A12 Chelmsford to A120 widening scheme TR010060

6.3 ENVIRONMENTAL STATEMENT

APPENDIX 14.6 SURFACE WATER DRAINAGE STRATEGY

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ENVIRONMENTAL STATEMENT
APPENDIX 14.6 SURFACE WATER DRAINAGE STRATEGY

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1 Executive summary

1.1 Proposed scheme overview

1.1.1 The widening of the A12 from Chelmsford to the A120 between junction 19 (Boreham interchange) and junction 25 (Marks Tey interchange) to dual three-lane all-purpose carriageway is one of the schemes to be progressed through the Road Investment Strategy 2 (RIS2) (Department for Transport, 2020) over the next five years (RIS2 – 2020 to 2025). The A12 is an important economic link in Essex and across the East of England. It provides the main south-west to north-east route through Essex and Suffolk, connecting Great Yarmouth and Ipswich in the north-east to the M25 and London in the south-west. The proposed scheme aims to improve safety, solve strategic traffic problems arising from inadequate and varying route standards, and reduce congestion and delay, which will collectively increase resilience for this key part of the Strategic Road Network (SRN) along the A12 main carriageway between junction 19 and junction 25.

1.2 Highway drainage design criteria

1.2.1 As part of the proposed scheme, highway drainage infrastructure must be provided to mitigate the potential for surface water flood risk to the proposed scheme and the surrounding area. The proposed highway drainage systems that will drain the proposed scheme are designed in accordance with the Design Manual for Road and Bridges (DMRB) CG 501 Design of Highway Drainage Systems (Highways England, 2020a) which requires that surface water carrier drains and filter drains within the proposed highway drainage systems are designed to accommodate a 1 in 1-year return period (100% Annual Exceedance Probability (AEP)) storm event in-bore without surcharge over the crown of the pipe. A design check is carried out to ensure that a 1 in 5-year return period (20% AEP) storm event would not cause chamber surcharge levels to exceed the level of the chamber covers. In both cases a climate change allowance is applied to the piped drainage design. Where practicable, sustainable drainage systems (SuDS), flow conveyance and attenuation features (e.g. attenuation ponds, swales, filter drains, etc.) have been used to reduce the impact of surface water runoff being discharged on the natural environment, thereby reducing flood risk and improving water quality. It should be noted that the proposed highway drainage design solutions have been developed based on the information available at the preliminary design stage and the drainage and design criteria discussed in this report.

1.2.2 In accordance with Environment Agency (EA) and DMRB, a climate change allowance of 20% has been applied to the preliminary highway drainage design for all design storm events to account for the anticipated increase in rainfall intensity due to climate change over the proposed scheme design life. A design sensitivity check for a climate change allowance of 40% (i.e. upper-end estimate for the 2080s, (2070 to 2115 time interval) has also

been undertaken to assess the extent of any potential surface water drainage system flooding from the proposed scheme and the associated impact on the proposed scheme permanent acquisition of land boundary for this upper end estimate. In May 2022, the Environment Agency updated the climate change guidance, with new values for climate change allowances for rainfall intensity, to account for the UKCP18. Given the timing of the revised guidance being published, it will not be possible to incorporate it into the proposed highway drainage design presented in this report and also ensure the DCO application is submitted in a timely fashion (given the time it would take to update this report). However, it is proposed that the guidance will be considered post-submission (and ideally pre-examination), by way of a sensitivity test that will report the implications of the new guidance on the assessments undertaken to date. The results of this will be submitted to the examination and will, as necessary to reflect any updates, be the basis on which the detailed design of the scheme is undertaken, should the DCO be granted.

1.3 Pavement edge collection drainage systems

1.3.1 Pavement edge collection drainage systems will be required as part of the proposed highway drainage systems to effectively collect surface water runoff from the proposed scheme. The type of edge collection drainage system will vary across the proposed scheme depending on the highway geometry and site-specific constraints (e.g. spatial constraints, etc.). The proposed edge collection drainage system principles are as follows:

- Where the proposed highway is located at-grade or on embankment, it will be drained with concrete surface water channels or a linear slot drainage system located in either the central reserve or adjacent to the verge depending on the carriageway crossfall. For instances where the central reserve and verges are spatially constrained, a linear slot drainage system is proposed.

- Where the proposed highway is located in cutting, it will be drained with combined filter drains if the carriageway crossfall falls towards the verges. For instances where the carriageway falls towards the central reserve, it will be drained by a concrete surface water channel (where space is available) or a linear slot drainage system (where space is constrained).

- At locations such as junctions, slip roads, realigned side roads, roundabouts and laybys, these will be drained by a kerb and gully arrangement, or by combined kerb drainage (i.e. where the proposed highway longitudinal gradient is insufficient for a kerb and gully arrangement). Regarding slip roads, where there is no kerbline proposed, a form of linear drainage will be required to drain the proposed highway which could be either linear slot drainage, filter drains, surface water channels or over-the-edge drainage.

- For proposed overbridges, bridge deck drainage units (a kerb drainage system used on the top of bridge decks) will be used.
- Sub-surface drainage will be provided on all new pavement construction for both online and offline sections of the proposed scheme where it is needed to drain and protect the underlying road pavement layers. This will connect into the proposed highway drainage system.

1.4 Surface water runoff flow conveyance systems

1.4.1 Surface Water runoff flow conveyance systems will be required as part of the proposed highway drainage systems to effectively convey the surface water runoff collected by the proposed scheme pavement edge collection drainage systems and discharge it to a nearby waterbody. The primary flow conveyance system used are surface water carrier drains where the proposed highway is either at-grade or on embankment. In locations where the proposed highway is in cutting combined filter drains are the primary flow conveyance system used. In a small number of locations where there is sufficient space available swales are used as the flow conveyance system.

1.5 Attenuation storage

1.5.1 Attenuation storage is built into the proposed highway drainage systems to facilitate the restriction of the proposed discharge rates to an allowable discharge rate equivalent to the existing site condition brownfield runoff rates (i.e. proposed online highway widening works) or greenfield runoff rates (i.e. proposed new offline highway works). For the estimation of the brownfield and greenfield discharge rates, it should be noted that a minimum practicable allowable discharge rate of 5l/s is used to inform the proposed highway drainage design based on a minimum flow control diameter of 100mm for both vortex flow control devices and orifice plates which is appropriate and takes into account the blockage risk and maintenance. Attenuation storage is primarily provided by means of attenuation ponds where there is sufficient land available. In more spatially constrained locations attenuation storage is provided by either oversized pipes, vegetated ditches, swales or underground geocellular attenuation storage systems depending on the site-specific constraints. Where required, an appropriate flow control device is proposed immediately downstream of the proposed attenuation storage that will restrict the discharge to achieve the allowable rates. The proposed attenuation storages are sized for design storm events up to and including the 1 in 100-year return period (1% AEP) storm event with a climate change allowance applied to account for the anticipated increase in rainfall intensity due to climate change. Refer to Section 1.2 for the applied climate change allowances.

1.6 Natural catchment drainage

1.6.1 The A12 crosses natural terrain and therefore either obstructs or intercepts natural catchment flow paths, which require natural catchment drainage measures in the form of proposed drainage ditches and / or filter drains to mitigate flood risk. Depending upon the proposed highway geometry, drainage ditches will be required at the top of cutting slopes and at the bottom of embankments. Where appropriate, filter drains may need to be considered instead of drainage ditches for spatially constrained locations. As far as reasonably practicable, the proposed drainage ditches and filter drains will be designed to maintain the existing natural drainage catchment areas that drain to the natural watercourses.

1.6.2 The A12 also crosses a number of Main Rivers, Ordinary Watercourses and land drainage ditches. These watercourses need to be conveyed under the A12.

1.7 Infiltration potential assessment

1.7.1 Along the proposed scheme highway alignment, the preliminary ground investigation (GI) includes ground permeability testing to inform the feasibility of using infiltration techniques in the development of the proposed highway drainage design. The infiltration rates determined from the ground permeability testing were generally poor to practically impervious and in a number of cases there was an insufficient fall in the water level during the permeability testing to calculate the infiltration rates. Although River Terrace, Glaciofluvial, Kesgrave Sand and Gravel Deposits are present throughout the proposed scheme, they can be highly variable and often contain a significant percentage of fines (i.e. clay and silt). The presence of clay and silt material within a coarser matrix (sands and gravels) can significantly reduce permeability and therefore make infiltration generally unfeasible.

1.7.2 Regarding the infiltration potential at the proposed attenuation storage locations, an assessment of the recorded groundwater levels, infiltration rates and contaminated land presence has been undertaken throughout the proposed scheme. The preliminary GI has been undertaken at the proposed attenuation pond locations and four proposed swale locations. It is generally found across the proposed scheme that a number of proposed attenuation storage locations require no impermeable liner, and a lesser number can rely on infiltration due to shallow groundwater and the generally poor to practically impervious ground drainage conditions identified by the assessment of the preliminary GI to date. The recommendations for the use of an impermeable liner are provisional at present given the preliminary GI undertaken to date. The recommendations for the use of an impermeable liner will be reviewed at the detailed design stage when further GI data becomes available regarding soil infiltration rates, contaminated land issues and groundwater levels to ensure there are no adverse environmental impacts due to the proposed scheme.

1.8 Exceedance flow assessment

1.8.1 Regarding the exceedance flow assessment, the proposed highway drainage systems have been assessed for the following design events:

- The 1 in 100-year return period storm event (plus 20% climate change allowance) for storm durations ranging from 15 minutes to 24 hours to establish the critical storm duration
- The 1 in 100-year return period storm event (plus 40% climate change allowance) for storm durations ranging from 15 minutes to 24 hours to establish the critical storm duration

1.8.2 The 1 in 100-year return period storm events plus climate change allowances are assessed to ensure that there are no potential surface water drainage flooding impacts to road users and third-party land outside the proposed scheme permanent acquisition of land boundary. The exceedance flow assessment findings for the 20% and 40% climate change allowances are presented in Section 9. It should be noted that a flood risk impact assessment has been undertaken with regard to the proposed flood extents and the associated flood depths. This is discussed within the Flood Risk Assessment (Appendix 14.5 of the Environmental Statement (ES) [TR010060/APP/6.3]).

1.9 Water quality

1.9.1 In order to protect the receiving waterbodies from a potential increased pollution risk as a result of the proposed scheme, water quality treatment measures within the proposed highway drainage systems are required for some drainage catchments. Where practicable, SuDS features incorporated within the highway drainage proposals, such as attenuation ponds, filter drains and swales will provide treatment of the surface water runoff. Water quality assessments have been undertaken for the proposed scheme in accordance with the National Highways (previously Highways England) Water Risk Assessment Tool (HEWRAT) in accordance with DMRB LA 113: Road Drainage and the Water Environment (RDWE) Revision 1 (Highways England, 2020b). The Water Quality Assessment Report (Appendix 14.1 of the ES [TR010060/APP/6.3]) concludes that between all single and cumulative HEWRAT routine surface water runoff assessments (simple and detailed) undertaken, the proposed highway drainage design and the mitigation measures (i.e., SuDS features) that are incorporated within it, the overall impact to receiving surface waters during operation of proposed scheme is anticipated to be ‘Not Significant’.

1.10 Operation and maintenance

1.10.1 The proposed highway drainage systems will require regular maintenance in order to operate effectively over the design life of the proposed scheme. This is especially important for the SuDS features such as attenuation ponds, vegetated drainage ditches and swales. Consultation is ongoing

with National Highways and Essex Highways to discuss and agree the ownership allocation between both parties, of the proposed highway drainage including the SuDS attenuation features and the associated downstream outfalls within the Order Limits. Also, prior to handover, arrangements for the operation and maintenance of the proposed highway drainage would be agreed with National Highways and Essex Highways.

2 Introduction

2.1 Purpose of report

2.1.1 National Highways has developed the Surface Water Drainage Strategy in support of the Development Consent Order (DCO) application for the A12 Chelmsford to A120 Widening Scheme (hereafter referred to as the 'proposed scheme') in accordance with the requirements of the National Networks National Policy Statement (NNNPS) (Department for Transport, 2014). The purpose of this report is to present the Surface Water Drainage Strategy for the paved and permeable catchment areas associated with the proposed scheme. The proposed highway surface water drainage will be referred to as the proposed 'highway drainage' hereafter. This Surface Water Drainage Strategy addresses the proposed scheme operational highway surface water drainage. The surface water drainage requirements during the construction stage are discussed in the Flood Risk Assessment (ES Appendix 14.5 [TR010060/APP/6.3]) and the Water Management Plan (in the first iteration Environmental Management Plan [TR010060/APP/6.5]).

2.1.2 The following key aspects have been assessed as part of the Surface Water Drainage Strategy, developed in line with SuDS principles:

- Design criteria
- Existing and proposed catchment areas to be drained
- Edge collection methods (e.g. slot drains, combined kerb drains, gullies, combined filter drains, etc.)
- Surface water runoff flow conveyance systems (e.g. carrier drains, drainage ditches, swales, etc.)
- Attenuation storage and flow control systems to achieve the allowable discharge rates
- Pollution control measures to mitigate the potential impacts of highway surface water runoff on receiving watercourses
- Operation and maintenance considerations for the proposed highway drainage systems to ensure that these can be undertaken safely

2.1.3 This Surface Water Drainage Strategy report should be read in conjunction with the documents listed in Table 2.1.

Table 2.1 Additional documents associated with the Surface Water Drainage Strategy

Document Title	Document reference
Water Quality Assessment Report	Appendix 14.1 of the ES [TR010060/APP/6.3]
Flood Risk Assessment	Appendix 14.5 of the ES [TR010060/APP/6.3]

2.2 Proposed scheme and location

2.2.1 The widening of the A12 from Chelmsford to the A120 between junction 19 (Boreham interchange) and junction 25 (Marks Tey interchange) to dual three-lane all-purpose carriageway is one of the schemes to be progressed through the Road Investment Strategy 2 (RIS2) (Department for Transport, 2020) over the five-year period (RIS2 – 2020 to 2025) to relieve congestion on the A12. The A12 is an important economic link in Essex and across the East of England. It provides the main south-west to north-east route through Essex and Suffolk, connecting Great Yarmouth and Ipswich in the north-east to the M25 and London in the south-west. The section of the A12 between Chelmsford and Colchester from junction 19 to junction 25 currently experiences congestion at peak times, with reduced traffic speeds, increased vehicular delays and increased journey times. In addition to the stated traffic issues, the A12 carriageway requires upgrading and repairs, while the widening to three lanes northbound and southbound will require numerous new structures as well as all associated highways works.

