M25 junction 28 improvement scheme TR010029
6.1 Environmental Statement
Chapter 8: Road drainage and the water environment

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6.1 ENVIRONMENTAL ASSESSMENT
CHAPTER 8: ROAD DRAINAGE AND THE WATER ENVIRONMENT

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Author:	M25 junction 28 improvement scheme project team, Highways England

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2	October 2020	DCO application – updated paragraph numbers
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Executive summary

The likely significant environmental effects with respect to the water environment resulting from the construction and operation of the Scheme have been assessed. The assessment has considered impacts on water quality (both surface and groundwater), flood risk and compliance with the Water Framework Directive (WFD).

A water quality assessment identified potential impacts to the surface water and groundwater during the construction and operation of the Scheme. However, subject to the implementation of all mitigation measures, the overall effect on surface water quality is neutral which is not considered significant. The overall effect to groundwater quality during the construction and operation of the Scheme was also assessed as neutral (subject to the implementation of all mitigation measures) which is not considered significant.

A Flood risk assessment (FRA) (application document TR010029/APP/6.6) considered the impact of fluvial, surface and groundwater flooding. It concluded that during the construction and operation of the Scheme, subject to the correct implementation of all mitigation measures, the overall effect on flood risk is neutral which is not considered significant.

A WFD compliance assessment (application document TR010029/APP/6.7) considered the impact of the construction and operation of the Scheme. It concluded none of the construction components of the Scheme are considered to cause deterioration at water body scale or prevent future attainment of good ecological status or ecological potential assuming mitigation already embedded in the preliminary design is implemented, any additional specific mitigation is implemented and generic guidance on the principles of WFD compliant design is adhered to.

8. Road drainage and the water environment

8.1 Introduction

8.1.1 This chapter has been prepared to identify the likely significant effects with respect to the water environment resulting from the construction and operation of the Scheme. The assessment covers:

- Water quality, both surface and groundwater
- Flood risk, both surface and groundwater
- Water Framework Directive (WFD) compliance

8.1.2 This chapter is supported by the following technical appendices:

- Flood Risk Assessment (FRA) (application document TR010029/APP/6.6)
- Water Framework Directive (WFD) compliance assessment (application document TR010029/APP/6.7)
- Drainage strategy (application document TR010029/APP/6.8)
- HAWRAT outputs (Appendix 8.1, application document TR010029/APP/6.3)

8.1.3 The spatial scope of the assessment has included features of the water environment within 1 km of the Scheme.

8.1.4 The assessment methodology followed is in accordance with the guidance provided in the Design Manual for Roads and Bridges (Highways Agency, November 2009)[1], herein referred to as HD 45/09.

8.1.5 This chapter does not cover hydrological impacts associated with the disturbance of contaminated land or the movement of groundwater flow. Potential impacts to groundwater resources and groundwater quality associated within these aspects have been considered in the Geology and Soils chapter (Chapter 10).

8.2 Competent expert evidence

8.2.1 This road drainage and the water environment chapter has been undertaken by the following individuals who have used their knowledge and professional judgement to undertake this assessment:

- A qualified Senior Environmental Scientist (BSc, MSc, AIEMA, CWEM, MCIWEM, CSci, CEnv) with over 10 years of knowledge and experience in road drainage and the water environment and holds professional membership with the Chartered Institution of Water and Environmental Management (CIWEM) and the Institute of Environmental Management and Assessment (IEMA).
- A qualified Principal Scientist (CWEM, MCIWEM) with over twenty years' experience in the water industry who is the author of the FRA.

[1] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment

- A qualified Hydrologist and Geomorphologist (BA, MSc, MPhil) with over 10 years of knowledge and experience in road drainage and the water environment who holds professional membership with the CIWEM and the Royal Geographical Society (FRGS, CGeog (geomorph)). This professional is the author of the WFD compliance assessment which is referred to in this chapter.
- A qualified Principal Consultant (BSc, MSc, CWEM, CSci, CEnv) with over 20 years of knowledge and experience in road drainage and the water environment and holds professional membership with CIWEM is the overall reviewer of the water related assessments.

8.3 Legislative and policy framework

8.3.1 Legislation and policy related to protection and management of the water environment is listed in Table 8.1. The aim of water legislation and policy in England is to protect both public health and the environment by maintaining and improving the quality of water features. This includes all surface water bodies (e.g. rivers, streams, canals, lakes, ponds) and groundwater.

8.3.2 The Department of the Environment, Food and Rural Affairs (Defra) is responsible for all aspects of water policy in England. Management and enforcement of water policy is the responsibility of Regulators, principally the Environment Agency (EA), but also Lead Local Flood Authorities (LLFAs).

Table 8.1: Legislation, regulatory and policy framework

Legislation / regulation	Summary of requirements
European	
Water Framework Directive (2000/60/EC)	The WFD aims to protect and enhance the quality of the water environment. The WFD requires all natural surface water bodies to achieve both good chemical status and good ecological status. Artificial and Heavily Modified Water Bodies may be prevented from reaching good ecological status due to the modifications necessary to maintain their function, e.g. navigation. They are, however, required to achieve good ecological potential, through the implementation of a series of mitigation measures. The WFD also requires good status (both qualitative and quantitative) to be achieved for all groundwater bodies and the prevention of the deterioration in groundwater status. In addition, it requires the achievement of objectives and standards for protected areas; and the reversal of significant and sustained upward trends in pollutant concentrations in groundwater. Status is reported at the water body scale, with individual water bodies forming part of larger River Basin Districts (RBD), for which River Basin Management Plans (RBMPs) have been developed. The first RBMPs were published in 2009 followed by a Cycle 2 update published in 2016.

Legislation / regulation	Summary of requirements
Environmental Quality Standards Directive (2008/105/EC), amended by Directive 2013/39/EU	Lists Environmental Quality Standards (EQS) for priority substances and certain other pollutants as provided for in Article 16 of the WFD, with the aim of achieving good surface water chemical status. It includes certain substances that may be associated with runoff from highways.
Groundwater Directive (2006/118/EC)	Complements the WFD. It requires measures to prevent or limit inputs of pollutants into groundwater to be operational so that WFD environmental objectives can be achieved.
Habitats Directive (92/43/EEC)	To promote the maintenance of biodiversity by taking measures to maintain or restore natural habitats and wild species at a favourable conservation status, introducing robust protection for those habitats and species of European importance. Sites or species that come under this Directive will heighten the importance of water features that sustain them.
Floods Directive (2007/60/EC)	The aim is of this Directive is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. It sets the strategic level for flood risk that any development will need to comply with.
National	
Antipollution Works Regulations 1999	Where pollution occurs or is likely to occur the EA can serve a works notice under Section 161A of the Water Resources Act on any person who has caused or knowingly permitted the pollution (or risk of pollution) to a watercourse, requiring them to carry out anti-pollution/preventative works and operations. The EA can also recover the costs of any investigation and anti-pollution works carried out. The Anti-Pollution Works Regulations prescribe the content of anti-pollution works notices and the particulars that need to be placed on the pollution control registers maintained by the EA.
Environment Act 1995	The Act provides for the establishment of a corporate body to be known as the EA, the key regulator for the water environment.
Environmental Damage (Prevention and Remediation) Regulations 2015	The emphasis of these Regulations is proactively putting in place appropriate pollution prevention measures to reduce risks to the environment.
Environmental Protection Act 1990	This Act brings in a system of integrated pollution control for the disposal of wastes to land, water and air.
Flood Risk Regulations 2009 Amended 2009/3042	These Regulations transpose the Floods Directive (2007/60/EC). They aim to provide a consistent approach to managing flood risk. The EA are responsible for managing flood risk from main rivers, the sea and reservoirs. LLFAs are responsible for local sources of flood risk, in particular surface water, groundwater and ordinary watercourses.
Flood and Water Management Act 2010 and Commencement Orders	The key areas covered by this Act are: • Roles and responsibilities for flood and coastal erosion risk management • Improving reservoir safety.

Legislation / regulation	Summary of requirements
Highways Act 1980 (HA 1980)	The Act deals with the management and operation of the road network in England and Wales including the drainage of highways into environmental waters and sewers.
National Planning Policy Framework (NPPF) (Department for Communities and Local Government (DCLG), 2019)	The NPPF sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow. It forms the basis of assessment of flood risk for Schemes.
National Planning Practice Guidance (NPPG) 2018	Accompanying the NPPF, the NPPG (DCLG, 2018) was published in 2014 and updated in 2018. This advises on how Local Planning Authorities can ensure protection of water quality, the delivery of adequate water infrastructure and take account of the risks associated with flooding in the plan–making and the planning application process.
The Environmental Permitting (England and Wales) Regulations 2016	These Regulations provide a consolidated system of environmental permitting in England and Wales and transpose provisions of fifteen EU Directives which impose obligations requiring delivery through permits or which are capable of being delivered through permits. Covers EA permits for flood risk (on Main River) and certain discharges to watercourses.
The Water Resources (Environmental Impact Assessment) (England and Wales) Regulations 2006	These Regulations impose procedural requirements in relation to the consideration of applications or proposals for an abstraction or impounding licence under Chapter II of Part II of the Water Resources Act 1991 and require consent in other cases.
Water Act 2003 and Water Act 2014	These Acts aim to improve water conservation, protect public health and the environment, and improve the service offered to consumers. The basis of the Act is three parts relating to water resources, regulation of the water industry and other provisions.
WFD (Standards and Classification) Directions (England and Wales) 2015	These Directions set out the environmental standards to be used for the second cycle of river basin plans. They transpose Directive 2013/39/EU on environmental quality standards for priority substances. They also cover Specific Pollutants which include certain metals that are associated with road are associated with road drainage.
Water Industry Act 1991 (Amendment) (England and Wales) Regulations 2009	This Act sets out the responsibilities of the EA of England and Wales in relation to water pollution, resource management, flood defence, fisheries, and in some areas, navigation. The Act regulates discharges to controlled waters, namely rivers, estuaries, coastal waters, lakes and groundwaters.
Water Resources Act 1991	This Act sets out to regulate water resources, water quality and pollution, and flood defence. It sets out standards for Controlled Waters.
Water Environment (Water Framework Directive) (England and Wales) Regulations 2017	These Regulations outline the duties of regulators (EA in England) in relation to environmental permitting, abstraction and impoundment of water.

Legislation / regulation	Summary of requirements
The Land Drainage Act 1991 and 1994	This Act requires that a watercourse be maintained by its owner in such a condition that the free flow of water is not impeded. The 1994 Act amends it in relation to the functions of internal drainage boards and local authorities.
The Control of Pollution (Oil Storage) (England) Regulations 2001	Applicable for storage of more than 200 litres of oil above ground at industrial, commercial or institutional sites. The sites they cover include; factories, shops, offices, hotels, schools, churches, public sector buildings and hospitals. The Regulations apply only in England.
Regional	
Thames River Basin Management Plan (RBMP)	This RBMP is designed to protect and improve the quality of the water environment. It includes consideration of the following topics: • Plans for the protection and improvement of the water environment • Future plans that may affect the infrastructure sector and its obligations • Development proposal considerations regarding the requirements of the plan • Environmental permit applications.
Local	
Essex County Council Sustainable Drainage Systems (SuDS) Design Guide (April 2016)	This provides guidance on the County Council's requirements for the design of sustainable drainage systems.

