course running through site. The proposed development would continue to discharge runoff to the water course albeit in a diverted location. The SuDS drainage proposed would provide attenuation and reduction to the volume and rate of discharge. The SuDS features and physical measures such as silt traps & petrol interceptors would provide a level of treatment to runoff from the development ensuring the quality of surface water entering the water course would not have any negative impact on the water quality or river network.
- 8.78 The sensitivity of the receiving water courses is assessed as medium and the magnitude of impact is low. Therefore, there is likely to be a direct, permanent, long-term effect on water quality of minor beneficial significance. This is not considered to be significant in terms of the EIA Regulations.

Further Mitigation and Monitoring

- 8.79 With the mitigation measures adopted as part of the design of the Proposed Development it has been assessed that there would be no significant effects in relation to flood risk or water quality. Therefore, no further mitigation is required post construction and the residual effect on hydrology and flood risk would be as stated above.
- 8.80 Monitoring of the FMEP should be undertaken regularly and updated with latest flood information should, which should include EA flood modelling, flood warning notification and impacts of climate changes.
- 8.81 The drainage network, SuDS features and culvert will require regular inspection and monitoring to ensure the system is functioning adequately, a maintenance schedule of items to be inspected is included in the drainage strategy in Appendix 8.2.

Accidents/Disasters

- 8.82 A major flood in the area that exceeds the 1.0% probability + climate change allowance event could result in wide spread flooding in the area and the development.
- 8.83 A build up of debris or blockage of the culverted water course could lead to localised flooding.

Potential Changes to the Assessment as a Result of Climate Change

- 8.84 The assessment of the development has considered the potential impacts resulting from climate change. The residual risk based on climate change allowances recommended by the EA have been considered in this assessment. While climate change and its causes have been known about for some time, there is still uncertainty over the extent of the impact it will have.
- 8.85 Given the uncertainty in predicting climate change impacts, the EA estimate that there is a 70% chance that the actual impact of climate change will be less than the allowance assumed when the residual risk was considered.
- 8.86 In the event that the climate change is not addressed, or the impact is greater than the allowances assumed this could result in deeper flooding across the development. A FMEP would be prepared for the development which would be a live document and would be updated as further information becomes available. This FMEP would be updated to include additional mitigation measures should the impact of climate change exceed that assessed as part of the FRA.

Assessment of Cumulative Effects

- 8.87 Within the surrounding area of the site there are other developments at varying stages of the planning process. These are set out in detail in Chapter 4: Environmental Assessment Methodology and Appendix 4.6 of this ES. The principles set out in NPPF and PPG will normally result in reduced discharge rates from each site and more or equal level of flood storage, this is true for all developments identified.
- 8.88 The net impact of the other developments that have been consented would result in a reduction in surface water runoff that is likely to reach the drainage networks and water courses. In addition, there would be no net loss of flood storage volumes therefore there would be no change and possibly a minor beneficial impact if all developments would be constructed.
- 8.89 Developments allocated but not yet approved are likely to be developed in line with current policy which will ensure that there is a reduction in the rate of discharge from each site and that flood storage volumes are maintained or increased.
- 8.90 Similarly, the policy requirements for allocated developments include measures that maintain or improve the water quality post development and include measures during the construction phase to mitigate potential contamination, the cumulative effect of all developments would result in no change or a negligible beneficial impact.

Inter-relationships

- 8.91 This chapter should be read in conjunction with the other chapters relating to the proposed works that result in any building works temporary or permanent that would result in loss of flood storage volumes, or excavations that would impact the groundwater or culverted surface water course within the site.
- 8.92 Further information on groundwater receptors in the area of the site is presented in Chapter 7 – Geology, Hydrogeology and Ground Conditions. Climate change data which on rainfall increases is set out in Appendix 4.5 – Climate Change Data.

Summary of Effects

- 8.93 The Site is located in a Flood zone 2 area, considered to have a 1.0%-0.1% risk of flooding from fluvial and tidal sources, there are no adopted sewers on sit but there is a culvert water course running through it, flooding from fluvial, surface water, ground water and sewers have therefore been assessed.
- 8.94 During the construction phase with regards to the fluvial flood risk to construction works and others in the local area the effects were assessed as minor adverse, in relation to flood risk from surface water a negligible adverse effect was assessed. The effects on water quality during this phase was also assessed to be minor adverse. Primary mitigation as part of the design and best practices as provided in the CoCP have been specified and used to inform the assessment of effect in this ES chapter.
- 8.95 During the operational phase of the development all effects were assessed as at least minor (adverse or beneficial). Fluvial flood risk will be managed by maintaining/increasing storage volumes across the site and providing safe access routes from all buildings, the effect on occupiers is therefore assessed as low adverse. The effect of maintaining/increase storage volumes on site is assessed as a negligible benefit for surrounding users. Surface water runoff from the development will be manage on site and attenuated, reducing the risk of flooding from runoff the effect of these measures on the site and occupiers is considered minor beneficial. The effect of applying SuDS techniques in the development to treat runoff is also assessed as minor beneficial.
- 8.96 A summary of the likely significance of effects of the Proposed Development on Water Resources, Flood Risk and Drainage is provided in Table 8.4.