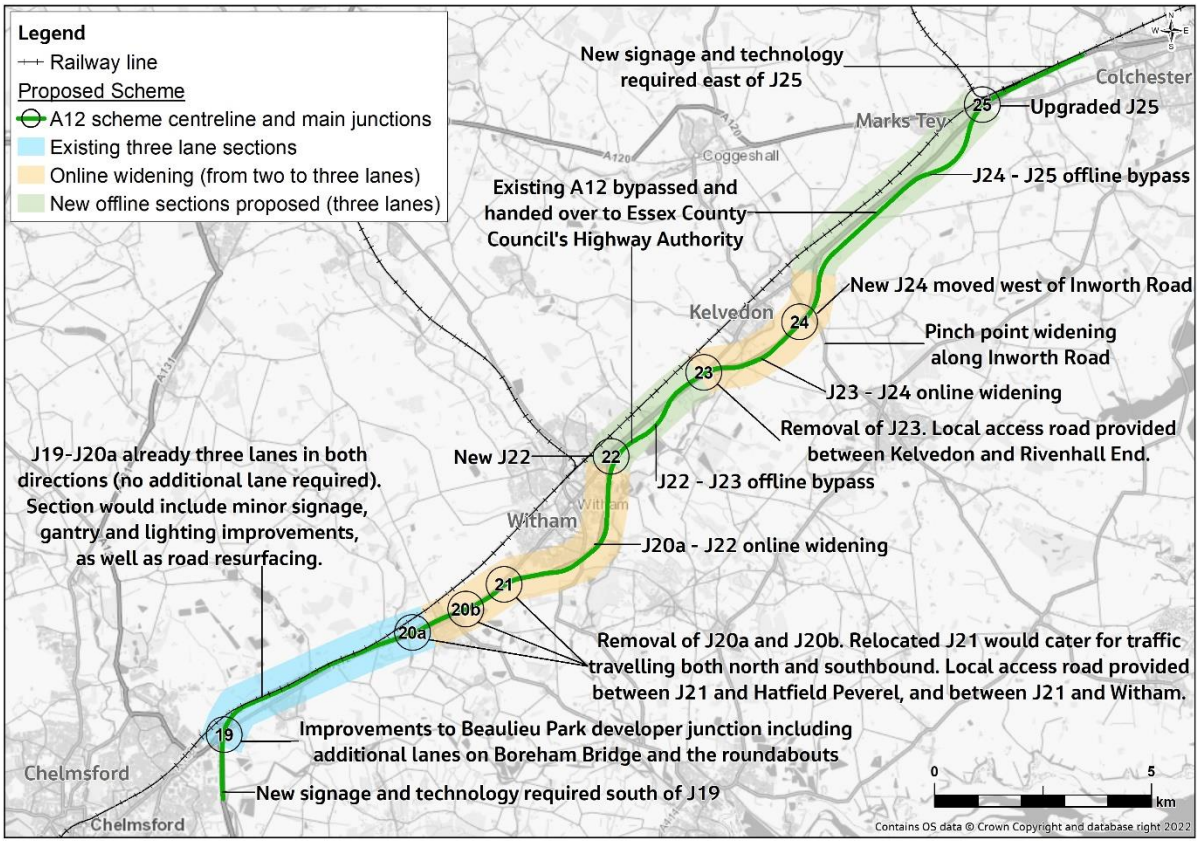
2.2.2 The proposed scheme aims to improve safety, solve strategic traffic problems arising from inadequate and varying route standards, and reduce congestion and delay, which will collectively increase resilience for this key part of the SRN along the A12 main carriageway between junction 19 and junction 25. Based on the DMRB standards, the A12 mainline varies in cross-section between junction 19 and junction 25. This section of the A12 mainline is approximately 24km in length, and predominantly a dual two-lane carriageway with a limited length of dual three-lane carriageway between junction 19 and junction 20a (Hatfield Peverel South Interchange). There are several direct accesses onto the A12 mainline carriageways, particularly between junction 22 (Colemans Interchange) and junction 23 (Kelvedon South Interchange) and between junction 24 (Kelvedon North Interchange) and junction 25.

2.2.3 The proposed scheme involves widening the existing A12 to three lanes (where it is not already three lanes) between junction 19 and junction 25. This would mainly involve online widening of the carriageway, with offline bypasses created between junction 22 and junction 23 (i.e. the Rivenhall End Bypass) and between junction 24 and junction 25 (i.e. the Kelvedon to Marks Tey Bypass). This would be accompanied by junction improvements at junction 19 and junction 25, the construction of new junctions to cater for traffic movements both northbound and

southbound (i.e. proposed junctions 21, 22 and 24) in addition to the decommissioning and removal of the existing junction 20a, junction 20b and junction 23. Junctions 21 and 22 will be above ground level with a bridge over the A12 to connect both roundabouts. Junction 24 will be built in cutting, with the A12 at ground level and an underpass to connect both roundabouts. Parts of the existing junction 23 would be retained to maintain local access provision, including Cranes Bridge (to be widened) and parts of the southbound and northbound slip roads.

2.2.4 Where the proposed scheme would directly affect existing public rights of way (PRoWs) such as footpaths, bridleways and existing cycle routes, provision of overbridges (or where a direct connection is not feasible, alternative routes using suitable diversions) has been proposed to ensure these remain open once the proposed scheme is open to traffic. Plate 2.1 is an overview plan of the proposed scheme highway design arrangement.

Plate 2.1 Overview of the proposed scheme highway design arrangement



2.2.5 For ease of presentation, the proposed scheme highway drainage design has been split into three sub-sections, namely Drainage Section 1, Drainage Section 2 and Drainage Section 3. The drainage layout key plan illustrates the drainage sub-sections (drawing number HE551497-JAC-LDC-SCHW-DR-D-0800 of the Drainage and Surface Water Plans [TR010060/APP/2.13]):

- **Drainage Section 1** – The Drainage Section 1 highway drainage encompasses the A12 mainline from the southern end of the proposed junction 19 to Oliver's Bridge (i.e. approximately A12 mainline chainage 9450 to 20500). The Drainage and Surface Water Plans [TR010060/APP/2.13] present the proposed scheme chainages.
- **Drainage Section 2 –** The Drainage Section 2 highway drainage encompasses the A12 mainline from Oliver's Bridge to the River Blackwater crossing (i.e. approximately A12 mainline chainage 20500 to 26370).
- **Drainage Section 3 –** The Drainage Section 3 highway drainage encompasses the A12 mainline from the River Blackwater crossing to the proposed scheme end at its tie-in to the vicinity of Marks Tey interchange (i.e. approximately A12 mainline chainage 26370 to 27085 and chainage 30000 to 40000).

2.3 Statutory consultees and stakeholders

2.3.1 The following parties summarised in Table 2.2 have been identified as drainage-related statutory consultees and stakeholders and have been consulted accordingly to inform the preliminary highway drainage design for the proposed scheme.

Table 2.2 Statutory consultees and stakeholders consulted to inform the Surface Water Drainage Strategy

Statutory consultee / stakeholder	Consultation purpose
Environment Agency (EA)	Under the Flood and Water Management Act 2010, the EA has direct responsibility for the mitigation and remediation of flood damages for Main Rivers. As such, given that a number of outfalls on the proposed scheme will discharge to Main Rivers, the EA has been consulted from the perspective of flood mitigation.
Essex County Council (ECC)	The A12 between junction 19 and junction 25 is located within Essex. ECC is the Lead Local Flood Authority, responsible for the management of local flooding from surface water, groundwater and Ordinary Watercourses. Consultation was required to inform the proposed outfall discharge rates and the drainage design criteria to mitigate flood risk.
Local landowners	Local landowners located in close proximity to the A12 and directly impacted by the

Statutory consultee / stakeholder	Consultation purpose
	proposed scheme have been consulted to inform the proposed surface water drainage at some locations where applicable. In particular for proposed attenuation storage systems (i.e. attenuation ponds and underground geocellular attenuation storage systems) or where drainage routes have to traverse land outside the current A12 highway boundary.
National Highways and Essex County Council (i.e. Essex Highways) road maintenance authorities	The National Highways highway maintenance authority has been consulted to inform the proposed scheme highway drainage design. The Essex Highways maintenance authority will be consulted as the proposed scheme progresses to the detailed design stage. The National Highways maintenance authority will be responsible for maintaining the A12 mainline highway drainage assets while the Essex Highways maintenance authority will be responsible for maintaining the local side road highway drainage assets. National Highways was consulted to inform the drainage design in general and to address Construction (Design and Management) Regulations 2015 requirements (i.e. health and safety) as part of the highway drainage design.

2.4 Main Rivers and Ordinary Watercourses

2.4.1 The proposed scheme is approximately 24km in length from junction 19 to junction 25. It crosses seven Main Rivers and several Ordinary Watercourses. The seven Main Rivers are the Boreham Brook, River Ter, River Brain, Rivenhall Brook, River Blackwater, Domsey Brook and the Roman River. The watercourses crossed are summarised in detail in tabular format within Annex N of the Flood Risk Assessment Report (ES Appendix 14.5 [TR010060/APP/6.3]) with the specific national grid reference coordinates quoted. The watercourses crossed are also identified and labelled accordingly on the Drainage and Surface Water Plans [TR010060/APP/2.13]. For a more detailed description of the watercourses crossed by the proposed scheme, refer to the Flood Risk Assessment (ES Appendix 14.5 [TR010060/APP/6.3]).

2.4.2 Ordinary Watercourses that are crossed and impacted by the proposed scheme offline highway proposals will be realigned and hydraulically re-connected to the upstream and downstream end of the watercourse using

new culverts as required. Existing culverts that are to be retained along the alignment of the existing A12 that is subject to proposed online widening works, will be extended accordingly if affected. Section 10.3 describes the proposed culvert provisions.

2.5 Geology

2.5.1 This section provides a general description of the geology within the proposed scheme extents. A buffer of 250m around the Order Limits has been applied to desk-study searches. The following sources have been used to establish the geological ground model:

- An Envirocheck report (Dated 25 May 2016) for the A12 between junction 19 and junction 25
- A Groundsure report (Dated 19 July 2018) specifically for the A12 alignment between junction 24 to junction 25
- Online British Geological Survey's Geology of Britain Viewer and relevant available historic borehole scans (BGS, 2019a)
- The GeoEssex website (2020). This website provides information on sites designated either as Sites of Special Scientific Interest or as local geological sites within the study area
- The findings of a site-specific preliminary ground investigation undertaken from 2020 to 2021, the findings of which have been summarised in a Ground Investigation Report

2.5.2 The study area is underlain by a bedrock geology consisting of the London Clay Formation, part of the Thames Group (clay with some silts and sands). The London Clay Formation is expected to be underlain by the undifferentiated Paleogene Lambeth Group and Thanet Formation (both consisting of silts, sands and gravel) and the Cretaceous Chalk. The geological maps, based on historical deep boreholes, indicate that the Thanet Sand Formation sub-crops beneath a cover of superficial deposits at two locations along the alignment: north-east of Witham, and south-west of Kelvedon. The sub-crops are a result of erosion associated with a deep drift-filled buried glacial channel which runs along the River Blackwater Valley in an approximately south-west to north-east direction from Witham to north-east of Kelvedon. The top of the Thanet Sand Formation was recorded as 77.1m bgl (below ground level) and 64.5m bgl at the two locations respectively, with the underlying top of the Chalk recorded at 87.4m bgl and 79.4m bgl. The current GI did not extend to sufficient depth to confirm the Paleogene deposits as the proposed construction works, including piled foundations, will not extend to such great depth. In addition, due to the significant cover of generally low-permeability deposits, the shallow groundwater is unlikely to be in hydraulic continuity with the underlying major Chalk aquifer.

2.5.3 The superficial geology comprises Head deposits (clay, silt and sand), Brickearth and localised Alluvium (clay, silt and sand), River Terrace

Deposits (sand and gravel), Lowestoft Formation (formed of Diamicton), Glaciofluvial deposits (sand and gravel) and Interglacial Silt and Clay / Glaciolacustrine materials (clays and silts). The Kesgrave Catchment Subgroup (sand and gravel) is only present in the north of the site area.

2.5.4 Localised areas of Made Ground, worked ground and infilled ground are present within the study area associated with historical land uses. This includes infilled historical mineral sites identified in several places along the proposed scheme, and the dismantled Witham and Kelvedon branch railway lines decommissioned in the 1970s, both crossing the current alignment of the A12. Localised pockets of potentially contaminated land are also present within the study area associated with some current and historical land uses. This includes potentially contaminated land associated with a historical sewage treatment works, a historical nursery, a nearby petrol station, etc.

2.5.5 There is one designated geological Site of Special Scientific Interest, Marks Tey Brickpit, located 115m north-west of junction 25, which is designated due to its geological features. Based on the GeoEssex database, there are no local geological sites within 250m of the proposed scheme. There are no other designated sites within 250m of the study area, including regionally important geological or geomorphological sites (RIGS) which are non-statutory designated sites for geology.

2.5.6 Where practicable, depending on the geology, the proposed highway drainage collection and conveyance features (e.g. filter drains, drainage ditches, etc.) and attenuation storage features (e.g. attenuation ponds, underground geocellular attenuation storage systems, etc.) will incorporate infiltration methods in line with SuDS principles. Section 8 describes if and where infiltration methods can potentially be used on the proposed scheme. This is informed by the available preliminary GI data at the time of writing this report. Section 8 assesses the key aspects which govern the use of SuDS infiltration methods including the infiltration capacity of the geology, groundwater levels and any identified potential contaminated land issues.

2.6 Flood risk

2.6.1 A Flood Risk Assessment (FRA) has been developed for the proposed scheme in parallel with the Surface Water Drainage Strategy. The FRA demonstrates that with appropriate flood risk mitigation measures, the proposed scheme will remain operational and safe for users in times of flood and will not increase flood risk elsewhere. The key findings of the FRA with respect to the proposed scheme Order Limits can be found in ES Appendix 14.5 [TR10060/APP/6.3].

3 Existing highway drainage

3.1 Overview

3.1.1 The purpose of this section is to provide a general description of the existing site and the associated existing highway drainage which will be impacted by the proposed scheme. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 to 0821 within the Drainage and Surface Water Plans [TR010060/APP/2.13] present both the existing and proposed highway drainage catchment extents.

3.2 Existing site

3.2.1 The proposed scheme lies within Essex, passing mainly through the Braintree and Colchester administrative areas, in addition to those of Chelmsford and Maldon. Chelmsford is located to the south-west of the proposed scheme and Colchester to the north-east. The A12 lies adjacent to the smaller settlements of Boreham, Hatfield Peverel, Witham, Rivenhall End, Kelvedon, Feering and Marks Tey. There are also individual business and residential properties which front directly onto the A12.

3.2.2 The A12 from junction 19 to junction 25 is approximately 24km in length, and is predominantly a dual two-lane carriageway with a limited length of dual three-lane carriageway between junction 19 and junction 20a. There are several direct accesses onto the A12 carriageways, particularly between junction 22 and junction 23 and between junction 24 and junction 25. The A12 runs in parallel and to the south of the Great Eastern Main Line railway for most of its length between junction 19 and junction 25. Major connecting roads to the A12 include the A130 which joins the A12 at junction 19 and the A120 which joins the A12 at junction 25. The B1018 and the B1019 local roads link Maldon to Witham and Hatfield Peverel respectively. The B1023 local road links Kelvedon and Tiptree.

3.2.3 Land use outside the A12 itself and the built-up areas in its vicinity, is generally broadacre arable cropping with pockets of other farming types. There are a number of large commercial plots (over 100 hectares) along the route. Soils are generally classed as ‘good’ or ‘very good’ according to Agricultural Land Classification data.

3.2.4 As described in Section 2.4, the A12 crosses seven Main Rivers between junction 19 and junction 25. These are Boreham Brook, River Ter, River Brain, Rivenhall Brook, River Blackwater, Domsey Brook and Roman River. The watercourses crossed are identified and labelled accordingly on the Drainage and Surface Water Plans [TR010060/APP/2.13].