National Policy Statement for National Networks (NPS NN)

8.3.3 Guidance and policy is set out in detail in paragraphs 5.219 to 5.231 of the NPS NN for water quality and resources and in paragraphs 5.90 to 5.115 for flood risk. The objectives include reference to the WFD and that new and existing development should be prevented from contributing to, or being put at unacceptable risk from, or being adversely affected by, water pollution. Existing status of water quality, water resources and physical characteristics in the water environment must be ascertained and that the impacts of the proposed project, including those associated with any cumulative effects, are assessed as part of the Environmental Statement. Careful design to facilitate adherence to good pollution control practice can reduce the risk of impacts on the water environment. For flood risk the National Planning Policy Framework (NPPF) is outlined with reference to the tests to be applied, decision making and potential mitigation required**.**

8.4 Study area

8.4.1 The spatial scope of the assessment includes features of the water environment within 1 km of the Scheme, as shown in Figure 8.1. In accordance with HD 45/09[2] a 1 km study area is considered appropriate for the assessment of surface water quality soluble pollutants as beyond this dilution would be

[2] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment

expected to occur and therefore reduce potential impacts. This has been used throughout the water environment assessment. For groundwater, the potential zone of impact assessed included the extent of the underlying WFD groundwater body.

8.4.2 For flood risk, a scheme has the potential to cause impacts beyond a 1 km boundary, however with appropriate mitigation, these impacts can be effectively minimised. The study area for flood risk (in particular fluvial flood risk) has been determined by the extent of potential impacts and locations where the flow characteristics at the Scheme location are not impacted by the flow characteristics at the boundaries.

8.4.3 This study area has been consistent throughout the EIA process and shared with stakeholders, including the EA. During this process the extent of the study area has not been questioned and as such it is assumed to be appropriate to capture and report on any potential impacts to the water environment.

8.5 Assessment methodology

8.5.1 The water environment assessment includes consideration of water quality (both surface and groundwater), the WFD and flood risk.

Water quality

8.5.2 HD 45/09[3] provides guidance on the assessment of likely significance of effects on the water environment associated with highway schemes. This assessment methodology follows this guidance and criteria. The significance of potential effects on the water environment has been determined by assessing the importance of the water receptors and magnitude of the impact of the Scheme (including mitigation measures).

Groundwater

8.5.3 Given the Scheme will not directly discharge to groundwater no detailed assessment for the impact on groundwater has been undertaken in the context of road drainage. Further, no WFD groundwater bodies have been identified within the study area, thus the WFD methodology is purely focused on the surface water environment. The Soils and Geology chapter (Chapter 10) provides the detail for the methodology adopted to assess the risk to groundwater from the presence of contaminated land and soils on groundwater (including any contamination made from the drainage network) and thus it will not be repeated here.

Flood risk

8.5.4 In addition to the guidance and criteria provided in HD 45/09, a FRA has been carried out in accordance with the requirements of the National Planning Practice Guidance (NPPF) (DCLG, 2019) and the EA's Flood risk assessments: climate change allowances (EA, 2016)[3]. The FRA is also in line with HD 45/09 (HA, 2009).

[3] Flood risk assessments: climate change allowances (EA) has since been updated in December 2019. The factors for fluvial climate change allowances have not changed in this update.

Water Framework Directive

8.5.5 A WFD compliance assessment has been undertaken by following the Planning Inspectorate's guidance on the preparation of WFD assessments for a Nationally Significant Infrastructure Project[4]. It has been based on a format that was originally developed in close consultation with the EA for a large transport infrastructure scheme[5]. This format has been subsequently promoted by the EA as an example of best practice, particularly for large schemes that affect many water bodies. It captures the core requirements of a compliance assessment whilst being transparent and simple to interpret.

8.5.6 The WFD compliance assessment is a standalone report (application document TR010029/APP/6.7) which considers the impacts of the Scheme at water body scale. For surface water bodies the WFD Compliance Assessment considers the potential impact of the Scheme on ecological components and chemical components. Ecological components include biological quality elements; physico-chemical elements; hydromorphology supporting elements; and specific pollutants. Chemical components include priority and priority hazardous substances. Groundwater is screened out of the WFD assessment because there are no WFD groundwater water bodies underlying the Scheme.

8.5.7 To determine whether water body components are affected by the Scheme, data has been drawn from the Biodiversity chapter (Chapter 7) as well as the Geology and Soils chapter (Chapter 10). Chapter 7 provides data specifically relating to biological quality elements of a surface water body and Chapter 10 provides data specifically relating to the quantitative and chemical quality of groundwater. The HD 45/09[6] assessment methods have also been incorporated in the WFD compliance assessment specifically those used to determine risks of deterioration to water quality (i.e. from specific pollutants, priority and priority hazardous substances).

Data collection

8.5.8 Following the identification of the defined study area of 1 km, the following activities were undertaken as part of the baseline assessment for the study area:

- Identification of surface water bodies: rivers, ditches, lakes
- Identification of groundwater bodies
- Identification of licenced water abstractions and discharges (both surface and groundwater)
- Identification of current and historic flood risk
- Collation of water body characteristics and WFD classification
- Identification of international / nationally designated conservation sites with citations related to the water environment

[4] The Planning Inspectorate (2017) Advice Note 18, The Water Framework Directive
[5] HS2, 2016. Water Framework Directive Compliance Assessment Update (C453) Supplementary Information. London: HS2. C454-ATK-EV-REP-000-000001
[6] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment

- Identification of Scheme design elements relevant to the water environment assessment such as (but not limited to) outfalls, soakaways, piling and gantries

8.5.9 Baseline conditions have been determined through desk studies and field surveys. The desk study included a review of the following information:

- British Geological Survey's Geology of Britain Viewer[7]
- EA flood maps
- Data published under the Open Government Licence[8]
- EA What's in your backyard[9] and Data Catchment Explorer[10]
- Environmental datasets held on Defra's MAGIC website[11]
- Envirocheck Report specifically purchased for this Scheme
- Field surveys

8.5.10 Field surveys comprised:

- River corridor survey carried out on the Ingrebourne River and Weald Brook by ecologists on 2 October 2017 and reported in Appendix C of the WFD compliance assessment (application document TR010029/APP/6.7).
- Ecological and geomorphological walkover surveys carried on the Ingrebourne River and Weald Brook on 15 February 2019 and 23 May 2019 - reported in Appendix D of the WFD compliance assessment (application document TR010029/APP/6.7).
- Electric fishing and aquatic macroinvertebrate surveys undertaken in September 2017. Full details can be found in the Biodiversity chapter (Chapter 7) of the ES.

Consultation

8.5.11 There has been ongoing stakeholder consultation through meetings and site visits with key stakeholders.

8.5.12 This consultation included teleconference meetings with the EA on 13 March 2017, 12 August 2019, 24 September 2019, 22 October 2019, 6 December 2019, 17 December 2019, 12 February 2020 and 27 February 2020 as well as face to face meetings on 30 October 2017, 6 November 2018 and 16 April 2019. A site meeting was also carried out with the EA on 23 May 2019.

8.5.13 Key issues raised by the EA included the effect of the proposed extension of Grove culvert on riverine / riparian habitat and biological continuity; the effect of the proposed Grove, Maylands and Duck Wood bridge crossings on flood conveyance, river continuity and river / riparian zone habitat; the potential effects of road runoff on the natural drainage network and the potential risk that construction of Balancing Pond 1 opens flow routes for contaminants between Brook Street Landfill and the Ingrebourne River / Weald Brook.

[7] http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[8] http://environment.data.gov.uk/ds/catalogue/#/catalogue
[9] http://apps.environment-agency.gov.uk/wiyby/default.aspx
[10] http://environment.data.gov.uk/catchment-planning/
[11] https://magic.defra.gov.uk/

8.5.14 The key issue raised by Essex County Council as the Lead Local Flood Authority for part of the Scheme area, in their response to the Scoping Opinion included the assessment of surface water, relating to flood risk, drainage and water quality.

Prediction and evaluation of effects

Water quality

8.5.15 The prediction and evaluation of the effects of the Scheme follows the requirements and detailed assessment method set out in HD 45/09[12] and as such are not fully reproduced here. The assessment Methods undertaken included Method A, a simple assessment of the dilution of routine runoff and pollutants using the Highways Agency Water Risk Assessment Tool (HAWRAT)) and Method D, a spillage risk assessment. For Method A, the thresholds are Environmental Quality Standards (EQS) for dissolved copper and zinc which must not be exceeded. It should be noted that the standards set out in HD 45/09 are legacy standards and have since been replaced by bio-availability standards. However, the standards stated in HD 45/09 are still appropriate and relevant as they provide an indication of the likelihood of potential impacts. Run-off Specific Thresholds (RSTs) also provide an assessment of short-term impact of the Scheme for soluble copper and zinc

8.5.16 Method B, a detailed assessment using the Biotic Ligand Model (BLM) and Method C, a groundwater assessment, were not undertaken as no long-term risks were identified in Method A and no discharge to groundwater is proposed respectively.

Flood risk

8.5.17 The assessment methodology for flood risk broadly follows HD 45/09[12] Method E – Hydrological Analysis of Design Floods and Method F – Hydraulic Assessment. The assessment methodology deviates from HD 45/09 where updates in policy and industry standard procedures for flood risk hydrological and hydraulic analysis have changed. The latest EA guidance on flood modelling has been followed as appropriate for the analysis undertaken.

Water Framework Directive

8.5.18 A colour coding “Red, Amber, Green” (RAG) system was used for the assessment. Definitions for the colour coding were assigned to indicate the level of risk of objective non-compliance within each waterbody, accounted for mitigation assumed to be ‘embedded’ into later phases of the design. Further details of the methodology are provided in the WFD compliance assessment (TR010029/APP/6.7).

[12] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment

Assessment criteria

Water quality, flood risk and Water Framework Directive

8.5.19 HD 45/09[13] methodology starts with identification of the importance of the environmental attributes within the Scheme study area. The magnitude of impact of the Scheme on the attribute is then determined using calculations and tests from the HD 45/09[14], taking into consideration the influence of mitigation measures. The combination of the importance of an attribute and the magnitude of impact on that attribute gives a significance of potential effect.

8.5.20 The assessment criteria used follows those set out in HD 45/09 and is shown in Tables 8.2 to Table 8.4. Examples for evaluating the importance of water attributes are shown in Table 8.2. Examples for assessing the magnitude of impacts are shown in Table 8.3. A matrix for determining significance of effects is shown in Table 8.4.