Table 8.4: Summary of Likely Environmental Effects on Hydrology and Flood Risk

Receptor	Sensitivity of receptor	Description of impact	Short / medium / long term	Magnitude of impact	Significance of effect	Significant / Not significant	Notes
Construction phase							
Construction workers	Medium	Impact of fluvial flooding on workers	Medium term	Low	Minor adverse	Not significant	
Users / residents in the area	Very high	Impact of fluvial flooding on residents in local area	Medium term	Negligible	Minor adverse	Not significant	
Site and river network	Low	Surface water flood risk to site.	Medium term	Negligible	Negligible adverse	Not significant	
Water Quality	Medium	Pollution	Medium term	Low	Minor adverse	Not significant	
Operational phase							
Occupiers	Very high	Impact of fluvial flooding on residents	Long term	Negligible	Low adverse	Not significant	
Users / residents in the area	Very high	Impact of fluvial flooding on residents in local area	Long term	Negligible	Negligible beneficial	Not significant	
Site and residents	Medium	Surface water flood risk to residents	Long term	Low	Minor beneficial	Not significant	
Water Quality	Medium	Pollution	Long term	Low	Minor beneficial	Not significant	

References

- Ref 8.1 Jacobs. (2009), Reading Borough Council Strategic Flood Risk Assessment. Reading: Reading Borough Council.
- Ref 8.2 Reading Borough Council, (2015). Reading Borough Local Development Framework Core Strategy. Reading: Reading Borough Council.
- Ref 8.3 Thames Water, (2019). Asset Location Search. Reading: Thames Water.
- Ref 8.4 British Geological Survey, (2018). Geology of Britain [viewed 12 October 2018]. <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>.
- Ref 8.5 Natural England, (2015). Magic interactive mapping [viewed 18 October 2018]. <https://magic.defra.gov.uk/MagicMap.aspx>.
- Ref 8.6 Ministry of Housing, Communities and Local Government. (2018). National Planning Policy Framework. Manchester: APS Group on behalf of the Controller of Her Majesty's Stationery Office.
- Ref 8.7 Ministry of Housing, Communities and Local Government. (2016), Planning Practice Guidance. [viewed 16 November 2018]. <https://www.gov.uk/government/collections/planning-practice-guidance>.
- Ref 8.8 Environment Agency, (2018), Long term flood risk assessment for locations in England. [viewed 10 November 2018]. <https://flood-warning-information.service.gov.uk/long-term-flood-risk>.
- Ref 8.9 Environment Agency, (2015). Product 4 (Detailed Flood Risk) for Royal Mail, Caversham Road, Reading. Oxon: Environment Agency.
- Ref 8.10 Point Surveyors, (2017). ROL Footprint Survey. London: Point Surveyors.
- Ref 8.11 Edenvale Young, (2011). Royal Mail Group River Thames Reading Flooding Modelling Report. Bristol: Edenvale Young.
- Ref 8.12 Arup, (2010). RMG Reading Flood Risk Assessment, London: Ove Arup & Partners Ltd
- Ref 8.13 Waterman Transport and Development Ltd, (2010). Reading RMG Caversham Road Drainage Management Plan. London: Waterman Transport and Development Ltd.
- Ref 8.14 Waterman Transport and Development Ltd, (2010). Reading RMG Assessment of floodplain storage. London: Waterman Transport and Development Ltd.
- Ref 8.15 Tony Bedford Drilling Services, (2010). Site Investigation. Peterborough: Tony Bedford Drilling Services.
- Ref 8.16 The Highways Agency, (2008). Design Manual for Roads and Bridges, Vol 11 Section 2 Part 5 HA205/08 Assessment and management of environmental effects. London: Department of Transport.

- Ref 8.17 Department of Transport, (2015). TAG Unit A3 Environmental Impact Appraisal.
London: Department of Transport.