3.2.5 The existing vegetation in the vicinity of the A12 includes general highway vegetation, the pattern of small woodland blocks and copses scattered throughout the wider surrounding landscape, and hedgerow boundaries. There are also watercourses lined with trees, woodland and locally distinctive plantations along the River Blackwater.

3.2.6 The key environmental designations and features along the route include the Blackwater Valley Landscape Character Area; Whetmead Local Nature Reserve to the east of the A12 at Witham; and Boreham House and Braxted Park registered parks and gardens near junction 19 and Great Braxted respectively. There is also the Rivenhall Long Mortuary Enclosure scheduled monument, south of the A12 to the east of Rivenhall End, and a geological Site of Special Scientific Interest to the north of junction 25.

3.2.7 It should be noted that most of the study area is classed as a mineral safeguarding area due to the underlying sand and gravel resources in the region. This designation denotes where minerals capable of being an economic resource are considered to be present, and where extraction should take place prior to non-mineral development if practicable, to avoid its sterilisation. There is an active quarry at Colemans Farm, within the river valley at Rivenhall End.

3.3 Existing highway drainage

3.3.1 The existing highway drainage information for the A12 between junction 19 and junction 25 (i.e. the extent of the proposed scheme) has been obtained primarily from drainage surveys (i.e. drainage connectivity and condition assessment surveys (CCTV surveys)) undertaken prior to the preliminary design stage. Other sources of information related to existing highway drainage included National Highways' Drainage Data Management System (HADDMS), available drainage construction drawings/As-Built drainage records, and limited topographical survey information for existing outfalls and watercourse alignments in the vicinity of existing outfalls. These combined sets of information were used to determine the existing highway drainage features, drainage catchments, outfall arrangements and existing culvert crossings within the footprint of the proposed scheme extent.

3.3.2 Using the existing drainage information sources described above, the existing highway drainage catchment extents and associated outfalls have been identified. These are illustrated on the Drainage and Surface Water Plans [TR010060/APP/2.13]. For ease of reference to the Drainage and Surface Water Plans, Tables 3.1 to 3.3 summarise the existing catchment areas, the existing A12 sub-catchment drained (e.g. junction 19, A12 mainline, local side road, etc.) and the applicable Drainage and Surface Water Plan drawing number. In summary, 15 existing drainage catchments have been identified for Drainage Section 1, 17 existing drainage catchments for Drainage Section 2 and 27 existing drainage catchments for Drainage Section 3.

3.3.3 Based on the assessment of the aforementioned drainage information sources, the primary drainage elements identified along the existing A12 within the proposed scheme extent, include the following surface water drainage edge collection features:

- Concrete surface water channels with catchpit gratings at regular intervals

- Kerb inlet gullies and traditional kerb / gully drainage arrangements
- Combined kerb drainage alignments
- Filter drains

3.3.4 Concrete surface water channels are the most commonly used edge collection feature along the existing A12 mainline while traditional kerb and gully drainage and/or kerb inlet gullies are most common through small urban and residential areas encountered along the A12. This is also the case at junction locations with other local and side roads. Combined kerb drainage is used for the kerb edges on bridge decks, along road edges for underbridges (e.g. where it is not practicable to continue drainage methods such as concrete surface water channels, filter drains, etc.), lay-bys or at junction locations with other local roads.

3.3.5 The collected surface water runoff from these edge collection features generally appears to be drained using carrier drains in particular where the existing highway is on embankments, and by combined surface and sub-surface filter drains where the existing highway is in cutting. Drainage ditches and toe drains are typically found to drain the existing highway embankments. Existing highway drainage systems within the proposed scheme extent generally have outfalls discharging to nearby field drains, open ditches, watercourses, and/or Main Rivers depending on their proximity to the highway. In some cases the existing highway drainage outfalls discharge directly into existing culverts that cross under the A12. For the proposed scheme the direct discharge of proposed highway drainage outfalls to culverts is avoided in favour of discharging to an open watercourse. The drainage surveys of the proposed scheme extent were limited at some locations, so the ultimate discharge point/outfalls could not be confirmed. For such locations, the highway drainage discharge is assumed to maintain connectivity to the existing drainage. It is noted that some of the existing minor side roads appear to have no formal highway drainage system and rely on ‘over-the-edge’ drainage into nearby field ditches or runoff into adjacent land.

3.3.6 The presence of existing surface water attenuation features such as attenuation ponds, underground attenuation storage tanks, flow control devices or pollution control measures were not found by the drainage surveys and site investigation undertaken prior to the preliminary design stage. It should also be noted that the drainage surveys could not confirm the presence of soakaways and/or other infiltration techniques other than a few localised soakaway chambers along the A138 highway just north of junction 19. There is also little relevant supporting highway drainage information in HADDMS and the As-Built drainage records. As a result, it is likely that the existing highway drainage surface water runoff discharges directly into the nearby receiving waterbody types mentioned previously.

3.3.7 Generally, the drainage surveys and other sources of information available at the preliminary design stage were found to be sufficient to inform the understanding of the existing highway drainage for the A12 mainline

alignment. However, there are some gaps in the current information for existing outfalls and the existing highway drainage along the minor and local roads. Appropriate design assumptions have been made where necessary; these would need to be confirmed through further drainage surveys prior to the detailed design stage. There may also be a need to determine the condition of any existing piped drainage and outfalls to be retained as part of the proposed highway drainage design. Where existing highway drainage is to be retained as part of the proposed highway drainage design, this is described under the relevant proposed highway drainage catchment sub-section in Section 6. Where the existing highway drainage is impacted by the proposed highway widening works and / or inadequate hydraulic capacity such that it could not be retained then the affected existing highway drainage would either need replacement and/or upgrading.

3.3.8 The maintenance responsibility for the existing highway drainage system serving the A12 is with National Highways. However, any surface water drainage assets located on local roads are the responsibility of the local highway authorities.

Table 3.1 Drainage Section 1 Existing highway drainage catchments

Number	Existing catchment	Existing A12 catchment drained	Drainage and Surface Water Plan drawing number
1	S1-OU1	A12 mainline and junction 19	HE551497-JAC-LDC-SCHW-DR-D-0801
2	S1-OU7	A130 (i.e. adjoins junction 19)	HE551497-JAC-LDC-SCHW-DR-D-0801
3	S1-OU8	A138 mainline	HE551497-JAC-LDC-SCHW-DR-D-0801
4	S1-OU10	B1137 (Main Road)	HE551497-JAC-LDC-SCHW-DR-D-0802
5	S1-OU10A	Paynes Lane	HE551497-JAC-LDC-SCHW-DR-D-0802
6	S1-OU12	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0802
7	S1-OU13	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0805
8	S1-OU14	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0805
9	S1-OU15	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0805
10	S1-OU17	A12 mainline and junction 20a / junction 20b	HE551497-JAC-LDC-SCHW-DR-D-0805
11	S1-OU19	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0806
12	S1-OU20	Station Road	HE551497-JAC-LDC-SCHW-DR-D-0805
13	S1-OU21	Station Road	HE551497-JAC-LDC-SCHW-DR-D-0805

Number	Existing catchment	Existing A12 catchment drained	Drainage and Surface Water Plan drawing number
14	S1-OU23	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0807
15	S1-OU24	A12 mainline and junction 21 (Partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0806

Table 3.2 Drainage Section 2 Existing highway drainage catchments

Number	Existing catchment	Existing A12 catchment drained	Drainage and Surface Water Plan drawing number
1	S2-OU3	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0808
2	S2-OU4	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0808
3	S2-OU5	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0808
4	S2-OU8	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0809
5	S2-OU9	A12 mainline and junction 22	HE551497-JAC-LDC-SCHW-DR-D-0810
6	S2-OU10	Little Braxted Lane (Partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0810
7	S2-OU11	Colchester Road	HE551497-JAC-LDC-SCHW-DR-D-0810
8	S2-OU14	A12 mainline (De-trunked in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0810
9	S2-OU15E	A12 mainline (De-trunked in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0811
10	S2-OU17	B1024 (London Road)	HE551497-JAC-LDC-SCHW-DR-D-0812
11	S2-OU18	B1024 (London Road)	HE551497-JAC-LDC-SCHW-DR-D-0812
12	S2-OU19	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0812
13	S2-OU20	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0812
14	S2-OU21	A12 mainline (redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0813
15	S2-OU24	A12 mainline (De-trunked/redundant in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0811

Number	Existing catchment	Existing A12 catchment drained	Drainage and Surface Water Plan drawing number
16	S2-OU25	A12 mainline (De-trunked/redundant in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0811
17	S2-OU26	A12 mainline (De-trunked/Partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0812

Table 3.3 Drainage Section 3 Existing highway drainage catchments

Number	Existing catchment	Existing A12 catchment drained	Drainage and Surface Water Plan drawing number
1	S3-OU1	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0813
2	S3-OU2	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0813
3	S3-OU3	Highfields Lane (partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0813
4	S3-OU4	Highfields Lane (partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0813
5	S3-OU5	Maldon Road (partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0813
6	S3-OU6	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0814
7	S3-OU7	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0814
8	S3-OU8	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0814
9	S3-OU8C	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0814
10	S3-OU8E	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0814
11	S3-OU9	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0814
12	S3-OU15	A12 mainline (de-trunked/partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0818
13	S3-OU16	junction 25	HE551497-JAC-LDC-SCHW-DR-D-0818

Number	Existing catchment	Existing A12 catchment drained	Drainage and Surface Water Plan drawing number
14	S3-OU17	A12 mainline and junction 25	HE551497-JAC-LDC-SCHW-DR-D-0818 and 0819
15	S3-OU18	A12 mainline	HE551497-JAC-LDC-SCHW-DR-D-0819
16	S3-OU19	A12 mainline (Partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0815
17	S3-OU23	London Road and A12 mainline (de-trunked/partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0815
18	S3-OU24	London Road and A12 mainline (de-trunked/partially redundant paved area in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0815
19	S3-OU29	A12 mainline (de-trunked in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0816
20	S3-OU33	A12 mainline (de-trunked in proposed scheme)	HE551497-JAC-LDC-SCHW-DR-D-0817
21	S3-IWR-OU1	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0814
22	S3-IWR-OU2	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0820
23	S3-IWR-OU3	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0820
24	S3-IWR-OU4	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0820
25	S3-IWR-OU5	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0820
26	S3-IWR-OU6	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0820
27	S3-IWR-OU7	Inworth Road	HE551497-JAC-LDC-SCHW-DR-D-0820

Notes:

1. The abbreviation “IWR” in some of the existing catchment labels presented in this table is in reference to the catchments being located on Inworth Road.

4 Highway drainage design overview and criteria

4.1 Overview

4.1.1 A preliminary highway drainage design has been undertaken to demonstrate the feasibility of the proposed scheme with respect to surface water management, the treatment of the surface water runoff and to determine the land take required. This Surface Water Drainage Strategy sets out the design principles and highway drainage design proposals to demonstrate that there will be no significant impact to the receiving watercourses, adjacent properties and adjacent land as a result of surface water runoff from the proposed scheme. It is proposed that SuDS will be used, where practicable, for each highway drainage catchment within the proposed scheme to attenuate and treat the surface water runoff prior to discharging to a receiving watercourse. The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 to 0821), present the highway drainage proposals and associated proposed catchment extents, among other associated drainage features. The proposed works shown on the Drainage and Surface Water Plans may be subject to change as part of design development at the detailed design stage. Any changes will be undertaken using the drainage principles and design criteria stated in this Surface Water Drainage Strategy Report and will be within the proposed scheme Order Limits.

4.2 Sustainable drainage systems

4.2.1 Surface water drainage systems developed in line with the ideals of sustainable development are collectively referred to as sustainable drainage systems (SuDS). The objective of SuDS techniques is to minimise the impacts from a proposed scheme on the quantity and quality of the surface water runoff and to maximise the amenity and biodiversity opportunities.

4.2.2 The traditional method of draining excess surface water runoff from urban areas has been through underground piped drainage systems, designed to prevent flooding locally by conveying the water as quickly as possible away from the site. However, there is a risk of increasing flooding to downstream receptors if appropriate flood risk mitigation is not incorporated.

4.2.3 The philosophy of SuDS is to replicate, as closely as possible, the natural drainage from a site prior to development. The SuDS Manual C753 (CIRIA, 2015) details techniques that should be considered for SuDS and indicates that allowing rainwater to soak into the ground (i.e. infiltration) should take precedence over storing runoff to mimic natural catchment runoff rates (i.e. attenuation). The SuDS Manual has been consulted to establish the most suitable SuDS techniques for the proposed scheme where practicable. The SuDS techniques that have been used throughout the proposed scheme include attenuation ponds, filter drains, vegetated

ditches, swales and underground geocellular attenuation storage systems. The method of SuDS to be used was chosen based on the site-specific constraints (e.g. sufficient land availability to use swales/attenuation ponds which typically require greater land take, and filter drains considered in spatially limited sites, etc.). The SuDS used as part of the proposed scheme's highway drainage systems are discussed in more detail in the site-specific proposed highway drainage catchment descriptions in Sections 6 and 7.

4.2.4 It should be noted that based on the findings of the preliminary GI, *in situ* testing undertaken to date found that ground conditions are generally not suitable across the majority of the proposed scheme for SuDS using infiltration. Section 8 assesses the ground investigation findings with respect to the feasibility of using infiltration methods for the proposed scheme highway drainage catchments.

4.3 Highway drainage design overview

4.3.1 In general, the highway drainage for the proposed scheme will be as summarised in the bullet point list below. Section 6 gives a detailed description of the proposed highway drainage for the various drainage catchments that comprise the proposed scheme (i.e. A12 mainline and junctions).

- **A12 mainline (at-grade or on embankment)** - Where the proposed A12 mainline dual three-lane all-purpose carriageway is located at-grade or on embankment, it will be drained with concrete surface water channels and / or linear slot drainage systems located in either the central reserve or adjacent to the verge depending on the carriageway crossfall orientation. Where the central reserve and verges are spatially constrained, a linear slot drainage system is proposed. The surface water channels and/or linear slot drainage systems will discharge to a formal carrier drain system beneath, that conveys the collected surface water runoff to a nearby receiving watercourse, or existing highway drainage system (where there is no nearby watercourse).
- **A12 mainline (in cutting)** - Where the proposed A12 mainline dual three-lane all-purpose carriageway is located in cutting, it will be drained with combined filter drains if the carriageway crossfall falls towards the verges. In the instances where the carriageway falls towards the central reserve it will be drained by a concrete surface water channel or a linear slot drainage system. The combined filter drains, surface water channels and/or linear slot drainage systems will subsequently discharge to a formal carrier drain system beneath, that conveys the collected surface water runoff to a nearby receiving watercourse, or existing highway drainage system (where there is no nearby watercourse).