Table 8.2: Estimating the importance of water environment attributes

Importance	Criteria	Typical Examples
Very High	Attribute has a high quality and rarity on regional or national scale	Surface Water: • EC Designated Salmonid/Cyprinid fishery • WFD Class 'High' • Site protected/designated under EC or UK habitat legislation (SAC, SPA, SSSI, WPZ, Ramsar site, salmonid water)/Species protected by EC legislation
		Groundwater: • Principal aquifer providing a regionally important resource or supporting site protected under EC and UK habitat legislation SPZ1
		Flood Risk: • Floodplain or defence protecting more than 100 residential properties from flooding
High	Attribute has a high quality and rarity on local scale	Surface Water: • WFD Class 'Good' • Major Cyprinid Fishery • Species protected under EC or UK habitat legislation
		Groundwater: • Principal aquifer providing locally important resource or supporting river ecosystem SPZ2
		Flood risk: • Floodplain or defence protecting between 1 and 100 residential properties or industrial premises from flooding

[13] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment

Importance	Criteria	Typical Examples
Medium	Attribute has a medium quality and rarity on local scale	Surface Water: • WFD Class 'Moderate'
		Groundwater: • Aquifer providing water for agricultural or industrial use with limited connection to surface water SPZ3
		Flood risk: • Floodplain or defence protecting 10 or fewer industrial properties from flooding
Low	Attribute has a low quality and rarity on local scale	Surface Water: • WFD Class 'Poor'
		Groundwater: • Unproductive strata
		Flood risk: • Floodplain with limited constraints and a low probability of flooding of residential and industrial properties
Key: SAC = Special Area Conservation; SPA = Special Protection Area; SPZ = Source Protection Zone=SPZ; SSSI = Site of Special Scientific Interest; WPZ = Water Protection Zone.		

Table Source: DMRB HD 45/09 Table A4.3

Table 8.3: Estimating the magnitude of an impact on an attribute

Magnitude	Criteria	Typical Examples
Major Adverse	Results in loss of attribute and/or quality and integrity of the attribute	Surface Water: • Failure of both soluble and sediment-bound pollutants in HAWRAT (Method A, Annex I) and compliance failure with EQS values (Method B) Calculated risk of pollution from a spillage >2% annually (Spillage Risk Assessment, Method D, Annex I) • Loss or extensive change to a fishery • Loss or extensive change to a designated Nature Conservation Site
		Groundwater: • Loss of, or extensive change to, an aquifer • Potential high risk of pollution to groundwater from routine runoff - risk score >250 (Groundwater Assessment, Method C, Annex I) • Calculated risk of pollution from spillages >2% annually (Spillage Risk Assessment, Method D, Annex I) • Loss of, or extensive change to, groundwater supported designated wetlands

Magnitude	Criteria	Typical Examples
		Flood risk: • Increase in peak flood level (1% annual probability) >100 mm (Hydrological Assessment of Design Floods and Hydraulic Assessment • Methods E and F, Annex I)
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	Surface Water: • Failure of both soluble and sediment-bound pollutants in HAWRAT (Method A, Annex I) but compliance with EQS values (Method B) • Calculated risk of pollution from spillages >1% annually and <2% annually • Partial loss in productivity of a fishery
		Groundwater: • Partial loss or change to an aquifer • Potential medium risk of pollution to groundwater from routine runoff - risk score 150-250 • Calculated risk of pollution from spillages >1% annually and <2% annually • Partial loss of the integrity of groundwater supported designated wetlands
		Flood risk: • Increase in peak flood level (1% annual probability) >50 mm
Minor Adverse	Results in some measurable change in attributes quality or vulnerability	Surface Water: • Failure of either soluble or sediment-bound pollutants in HAWRAT • Calculated risk of pollution from spillages >0.5% annually and <1% annually
		Groundwater: • Potential low risk of pollution to groundwater from routine runoff - risk score <150 Calculated risk of pollution from spillages >0.5% annually and <1% annually Minor effects on groundwater supported wetlands
		Flood risk: • Increase in peak flood level (1% annual probability) >10 mm
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	The Scheme is unlikely to affect the integrity of the water environment
		Surface Water: • No risk identified by HAWRAT (Pass both soluble and sediment-bound pollutants) • Risk of pollution from spillages <0.5%

Magnitude	Criteria	Typical Examples
		Groundwater: No measurable impact upon an aquifer and risk of pollution from spillages <0.5%
		Flood risk: • Negligible change in peak flood level (1% annual probability) <+/- 10 mm
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Surface Water: • HAWRAT assessment of either soluble or sediment-bound pollutants becomes Pass from an existing site where the baseline was a Fail condition • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually)
		Groundwater: • Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually)
		Flood risk: • Reduction in peak flood level (1% annual probability) >10 mm
Moderate Beneficial	Results in moderate improvement of attribute quality	Surface Water: • HAWRAT assessment of both soluble and sediment-bound pollutants becomes Pass from an existing site where the baseline was a Fail condition • Calculated reduction in existing spillage by 50% or more (when existing spillage risk >1% annually)
		Groundwater: • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually)
		Flood risk: • Reduction in peak flood level (1% annual probability) >50 mm
Major Beneficial	Results in major improvement of attribute quality	Surface Water: • Removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to a watercourse
		Groundwater: • Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring • Recharge of an aquifer
		Flood risk: • Reduction in peak flood level (1% annual probability) >100 mm

Table Source: HD 45/09 Table A4.4

Table 8.4: Estimating the significance of potential effects

Importance of Attribute	Magnitude of Impact			
	Major	Moderate	Minor	Negligible
Very High	Very Large	Large/Very Large	Moderate/Large	Neutral
High	Large/Very Large	Moderate/Large	Slight/Moderate	Neutral
Medium	Large	Moderate	Slight	Neutral
Low	Slight/Moderate	Slight	Neutral	Neutral

Table Source: HD 45/09 Table A4.5

WFD compliance assessment

8.5.21 A WFD compliance assessment is required for new developments to demonstrate that proposals will not result in a deterioration in status (or potential) of any water body (defined in this assessment as Test A) or prevent the water body from meeting good status (or potential) in the future (2021 or 2027), defined in this assessment as Test B.

8.5.22 The Scheme was assessed for its effect on achieving these two key environmental objectives. This was undertaken for each water body where the Scheme resulted in some modification to a water body or an indirect effect to the volume or quality of water within a water body.

8.5.23 A precautionary risk-based approach was taken to the assessment. This considered tests A and B, accounting for uncertainty of potential impacts. Uncertainties associated with the preliminary design and other baseline data sets were taken into account during the assessment.

8.6 Assumptions and limitations

8.6.1 This assessment has relied upon the accuracy and level of detail of the documented data sources. For example, the identification of water bodies and current characteristics has involved reference to EA websites for RBMPs and associated WFD water body information sheets. The datasets are updated annually and the latest available information has been used in this assessment.

8.6.2 For the sediment test, river width was sought from MasterMap and complemented through cross-sectional data obtained for the FRA.

8.6.3 Ground investigation data were not available at the time of reporting. However, given the proposed method of discharge is to surface water, there is confidence that the data available are appropriate to make a reasoned assessment of the potential risks to groundwater quality. The limitations and assumptions are considered in the Geology and Soils Chapter (Chapter 10) and will therefore not be repeated here.

8.6.4 With regards to the surface water quality assessment a number of limitations are presented:

- Stream flow data for the receiving watercourse are required for the assessment. However, no gauged flows are available for the receiving watercourses. The Q95 low flow rates were calculated using LowFlows™

software (in line with HD 45/09). The watercourse catchments used for these calculations were derived using GIS. No river gauging stations are located in the vicinity of the Scheme.

- The traffic modelling completed for the Scheme suggests that although traffic is predicted to increase in the long term (2027 scenario) from the base-case scenario this increase is predicted to be less than 100,000 AADT two-way traffic. Therefore, the water quality results are only relevant to these traffic bands.
- The required treatment percentages returned by HAWRAT are very precise, however the guidance on the treatment efficiency of Sustainable urban Drainage Systesm (SuDS) provided in HD 33/16[14] can only be used as broad indicator of performance. With the above in mind, a degree of pragmatism is required when designing and assessing the road drainage system; the treatment train should be sufficient to reasonably treat runoff.

8.7 Baseline conditions

8.7.1 Figure 8.1 (application document TR010029/APP/6.2) shows the water environment features in the study area.

Surface watercourses

8.7.2 Waterbodies within the study area fall within the Thames RBD as set out within the Thames RBMP (Defra, 2016[15]).

8.7.3 One WFD (2000/60/EC) assessed surface waterbody has been identified within the study area. This is the Ingrebourne River (GB106037028130) which is also designated as a Main River. The existing M25 junction 28 currently crosses the Ingrebourne River, running parallel and north of the A12. It flows south where at Putwell Bridge the Weald Brook (designated as a Main River) joins. The Weald Brook lies to the west of the M25 and runs parallel to the M25. Paine's Brook (designated as a Main River) also joins the Ingrebourne River approximately 1.6 km downstream (within 1 km of the Scheme) of Putwell Bridge. All other watercourses in the study area are Ordinary watercourses. The locations can be found on Figure 8.1.

8.7.4 Table 8.5 provides details of the Ingrebourne River. The current overall status for this water body is moderate. However, in line with the EA's aspiration for the status of this water body to reach 'good' status, the importance assigned to this water body is high. This applies to all watercourses within the waterbody, including contributing tributaries.

[14] Highways England. May 2016. Design Manual for Roads and Bridges. Volume 4. Section 2. Part 3. HD33/16. Design of Highway Drainage Systems
[15] DEFRA. 2016. https://www.gov.uk/government/publications/thames-river-basin-district-river-basin-management-plan

Table 8.5: WFD surface water

Receptor	Classification (2016) chemical status	Classification (2016) ecological status	Overall waterbody status (2016)
Ingrebourne River (GB106037028130	Good	Moderate	Moderate

Table Source: EA. Catchment Data Explorer. Accessed June 2019. https://environment.data.gov.uk/catchment-planning/WaterBody/GB106037028130

8.7.5 As well as the Main Rivers mentioned above, there are also numerous tributaries of the Ingrebourne River and Weald Brook within the study area. Approximately 17 km of tributaries/drains of the Ingrebourne River are located to the north-east of the Scheme (near Brentwood) and south-east of the M25 in the study area.

8.7.6 Approximately 9.6 km of tributaries/drains of the Weald Brook are located to the north-west in the study area.

8.7.7 There are no WFD designated lakes within the study area and therefore these features have not been considered further.

8.7.8 There are also a number of ponds within the study area, which are not WFD designated and could potentially be impacted by the Scheme, these are shown on Figure 7.1. Potential impacts to ponds have been considered in the Biodiversity chapter (Chapter 7). As they are not connected by watercourses, they are not anticipated to be affected through the water environment.

Surface water abstractions

8.7.9 One surface water abstraction has been identified within the study area. Details of the associated abstraction licence have been obtained from a site-specific Envirocheck Report[16] and are documented in Table 8.6. The location to which this abstraction licence applies is shown in Figure 8.1.

Table 8.6: Surface water abstractions

ID	Licence number	Purpose	Source	Approximate distance from Scheme (m)
17	08/37/55/0068	General agriculture: spray irrigation-direct	Tributary of Ingrebourne	950 m north east of junction 28 and upstream of works area

Table Source: Envirocheck ® Report. June 2016. Order no 88528679_1_1

Surface water discharges

8.7.10 Thirteen surface water discharges have been identified within the study area. The study area is 1 km from the Development Consent Order (DCO) boundary, which captures construction compounds, however for ease, the point of reference stated in Table 8.4 is from junction 28, therefore the distances are slightly beyond 1 km.

[16] Envirocheck ® Report. June 2016. Order no 88528679_1_1

8.7.11 Details of these discharge licences have been obtained from a site-specific Envirocheck Report[17] and are documented in Table 8.7. The locations to which the licences apply are shown in Figure 8.1.