- **Junctions, slip roads, side roads, roundabouts and laybys** - There are discrete areas of the proposed scheme such as junctions, slip roads, realigned side roads, roundabouts and laybys that will need to be drained by a kerb and gully arrangement or by combined kerb drainage units (i.e. where the proposed highway longitudinal gradient is insufficient for a kerb and gully arrangement). With regard to slip roads, where no kerbline is proposed, a form of linear drainage (linear slot drainage, filter drains, concrete surface water channels or over-the-edge drainage) will be required.
- **Bridge decks** - Bridge deck drainage units, the kerb drainage system used on the top of bridge decks, will be used on proposed overbridges.
- **Earthworks (embankments and cutting slopes)** - Where space is available, drainage ditches will be provided at the bottom of embankments and at the top of cutting slopes where any adjacent external land falls towards the proposed highway. In more spatially constrained locations, filter drains will be provided at the bottom of embankments and at the top of cutting slopes. Combined filter drains will be provided at the bottom of cutting slopes where the proposed highway carriageway drains towards the base of the cutting slope. Filter drains will be provided at the bottom of cutting slopes where the proposed highway carriageway drains towards the central reserve (i.e. away from the cutting slope). Where earthworks drainage ditches and filter drains do not receive surface water runoff from the proposed highway, the collected surface water runoff will be discharged untreated and unattenuated, directly to nearby receiving watercourses thereby mimicking the natural drainage condition.
- **Sub-surface drainage** - Sub-surface drainage will be provided on all new pavement construction and will connect to the proposed highway drainage system, for both online and offline sections where it is needed to drain and protect the underlying road pavement layers. The need for sub-surface drainage will be assessed and confirmed during the detailed design stage to comply with DMRB CD 524 - Edge of Pavement Details (National Highways, 2021a).

4.3.2 The proposed highway drainage edge collection features will be reviewed as the proposed scheme design progresses through to the detailed design stage.

4.4 Climate change allowance

4.4.1 During the lifetime of the proposed scheme, surface water runoff rates and volumes from the proposed carriageway paved surfaces may increase as a result of the expected increase in rainfall intensity due to climate change. The effects of climate change will have to be mitigated to minimise the risk of surface water drainage flooding in the future. Climate change has been accounted for in the proposed highway drainage design by increasing the peak rainfall intensity by a climate change allowance of 20% for the 2080s (i.e. central estimate for the 2070 to 2115 time interval). This is in

accordance with EA climate change guidance, that was informed by the United Kingdom Climate Projects 2009 (UKCP09), Table 1 (Peak rainfall intensity allowance in small and urban catchments), as of the October 2021 update and the 20% climate change allowance stated in DMRB, CG 501 Design of Highway Drainage Systems (Highways England, 2020a).

4.4.2 In accordance with EA and DMRB, any potential surface water drainage flooding arising on the proposed scheme during the 1 in 100-year return period storm event plus 20% climate change allowance is to be contained within the proposed scheme permanent acquisition of land boundary and not encroach on the surrounding areas. The EA guidance of 20% climate change allowance is the central estimate for the 2080s (2070 to 2115) time interval. In accordance with Section 4.2, DMRB CG 501 Design of Highway Drainage Systems (Highways England, 2020a), the minimum design life for the proposed scheme highway drainage is 60 years, which takes the proposed highway drainage into the time interval 2070 to 2115. This climate change allowance aligns with that for the wider proposed scheme, which has a design life of 100 years, given that the 2070 to 2115 time interval currently represents the most stringent EA climate change allowance criteria. Furthermore, in accordance with DMRB a design sensitivity check for a climate change allowance of 40% (i.e. upper end estimate for the 2080s, 2070 to 2115 time interval) has also been undertaken to assess the extent of any potential surface water drainage flooding from the proposed scheme and the associated impact on the proposed scheme permanent acquisition of land boundary for this upper end estimate. The design sensitivity check for the 40% climate change allowance is for confirmation that there is no increased surface water drainage flood risk to third-party land outside the proposed scheme permanent acquisition of land boundary as a result of the proposed scheme. Therefore, all the surface water drainage models for the proposed highway drainage systems have been simulated for both the 20% and 40% climate change scenarios. Refer to the Lead Local Flood Authority meeting minutes, presented in Annex F.

4.4.3 In May 2022, the Environment Agency updated the climate change guidance, with new values for climate change allowances for rainfall intensity, to account for the UKCP18. Given the timing of the revised guidance being published, it will not be possible to incorporate it into the proposed highway drainage design presented in this report and also ensure the DCO application is submitted in a timely fashion (given the time it would take to update this report). However, it is proposed that the guidance will be considered post-submission (and ideally pre-examination), by way of a sensitivity test that will report the implications of the new guidance on the assessments undertaken to date. The results of this will be submitted to the examination and will, as necessary to reflect any updates, be the basis on which the detailed design of the scheme is undertaken, should the DCO be granted.

4.5 Design standards and guidance

4.5.1 The highway drainage design for the proposed scheme has primarily been developed in accordance with DMRB. The relevant DMRB standards, used for the proposed highway drainage design, are presented and described under the applicable drainage element type sub-heading below for clarity in Section 4.5.2 to Section 4.5.14. The proposed scheme highway drainage design has also been supplemented with the following industry standard guidance:

- The SuDS Manual C753 (CIRIA, 2015)
- Rainfall Runoff Management for Developments (Report No: SC030219) from the Environment Agency (2013)
- Sewerage Sector Guidance Appendix C - Version 2.1 (Water UK, 2021)
- The Manual of Contract Documents for Highway Works (National Highways, 2022)
- Essex County Council Sustainable Drainage Systems Design Guide (Essex County Council, 2020)

4.5.2 Based on the preliminary GI undertaken across the proposed scheme to date, the ground drainage conditions are found to be generally poor to practically impervious. Therefore, at the preliminary design stage, infiltration techniques are not practicable to incorporate in the drainage design. As the proposed scheme progresses through to the detailed design stage, if further GI data raise the possibility of using infiltration techniques, the DMRB CD 530 Design of Soakaways (National Highways, 2021b) design standard will apply.

Surface water channels

4.5.3 The proposed concrete surface water channel design is in accordance with the requirements and guidance provided in DMRB CD 521 Hydraulic Design of Road Edge Surface Water Channels and Outlets (National Highways, 2021c). The surface water channels are sized to accommodate surface water flows for a 1 in 1-year return period storm event within channel. The surface water channel capacity is assessed to ensure that surface water flows for a 1 in 5-year return period storm event do not encroach into the adjacent highway running lane. A climate change allowance is applied to the surface water channel design as described in Section 4.4. Table 4.1 presents the hydraulic design parameters associated with surface water channels.

Linear slot drainage

4.5.4 For superelevated carriageway sections where the width available from the edge of the hard strip to the central reserve barrier is spatially constrained for surface water channels, linear slot drainage is proposed. Linear slot

drainage is sized to accommodate surface water flows for a 1 in 1-year return period storm event within the channel cross-section. The linear slot drainage capacity is designed to ensure that surface water flows for a 1 in 5-year return period storm event do not encroach into the adjacent highway running lane. A climate change allowance is applied to the linear slot drainage design as described in Section 4.4. Table 4.1 presents the hydraulic design parameters associated with the linear slot drainage.

Gullies and combined kerb drainage

4.5.5 The proposed gully spacing design is in accordance with the requirements and guidance provided in DMRB CD 526 Spacing of Road Gullies (Highways England, 2020c). The gully spacing design is to the 1 in 5-year return period storm event. A climate change allowance is applied to the gully spacing design as described in Section 4.4.

4.5.6 Where the gully spacing calculations determine that it is not economical to use gully units, combined kerb drainage units are proposed. This typically arises where the longitudinal slope of the proposed highway is too flat. The design of the combined kerb drainage units is based on achieving no flooding for a 1 in 5-year return period storm event with a climate change allowance of 20%. Table 4.1 presents the hydraulic design parameters associated with the gullies and combined kerb drainage units.

Piped drainage

4.5.7 In accordance with the requirements and guidance provided in DMRB CG 501 Design of Highway Drainage Systems (Highways England, 2020a), surface water carrier drains and filter drains within the proposed highway drainage systems are designed to accommodate a 1 in 1-year return period storm event in-bore without surcharge over the crown of the pipe. A design check is carried out to ensure that a 1 in 5-year return period storm event would not cause chamber surcharge levels to exceed the level of the chamber covers. In both cases a climate change allowance is applied to the piped drainage design, as described in Section 4.4. Table 4.1 presents the hydraulic design parameters associated with the piped drainage.

4.5.8 The proposed highway drainage system as a whole must be assessed for the consequences of exceedance flows associated with the 1 in 100-year return period storm event plus climate change allowance as described in Section 4.4. Any flooding associated with this design event is to be contained within the proposed scheme permanent acquisition of land boundary at depths and velocities that would not represent a safety risk for road users. Section 9 assesses the proposed highway drainage design with respect to exceedance flows in further detail.

Swales

4.5.9 Swales, which fall under the category of vegetated drainage systems, are designed in accordance with the requirements and guidance given in DMRB CD 532 Vegetated Drainage Systems for Highway Runoff (National Highways, 2021d). This states that swale channels should be

designed for a 1 in 5-year return period storm event. It also states that a surcharged channel must be able to cater for a 1 in 10-year return period storm event without overflowing. In both cases, a climate change allowance has been applied to the design of swales as described in Section 4.4 of this appendix. Table 4.1 presents the hydraulic design parameters associated with swales.

Natural catchment drainage ditches and filter drains

4.5.10 Natural catchment drainage ditches are designed in accordance with the requirements and guidance provided in DMRB CD 522 Drainage of Runoff from Natural Catchments (Highways England, 2020d). The drainage ditches are designed to convey the 1 in 100-year return period storm event including a climate change allowance as follows:

- **Proposed scheme in cutting with surface water runoff from the natural catchment flowing towards the proposed scheme** – A proposed drainage ditch will sit at the top of the cutting slope to collect and convey surface water runoff from the natural catchment to a nearby watercourse or culvert. These drainage ditches will be sized to convey surface water runoff for the 1 in 100-year return period storm event plus 40% climate change allowance.
- **Proposed scheme on embankment with surface water runoff from the natural catchment flowing towards the proposed scheme** – A proposed drainage ditch will be provided at the toe of the embankment to collect and convey both surface water runoff from the embankment and the natural catchment. These drainage ditches will be sized to convey surface water runoff from the natural catchment for the 1 in 100-year return period storm event plus 40% climate change allowance.
- **Proposed scheme on embankment with surface water flows from the natural catchment flowing away from the proposed scheme** – A proposed drainage ditch will be provided at the toe of the embankment as a highway drainage ditch to collect and convey surface water runoff from the embankment slope. These drainage ditches will be sized for the 1 in 100-year return period storm event plus 20% climate change allowance and checked against the 40% climate change allowance as per the design criteria stated in Section 4.4. There will not be any natural catchment drainage requirements for these drainage ditches given that the natural catchment is draining away from the proposed scheme.

4.5.11 It should be noted that drainage ditches are sized to greenfield runoff rates given that they will intercept natural catchment runoff. Table 4.1 presents the hydraulic design parameters associated with drainage ditches.

4.5.12 Filter drains (perforated pipes) are used in spatially constrained locations where drainage ditches are not practicable. Section 10 describes the natural catchment drainage principles further.

Culverts

Proposed culverts

4.5.13 Proposed culverts at watercourse crossings and earthworks drainage ditch/ filter drain crossings are designed in accordance with the requirements of DMRB, CD 529 Design of Outfall and Culvert Details (National Highways, 2021e), and CIRIA C786: Culvert Screen and Outfall Manual (CIRIA, 2019). Proposed culverts on Main Rivers and Ordinary Watercourses are designed to convey flows up to the 1 in 100-year return period storm event including a climate change allowance. The Flood Risk Assessment (ES Appendix 14.5 [TR10060/APP/6.3]) provides details on the proposed culvert climate change allowances and the hydraulic design criteria, for example, self-cleansing flow velocities, minimum culvert diameters, freeboard requirements, etc.

Existing culverts

4.5.14 Proposed extensions of existing culverts (to be retained) have generally maintained the existing culvert flow conveyance capacity (culvert extension would retain existing pipe culvert geometry and pipe gradient). Where downstream flood risk issues permit, upsizing and modifications to existing culverts are required in order to consider climate change allowance and reduce flood risk to the proposed scheme. The Flood Risk Assessment (ES Appendix 14.5 [TR10060/APP/6.3]) provides details on the climate change allowances and the hydraulic design criteria considered in the existing culvert hydraulic assessment.

4.6 Rainfall data and hydraulic design parameters

4.6.1 The latest Flood Estimation Handbook (FEH) rainfall data (i.e. FEH2013) (Centre for Ecology and Hydrology, 2020) have informed the hydraulic design of the highway drainage systems for the proposed scheme. This is in line with rainfall data best practice stated in the SuDS Manual C753 (CIRIA, 2015). The FEH rainfall data has been taken as far as the downstream node of the relevant watercourse catchment within which the relevant portion of the proposed highway alignment is located. This gives the best representation of the rainfall distribution across the proposed scheme, given that it extends for approximately 24km between Chelmsford and Marks Tey.

4.6.2 Presented in Table 4.1 below are the various hydraulic parameters that inform the highway drainage design and associated hydraulic modelling for the proposed scheme. Section 5 describes the highway drainage hydraulic modelling methodology in further detail.

Table 4.1 Highway drainage hydraulic design parameters

Parameter	Parameter aspect	Value
Rainfall data		
Rainfall and Inflow	FEH 2013 Rainfall Model[1]	N/A
	Watercourse catchment downstream node coordinates, British National Grid, for rainfall data (i.e. at watercourse crossings with the A12). Catchment node coordinates presented from west to east (junction 19 to junction 25)[2]	
	1. Ordinary Watercourse 1B (River Chelmer Tributary)	1. GB 574100 207900
	2. Ordinary Watercourse 1 (Boreham Hall Cottages)	2. GB 574850 208550
	3. Boreham Brook	3. GB 574600 210000
	4. River Ter	4. GB 578300 211550
	5. River Brain	5. GB 582750 213700
	6. Ordinary Watercourse 11 (near Colemans Quarry)	6. GB 583500 215450
	7. Rivenhall Brook	7. GB 584200 216750
	8. Ordinary Watercourse 17 (near Great Braxted Mill)	8. GB 584900 216600
	9. River Blackwater	9. GB 585550 217650
	10. Domsey Brook 1 (near Inworth Road)	10. GB 587850 219150
	11. Domsey Brook 2 (near Easthorpe Road)	11. GB 589600 221900
	12. Roman River	12. GB 592450 224350
	Global time of entry	5 minutes
	Maximum time of concentration	60 minutes
	Volumetric runoff coefficient	1.00
Catchment area coefficients		
Contributing area runoff coefficients[3]	Road (Paved)	1.00 (100%)
	Paved central reserve	1.00 (100%)

Parameter	Parameter aspect	Value
	Grassed central reserve	0.20 (20%)
	Footpath (Paved)	1.00 (100%)
	Grassed embankment and cut slopes	0.30 (30%)
	Grassed verges	0.20 (20%)
	Minor natural catchment (i.e. open grassed spaces surrounded by side road / slip road arms at junctions)	0.20 (20%)
	Large and relatively flat grassed areas	0.10 (10%)
	Footprint of attenuation ponds and ditches	1.00 (100%)
Piped drainage		
Minimum pipe sizes (nominal diameter)	Carrier drains	150mm
	Combined filter drains	225mm
Maximum pipe sizes (nominal diameter)	Carrier drains	900mm
	Combined filter drains	300mm
Minimum design depths (to pipe soffit)[4]	Carriageways	1.20m
	Verges	0.90m
	Grassed areas (non-verge)	0.90m
Roughness coefficients (k)	Carrier drains	0.6mm
	Combined filter drains	1.5mm
Pipe gradient	Minimum gradient (i.e. carrier drains and filter drains)	1 in 500
Pipe velocities	Minimum full bore	1.00m/s
	Minimum proportional (1 in 1-year return period event)	0.75m/s
	Maximum (with potential scour protection at any outfall to a watercourse channel)	3.00m/s
Chambers	Spacing	90 - 150m
	Minimum catchpit size (internal diameter)	1,050mm
	Minimum manhole size (internal diameter)	1,200mm
Vegetated drainage channels		
Drainage ditches	Minimum longitudinal slope	1 in 500
	Side slopes	1 in 2
	Minimum depth	0.50m
	Maximum depth	1.00m
	Minimum base width	0.50m
	Maximum base width	1.00m
	Manning's roughness coefficient (n)	0.050
Swales	Side slopes	1 in 4
	Minimum depth	0.20m

Parameter	Parameter aspect	Value
	Maximum depth	1.00m
	Minimum base width	1.00m
	Maximum base width	3.00m
	Manning's roughness coefficient (n)	0.050
Surface water channels		
W	Overall width of channel	1.50m
W_s	Surcharged flow width	0.75m
Y	Depth of channel from lower edge of carriageway to centre line of channel invert	0.12m
B	Channel side slopes	1 in 5
N	Manning's roughness coefficient (concrete)	0.013
Gullies		
T	Critical storm duration	5 minutes
L	Kerb/grating length	0.45m
t_s	Time for water to travel from furthest point to kerb	3 minutes
G	Grating type (grating parameter)	R (60)
n	Manning's roughness coefficient (asphalt)	0.017
m	Maintenance factor (assumed)	0.90
Combined kerb drainage		
Kerb drainage length	Maximum kerb drainage alignment length between intermediate outlet points	50m
Kerb drainage unit internal dimensions	Marshalls Beany Block 205 unit assumed	280mm (W) x 285mm (D)
n	Manning's roughness coefficient (concrete)	0.013

Notes:

1. FEH2013 rainfall data have been used in the hydraulic modelling of the proposed highway drainage systems for the proposed scheme. FEH2013 rainfall cannot be used for the assessment of the 1 in 1-year return period storm event. Therefore, FEH1999 rainfall data have been used for the assessment of the 1 in 1-year return period storm event.
2. Given the extent of the proposed scheme (i.e. approximately 24km in length), it was necessary to use FEH rainfall data for multiple locations in the hydraulic modelling across the various proposed highway drainage catchments. The rainfall data used were informed by the watercourse catchment within which the relevant highway alignment portion was located within.
3. PIMP (Percentage Impermeable) values for grassed verge/embankments and cut slopes are based on permeability values in accordance with Table 5.6.2 of DMRB, CD 521 (National Highways, 2021c).
4. Where the design depths to the pipe soffit are less than those specified in this table due to site-specific constraints (e.g. shallow depth at watercourse, topographical constraints, shallow outlet units from combined kerb drainage, utility crossings, etc.), consideration will be required at a subsequent phase of design on the need for appropriate engineering mitigation measures to the loading.

4.7 Interception storage

4.7.1 In Section 3.3.1 of the SuDS Manual C753 (CIRIA, 2015) it is suggested that the initial 5mm of a rainfall event is attenuated and lost through infiltration and / or evapotranspiration (interception), rather than being allowed to runoff. Existing undeveloped areas of the proposed scheme will likely meet this criterion. Proposed paved areas will provide a degree of surface water storage due to the initial wetting and surface retention, typically amounting to 2 to 4mm. This retained rain will be lost to evaporation or infiltration. In addition, further interception will be provided by vegetated SuDS (i.e. attenuation ponds and swales / vegetated ditches) where they are provided throughout the proposed scheme. Where attenuation ponds are used, the attenuation pond water depth to be provided will also evaporate between rainfall events thereby giving an additional loss of retained rainfall.

4.8 Allowable discharge rates

Allowable discharge rates estimation

4.8.1 The proposed scheme will result in an increase in paved area due to the proposed online widening works, proposed offline highway additions and new junction additions. Without mitigation this has the potential to increase the surface water runoff rates realised locally. Therefore mitigation is required to be incorporated within the proposed highway drainage systems such that local flood risk is not increased. The allowable discharge rates at the proposed highway drainage outfalls are determined using the following approaches depending on the proposed highway options:

- **Offline highway route alignment (new highway catchments)** – The proposed offline highway options will largely be developed on greenfield sites. Therefore, it will be required that the allowable discharge rate from the proposed highway drainage systems be restricted to the existing site condition greenfield runoff rates for events up to and including the 1 in 100-year return period storm event plus climate change allowance. The greenfield runoff rates in this case are determined using the FEH statistical method, in line with the SuDS Manual C753 Table 24.1, (CIRIA, 2015) for the rural catchments. The FEH statistical method is used to estimate the median flood (QMED) for the catchment area draining to a nearby watercourse which encompasses the greenfield area affected by the proposed scheme extent. According to the FEH statistical method methodology, the catchment area to the point of interest should be at least 50 hectares in size, to undertake the greenfield runoff rates calculation. Therefore, the QMED estimate for the 50-hectare catchment size will be divided by the said catchment area to the point of interest on the watercourse to determine the catchment runoff in units of l/s/ha. This figure will then be multiplied by the greenfield catchment area of interest affected by the proposed scheme extent to determine the allowable discharge rate for the proposed highway drainage catchment of interest.

- **Online highway route alignment** – The proposed online highway options will typically involve the widening of the existing A12 highway alignment. Therefore, the allowable discharge rates have to be determined using hydraulic modelling to determine the brownfield runoff rates from the combination of existing highway paved areas and adjacent contributing local grassed catchments (e.g. grassed verges, earthworks slopes, etc.) for a given existing highway drainage catchment. The existing brownfield runoff rates are estimated for the 1 in 1, 1 in 2, 1 in 5 and 1 in 100-year return period storm events with the development of hydraulic models of the existing highway drainage systems. The hydraulic models are then simulated using the aforementioned storm events (for various storm durations) to determine the peak discharge rates at the existing outfall locations for the critical storm duration. No allowance for climate change has been applied in determining the allowable discharge rates for the proposed highway drainage systems given that current climatic conditions inform the existing case discharge rates. The existing case hydraulic models have been developed using topographical survey data and highway drainage survey data (including CCTV where the existing drainage was accessible).

4.8.2 The estimated greenfield runoff rates (i.e. new highway catchments on greenfield sites) and brownfield runoff rates (i.e. proposed online highway widening) are implemented in the hydraulic model for each proposed highway drainage catchment to simulate the restriction at the downstream end of the highway drainage system prior to discharge to a nearby watercourse or existing surface water drainage system. This is discussed further in Section 5.

4.8.3 The allowable discharge rates used in the hydraulic modelling of the various proposed highway drainage systems that comprise the proposed scheme are presented in Section 7. This relates to all the proposed highway drainage catchments contained within the Drainage Section 1, Drainage Section 2 and Drainage Section 3 proposed highway drainage sections.

Minimum practicable allowable discharge rate

4.8.4 Following the estimation of the greenfield and brownfield discharge rates as described in Sections 4.8.1 to 4.8.3, it should be noted that the minimum practicable allowable discharge rate used to inform the proposed highway drainage design is 5l/s based on a minimum flow control diameter of 100mm for both vortex flow control devices and orifice plates, which is appropriate and takes into account blockage risk and maintenance. It was found through hydraulic modelling that to achieve discharge rates less than 5l/s, the flow control diameter for both vortex flow control devices and orifice plates typically drops below 100mm in diameter. This is the minimum acceptable flow control diameter according to Sewerage Sector Guidance (V2.1) (Water UK, 2021) which is the replacement guidance for Sewers for Adoption and which states:

'*Where debris can enter the control (e.g. where the upstream system is open or where the inlets are gullies), static controls (such as vortex flow controls or fixed orifice plates) should have a minimum opening size of 100mm.*'

4.8.5 This is also the minimum acceptable flow control diameter according to Rainfall Runoff Management for Developments (SC030219) (Environment Agency, 2013) which states:

'*A practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low flow rate while keeping the risk of blockage to an acceptable level. This limit is set at 5 litres per second, using an appropriate vortex or other flow control device.*'

4.8.6 This approach has also been supported by the relevant highway maintenance authorities for the A12 and adjoining local roads, namely National Highways and Essex Highways during consultation undertaken as part of design development.

4.8.7 For some proposed outfall locations the use of a minimum practicable discharge rate of 5l/s would result in a slight increase in discharge rates in comparison to the existing site allowable discharge rates or greenfield runoff rates. Such increases in proposed discharge rates have been adjusted (reduced) with adjacent proposed catchments with the same receptors to ensure that there is no overall increase to the existing site allowable discharge rates and there is no potential change in flood risk. However, there is a small number of proposed outfall locations where this adjustment has not been possible. These proposed outfall locations have been assessed in the Flood Risk Assessment (ES Appendix 14.5 of the ES ([TR010060/APP/6.3]), which identifies a negligible impact on the surface water drainage flood risk, generally as a result of the existing flows within the watercourses into which the 5l/s discharges flow being larger than the change in flows that would result from the proposed scheme.

Adjusted allowable discharge rates

4.8.8 In a small number of localised cases the allowable discharge rates for the proposed catchments which have potential spatial constraints and other site-specific constraints, have been adjusted to manage the mitigation requirements for attenuation storage. It is noted that the proposed adjusted allowable discharge rates have been limited to proposed catchments with the same receptors ensuring that there is no overall increase to the existing site allowable discharge rates and provided that there is no potential adverse flood risk impact. The proposed catchments that require adjusted allowable discharge rates and the associated site-specific constraints are described accordingly in Section 6, Section 7 and Annex C. .

4.9 Attenuation storage

4.9.1 To mitigate the expected increased surface water runoff rates and any associated potential increase in surface water flood risk to and from the

proposed scheme it is proposed to introduce attenuation storage at appropriate locations within the proposed highway drainage systems. Attenuation storage is to be provided in the form of attenuation ponds, underground geocellular attenuation storage systems, swales, vegetated drainage ditches and oversized pipes depending on the site constraints. Attenuation ponds are the preferred means of attenuation storage where there is sufficient space available, given that they are grassed SuDS features at the ground surface as opposed to being buried underground.

4.9.2 Where required an appropriate flow control device is proposed immediately downstream of the proposed attenuation storage that will restrict the discharge to achieve the allowable discharge rates. Flow controls typically proposed include vortex flow control devices, orifice plates, reduced diameter outlet pipes or a vortex flow control device / orifice plate combination. The flow control device will have the effect of increasing the duration of the discharge hydrograph from the attenuation storage concerned, resulting in a reduced and more controlled discharge to a receiving watercourse or existing highway drainage system. The proposed attenuation storage will be sized for design events up to and including the 1 in 100-year return period storm event with a climate change allowance applied to the chosen design storm to account for the anticipated increase in rainfall intensity due to climate change. As described in Section 4.4, in addition to a climate change allowance of 20% for all design storm events, a 40% climate change allowance has been tested as a sensitivity test for the consequences of exceedance for the 1 in 100-year return period storm event plus 40% climate change allowance. The proposed attenuation storage hydraulic design parameters are presented in Table 4.2 below.

4.9.3 For the proposed highway drainage, the volume of the aforementioned attenuation storage required throughout the proposed scheme is optimised through running simulations in the MicroDrainage software package for design storm events up to and including the 1 in 100-year return period storm event plus 20% and 40% climate change allowances (and various storm durations from 15 minutes up to and including 24 hours) to establish the critical storm event(s). The hydraulic modelling methodology is discussed further in Section 5. The attenuation storage volume estimates and the associated flow control devices employed for the various proposed highway drainage catchments are presented in Section 7 and associated Annex C.

4.9.4 It should be noted that at the preliminary design stage, it was assumed that there are no water losses as a result of infiltration or evaporation and water is permanently present within the attenuation ponds. This is to determine the most conservative attenuation storage size with respect to land take requirements and given that the ground investigation is ongoing and yet to be fully completed. Section 8 discusses the available preliminary ground investigation data (i.e. infiltration rates, groundwater levels, contaminated land, etc.) relative to the proposed scheme highway drainage locations.

Table 4.2 Attenuation storage hydraulic design parameters

Attenuation storage[5]	Parameter	Value
Attenuation pond[3]	Side slopes	1 in 4 (no space constraints) 1 in 3 (with space constraints)
	Design top water depth[1]	0.90m
	Freeboard[2]	0.30m
Underground geocellular attenuation storage systems[4]	Geocellular unit size (standard)	0.66m
	Geocellular unit size (shallow variant)	0.35m
	Void ratio	0.95
	Minimum cover depth[6]	1.00m
Oversized pipes	Maximum pipe diameter	0.90m
	Pipe roughness	0.6mm

Notes:

1. The attenuation pond top water level design depth of 0.90m and additional 0.30m freeboard is informed by the 1 in 100-year return period storm event plus 20% climate change allowance. The top water level design depth is the water depth above the proposed attenuation pond outlet pipe invert level.
2. In general, the total design depth of the proposed attenuation ponds has been limited to 1.20m maximum (i.e. 0.9m design water depth of storage plus 0.3m freeboard) to the proposed attenuation pond outlet pipe invert level where practicable. However, there may be a need to depart from this criterion due to site-specific constraints such as the topography, minimising the excavation depth and earthworks balancing between cut and fill.
3. An additional water depth of 0.3m is to be designed at the bottom of the attenuation ponds (i.e. below the proposed attenuation pond outlet pipe invert level) to create a “wetland” feature to achieve water quality treatment and biodiversity benefits. The additional water depth below the attenuation pond outlet pipe invert also provides some further mitigation for potential increased flood volumes due to climate change. During dry weather periods before heavy

Attenuation storage[5]	Parameter	Value
rainfall events the aforementioned additional water depth will likely have partially evaporated thereby providing some additional attenuation storage volume. 4. The Stormbloc geocellular attenuation storage product by Hydro International was assumed to inform the proposed highway drainage design. 5. The hydraulic design parameters for swales and vegetated drainage ditches (where used as attenuation storage) have been presented previously in Section 4.6, Table 4.1. 6. At the preliminary design stage, a minimum design cover depth for proposed underground geocellular attenuation storage systems was assumed to be 1.00m as this is typical. The site-specific minimum cover depth requirements will be assessed at the detailed design stage.		

4.10 Outfalls discharge hierarchy

4.10.1 Outfalls are required at the downstream end of each highway drainage system on the proposed scheme in order to discharge the collected surface water runoff into a nearby receiving waterbody. Depending on the location of the relevant highway section of the proposed scheme, the highway drainage will discharge to one or a series of the following options in order of preference:

- Groundwater (subject to the outcome of further ground investigation to confirm ground infiltration rates, groundwater levels, potential contaminated land presence, etc.)
- Nearby watercourses
- Existing land drains/drainage ditches which ultimately drain into nearby watercourses
- Proposed surface water drainage ditches where no existing land drain/drainage ditches are available. Proposed surface water drainage ditches will ultimately drain to a nearby watercourse
- Existing highway drainage system, where available, in the absence of a nearby watercourse
- Existing foul sewer or combined sewer, where available, in the absence of the above discharge options

4.10.2 Proposed outfalls that will discharge to nearby watercourses may require appropriate scour protection measures locally. Scour protection is required to prevent the erosion of the watercourse main channel and banks resulting from the discharge of collected surface water runoff. Scour protection measures ensure the stability of the watercourse banks and any nearby drainage infrastructure built into the banks (e.g. headwall units, outfall carrier drains, etc.).