Table 8.7: Surface water discharges

ID	Licence number	Purpose	Receiving receptor	Approximate distance from Scheme (m)
2	Cssc.0328	Sewage discharges - pumping station - water company	Ingrebourne River	600 m downstream of the Ingrebourne River crossing at junction 28
3	Temp.2414	Public sewage: Storm sewage overflow	Ingrebourne River	600 m downstream of the Ingrebourne River crossing at junction 28
4	Canm.0563	Sewage discharges - final/treated effluent - not water company	Ingrebourne River	1.4 km south west of junction 28 and upstream of works area
5	Cssc.0328	Sewage discharges - final/treated effluent - water company	Ingrebourne River	900 m downstream of the Ingrebourne River crossing at junction 28
6	Canm.0112	Sewage discharges - final/treated effluent - not water company	Ingrebourne River	1.4 km south east of junction 28 and upstream of works area
7	Npswqd001126	Sewage Discharges - Final/Treated Effluent - Not Water Company	Trib of River Weald	650 m north east of junction 28 and upstream of works area
8	CTWC.1758	Sewage Discharges - Final/Treated Effluent - Not Water Company	Unnamed Trib Of R. Ingrebourne	1 km north east of junction 28 and upstream of works area
9	Canm.0450	Sewage Discharges - Final/Treated Effluent - Not Water Company	Ditch Trib Ingrebourne River	1.2 km north east of junction 28 and upstream of works area
12	CATM.3607	Sewage Discharges - Final/Treated Effluent - Not Water Company	Tributary of Ingrebourne River	1.3 km north east of junction 28 and upstream of works area
13	Cntw.1188	Sewage Discharges - Final/Treated Effluent - Not Water Company	Tributary of Weald Brook	1.2 km north east of junction 28 and upstream of works area
14	CATM.3169	Sewage and Trade Combined - Unspecified	Trib of the Ingrebourne River	1.4 km north east of junction 28 and

[17] Envirocheck ® Report. June 2016. Order no 88528679_1_1

ID	Licence number	Purpose	Receiving receptor	Approximate distance from Scheme (m)
				upstream of works area
15	Canm.1229	Sewage Discharges - Final/Treated Effluent - Not Water Company	Dit Trib of Ingrebourne	1.3 km north east of junction 28 and upstream of works area
16	CNTM.1848	Sewage Discharges - Final/Treated Effluent - Not Water Company	Tributary of the Ingrebourne	1.3 km north east of junction 28 and upstream of works area

Table Source: Envirocheck ® Report. June 2016. Order no 88528679_1_1

Groundwater

8.7.12 The study area is underlain by Secondary A bedrock aquifers and Secondary A and Secondary (undifferentiated) superficial aquifers.

8.7.13 There are no designated WFD groundwater bodies within the study area.

8.7.14 There is one Source Protection Zone (SPZ) which dissects the eastern portion of the study area.

8.7.15 Groundwater importance has been assigned as High given the Secondary A bedrock aquifers and Secondary A and Secondary (undifferentiated) superficial aquifers have the potential to be supporting the surface water network.

Groundwater abstractions

8.7.16 Three groundwater abstractions have been identified within the study area.

8.7.17 The study area is 1 km from the DCO boundary, which captures construction compounds, however for ease, the point of reference stated in Table 8.5 is from junction 28, therefore the distances are slightly beyond 1 km.

8.7.18 Details of these abstraction licences have been obtained from a site-specific Envirocheck Report[18] and are documented in Table 8.8. The locations of the abstraction licences are shown in Figure 8.1.

[18] Envirocheck ® Report. June 2016. Order no 88528679_1_1

Table 8.8: Groundwater abstractions

ID	Licence number	Purpose	Source	Approximate distance from Scheme (m)
18	08/37/55/0034	General farming and domestic	Groundwater	1.3 km south east of junction 28 and upstream of works area
19	08/37/55/0034	General farming and domestic	Groundwater	1.1 km south east of junction 28 and upstream of works area
20	08/37/55/0034	General farming and domestic	Groundwater	1.2 km south east of junction 28 and upstream of works area

Table Source: Envirocheck ® Report. June 2016. Order no 88528679_1_1

Groundwater discharges

8.7.19 Three groundwater discharges have been identified within the study area. The study is 1 km from the DCO boundary, which captures construction compounds, however for ease, the point of reference stated in Table 8.6 is from junction 28, therefore the distances are slightly beyond 1 km.

8.7.20 Details of these discharge licences have been obtained from a site-specific Envirocheck Report[19] and are documented in Table 8.9. The locations to which the licences relate are shown in Figure 8.1.

Table 8.9: Groundwater discharges

ID	Licence number	Purpose	Receiving receptor	Approximate distance from Scheme (m)
1	CANM.0025	Trade effluent discharge - site drainage	Land via soakaway	250 m east of junction 28
10	CEPU.0188	Sewage Discharges - Final/Treated Effluent - Not Water Company	London Claystrata	1.3 km north east of junction 28 and upstream of works area
11	CTLU.0481	Sewage Discharges - Final/Treated Effluent - Not Water Company	Unknown	1.3 km north east of junction 28 and upstream of works area

Table Source: Envirocheck ® Report. June 2016. Order no 88528679_1_1

[19] Envirocheck ® Report. June 2016. Order no 88528679_1_1

Flood risk

Fluvial flood risk

8.7.21 The three watercourses that pass through the study area; Weald Brook, Ingrebourne River and Paine's Brook, are all classified as "Main Rivers" and therefore fall under the regulation of the EA.

8.7.22 The Weald Brook flows north to south through the study area discharging into the Ingrebourne River upstream of the A12 culvert. It has an entirely rural upstream catchment where it is culverted under the existing M25 over 1 km upstream of the A12. The watercourse has high sinuosity and a natural floodplain approximately 100 m wide throughout the study reach.

8.7.23 The Ingrebourne River flows east to west entering the study area through an existing 160 m long dual bore box culvert. Its upper catchment is largely urbanised with a heavily modified straight channel running through the study area adjacent to the existing A12 road. There are three further significant culverts upstream of the study area. The Weald Brook joins the Ingrebourne River directly upstream of the A12, from here on it is known only as the Ingrebourne River as it leaves the study area through the existing single bore 8 m wide A12 culvert.

8.7.24 Paine's Brook also joins the Ingrebourne River approximately 1.6 km downstream (within 1 km of the Scheme) of Putwell Bridge.

8.7.25 Flood zones 2 and 3 are present throughout the study area (see Figure 2.2 of the Flood Risk Assessment). These flood zones are associated with the Ingrebourne River, Weald Brook and Paine's Brook watercourses. The flood zones within the study area have been updated from detailed hydraulic modelling carried out as part of the flood risk assessment to provide a higher level of confidence throughout the area.

8.7.26 No vulnerable receptors (residential, commercial or industrial properties) were identified within the study area that are at risk of fluvial flooding. Historical flooding in the area has been recorded downstream of the A12 culvert.

8.7.27 The importance of fluvial flood risk is Low.

Surface water flood risk

8.7.28 Across the study area, surface water flooding risk is variable, ranging from low to high. The majority of these high-risk areas are associated with watercourses and are considered as fluvial flood risk. The other areas at risk are largely associated with isolated depressions in topography and areas along the A12 and M25 which are at a slightly lower elevation than other sections of the road. The notable areas at risk from surface water flooding that are not associated with the main watercourses are the drainage channels flowing west to east into Weald Brook on the western side of the study area.

8.7.29 Although the surface water flood risk within the study area is considered high, this is in areas where there are no vulnerable receptors. The existing drainage system reduces the surface water risk to an acceptable level along the road network

8.7.30 The importance of surface water flood risk is Low.

Groundwater flood risk

8.7.31 With reference to the Preliminary Sources Study Report (Highways England, April 2017), there is potential for groundwater flooding across the study area.

8.7.32 Based on the groundwater flood risk mapping provided within the Strategic Flood Risk Assessment (SFRA) (Jacobs, 2016), which is based on geology for the area, the study area is predominantly low to moderate risk with 25-50% at risk of groundwater flooding from water within the limited superficial geology deposits. The Cadent gas pipeline intersecting the site is also identified as infrastructure at risk of flooding from groundwater.

8.7.33 The importance of groundwater flood risk is Low.

Designated sites

8.7.34 There are no statutory designated sites within the study area. Designated sites will not be considered further in the context of water resources.

Existing drainage system

8.7.35 The Scheme comprises of the following eight existing drainage catchments:

- Two existing drainage catchments (catchments 5b and catchment 7) which will remain unchanged.
- Six existing drainage catchments, which are being extended as a result of the Scheme.

8.7.36 Of the eight drainage catchments, four outfall to Weald Brook and four to the Ingrebourne River. Catchment 7 is the only catchment thought to have existing mitigation in place in the form of a highway drainage ditch.

8.7.37 Table 8.10 provides a summary of the existing drainage catchments.

Table 8.10: Existing drainage catchments

Catchment reference	Receptor
2	Weald Brook
3	Weald Brook
4	Ingrebourne River
5a	Ingrebourne River
5b	Ingrebourne River
6a	Weald Brook
6b+6c	Weald Brook
7	Ingrebourne River

8.8 Potential impacts

8.8.1 The potential impacts of the Scheme are discussed in this section.

Construction

8.8.2 Temporary impacts during construction have the potential to affect the water environment through the construction activities listed below. Scheme examples of where and how the impacts might occur have been provided to illustrate the types of activity that may manifest the potential issue. It should be noted that generally only one example has been provided. These examples are provided for illustrative purposes. Nonetheless, the potential impact of activities has been assessed for the construction process as a whole.

Surface water

- The excavation of materials, and the subsequent deposition of soils, sediment, or other construction materials, for example through the creation of dry attenuation ponds which are predominately proposed to be located northwest of the M25 junction 28 DCO boundary.
- The spillage of fuels or other contaminating liquids from plant used in the construction process.
- The mobilisation of contamination following the disturbance of contaminated ground or groundwater, for example through earth movement near some potential contamination on Grove Farm during the construction of the new loop road.
- Runoff from construction sites to surface water bodies, for example the site compound situated approximately 300 m west of Weald Brook and the satellite compound site approximately 70 m east of Weald Brook. Haul roads and a temporary bridge also cross Weald Brook, thereby creating potential construction contamination sources to Weald Brook. Direct impacts to Weald Brook could have potential indirect impacts to the Ingrebourne River downstream of Weald Brook.
- Disturbance of non-native invasive species (NNIS) - construction activities can encourage the spread of NNIS along surface water bodies and their riparian zones. Examples include disturbance of ground associated with the construction of the Grove Culvert extension and Grove, Maylands and Duck Wood bridges.
- Vegetation management – clearance of riparian and in-channel vegetation during construction, for instance along proposed realignments of the Ingrebourne River and Weald Brook.

8.8.3 These impacts could result in sediment and/or other contaminants entering watercourses and affecting the quality of the water which could have implications for abstractions downstream and WFD compliance.

Groundwater

8.8.4 Groundwater effects would include the same potential effects as for surface water. In addition, if localised dewatering is required, disposal of pumped water to surface water must be undertaken in accordance with the discharge consent,

preventing excess sediment or contaminants entering surface water. This may be necessary where the ground is excavated to create a cutting.

8.8.5 Further, deep foundations may create rapid vertical flow pathways into the underlaying aquifers or affect flow paths. The Scheme includes the construction of four new permanent bridges, which will require deep pile foundations.

8.8.6 The excavation of the ground to form cuttings may also create rapid vertical flow pathways into the underlaying aquifers or affect flow paths.

Flood risk

8.8.7 Both the proposed site compounds would be situated outside of areas at risk of fluvial flooding, however the storage of materials and temporary impermeable areas at site compounds could result in an increase in surface water flood risk to the Scheme itself and surrounding land.

8.8.8 Discharge of abstracted water during construction could also give rise to increased flood risk, especially if discharged to smaller watercourses.

8.8.9 Temporary works to watercourses to facilitate construction, such as temporary bridge crossings over Weald Brook to facilitate haul roads and access, have the potential to affect flows in the channels and on floodplains.

WFD

8.8.10 Potential construction impacts are consistent with those listed above under surface water.

Operation

Surface water

8.8.11 During the operational phase of the Scheme, the road will be designed to drain freely to prevent build-up of standing water on the carriageway and thus avoiding exposure to or causing surface water flooding.

8.8.12 There would be potential impacts to surface water quality owing to the increase in impermeable area as a result of the M25 junction 28 and A12 widening works and the construction of the new M25 loop road. This would be from the additional runoff and the associated contaminants deposited on the road surface washed off during rainfall. Where traffic levels are high the level of contamination in runoff increases and therefore, the potential for unacceptable harm being caused to the receiving water also increases[20].

8.8.13 On all roads, there is also a risk that a spillage may lead to an acute pollution incident. Where spillages do reach a surface watercourse the pollution impact can be severe but is usually of short duration.

8.8.14 In addition, surface water abstractions downstream could be affected by contaminated road runoff.

8.8.15 A broad range of potential pollutants are also associated with routine cleaning activities such as cleaning gully pots and similar entrapment structures to carriageway maintenance work. The flushing-out of gully pots has been identified

[20] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment

as a potential source of pollutants, which may be as damaging as some spillage impacts. The use of herbicides for the control of plant growth along road verges and central reservations may also lead to contamination of road runoff[21].

8.8.16 Other than heavy metals and nutrients, the significant dissolved constituent of highway runoff in the UK is sodium chloride (NaCl), applied as de-icing salt during the winter. Sodium chloride can cause damage to vegetation and can potentially trigger the release of accumulated nutrients and heavy metals adsorbed to the suspended solids into solution (HD103/06[22]).

Groundwater

8.8.17 Deep foundations created for the construction of gantries may create rapid vertical flow pathways into groundwater and may form a barrier to groundwater flow, potentially reducing groundwater contributions to adjacent water courses and any groundwater abstractions in the water body.

8.8.18 During operation cuttings have the potential to impact groundwater quality and levels. Cuttings may create rapid vertical flow pathways into the groundwater and form a barrier to groundwater flow. This may result in the reduction in groundwater contributions to adjacent watercourses and any groundwater abstractions in the waterbody

8.8.19 On the roads, there is also a risk that a spillage may lead to an acute pollution incident. Where spillages do reach groundwater the pollution impact can be long lasting and difficult, if not impossible, to remediate[18].

Flood risk

8.8.20 Any new development has the potential to impact on ground permeability and therefore flood risk. This is of primary importance where development will increase the impermeable ground coverage within a site. The Scheme involves additional roads (for example the new M25 junction 28 loop road), and road widening on the existing M25 and A12, which would involve an increase in impermeable surfacing.

8.8.21 There are potential impacts on fluvial flooding as a result of loss of floodplain due to construction and modification of river crossings. Any construction on land that is within a flood zone has the potential to alter flow paths and/or flood levels. By taking up some of the existing floodplain storage, there would be less opportunity for water to spread out and this could result in increased flood levels. Flows can be restricted at watercourse crossings and this in turn can raise the likelihood of flooding upstream or to the constructed carriageway itself.

8.8.22 Increasing culvert lengths under the M25 may have adverse impacts on flood risk if sufficient culvert capacity is not provided.

8.8.23 There is potential for an increase in surface water flooding due to increased impermeable area associated with the M25 junction 28 and A12 widening works and the construction of the new loop road. With an increase in impermeable catchment, more water would be collected for a given rainfall event, which induces higher rates and volumes of runoff. This has the potential to overload the

[21] Highways Agency. November 2009. Design Manual for Roads and Bridges. Volume 11. Section 3. Part 10. HD 45/09. Road Drainage and the Water Environment
[22] Highways Agency. May 2006. Design Manual for Roads and Bridges. Volume 4. Section 2. Part 1. HA 103/06. Vegetated Drainage Systems for Highway Runoff

capacity of the drainage system. The increased flow rates can also contribute to larger flood peaks in receiving watercourses.

8.8.24 Where Scheme elements coincide with areas of existing groundwater flood risk, these may lead to an increased risk of groundwater flooding. Where subsurface activities are in an area of significant groundwater presence, risk of groundwater flooding is increased.

8.8.25 Where deep foundations for new overbridges and gantries or sheet piling is located within areas of existing groundwater flood risk, these have potential to form a barrier to groundwater flow, thereby locally increasing the groundwater flood risk up gradient.

8.8.26 Drainage of cuttings may also add to surface water stream flows with the potential to open up flow paths from groundwater, depending on the depth of the water table in the area.

WFD

8.8.27 Realignment of river channels to make space for highway infrastructure has the potential to reduce hydromorphological complexity (e.g. reduced channel length, loss of channel bends and in-channel features such as bars, berms and backwaters). This may adversely affect the WFD hydromorphological quality element. Loss of hydromorphological complexity can lead to a simplification of in-channel, riparian and floodplain habitat, and hence an adverse effect on WFD ecological quality elements.

8.8.28 Culvert extensions and construction of bridge crossings can lead to a reduction in hydromorphological complexity if channels are realigned to accommodate new structures (see paragraph 8.8.28 above). This loss of channel complexity, together with the shading effect of structures and possible loss of riparian zone / floodplain can lead to a simplification / loss of in-channel, riparian and floodplain habitat. Bridge and culvert structures can also reduce biological or sediment continuity (e.g. reduce the ease with which fish or gravels can move along a channel).

8.8.29 Discharge of road runoff to the natural drainage network as well as disturbance of potentially contaminated landfill may adversely affect WFD specific pollutants and chemical quality elements.

8.9 Design, mitigation and enhancement measures

Construction mitigation

8.9.1 The risk of pollution during construction can be reduced by the adoption of good working practices and adherence to Pollution Prevention Guidelines (PPG). Mitigation measures that should be applied prior to and during construction are laid out in the following sections. These lists are not exhaustive and provide a flavour the types of mitigation required. This list should be read in conjunction with the Outline Construction Environmental Management Plan (CEMP) (application document TR010029/APP/7.2) and the Register of Environmental Actions and Commitments (REAC) (application document TR010029/APP/7.3).

Surface water

8.9.2 Construction mitigation could include, but not be limited to, the following:

- All works to be undertaken with regard to PPGs[23]. These detail good practice advice for undertaking works which may have the potential to cause water pollution.
- Temporary works sites, haul roads and other associated works would be designed and maintained to minimise impact. Risk areas identified are the site compounds situated approximately 300 m west of Weald Brook and the satellite compound site approximately 70 m east of Weald Brook. Haul roads and a temporary bridge also cross Weald Brook.
- Areas which may generate contaminated water, such as oil storage areas (for example the main and satellite compounds which are in close proximity to Weald Brook), would need to be bunded and have water discharged to self–contained units with treatment facilities.
- Tests would be undertaken to ensure contaminated material was identified, isolated and reworked or removed to special landfill to avoid any leachate problems.
- Temporary land–take required for construction would include adequate areas of land set aside for robust control measures, for example sustainable drainage control.

Groundwater

- Where deep foundations extending below the groundwater table are intended to be installed as part of the Scheme, these should be designed in accordance with industry standards - taking into account the site-specific water level and flow monitoring data obtained from intrusive ground investigation for the Scheme.
- A piling risk assessment would be carried out to ensure the selected piling method would not introduce contamination pathways into the aquifer. Piling design should include mitigation in the form of substantial clear spacing between piles and appropriate piling installation methods.
- Areas which may generate contaminated water, such as oil storage areas, would need to be bunded and have water discharged to self–contained units with treatment facilities.
- There would be no discharge to groundwater.

[23] Pollution Prevention Guidelines (PPGs) with particular reference to PPG1 (general guide to the prevention of water pollution), PPG3 (use and design of oil separators in surface water drainage systems), PPG5 (works near or liable to affect watercourses) and PPG6 (working at construction and demolition sites). The PPGs contain a mix of regulatory requirements and good practice advice. They have been withdrawn by the EA but are still considered good practice advice to avoid pollution of watercourses. All of the PPGs are available from http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx

Flood Risk

- For construction work which has drainage implications, the proposed drainage system should comply with the National Standards, such as Schedule 3 under the Flood and Water Management Act 2010. In addition, any planning obligations will need to make provision for the adoption and maintenance of any SuDS, including any necessary access rights to property.
- Construction activities within the floodplain will be minimised as far as possible (consultation with the LLFAs will take place as appropriate and sustainable drainage mitigation will be incorporated into the design to not increase surface water flood risk).
- The EA flood warning system will be adopted during construction. A suitable plan would be put in place to ensure effective and safe evacuation of personnel (and plant if safe to do so) from the areas at risk on receipt of a flood warning.
- Where subsurface works are required, depending on the groundwater levels at the time of construction, localised dewatering may be required. No works are planned which would increase the groundwater flood risk.
- To mitigate the impact of earthworks within the floodplain, construction work will be phased so that floodplain compensation areas would be constructed prior to loss of floodplain volume to ensure no overall adverse impact.

WFD

- The mitigation measures listed under the surface water sections above would also protect WFD quality elements during construction.

Operation mitigation

8.9.3 Mitigation measures during operation are required for several reasons:

- To treat contaminants in normal road run-off.
- To deal with any accidental spillages occurring on the carriageway.
- To prevent any increase to flood risk in the area.
- To protect and enhance wildlife corridors near watercourses.

8.9.4 The proposed design of the drainage system complies with all current standards (HD 45/09) and SuDS best practice techniques (HD33/16) to ensure that sustainability is a key drainage design criterion.

Surface water

8.9.5 The preferred approach is to provide mitigation in the form of SuDS. HD 45/09 considers how SuDS may be used to treat run-off and provide mitigation for both the quality and attenuation of water.

8.9.6 The Scheme will introduce the construction of a new highway drainage catchment (reference catchment 1) to accommodate the new loop road. In total, with the existing eight drainage catchments (as outlined in the baseline) the Scheme will entail nine drainage catchments.

8.9.7 A combination of dry attenuation ponds, ditches and filter drains are the proposed mitigation for surface water quality mitigation. Sediment catch-pits are proposed for sediment mitigation. Table 8.11 presents the catchments and the proposed mitigation.