4.10.3 The site-specific proposed outfall locations are described among the various highway drainage systems for the proposed scheme in Section 6 and shown on the Drainage and Surface Water Plans [TR010060/APP/2.13].

5 Highway drainage hydraulic modelling methodology

5.1.1 In order to size the highway drainage elements (i.e. carrier drains, filter drains, swales, geocellular attenuation storage systems, attenuation ponds, etc.) hydraulic modelling of the existing and proposed highway drainage systems for the proposed scheme has been undertaken. The hydraulic modelling software package MicroDrainage (Version 2020.1.3), from Innovyze, has been used. The points below describe the general methodology employed to model each of the existing and proposed highway drainage systems:

- **FEH rainfall data inputs** - FEH rainfall data taken at various locations along the A12 highway alignment have been used in the hydraulic model simulations to assess the capacity and size of the existing and proposed highway drainage elements. Refer to Section 4.6 and Table 4.1 for full details on the rainfall data parameters.
- **Modified rational method** – MicroDrainage uses the Modified Rational Method (in accordance with the Wallingford Procedure) to design and optimise highway drainage networks.
- **Catchment area delineation** – The contributing catchment areas have been determined using the existing site condition topographic survey and proposed site condition topographic contour models for the various mainline, junction and side road aspects of the proposed scheme. In some cases, where segments of the existing natural catchment drain towards the proposed scheme, the existing site condition contours from LiDAR data have been used to define the catchment areas.
- **Proposed flow control device sizing** – Depending on whether brownfield or greenfield discharge rates need to be achieved for a given proposed highway drainage system, either a ‘vortex flow control’ or an ‘orifice’ has primarily been specified as the flow control device in the MicroDrainage models for each proposed catchment. This is to simulate the vortex flow control or orifice plate flow control devices required to restrict the discharges from the proposed highway drainage systems.
- **Proposed flow conveyance system sizing** – The surface water drainage hydraulic models for each proposed catchment have been simulated for the 1 in 1, 1 in 2, 1 in 5 and 1 in 100-year return period storm events, 15 minute to 24-hour durations (plus climate change allowance in each case) to size the proposed carrier drains, combined filter drains, combined kerb drainage, swales, drainage ditches, etc. and to check that they have the required capacity to minimise flooding on the proposed scheme. This is also to demonstrate that there is no increased surface water drainage flood risk to third-party land outside the proposed scheme permanent acquisition of land boundary for

these events. This is in line with the design criteria quoted previously in Section 4.4.

- **Proposed attenuation storage sizing** – To assess the performance of the proposed attenuation storage within each drainage model, they have been simulated for the 1 in 1, 1 in 2, 1 in 5 and 1 in 100-year return period storm events and storm durations between 15 minutes and 24 hours, to establish the critical storm duration to size the attenuation storage and identify any potential flood issues. A climate change allowance of 20% has also been applied to inform the proposed attenuation storage design as described in Section 4.4. A sensitivity test has been undertaken on the proposed attenuation storage design for a climate change allowance of 40% as described in Section 4.4.
- **2D flood modelling** – The FloodFlow module in MicroDrainage has been used to assist in the assessment of exceedance flows from the proposed highway drainage systems for the 1 in 100-year return period storm event plus climate change allowance. This assessment of exceedance flows is described in further detail in Section 9.

6 Proposed highway drainage design

6.1 Overview

6.1.1 The purpose of this section is to describe the highway drainage for the proposed scheme based on the highway design proposals. The drainage catchment area extents, the proposed edge collection methods, the need to retain / relocate / upgrade any existing highway drainage, attenuation storage requirements and the proposed outfall locations have been assessed as part of the proposed highway drainage. The Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the proposed highway drainage catchment extents, the existing highway drainage catchments to be retained (where applicable), the drainage ditch alignments, the proposed outfall locations, the proposed attenuation storage locations and other relevant drainage features.

6.1.2 This section focuses on the description of the proposed highway drainage requirements of the A12 mainline and the associated adjoining side roads. The external natural catchment drainage requirements (i.e. natural catchment drainage ditches and filter drains) are illustrated in the Drainage and Surface Water Plans [TR010060/APP/2.13]. Where natural catchment drainage is not illustrated adjacent to the proposed highway alignment(s), this indicates that the adjacent external natural catchments drain away naturally from the proposed scheme to a nearby watercourse and / or land drainage system. The proposed scheme highway drainage has been divided into three sections, described within three sub-sections: Drainage Section 1 (sub-section 6.2), Drainage Section 2 (sub-section 6.3) and Drainage Section 3 (sub-section 6.4). The highway drainage catchments within each of the three Drainage Sections are presented and described accordingly on the basis of the primary highway features which they drain (i.e. the A12 mainline, junctions and side roads). The proposed highway drainage is described from west to east along the A12 from junction 19 (near Chelmsford) to junction 25 (near Marks Tey).

6.1.3 The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The emergency areas located in the proposed highway drainage catchments are proposed to be drained by combined kerb drainage which will discharge at regular intervals to the main carrier drain system to serve the proposed catchments. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the proposed highway drainage catchments are presented in Table B.1 to Table B3 in Annex B. Section 7 (and associated Annex C) present the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed and the catchment-specific comments regarding the greenfield / brownfield / adjusted discharge rate criteria for the proposed highway drainage systems. An assessment of the exceedance flows for each of the proposed highway drainage catchments

has also been undertaken to understand the surface water flood risk associated with the proposed scheme. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

6.1.4 For the proposed highway drainage catchment descriptions in Section 6.2 to Section 6.4, where it is stated that existing highway drainage is to be retained, it is subject to further assessment to be undertaken at the detailed design stage. Additionally, existing highway drainage that is to be retained is assumed to be in adequate condition. This will need to be confirmed through CCTV survey prior to the construction phase. Where the existing highway drainage is impacted by the proposed highway widening works and / or inadequate hydraulic capacity such that it could not be retained then the affected existing highway drainage would either need replacement and/or upgrading.

6.2 Drainage Section 1 highway drainage proposals

Junction 19

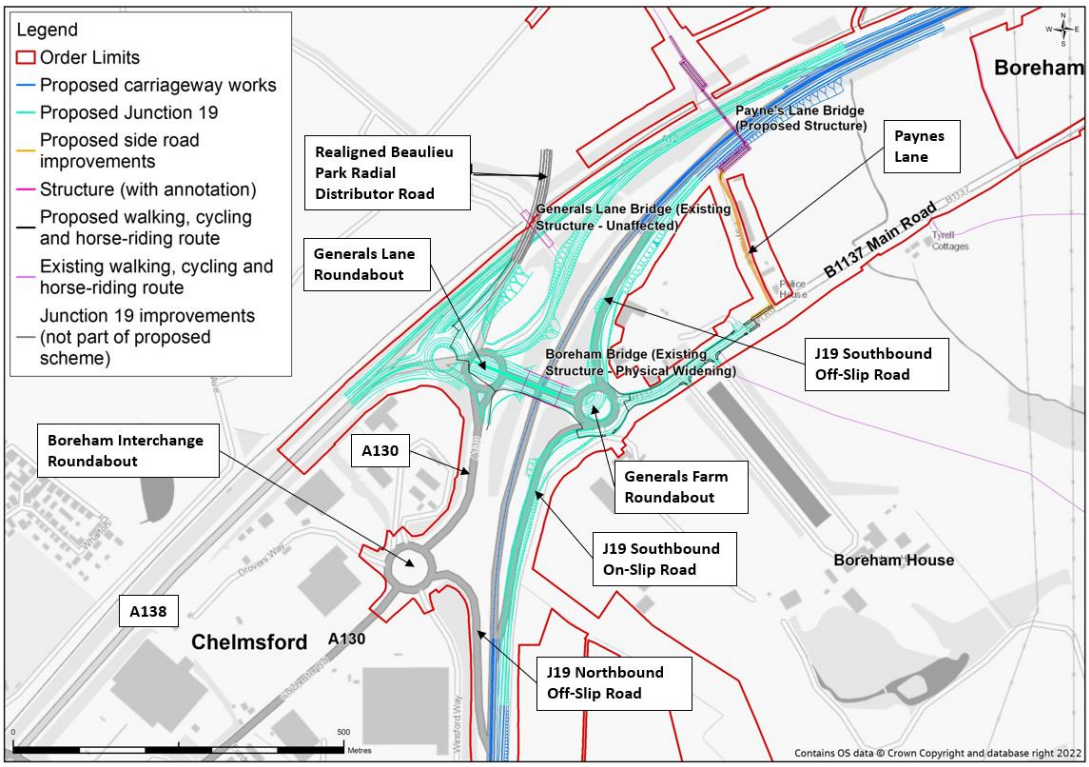
6.2.1 At the time of writing this report, junction 19 is being improved as part of the Beaulieu Park development. The changes are being made by the developer, and the construction is due to be completed by early 2023. As the improvements required for Beaulieu Park are due to be completed before construction of the proposed scheme begins, these have been taken into account in the proposed scheme design proposals. The proposed scheme would deliver additional improvements to junction 19, including:

- Additional lanes on Boreham Bridge (i.e. symmetrical widening)
- Additional lanes on Generals Farm Roundabout
- Additional lanes on Generals Lane Roundabout and adjoining access roads
- Online widening of the A12 mainline southbound carriageway to the north and south of
- Junction 19
- Online widening of the A12 mainline northbound carriageway to the north of junction 19
- Online widening of Main Road (B1137) near Boreham
- Online widening of Generals Farm Roundabout on-slip road
- Online widening of Generals Farm Roundabout off-slip road
- Online widening of the A138 located on the western side of junction 19
- Addition of paved area to Paynes Lane WCH route
- Addition of Generals Lane Roundabout offline slip road

6.2.2 An overview of the proposed junction 19 general arrangement is shown in Plate 6.1. The proposed junction 19 comprises five main highway drainage catchments which discharge to proposed outfalls S1-OU1, S1-OU7, S1-OU7A, S1-OU10, and S1-OU11. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the junction 19 drainage catchments described below are presented in Table B.1 in Annex B.

6.2.3 Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 and 0802, which illustrate the main drainage features and catchment extents for the junction 19 drainage catchments. Section 7 (and associated Annex C) present the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types and diameters employed for the drainage systems, and the catchment-specific comments regarding the greenfield / brownfield / adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Plate 6.1 Overview of the proposed junction 19 general arrangement



Catchment S1-OU1

6.2.4 The S1-OU1 catchment includes the A12 mainline drainage catchment from chainage 9450 to 11300, the junction 19 southbound off-slip road, the junction 19 northbound off-slip road, portions of the existing Boreham Interchange Roundabout and the adjoining A130 located to the south-east, the southbound lane of the A130 between the existing Boreham Interchange Roundabout and Generals Lane Roundabout, the Generals Lane Roundabout, the A138 adjoining Generals Lane Roundabout and the proposed realigned Beaulieu Park Radial Distributor Road (i.e. located north of Generals Lane Roundabout). Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 and 0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU1 catchment. The proposed highway drainage arrangements for the A12 mainline (chainage 9450 to 11300) and the aforementioned junction catchments are as follows:

- **A12 mainline chainage 9450 to 11300** – The A12 mainline highway geometry has a superelevated crossfall, falling from west to east across the full carriageway section. The northbound carriageway falls east towards the central reserve while the southbound carriageway falls east towards the southbound verge. It is proposed to collect the surface water runoff from the widened southbound carriageway with primarily combined filter drains, concrete surface water channels and / or linear slot drainage systems located within the southbound verge, discharging to carrier drains located in the southbound verge. Given

that no proposed highway widening or improvement works are being undertaken on the A12 mainline northbound carriageway, the northbound carriageway existing highway drainage located along the central reserve will be retained. The cutting slopes and large open grassed areas within this portion of the A12 mainline are drained via filter drains positioned within the northern and southern verges. The carrier drain system serving both the northbound and southbound carriageways will converge, discharge south down the A12 mainline and ultimately discharge east to a cross-carriageway carrier drain at A12 mainline chainage 9760. This cross-carriageway carrier drain discharges east of the A12 mainline into a larger diameter proposed carrier drain located within the field to the east of the A12 mainline. This larger diameter carrier drain subsequently discharges south to a proposed attenuation pond.

- **Junction 19 southbound off-slip road** – The junction 19 southbound off-slip road has a superelevated crossfall, north-easterly towards the eastern verge. It is proposed to collect the surface water runoff from this portion of the proposed S1-OU1 catchment (i.e. Generals Farm Roundabout to the merge of the slip road with the A12 mainline) with combined filter drains as it is located in cutting which will discharge to the primary carrier drains serving the southbound off-slip road located in the eastern verge. The carrier drains will subsequently discharge to an underground geocellular attenuation storage system located in the slip road eastern verge. The underground geocellular attenuation storage system will discharge north-west via an orifice plate flow control device to the A12 mainline highway drainage system (approximate A12 mainline chainage 11100).
- **Junction 19 northbound off-slip road** – The junction 19 northbound off-slip road connects from the eastern side of the Boreham Interchange Roundabout, heads south and merges with the A12 mainline approximately 225m to the south of the roundabout. The existing slip road carriageway is to be retained with no highway works proposed. The existing northbound off-slip road carriageway is drained by a kerb and gully arrangement and filter drains all of which will be retained. The northbound off-slip road highway drainage system also receives surface water inflows at its upstream end from the Boreham Interchange Roundabout, discharges south along the slip road and subsequently discharges into the A12 mainline highway drainage. The Boreham Interchange Roundabout highway drainage is described further below.
- **Boreham Interchange Roundabout** – The existing Boreham Interchange Roundabout and the adjoining side roads consisting of the A130 to the south-west, Drovers Way and the local access to the Boreham Services site are to be retained in their current site condition. The southern portion of the Boreham Interchange Roundabout and approximately 260m of the A130 southbound lane to the south-west of the roundabout, drain to the S1-OU1 drainage catchment while the

remainder of the Boreham Interchange Roundabout drains to the S1-OU7 drainage catchment (i.e. described later under the S1-OU7 catchment report sub-section). The Boreham Interchange Roundabout and the A130 are drained by a kerb and gully arrangement discharging to carrier drains. The carrier drains discharge into the upstream end of the previously described junction 19 northbound off-slip road highway drainage.

- **A130 side road (between Boreham Interchange Roundabout and Generals Lane Roundabout)** – The A130 side road is undergoing improvement works by the developer of Beaulieu Park but will remain largely unchanged. The A130 southbound carriageway and adjacent central reserve form part of the S1-OU1 drainage catchment. The southbound carriageway is drained by a kerb and gully arrangement which discharges to a carrier drain located in the southbound carriageway verge. This carrier drain system discharges into the upstream end of the previously described Boreham Interchange Roundabout carrier drains.
- **Generals Lane Roundabout** – The Generals Lane Roundabout is undergoing improvement works by the developer of the Beaulieu Park development. The roundabout has a balanced crossfall. It is proposed to collect the surface water runoff from the roundabout carriageway with combined kerb drainage units which will discharge into downstream carrier drains. Three online underground geocellular attenuation storage systems will attenuate the roundabout surface water runoff before the runoff discharges into the upstream end of the previously described A130 southbound carriageway carrier drains. Two underground geocellular attenuation storage systems (includes an existing offline underground attenuation storage system designed by Beulieu Park Developer) located within the centre of the Generals Lane Roundabout while the third is located in a wide verge between the A130 and the junction 19 Main Road. The underground geocellular attenuation storage systems discharge via vortex flow control and orifice plate flow control devices to the carrier drain system serving the Generals Lane Roundabout which ultimately discharges to the upstream end of the A130 southbound carriageway highway drainage system.
- **A138 side road –** From Generals Lane Roundabout to a location approximately 125m south-west, minor highway widening works are proposed on the A138. It is proposed to collect the surface water runoff from the widened carriageway via a kerb and gully arrangement. Beyond the proposed widening works (i.e. heading further south-west on the A138), the existing highway drainage comprising a kerb and gully arrangement will be retained given that there are no proposed highway improvement works. The retained highway drainage will discharge into the proposed carrier drains serving the widened A138 side road. The proposed carrier drains from the A138 will discharge east to the Generals Lane Roundabout

highway drainage.

- **Realigned Beaulieu Park Radial Distributor Road –** The realigned road is a new highway alignment that will extend north-east from Generals Lane Roundabout to connect into the Beaulieu Park development which is currently under construction. This realigned road initially has a balanced crossfall which subsequently transitions to superelevated crossfall falling in a south-westerly direction. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage arrangement discharging at regular intervals to carrier drains. The proposed carrier drains will discharge east into the upstream end of the Generals Lane Roundabout highway drainage system where the surface water runoff will be attenuated by the existing underground attenuation storage located within the roundabout.
- **Junction 19 Boreham Bridge –** A portion of the junction 19 Boreham Bridge drains to the proposed S1-OU1 drainage catchment through the highway drainage system serving the A130 located to the south. The overbridge carriageway has a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway with combined kerb drainage units. The combined kerb drainage units discharge to proposed carrier drains and located within the footpaths on both sides of the carriageway. The proposed carrier drain system discharges into the previously described underground geocellular attenuation storage system located within the wide verge between the A130 and the junction 19 Main Road (described under **Generals Lane Roundabout**, above).

6.2.5 Once all the above-described proposed highway drainage from the A12 mainline (chainage 9760 to 11300) and the associated contributing junction 19 drainage catchments have converged to the A12 mainline primary cross-carriageway carrier drain at chainage 9760, the carrier drain continues south-east of the A12 mainline embankment and discharges south into a proposed attenuation pond. The attenuation pond is located east of the A12 mainline and discharges to the River Chelmer without the need for a formal flow control device as the attenuation pond outlet pipe restricts the discharge rate sufficiently. Between the attenuation pond and the outfall location, an additional cross-carriageway carrier drain at chainage 9450 discharges the remaining portion of the A12 mainline carriageway (i.e. carriageway extends beyond the attenuation pond location) into the downstream end of the attenuation pond outfall pipe. Brownfield discharge rates are applicable for this outfall location due to the online highway widening works on the A12 mainline, slip roads and adjoining junction 19 improvement works. A new outfall is required to the River Chelmer.

Catchment S1-OU7

6.2.6 The S1-OU7 catchment includes portions of the Boreham Interchange Roundabout, the northbound lane of the A130 side road between the

Boreham interchange and Generals Lane Roundabout, the A130 to the south-east, Drovers Way and the local access road to the Boreham Services site. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 and 0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU7 catchment. There are no proposed highway works for the aforementioned highway features and therefore the existing highway drainage will be retained. Given that there are no proposed highway works within the S1-OU7 catchment, it is not assessed or discussed any further in the subsequent report sections. The existing highway drainage arrangements are as follows:

- **Boreham Interchange Roundabout and adjoining side roads** – The existing Boreham Interchange Roundabout and its adjoining side roads consisting of the A130 to the south-east of the roundabout, Drovers Way and the access road to the Boreham Services site are to be retained. A portion of the A130 to the south-west, Drovers Way and the local access road to the Boreham Services site use a kerb and gully edge collection system. The gullies discharge to carrier drains which drain towards the Boreham Interchange Roundabout. The northern portion of the Boreham Interchange Roundabout drains to the S1-OU7 catchment while the aforementioned southern portion drains to the proposed S1-OU1 catchment (previously described). The northern portion of the roundabout draining to the S1-0U7 catchment uses a kerb and gully edge collection system discharging to carrier drains. The carrier drains discharge to the S1-OU7 highway drainage system unattenuated.
- **A130 side road between Boreham Interchange Roundabout and Generals Lane Roundabout** – The existing A130 is undergoing highway improvement works as part of the Beaulieu Park development. The A130 side road is to remain largely unchanged from the developer's highway improvements. The northbound carriageway of the A130 side road forms part of the S1-OU7 catchment given that the southbound carriageway discharges to the proposed S1-OU1 catchment as previously described. The existing highway drainage is to be retained, with no new proposed highway drainage works to be undertaken. The existing highway drainage uses a kerb and gully arrangement discharging into carrier drains. The carrier drains discharge into the upstream end of the Boreham Interchange Roundabout highway drainage system.

6.2.7 The existing carrier drains discharge unattenuated off the highway alignment to the existing outfall location at Ordinary Watercourse 2. Brownfield discharge rates are applicable for this outfall location given that it is an existing outfall with no highway works or associated drainage works proposed.

Catchment S1-OU7A

6.2.8 The S1-OU7A catchment includes the junction 19 Boreham Bridge, Generals Farm Roundabout and the junction 19 southbound on-slip road from the Generals Farm Roundabout to its tie-in with the A12 mainline further south near chainage 10570. The proposed S1-OU7A drainage catchment was part of the existing S1-OU1 drainage catchment. However, it is now separated out due to potential spatial constraints in providing attenuation storage for the S1-OU7A catchment and other site-specific constraints (i.e. potential clash with the existing CL-02 culvert crossing). Drawing number HE551497-JAC-LDC-SCHW-DR-D-0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU7A catchment. The proposed highway drainage arrangements for the highway features are as follows:

- **Junction 19 Boreham Bridge –** The junction 19 Boreham Bridge has a balanced cross-section geometry. It is proposed to collect the surface water runoff via bridge deck drainage units located along the carriageway and footpath interface on either side of the balanced overbridge. The bridge deck drainage units discharge east into the upstream end of the Generals Farm Roundabout carrier drains, described below.
- **Generals Farm Roundabout –** The Generals Farm Roundabout is undergoing highway improvement works by the Beaulieu Park developer. The roundabout has a balanced crossfall. It is proposed to collect the surface water runoff from the roundabout carriageway, roundabout grassed areas and the right-turning lanes from the junction 19 southbound off-slip road to Boreham Bridge via combined kerb drainage units which will discharge to carrier drains. The upstream end of the main roundabout carrier drain system accepts surface water discharges from the overbridge bridge deck drainage units. The downstream end of the main roundabout carrier drain system discharges to the upstream end of the junction 19 southbound on-slip road carrier drain system located in the slip road eastern verge. An existing offline underground attenuation storage system (designed by the Beaulieu Park developer) is located within the centre of the roundabout and will be retained. This existing underground attenuation storage system attenuates the surface water flows from the roundabout and subsequently discharges to the junction 19 southbound on-slip road highway drainage.
- **Junction 19 southbound on-slip road –** The junction 19 southbound on-slip road has a superelevated crossfall, falling in a south-easterly orientation. From the Generals Farm Roundabout junction to the A12 mainline existing culvert CL-02, it is proposed to collect surface water runoff from the carriageway via a combined filter drain located within the eastern verge of the slip road. The combined filter drain will discharge to a carrier drain system at regular intervals. An additional

filter drain alignment located along the slip road western verge will drain the slip road cut slopes. The carrier drain system located within the slip road eastern verge continues to drain south towards existing culvert CL-02 and discharges south-east of the slip road cutting and into a proposed attenuation pond.

6.2.9 The proposed attenuation pond is located east of the A12 mainline. The attenuation pond discharges to Ordinary Watercourse 2 using a vortex flow control device. Given that the proposed S1-OU7A drainage catchment is separated from the existing S1-OU1 catchment, a new outfall is required for the proposed S1-OU7A catchment to Ordinary Watercourse 2. Therefore, the 5l/s minimum practicable discharge rate criteria applies for this new outfall location.

Catchment S1-OU10

6.2.10 The S1-OU10 catchment drains a portion of the existing B1137 local road which spurs off junction 19 and heads east. The B1137 local road here is subject to highway widening works from junction 19 to its eventual tie-in to the existing B1137 carriageway approximately 230m east of junction 19. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU10 catchment.

6.2.11 The B1137 local road highway geometry initially has a superelevated crossfall from the proposed junction 19 southern roundabout (i.e. Generals Farm Roundabout). The superelevated highway cross-section initially falls in a north-easterly orientation, then the highway transitions to a balanced cross-section as it ties-in to the existing B1137 local road. From the junction 19 southern roundabout it is proposed to collect the surface water runoff from the carriageway via a combined kerb edge collection arrangement which will discharge at regular intervals to a carrier drain system. These carrier drains will discharge east to the proposed outfall location which is an existing manhole chamber on the B1137 highway drainage system. A proposed filter drain is required along the southern edge of the proposed B1137 local road given that it is raised on a low height embankment. The outfall discharge rates will be controlled by an orifice plate flow control device with the flow backing up into the proposed drainage system and into an offline underground geocellular attenuation storage system located north of the proposed highway works. Brownfield discharge rates are applicable for this outfall location due to the online highway widening works and given that the proposed highway drainage is discharging to the existing highway drainage system. The offline underground geocellular attenuation storage system is required due to spatial constraints and land take restrictions to the east and south of the proposed scheme.

Catchment S1-OU11

6.2.12 The S1-OU11 catchment includes a portion of the A12 mainline from chainage 11300 to 11460, a portion of the junction 19 northbound on-slip

road from the proposed Generals Lane Roundabout, a portion of the A138 side road and a small portion of the proposed realigned Beaulieu Park Radial Distributor Road (i.e. proposed highway heading north-east from Generals Lane Roundabout to the Beaulieu Park development). The proposed S1-OU11 drainage catchment was part of the existing S1-OU12 drainage catchment. However, it is now separated, due to the proposed highway geometry constraints. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU11 catchment. The proposed highway drainage arrangements for the aforementioned A12 mainline (chainage 11300 to 11460) and adjoining junction 19 catchments are as follows:

- **A12 mainline (chainage 11300 to 11460)** – The A12 mainline highway geometry has a superelevated crossfall, falling from north-west to south-east across the full carriageway section. No highway works are being undertaken to the northbound carriageway with online widening works only proposed on the central reserve. It is therefore proposed to remove and replace the existing gullies located at the central reserve to enable the continued draining of the existing northbound carriageway and discharge into the retained carrier drain system located within the central reserve. The carrier drain system serving the northbound carriageway will discharge east to a cross-carriageway carrier drain at A12 mainline chainage 11460. It is proposed to collect the surface water runoff from the widened A12 mainline southbound carriageway via concrete surface water channels and / or linear slot drainage systems located within the southbound verge. The drainage edge collection systems will discharge at regular intervals to a carrier drain system underneath located in the southern verge. The carrier drain system serving the widened southbound carriageway will discharge east to the aforementioned cross-carriageway carrier drain at A12 mainline chainage 11460. The cross-carriageway carrier drain arrangement continues off the A12 mainline embankment and drains towards a proposed attenuation pond.
- **Realigned Beaulieu Park Radial Distributor Road** – The proposed realigned Beaulieu Park Radial Distributor Road is a new highway alignment that will extend north-east from Generals Lane Roundabout to connect into the Beaulieu Park development, currently under construction. This realigned road initially has a balanced crossfall and transitions to superelevated crossfall. It is proposed that the surface water runoff from the superelevated carriageway section is collected by the proposed S1-OU1 catchment highway drainage as described previously. The remaining small portion of the realigned Beaulieu Park Radial Distributor Road southbound carriageway drains to the proposed S1-OU11 catchment as a result of the balanced highway crossfall. It is proposed to collect the surface water runoff from the carriageway via a combined filter drain. The combined filter drain will

discharge into the proposed highway drainage for the northbound on-slip road off junction 19.

- **Junction 19 northbound on-slip road –** The junction 19 northbound on-slip road has a primarily superelevated crossfall, falling towards the northbound verge. It is proposed to collect the surface water runoff from the northbound on-slip road via a combination of a kerb and gully arrangement and combined filter drains. The gullies and combined filter drains will discharge to a carrier drain system located in the slip road northbound verge. The cutting slopes associated with the proposed northbound on-slip road will be drained by filter drains which will discharge to the carrier drain system. The slip road carrier drain system will ultimately discharge into the adjoining A138 highway carrier drain system (located within the southern verge of the A138).
- **A138 side road –** The existing A138 side road carriageway is to be partially retained and has a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via a combination of a kerb and gully arrangement and combined kerb drainage which will discharge to a carrier drain system which will connect into the proposed highway drainage serving the A12 mainline.

6.2.13 Once the proposed highway drainage from the A12 mainline (chainage 11300 to 11460), the proposed realigned Beaulieu Park Radial Distributor Road, the junction 19 northbound on-slip road and the A138 have converged to the A12 mainline cross-carriageway carrier drain located at chainage 11460, the carrier drain continues south of the A12 mainline and discharges into a proposed attenuation pond. The attenuation pond is located south of the A12 mainline and outfalls via an orifice plate flow control device to Boreham Brook. Given that the proposed S1-OU11 drainage catchment is separated out from the existing S1-OU12 catchment, a new outfall is required for the proposed S1-OU11 catchment to Boreham Brook. Brownfield discharge rates are applicable due to the proposed online highway widening works and given that the existing A12 discharges to the Boreham Brook.

A12 mainline

6.2.14 The A12 mainline encompassed by the Drainage Section 1 highway drainage sub-section is a total length of 10.1km from junction 19 to the existing junction 21. The A12 mainline as it passes through junction 19 would be widened locally to suit the junction 19 improvement works. The approximately 3.2km A12 mainline alignment between junction 19 and existing junction 20a (to be removed) already consists of three lanes in each direction. The works here would consist of localised highway improvements to roadside infrastructure (such as signage, gantry and lighting improvements). The southbound carriageway of this mainline alignment would also be resurfaced with road surfacing that has better noise reducing properties than a conventional low noise road surface. The remaining 6.7km A12 mainline alignment between existing junction 20a and the end

of the Drainage Section 1 highway drainage sub-section would be subject to online widening works to provide a dual three-lane carriageway. The proposed scheme boundary extends to the south of junction 19 to allow for temporary traffic management and roadside works in the verges such as new signage and works associated with the proposed junction 19 improvements.

6.2.15 The proposed A12 mainline within the Drainage Section 1 highway drainage sub-section comprises seven main highway drainage catchments which discharge to proposed outfalls S1-OU12, S1-OU13, S1-OU14, S1-OU15, S1-OU17, S1-OU18 and S1-OU23. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. It should be noted that emergency areas are contained within the proposed S1-OU13, S1-OU15 and S1-OU23 catchments. The emergency areas located in these catchments are proposed to be drained by combined kerb drainage. The combined kerb drainage will discharge at regular intervals to the main carrier drain system to serve the proposed catchments. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the A12 mainline (Drainage Section 1) drainage catchments described below are presented in Table B.1 in Annex B.