Table 8.11: Drainage catchments

Catchment ref	Status	Receptor	Proposed mitigation	Proposed discharge	Existing areas		Scheme areas	
					Impermeable area (ha)	Permeable area (ha)	Impermeable area (ha)	Permeable area (ha)
1	New	Weald Brook	Pond 1 and then outfall to existing water course via ditch Sediment catchpits	Orifice flow control, Pond and to greenfield runoff	n.a	n.a	1.321	9.417
2	Existing	Weald Brook	Pond 2 and then outfall to existing water course via ditch Sediment catchpits	Orifice flow control, Pond and to greenfield runoff	0.132	0.108	1.748	2.547
3	Existing	Weald Brook	Pond 3 and then outfall to existing water course via ditch Sediment catchpits	Orifice flow control, Pond and to greenfield runoff	0.114	0.046	1.114	0.613
4	Existing	Ingrebourne River	Sediment catchpits	Orifice flow control and to greenfield runoff	0.143	0	0.457	0.356
5A	Existing	Ingrebourne River	Filter drains Sediment catchpits	Orifice flow control and to Brownfield runoff	0.105	0	0.375	0.15
5B	Existing	Ingrebourne River	Sediment catchpits	Orifice flow control and to Brownfield runoff	1.637	0.538	1.637	0.15
6A	Existing	Weald Brook	Outfall to proposed ditch and then to existing water course	Orifice flow control and to Brownfield runoff	0.465	0	0.523	0.133

Catchment ref	Status	Receptor	Proposed mitigation	Proposed discharge	Existing areas		Scheme areas	
					Impermeable area (ha)	Permeable area (ha)	Impermeable area (ha)	Permeable area (ha)
			Sediment catchpits					
6B+6C	Existing	Weald Brook	Outfall to proposed ditch and then to existing water course Sediment catchpits	Orifice flow control and to Brownfield runoff	0.830	0	1.004	1.41
7	Existing	Ingrebourne River	None proposed utilising the existing ditch		0.93	0.26	0.93	0.26

Groundwater

8.9.8 Deep foundations extending below the groundwater table should be designed in accordance with industry standards, considering the site-specific water level and flow monitoring data obtained from intrusive ground investigation for the Scheme

8.9.9 Piling design should include substantial clear spacing between piles and appropriate piling installation methods as mitigation.

Flood risk

8.9.10 To contribute to the flood management objectives of neutral or better effect on the overall flood risk, discharge to watercourses must be controlled, so that the discharge of the water into the watercourses does not increase flood risk.

Fluvial flood risk

8.9.11 The proposed drainage design will ensure that the runoff from the Scheme is attenuated before reaching the watercourse for the 1 in 100 annual probability event (an extreme flood event that has a 1% chance for occurring in any given year) taking into account a 20% allowance for climate change and hence there will be no increase in runoff from the site and no increase in flood risk.

8.9.12 Floodplain compensation areas would be constructed to mitigate against lost floodplain volume as a result of the Scheme. These would be designed in line with Construction Industry Research and Information Association (CIRIA) guidance (CIRIA, 2004) and their effectiveness confirmed with hydraulic modelling.

Surface water flood risk

8.9.13 The drainage system would be designed in line with the current standards of the HD 45/09 (HA, 2009) to ensure that runoff from the site does not exceed the greenfield rate (i.e. the rate at which water would flow off the area if the area was natural undeveloped land). Longitudinal drains would be designed to take into account a 1 in 5 year annual probability event, plus 20% climate change, this is in line with the details set out in the drainage strategy.

Groundwater flood risk

8.9.14 Where deep foundations extending below the groundwater table are designed to be part of the Scheme, these should be designed in accordance with industry standards, considering the site-specific water level and flow monitoring data obtained from intrusive ground investigation. Piling design should include mitigation in the form of substantial clear spacing between piles and appropriate piling installation methods. Where sheet piling is replacing existing retaining walls, the design should not exceed the existing extent and depth of the retaining wall.

WFD

8.9.15 Mitigation for the effects of the operation of the Scheme on WFD quality elements is presented in full in Chapter 5 of the WFD compliance assessment (application document TR010029/APP/6.7), and summarised below. Three categories of mitigation are used: a) mitigation embedded into the preliminary design; b) additional mitigation (specific to scheme components) and c)

additional mitigation (generic guidance). Where possible, the location of mitigation is shown in the Preliminary environmental design plans (Figure 2.2, application document TR010029/APP/6.2) and cross referenced in bullet list below using codes (e.g. W02).

8.9.16 Mitigation 'embedded' into the preliminary design is as follows:

- Ingrebourne River and Weald Brook realignments (W01 and W02). Realignment of currently straight and uniform sections of the two watercourses to create reaches of more natural form and function (total restored river length approximately 535 m).
- Depressed inverts and natural river beds on culvert extensions (W03). A natural river bed will be incorporated into the design of culverts carrying the Ingrebourne beneath junction 28 (Grove Culvert extension) and the Weald Brook under the M25 (Weald Brook Culvert extension).
- A12 slip constructed on retaining wall (W04). The effects of the scheme will be reduced by minimising its footprint on the Ingrebourne floodplain by supporting the A12 slip road on a retaining wall instead of a large embankment structure.
- Widespan bridge structures (W05). Within the restrictions defined by other constraints, Grove, Maylands and Duck Wood Bridges have been set as high and wide as feasible to limit adverse geomorphological impacts, conveyance and shading effects.
- Minimisation of hard bank protection at river crossings (W06). Channel crossings and realignments associated with Grove and Duck Wood Bridges have been planned to limit the need for hard bank protection to reduce potential impacts on the biological and hydro-morphological quality elements.
- Management of road runoff before discharge to the natural drainage system (W07). The road drainage system has been designed to meet WFD toxicity standards at points of discharge to natural waters (further detail under the title Surface Water, above).

8.9.17 The measures bulleted below are 'Additional' mitigation (specific to scheme components). Highways England have committed to implementing these measures, but they are not captured in the preliminary design as embedded mitigation. These measures are secured by inclusion in the REAC (application document TR010029/APP/7.3). They comprise:

- Mitigation works outside of the DCO boundary, delivered by the EA as part of their programme of works within the Ingrebourne WFD water body (W13).
- Measures to prevent excessive scour or "wash-out" of bed material immediately downstream of Grove culvert extension and Weald Brook culvert extension (W14).
- Measures to facilitate mammal passage through Grove culvert extension and Weald Brook culvert extension during higher than normal flows (W15).
- Measure to line Balancing Pond No.1. (only required if further Ground Investigations indicate a risk of the leaching of contaminants from the Brook Street Landfill to watercourses) (W16).

8.9.18 'Additional' mitigation (generic guidance) is set out in Section 5.4 of the WFD compliance assessment (application document TR010029/APP/6.7). This is guidance on securing WFD compliance for reference in the detailed design process. Implementation of this guidance is secured by inclusion in the REAC (application document TR010029/APP/7.3).

8.9.19 Also embedded into the preliminary design are works to enhance the water environment. These comprise:

- Ingrebourne floodplain lowering (W03). Lowering of approximately 3,500 m^2 of floodplain, creation of backwaters on the Ingrebourne between Grove Farm and the Weald Brook confluence.
- Weald Brook floodplain lowering upstream (W04). Lowering of approximately 2,100 m^2 of floodplain, a flood compensation area and creation of a backwater to Weald Brook, just upstream of Duck Wood Bridge.
- Weald Brook floodplain lowering downstream (W05). Lowering of approximately 7,800 m^2 of floodplain in combination with a flood compensation area adjacent to Grove Bridge and Maylands Bridge.
- Maintenance of riparian trees on Weald Brook (W06). Long term maintenance works to manage riparian trees along the Weald Brook in a way that creates varied light intensity on the channel and riparian zone of the river (W06). These works are identified within the Outline Landscape and ecological management and monitoring plan (Outline LEMP, application document TR010029/6.3, Appendix 7.16) and will be delivered through the LEMP secured by requirement 5 of the DCO (application document TR010029/3.1). Unlined drainage ditches (W07). As part of the Scheme, significant lengths of unlined ephemeral drainage ditch will be created to manage 'clean' runoff from non-pavement surfaces. These ditches will generate habitat that mitigates for loss of existing ephemeral drainage ditches to the Scheme.

8.10 Assessment of effects

Significant effects

8.10.1 This section describes the likely significant effects of the Scheme following the implementation of avoidance and mitigation measures

8.10.2 Very large to moderate effects are considered significant and slight and neutral effects are considered not significant, in accordance with standard EIA practice.

Construction

Surface water

8.10.3 Likely impacts from road construction activities (as referenced in section 8.8 of this chapter) are typically temporary and can be mitigated through good engineering practices.

8.10.4 For surface water receptors of high importance, with the implementation of all mitigation measures (as listed in section 8.9 of this chapter and the REAC), the overall effect on surface water would be neutral which is not considered significant.

8.10.5 Potential significant effects on surface water features could have the potential to affect licenced abstractions and or consented discharges. However, with the implementation of all mitigation measures (as listed in section 8.9 of this chapter and the REAC), the overall effect would be neutral which is not considered significant.

Groundwater

8.10.6 As for surface water, likely impacts from road construction activities (as referenced in section 8.8 of this chapter) are typically temporary and can be mitigated through good engineering practices.

8.10.7 For groundwater receptors, with the correct implementation of all mitigation measures (as listed in section 8.9 of this chapter and the REAC), the overall effect on ground water would be neutral which is not considered significant.

Flood risk

8.10.8 For flood receptors, subject to the correct implementation of all mitigation measures (as listed in section 8.9 of this chapter and the REAC), the overall effect on flood risk has been assessed as neutral which is not considered significant.

WFD

8.10.9 The construction phase of the Scheme is considered compliant with the requirements of the WFD. Construction activities are not considered to cause deterioration in any WFD quality element at the water body scale. They are not considered to prevent future attainment of Good Ecological Status (GES). This assessment is based on the implementation of mitigation as set out in paragraph 8.9.2.

8.10.10 The WFD compliance assessment can be seen in full in application document TR010029/APP/6.7.

Operation

Surface water

8.10.11 The preliminary drainage design for the Scheme can be seen on the Scheme layout plans (application document TR010029/APP/2.7). The Scheme comprises nine drainage catchments. One of these (catchment 1) is a new catchment being built as part of the Scheme design. The remaining eight are existing as presented in the baseline.

8.10.12 Of the nine in total, two are unchanged (catchments 5b and catchment 7). Table 8.8 provides a summary of the drainage catchments. All of the catchments discharge to surface water, either Weald Brook (five outfalls) or the Ingrebourne River (four outfalls).

8.10.13 With mitigation in the form of dry attenuation ponds (catchments 1 + 2 + 3) and ditches (catchments 6a + 6b + 6c) prior to discharge to Weald Brook, all outfalls discharging to this receptor meet and pass all water quality thresholds, including RST's, EQS and sediment. No risk to Weald Brook has been identified from the Scheme with mitigation in place. This is assessed as negligible impact with neutral significance.

8.10.14 With mitigation in the form of filter drains (catchment 5a) and an existing ditch (catchment 7) prior to discharge to the Ingrebourne River all outfalls, meet and pass all water quality thresholds, including RST's, EQS and sediment. Although catchment 5b has no existing or proposed mitigation measures, it also meets and passes all water quality thresholds, including RST's, EQS and sediment.

8.10.15 The cumulative/collective water quality assessments for all outfalls discharging into Weald Brook (within 100 m for sediment or 1 km for soluble pollutants) with the proposed mitigation in the form of dry attenuation ponds and ditches, demonstrate compliance and passes in all water quality tests. As no risk has been identified to Weald Brook from the Scheme with mitigation in place, this is assessed as negligible impact with neutral significance.

8.10.16 The cumulative/collective water quality assessments for outfalls 5A and 5B discharging into Ingrebourne River and within 100 m for sediment with the proposed mitigation in the form of filter drains (catchment 5a), demonstrates compliance and passes in all water quality tests. As no risk has been identified to Ingrebourne River from the Scheme with mitigation in place, this is assessed as negligible impact with neutral significance.

8.10.17 For the combined runoff for outfalls more than 100 m from one another, no sediment test was undertaken based on best practice industry guidance which suggests anything beyond 100 m sediment will settle. This was for outfalls 4, 5A, 5B and 7. The soluble tests indicate compliance and a pass for both copper and zinc RSTs and EQS. As no risk has been identified to Ingrebourne River from the Scheme with mitigation in place, this is assessed as negligible impact with neutral significance

8.10.18 The operational impacts and overall effects of the Scheme on surface water are presented in Tables 8.12 to 8.14.

8.10.19 In terms of spillage risk, there is a low risk of spillage (less than 1 in 100 years) from the Scheme with mitigation in the form of dry attenuation ponds and ditches for the Weald Brook and the Ingrebourne River. Results are presented in Table 8.15.

8.10.20 All HAWRAT results (Method A, Method D and cumulative assessments) are provided in Appendix 8.1.

Groundwater

8.10.21 The road runoff from the Scheme will not discharge to ground and as such no impacts to groundwater are anticipated.

Flood risk

8.10.22 The construction of the Scheme is within the floodplains of the rivers it crosses, and therefore without mitigation within the Scheme has the potential to impact flood risk. The Scheme includes construction of two formal floodplain compensation areas to offset the loss of floodplain. The improvements to the Ingrebourne River upstream of the A12 further increase floodplain storage.

8.10.23 The roads will increase the area of impermeable surfaces, and therefore direct runoff from these areas will be increased compared to the runoff from the existing ground. The drainage system included within the Scheme accounts for

this increase in discharge and attenuates it so that there is no increase in discharge into the watercourses.

8.10.24 With construction of the proposed road drainage and floodplain compensation areas the Scheme would not have an adverse impact on flood risk during its operational life. Full details of the impacts and mitigation can be found in the Flood Risk Assessment (application document TR010029/APP/6.6).

WFD

8.10.25 The operational phase of the Scheme is considered compliant with the requirements of the WFD. The Scheme is not considered to cause deterioration in any WFD quality element at the water body scale. It is not considered to prevent future attainment of GES.

8.10.26 This assessment is based on implementation of a) mitigation already 'embedded' into the preliminary design of the Scheme (as summarised in paragraph 8.9.16 a) and b) the 'additional' mitigation described in paragraphs 8.9.17 and 8.9.18.

8.10.27 Also embedded into the preliminary design are works to enhance the water environment. These measures will make a positive contribution towards future attainment of GES in the Ingrebourne WFD water body. They are summarised in paragraph 8.9.19.

8.10.28 Implementation of mitigation on the ground is secured through four mechanisms. First, embedded mitigation is safe-guarded because it is explicitly represented in the Preliminary environmental design (Figure 2.2, application document TR010029/APP/6.2). Second, both embedded mitigation and additional mitigation (in the form of specific mitigation and generic guidance) is secured by inclusion in the REAC for the Scheme (application document TR010029/APP/7.3) and through requirement 4 of the DCO (application document TR010029/APP/3.1). Third, implementation of specific additional measure W13 (works outside of the DCO boundary) is proposed to be secured by means of a legal agreement between Highways England and the EA. Finally, long term maintenance and management plans for river and floodplain features are set out in the Outline LEMP (application document TR010029/APP/6.3, Appendix 7.16) and will be secured through requirement 4 of the DCO (application document TR010029/APP/3.1).

8.10.29 The WFD compliance assessment can be seen in full in application document TR010029/APP/6.7.

Table 8.12: Method A effects of routine runoff on surface waters from the baseline/existing

Catchments reference	Receiving watercourse	RST		EQS (µg/l)		Sediment test (Tier 1)	Magnitude of potential impact	Significance
		Copper	Zinc	Copper*	Zinc**			
1	N.a – proposed new catchment no baseline/existing							
2	Weald Brook	Pass	Pass	0.01 Pass	0.04 Pass	Pass	Negligible	Neutral insignificant
3	Weald Brook	Pass	Pass	0.01 Pass	0.03 Pass	Pass	Negligible	Neutral insignificant
4	Ingrebourne River	Pass	Pass	0.03 Pass	0.07 Pass	Pass	Negligible	Neutral insignificant
5A	Ingrebourne River	Pass	Pass	0.02 Pass	0.05 Pass	Pass	Negligible	Neutral insignificant
5B	Ingrebourne River	Pass	Pass	0.25 Pass	0.62 Pass	Pass	Negligible	Neutral insignificant
6A	Weald Brook	Pass	Pass	0.05 Pass	0.13 Pass	Pass	Negligible	Neutral insignificant
6B+6C	Weald Brook	Pass	Pass	0.09 Pass	0.23 Pass	Pass	Negligible	Neutral insignificant
7	Ingrebourne River	Pass	Pass	0.13 Pass	0.33 Pass	Pass	Negligible	Neutral insignificant
Key: EQS = Environmental Quality Standards; RST= Run-off Specific Threshold; *copper threshold at high hardness (>200 mg/l $caco_3$) is 10 µg/l; **zinc threshold 7.8								

Table 8.13: Method A effects of routine runoff on surface waters from the Scheme with mitigation

Catchment ref	Receiving watercourse	With mitigation						
		RST		EQS (µg/l)		Sediment test (Tier 1)	Magnitude of potential impact	Significance
		Copper	Zinc	Copper*	Zinc**			
1	Weald Brook	Pass	Pass	0.11	0.28	Pass	Negligible	Neutral insignificant
2	Weald Brook	Pass	Pass	0.16	0.40	Pass	Negligible	Neutral insignificant
3	Weald Brook	Pass	Pass	0.11	0.28	Pass	Negligible	Neutral insignificant
4	Ingrebourne River	Pass	Pass	0.08	0.20	Pass	Negligible	Neutral insignificant
5A	Ingrebourne River	Pass	Pass	0.07	0.19	Pass	Negligible	Neutral insignificant
5B	Ingrebourne River	Pass	Pass	0.25	0.62	Pass	Negligible	Neutral insignificant
6A	Weald Brook	Pass	Pass	0.05	0.13	Pass	Negligible	Neutral insignificant
6B+ 6C	Weald Brook	Pass	Pass	0.09	0.23	Pass	Negligible	Neutral insignificant
7	Ingrebourne River	Pass	Pass	0.13	0.33	Pass	Negligible	Neutral insignificant

Key: EQS = Environmental Quality Standards; RST= Run-off Specific Threshold; *copper threshold at high hardness (>200 mg/l $caco_3$) is 10 µg/l; **zinc threshold 7.8

Table 8.14: Method A effects of routine runoff on surface waters from the Scheme with mitigation – cumulative assessment

Catchments ref	Receiving watercourse	With mitigation						
		RST		EQS (µg/l)		Sediment test (Tier 1)	Magnitude of potential impact	Significance
		Copper	Zinc	Copper*	Zinc**			
1+2	Weald Brook	Pass	Pass	0.24	0.58	Pass	Negligible	Neutral insignificant
1+2+3	Weald Brook	Pass	Pass	0.31	0.75	n.a	Negligible	Neutral insignificant
1+2+3+6A+6B+6C	Weald Brook	Pass	Pass	0.39	0.94	Pass	Negligible	Neutral insignificant
6A+6B+6C	Weald Brook	Pass	Pass	0.13	0.34	Pass	Negligible	Neutral insignificant
4+5A+5B	Ingrebourne River	Pass	Pass	0.35	0.86	n.a	Negligible	Neutral insignificant
5A+5B	Ingrebourne River	Pass	Pass	0.30	0.73	Fail	Negligible	Neutral insignificant
4+5A+5B+7	Ingrebourne River	Fail	Pass	0.44	1.05	n.a	Negligible	Neutral insignificant
Key: EQS = Environmental Quality Standards; RST= Run-off Specific Threshold; *copper threshold at high hardness (>200 mg/l $caco_3$) is 10 µg/l; **zinc threshold 7.8; n.a = not applicable as >100 m in distance from outfalls								

Table 8.15: Method D pollution impacts from accidental spillages from the Scheme with mitigation

Catchments reference	Receiving watercourse	With mitigation		
		Return period (years)	Magnitude of potential impact	Significance
1+2+3+6A+6B+6C	Weald Brook	701	Negligible	Neutral insignificant
4+5A+5B+7	Ingrebourne River	434	Negligible	Neutral insignificant
1+2+3+4+5A+5B+6A+6B+6C	Weald Brook + Ingrebourne River	233	Negligible	Neutral insignificant

Residual effects

8.10.30 This section describes the likely residual effects of the Scheme following the implementation of avoidance and mitigation measures.

8.10.31 Very large to moderate effects are considered significant and slight and neutral effects are considered not significant, in accordance with standard EIA practice.

Construction

Surface water

8.10.32 For surface water receptors, subject to the correct implementation of all mitigation measures, the overall residual effect on surface water has been assessed as neutral which is considered not significant.

8.10.33 As no significant effects on surface water features have been identified, no significant residual effects on licenced abstractions or consented discharges are predicted.

Groundwater

8.10.34 As for surface water, likely impacts from road construction activities are typically temporary and can be mitigated through good engineering practices.

8.10.35 For groundwater receptors, subject to the correct implementation of all mitigation measures, the overall residual effect on groundwater has been assessed as neutral which is considered not significant.

Flood risk

8.10.36 No residual impacts to flood risk are anticipated.

WFD

8.10.37 Subject to the mitigation measures being implemented and guidance on the principles of WFD compliant design being adhered to, the Scheme will be compliant with the WFD and there will be no overall residual effect.

Operation

Surface water

8.10.38 For surface water receptors, subject to the correct implementation of all mitigation measures, the overall residual effect on surface water has been assessed as neutral which is considered not significant.

Groundwater

8.10.39 No residual impacts to groundwater are anticipated.

Flood risk

8.10.40 No residual impacts to flood risk are anticipated.

WFD

8.10.41 Subject to the mitigation measure being implemented and guidance on the principles of WFD compliant design being adhered to, the Scheme will be compliant with the WFD and there will be no overall residual effect.

8.11 Cumulative effects

8.11.1 Cumulative effects can arise from within one scheme, for example the combined impacts of multiple drainage outfalls on a single receiving watercourse and where more than one Scheme is under construction at the same time that has the potential to impact on the same receptor. These types of impacts have been assessed as part of the EIA and the results are summarised below and presented in Table 8.16.

8.11.2 A Method A cumulative HAWRAT assessment for outfalls within 1 km of one another other and discharging into the same watercourse was completed. Sediment was not assessed as part of the cumulative assessment where outfalls are more than 100 m apart from one another.

8.11.3 The input parameters for the assessment was based on the combined impermeable and permeable drainage from the outfalls. To avoid overcompensating the removal efficiency of measures, the mitigation removal of the features (e.g ditches) was scaled proportionately to the area the mitigation is proposed, For example, catchments 6A and 6B+6C all have ditches which provide 25% sediment removal. A removal total of 50% would be incorrect as catchment 6A only makes up 34% of the total combined area as 66% is from catchments 6B+6C. Therefore, the ditch in catchment 6A alone would only remove 9% of sediment and 6B+6C 16%, providing a total removal of 25%.

8.11.4 A cumulative assessment for outfalls discharging into the Weald Brook and the Ingrebourne River was undertaken.

8.11.5 All the catchments which were aggregated for Weald Brook pass the Method A surface water quality tests with mitigation and would have a negligible impact with neutral significance of effect. This is deemed not significant.

8.11.6 All the catchments which were aggregated for the Ingrebourne River pass the Method A surface water quality tests with mitigation and would have a negligible impact with neutral significance of effect. This is deemed not significant

8.11.7 A cumulative assessment for outfalls discharging into Weald Brook and the Ingrebourne River was undertaken for spillage risk (Method D) and also the combined risk from all outfalls given Weald Brook is in direct hydraulic connectivity to the Ingrebourne River. It is assessed that there should be no significant adverse cumulative effects risk of accidental spillages as presented in Table 8.14.

8.11.8 All HAWRAT results (Method A, Method D and cumulative assessments) are provided in Appendix 8.1.

8.11.9 Additionally, cumulative impacts can arise where more than one Scheme is under construction that has the potential to impact on the same receptor. These sorts of impacts have been assessed as part of the method for the ES and the results are summarised below and presented in Table 8.12. Typically, new developments increase impermeable area and run-off. They can potentially

cause drainage pathways to be altered and can provide an increased source of pollution to shared water receptors.

8.11.10 Only developments within the study area have been assessed. For developments shown on Figure 15.1, drainage strategies should be in place or proposed for these developments. These separate drainage systems should accommodate their own temporary drainage requirements during the construction phases and appropriate mitigation that should ensure minimal impacts to water through construction and operational phases.

8.11.11 With this in mind, it is assessed that there should be no significant adverse cumulative effects during construction or once operational.

Table 8.16: Cumulative effects

Other scheme	Cumulative impact on assets affected by scheme
The Lower Thames Crossing	Lower Thames Crossing is currently developing the preliminary design and as such, detailed information regarding the likely construction programme was not available at the time of reporting.. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the Ingrebourne River indirectly (located approx. 1.7 km downstream) from tributaries which are approximately 315 m downstream of the development. Groundwater aquifers which are located beneath the development also have the potential to be impacted. Potential impacts during construction and operation to the surface water and groundwater environment are documented in the above sections. During construction adherence to best practice guidance and the adoption of good working practices and strict adherence to the EA Pollution Prevention Guidance (PPGs) during construction means there should be no significant adverse cumulative effects during construction. With the adoption of mitigation measures there should be no significant adverse cumulative effects during operation.
28 small, medium, large wind development sites	Information regarding the likely timescales for construction of these developments was not publicly available at the time of reporting. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the Weald Brook and drainage channels / tributaries of Weald Brook which are adjacent to the development. There could also be potential impacts to the Ingrebourne River located approximately 100 m downstream of the proposed windfarm development. Potential impacts during construction and operation to the surface water and groundwater environment are documented in the above sections. During construction adherence to best practice guidance and the adoption of good working practices and strict adherence to the EA PPGs during construction means there should be no significant adverse cumulative effects during construction. With the adoption of mitigation measures there should be no significant adverse cumulative effects during operation.
The Caravan Park, Putwell Bridge - addition of Gypsy and Traveller Site	Information regarding the likely timescales for construction of this development was not publicly available at the time of reporting. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the Ingrebourne River which is adjacent to the proposed Putwell Bridge development and groundwater aquifers which are located beneath the development. The development is downstream of

Other scheme	Cumulative impact on assets affected by scheme
	Weald Brook (approximately 120 m from Putwell Bridge) so no impacts are assumed. Potential impacts during construction and operation to the surface water and groundwater environment are documented in the above sections. During construction adherence to best practice guidance and the adoption of good working practices and strict adherence to the EA PPGs during construction means there should be no significant adverse cumulative effects during construction. With the adoption of mitigation measures there should be no significant adverse cumulative effects during operation.
Land East of Nags Head Lane - residential development	Information regarding the likely timescales for construction of this development was not publicly available at the time of reporting. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the Ingrebourne River which is approximately 220 m north of the residential development and associated tributaries/drains located approximately 200 m south of the development. There is also potential impact to the groundwater aquifers which are located beneath the development However, residential developments will typically have a low pollution risk once constructed and will be required to follow well established best practice guidance to mitigate pollutant loading and flood risk. It is considered likely that the development would have appropriate mitigation in place in order to obtain planning permission and therefore there should be no significant adverse cumulative effects during operation.
Gardens of Peace (formerly known as Land at Oak Farm) - change of use of land to burial grounds	Construction has commenced for this scheme at the time of reporting. It is unknown if the construction programme will overlap with this Scheme. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the Ingrebourne River which is adjacent to the development and groundwater aquifers which are located beneath the proposed burial ground development. The development is downstream of Weald Brook (approximately 120 m from Putwell Bridge) so no impacts are assumed. Potential impacts during construction and operation to the surface water and groundwater environment are documented in the above sections. During construction adherence to best practice guidance and the adoption of good working practices and strict adherence to the EA PPGs during construction means there should be no significant adverse cumulative effects during construction. With the adoption of mitigation measures there should be no significant adverse cumulative effects during operation.
Regent House - residential development	Information regarding the likely timescales for construction of this development was not publicly available at the time of reporting. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the tributary/drain of the Ingrebourne River which is adjacent to the development and indirectly to the Ingrebourne River which is approximately 500 m downstream of the development. Groundwater aquifers which are located beneath the development also have the potential to be impacted. However, residential developments will typically have a low pollution risk once constructed and will be required to follow well established best practice guidance to mitigate pollutant loading and flood risk. It is considered likely that the development would have appropriate mitigation in place in order to

Other scheme	Cumulative impact on assets affected by scheme
	obtain planning permission and therefore there should be no significant adverse cumulative effects during operation.
Regent House - residential development	Information regarding the likely timescales for construction of this development was not publicly available at the time of reporting. For a conservative assessment it is therefore assumed to take place at the same time as the Scheme. As such, there could be potential cumulative effects to the water environment, particularly to the tributary/drain of the Ingrebourne River which is adjacent to the development and indirectly to the Ingrebourne River which is approximately 500 m downstream of the development. Groundwater aquifers which are located beneath the development also have the potential to be impacted. However, residential developments will typically have a low pollution risk once constructed and will be required to follow well established best practice guidance to mitigate pollutant loading and flood risk. It is considered likely that the development would have appropriate mitigation in place in order to obtain planning permission and therefore there should be no significant adverse cumulative effects during operation.
Boyles Court Farm	Although within the 1 km ZOI, this development is 1.6 km upstream of the scheme works. On the assumption that water quality impacts beyond 1 km will be sufficiently diluted, in conjunction with good site practice, no impacts are anticipated.

8.12 NPS NN compliance

8.12.1 Paragraph 5.221 of the NPS NN sets out that where a development is likely to have significant adverse effects on the water environment, assessment of the impacts is required. In line with the NPS NN requirements this chapter of the ES ascertains the existing status of and undertakes an assessment of the impacts of the proposed Scheme on water quality, water resources and physical characteristics.

8.12.2 The NPS NN also states that development proposals should have regard to the relevant RBMP and the requirements of the WFD (including Article 4.7) and its daughter directives, including those on priority substances and groundwater. A WFD Compliance Assessment has been prepared and appropriate design and mitigation measures has been incorporated into the Scheme to facilitate WFD compliance.

8.12.3 The principles of how developments are to be assessed by the Examining Authority and the Secretary of State with respect to pollution control and other environmental protection regimes are detailed in paragraphs 4.48 to 4.56 of the NPS NN. Key requirements are that any discharges or emissions from a scheme may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes and relevant permissions will need to be obtained for such activities with permit applications submitted at least six months prior to submission of a DCO.

8.12.4 With regard to flood risk and surface water drainage, the NPS NN supports the NPPF (DCLG, 2012). In line with the Flood Risk section (paragraphs 5.90 to 5.115) of the NPS NN, the Scheme would be subject to a FRA that considers all sources of flood risk. The FRA would be informed by consultation with the EA and relevant LLFA. The FRA would also be informed by the results of any hydrological and hydraulic modelling undertaken to define baseline flood risk,

quantify any Project impacts on this baseline, and to inform the design of any necessary flood risk management measures. An FRA has been completed for the Scheme (application reference TR010029/APP/6.6). The Scheme design has incorporated a drainage strategy that centres on the application of SuDS, appropriate to local conditions, to manage surface water runoff.

8.12.5 NPS NN encourages pre-application discussions with all relevant regulators to begin as early as possible. Discussions with stakeholders, including the EA has taken place regarding the WFD Compliance Assessment and FRA these are documented in the consultation section above.

8.13 Monitoring

8.13.1 To ensure mitigation measures are properly implemented it is essential there is effective environmental management throughout the construction, operation and aftercare of the Scheme.

8.13.2 The Outline CEMP (application document TR010029/APP/7.2) will ensure that environmental issues are properly addressed initially through the construction phase and the operation and aftercare of the Scheme. The Outline CEMP includes monitoring plans to assess the effectiveness of a) river realignments (to restore natural form and function); b) management of riparian trees and backwater and c) floodplain lowering.

8.14 Summary

8.14.1 The spatial scope of the assessment has included features of the water environment within 1 km of the Scheme.

8.14.2 The assessment has considered the impacts (both construction and operation) on water quality (both surface and groundwater), flood risk through the means of an FRA (application document TR010029/APP/6.6) and the compliance with the WFD (application document TR010029/APP/6.7).

8.14.3 Key water environment receptors within the study area include:

- Ingrebourne River (GB106037028130), a WFD water body and Main River
- Weald Brook, a Main River
- Floodplains associated with Ingrebourne River and the associated flood zones 2 and 3
- Floodplains associated with Weald Brook and the associated flood zones 2 and 3
- Secondary A bedrock aquifers
- Secondary A and Secondary (undifferentiated) superficial aquifers

8.14.4 The assessment shows that, subject to the correct implementation of all mitigation measures, there will be no significant temporary adverse effects on surface water, WFD compliance, groundwater or fluvial and surface water flood risk during the construction period.

8.14.5 The water quality assessment concluded the following during the operational phase:

- Negligible impact with neutral significance of effect to Weald Brook from the discharge from the Scheme subject to the implementation of the proposed mitigation measures.
- Negligible impact with neutral significance of effect to the Ingrebourne River subject to the implementation of the proposed mitigation measures.
- Spillage risk for all surface water catchments is assessed as negligible with neutral significance subject to the implementation of the proposed mitigation measures.

8.14.6 The FRA concludes that, based on current flood risk understanding and the incorporation of flood risk mitigation, the Scheme would be at an acceptable level of flood risk and would not increase flood risk elsewhere.

8.14.7 The WFD compliance assessment concludes that the Scheme is considered compliant with the requirements of the WFD. The Scheme is not considered to cause deterioration in any WFD quality element at the water body scale. It is not considered to prevent future attainment of GES.

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