6.2.16 Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0802 to 0808, illustrate the main drainage features and catchment extents for the aforementioned A12 mainline (Drainage Section 1) drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield/brownfield and adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Catchment S1-OU12

6.2.17 The S1-OU12 catchment extends for approximately 460m of the A12 mainline from the northern end of junction 19 (approximate A12 mainline chainage 11420) to the end of the proposed highway works at a location in the vicinity of the western boundary of Boreham (approximate A12 mainline chainage 11880). Highway widening works are required for this localised portion of the A12 mainline to accommodate the adjoining proposed junction 19 north-eastern slip road. The proposed S1-OU12 catchment also includes the existing A12 mainline from chainage 11880 to chainage 12250 for which no highway improvement works are proposed. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features

and catchment extents for the S1-OU12 catchment. The proposed highway drainage arrangements for the proposed S1-OU12 catchment are as follows:

- **A12 mainline chainage (11420 to 11880) –** The A12 mainline highway geometry has a superelevated crossfall, falling from north to south across the full carriageway section. The surface water runoff from the northbound carriageway will continue to be collected at the central reserve as per the existing site condition. From A12 mainline chainage 11420 to 11620 it is proposed to remove and replace the existing gullies located at the widened central reserve to continue draining the northbound carriageway and discharge to a retained carrier drain system located within the central reserve. From A12 mainline chainage 11620 to 11880, given that the carriageway widening works are minor, it is proposed that the surface runoff will be collected via a series of existing concrete surface water channels and/or slot drains located at the central reserve that discharge to an existing carrier drain system located within the central reserve. The aforementioned carrier drain system serving the northbound carriageway will discharge east and west respectively to an existing cross-carriageway carrier drain at A12 mainline chainage 11620.
- For the widened southbound carriageway (chainage 11420 to 11620) it is proposed to collect the surface water runoff via new concrete surface water channel and / or linear slot drainage systems located within the southbound verge. For the southbound carriageway (chainage 11620 to 11880) no highway improvement works are being undertaken. It is proposed that the surface water runoff from this portion of the southbound carriageway will be collected by a combination of retained existing concrete surface water channels and retained existing gullies which discharge to an existing carrier drain system located within the southern verge. The aforementioned existing carrier drain system serving the southbound carriageway will discharge east and west respectively to the aforementioned cross-carriageway carrier drain at A12 mainline chainage 11620.
- **A12 mainline existing 370m section (A12 mainline chainage 11880 heading east) –** For the existing A12 mainline between chainage 11880 and chainage 12250 there are no proposed highway improvement works. Therefore, the existing A12 mainline highway geometry and associated highway drainage is to be retained. For the easternmost (approximately) 120m highway length, the existing highway geometry has a superelevated crossfall falling from south to north across the full carriageway section. The existing concrete surface water channels draining the northbound carriageway and the southbound carriageway are to be retained. The surface water channels discharge to a carrier drain system discharging west into the upstream end of the existing highway drainage described in the preceding A12 mainline bullet points for catchment S1-OU12. Heading west from the aforementioned 120m length of highway, the

existing highway geometry changes to a balanced cross-section. The existing concrete surface water channels draining the northbound carriageway and the southbound carriageway are to be retained. The surface water channels discharge to a carrier drain system serving both the northbound and southbound carriageways will discharge west into the upstream end of the existing highway drainage described in the preceding A12 mainline bullet points for catchment S1-OU12.

6.2.18 Once the proposed highway drainage serving the A12 mainline northbound and southbound carriageways has discharged into the cross-carriageway carrier drain at chainage 11620, the carrier drain continues south of the A12 mainline embankment and discharges into an attenuation pond. The attenuation pond is located south of the A12 mainline and outfalls to a repositioned existing outfall on Boreham Brook via an orifice plate flow control device. Brownfield discharge rates are applicable due to the proposed online highway widening works.

Catchment S1-OU13

6.2.19 The S1-OU13 catchment extends for approximately 340m of the A12 mainline from the Crix Bridge vicinity to the Ordinary Watercourse 28 crossing (A12 mainline chainage 15100 to 15440). The A12 mainline highway alignment between junction 19 and existing junction 20a already consists of three lanes in each direction. Therefore, the proposed highway works would be confined to localised improvements to roadside infrastructure (such as signage, road surfacing, etc.). The proposed S1-OU13 catchment is included within the aforementioned A12 mainline alignment subject to localised improvement works. An emergency area is proposed within this catchment between A12 mainline chainage 15350 and 15540. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0804 and 0805 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU13 catchment.

6.2.20 Due to spatial constraints that prevent providing an attenuation pond locally for the adjacent proposed S1-OU15 catchment, the proposed S1-OU13 highway drainage has been designed such that a sizable portion of the existing highway drainage catchment draining to the existing S1-OU15 outfall (i.e. to be retained as part of the proposed S1-0U15 catchment) is intercepted by the proposed S1-OU13 catchment highway drainage. This existing case S1-OU15 highway drainage catchment has been intercepted and diverted into the upstream end of the proposed S1-OU13 highway drainage system.

6.2.21 The A12 mainline highway geometry has a balanced crossfall, falling from north to south across the full carriageway section. The surface water runoff from the northbound carriageway is intercepted by the proposed S1-OU14 highway drainage system (refer to the S1-OU14 catchment description). For the A12 mainline southbound carriageway (chainage 15100 to 15350) the proposed localised highway improvements are minor. Therefore, it is proposed to collect the surface water runoff from this portion of the

southbound carriageway via a retained existing concrete surface water channel. The carrier drain system serving the southbound carriageway will discharge east to a cross-carriageway carrier drain at A12 mainline chainage 15430.

6.2.22 Once the proposed highway drainage from the A12 mainline (chainage 15100 to 15440) has reached the cross-carriageway carrier drain at chainage 15430, the carrier drain continues south of the A12 mainline and traverses beneath the B1137 local road / embankment, continuing south and discharging into a proposed attenuation pond. The attenuation pond is located south of the A12 mainline and outfalls to the River Ter via an orifice plate flow control device. As a result of the previously described interception of a large portion of the existing case S1-OU15 catchment into the proposed S1-OU13 catchment, the proposed S1-OU13 catchment exceeds the existing case S1-OU13 allowable discharge rates. Therefore, provision has been allowed for this by reducing the discharge rates from the adjacent proposed drainage catchments (i.e. the S1-OU14 and S1-OU15 catchments) which discharge into the same watercourse, the River Ter, such that the total combined discharge rates into the River Ter do not increase from the existing case.

Catchment S1-OU14

6.2.23 The S1-OU14 catchment encompasses approximately 310m of the A12 mainline northbound carriageway from the Crix Bridge vicinity (A12 mainline chainage 15130) and extending to the Ordinary Watercourse 28 crossing (A12 mainline chainage 15440). The A12 mainline highway alignment between junction 19 and existing junction 20a already consists of three lanes in each direction, therefore the highway works here would be confined to localised improvements to roadside infrastructure (such as signage, road surfacing, etc.). The proposed S1-OU14 catchment is included within the aforementioned A12 mainline alignment subject to localised improvement works. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0804 and 0805 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU14 catchment.

6.2.24 From A12 mainline chainage 15130 to 15440, the proposed highway geometry has a balanced crossfall. As the proposed localised highway improvements are minor across this highway length, it is proposed that the surface runoff for the northbound carriageway will be collected via a series of existing surface water channels located adjacent to the northern verge and discharge into a retained existing carrier drain system. The carrier drain system serving the northbound carriageway will discharge to the Ordinary Watercourse 28 to an existing outfall serving the A12 mainline near chainage 15440. A flow control device is not required given that the proposed S1-OU14 drainage catchment has reduced in size from the existing case such that the proposed discharge rates are less than those for the existing case. The proposed highway drainage has been designed such that a sizable portion of the existing drainage catchment draining to

the existing outfall (i.e. to be retained as part of the proposed S1-OU14 drainage catchment) is intercepted by the adjacent S1-OU13 drainage catchment where there is space available to provide an attenuation pond. The A12 mainline southbound carriageway is intercepted by the proposed S1-OU13 highway drainage system as previously described.

Catchment S1-OU15

6.2.25 The S1-OU15 catchment extends for approximately 230m of the A12 mainline from the Ordinary Watercourse 28 crossing (A12 mainline chainage 15440) and extending to the end of the River Ter Bridge crossing (A12 mainline chainage 15670). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. An emergency area is proposed within this catchment between A12 mainline chainage 15460 and 15530. Drawing No. HE551497-JAC-LDC-SCHW-DR-D-0805 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU15 catchment.

6.2.26 The A12 mainline highway geometry at this location has a balanced crossfall, falling outwards from the central reserve and towards the northern and southern verges respectively. Due to the proposed highway widening works the existing concrete surface water channels draining the existing highway and the associated carrier drains will be removed and replaced. It is proposed to collect surface water runoff from the northbound and southbound carriageways with new concrete surface water channels and / or linear slot drainage systems located at the edge of the proposed hard strip beside the northern and southern verges. The drainage edge collection systems will discharge at regular intervals to a carrier drain system. It should be noted that the River Ter bridge is also located within the S1-OU15 drainage catchment. The existing kerb inlet gully units serving the River Ter Bridge will be replaced with new bridge deck drainage units which will discharge to the aforementioned carrier drain system.

6.2.27 The carrier drain system serving both the northbound and southbound carriageways in addition to the River Ter bridge will discharge to the River Ter unrestricted to an existing outfall serving the A12 mainline near chainage 15630. A flow control device is not required given that the proposed S1-OU15 catchment has reduced in size significantly from the existing case such that the proposed discharge rates are less than those for the existing case. Due to spatial constraints in providing an attenuation pond locally for the S1-OU15 drainage catchment, the proposed highway drainage has been designed such that a sizable portion of the existing drainage catchment draining to the existing outfall (i.e. to be retained as part of the proposed S1-OU15 drainage catchment) is intercepted by the adjacent S1-OU13 drainage catchment to the west where there is space available to provide an attenuation pond. Refer to the S1-OU13 drainage catchment description previously described for further details.

Catchment S1-OU17 and S1-OU18

6.2.28 The S1-OU17 and S1-OU18 catchments extend for approximately 1.63km of the A12 mainline from the River Ter bridge crossing (A12 mainline chainage 15670) and extend east to the Ordinary Watercourse 7 culvert crossing near proposed junction 21 (A12 mainline chainage 17300). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. The proposed highway drainage associated with the S1-OU17 catchment drains approximately 65 to 70% of the proposed catchment area associated with the A12 mainline northbound and southbound carriageways. The proposed highway drainage associated with the S1-OU18 catchment drains the remaining approximately 30 to 35% of the proposed catchment area which includes a portion of the northbound carriageway as far as Bury Lane Bridge (i.e. chainage 15670 to 16090) and the existing junction 20a (to be removed). Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0805 and 0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU17 and S1-OU18 catchments. The S1-OU17 and S1-OU18 drainage catchments are described in further detail below under their respective headings.

S1-OU17 (A12 northbound and southbound carriageways)

6.2.29 The A12 mainline highway geometry has a superelevated crossfall (with a number of crossfall transitions) along its entire 1.63km length that encompasses the S1-OU17 and S1-OU18 drainage catchments. The A12 mainline between the River Ter bridge crossing and A12 mainline chainage 17300 is in cutting. For the proposed S1-OU17 catchment, based on the above described crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with a combination of primarily combined filter drains and linear slot drainage. The aforementioned edge collections systems will discharge at regular intervals to carrier drains located underneath the edge collection systems. These carrier drains will discharge to the primary surface water carrier drain system located within the A12 mainline central reserve.

6.2.30 As described previously the A12 mainline between the River Ter bridge crossing and A12 mainline chainage 17300 is in cutting. The combined filter drains located in the northern and southern verges, which drain the proposed highway, will also intercept and drain the proposed cutting slopes. From chainage 16030 to 17020 (southbound carriageway) and chainage 16100 to 16700 (northbound carriageway) the proposed A12 mainline cutting transitions from earthworks slopes to retaining wall structures. Filter drains are provided at the top of the retaining walls to intercept any natural catchment draining towards the back of the retaining walls. These filter drains discharge into the proposed highway drainage serving A12 mainline.

6.2.31 Once all the above-described linear slot drainage, combined filter drains and downstream carrier drains have discharged to the primary surface water carrier drains located in the central reserve, the carrier drains continue to discharge west and outfall to the River Ter via an existing outfall

to be retained near the River Ter bridge (A12 mainline chainage 15640). The proposed S1-OU17 drainage catchment will discharge unattenuated to the River Ter at brownfield discharge rates due to the online highway widening works. Attenuation pond provision is not possible for the proposed S1-OU17 catchment due to the site-specific spatial constraints. The attenuation storage required for the proposed S1-OU17 catchment is mitigated for by the adjacent proposed S1-OU18 catchment attenuation pond as the receptor for the proposed S1-OU17 and S1-OU18 catchments is the River Ter.

S1-OU18 (A12 northbound carriageway chainage 15670 to 16090 and existing junction 20a)

6.2.32 The S1-OU18 catchment includes the existing junction 20a (to be removed), a portion of Bury Lane Bridge which drains north from the high point midway along its bridge deck and a 420m length of the proposed A12 mainline northbound carriageway (chainage 15670 to 16090) where it passes under Bury Lane Bridge. It is proposed to collect surface water runoff from the drainage catchments that comprise the S1-OU18 drainage catchment as follows:

- **Existing junction 20a –** The existing junction 20a highway carriageway is to be decommissioned from its current function as a slip road to the A12 and re-purposed to maintain local access to nearby properties in Hatfield Peverel and provide access to the proposed S1-OU18 attenuation pond from Bury Lane Bridge. A small portion of the existing junction 20a slip road, where it connects into the A12, will be removed and landscaped thereby cutting off any direct connection to the proposed A12 mainline. The existing junction 20a carriageway is drained by a kerb and gully arrangement which discharges to a filter drain located in the highway southern verge. This filter drain also intercepts surface water runoff from the natural catchment area located within the footprint of junction 20a which falls in a north-westerly direction. This filter drainage system discharges west off junction 20a and will connect into the proposed A12 mainline northbound carriageway drainage system.
- **Bury Lane Bridge (northern portion from bridge deck high point) –** The Bury Lane Bridge has a balanced crossfall. The existing kerb inlet gully units serving Bury Lane Bridge will be replaced with bridge deck drainage units as part of the bridge refurbishment. The bridge deck drainage units will drain north and subsequently west off the bridge deck via carrier drains to a proposed drainage ditch. The drainage ditch is located within the grassed area of existing junction 20a at the top of the proposed A12 mainline cutting slope. The proposed drainage ditch will discharge west and connect into the proposed A12 mainline northbound carriageway drainage system.
- **A12 mainline northbound carriageway (chainage 15670 to 16090)** – Given that the superelevated northbound carriageway falls in a north-westerly orientation, a proposed combined filter drain is required

adjacent to the northern verge. The combined filter drain will discharge at regular intervals to a surface water carrier drain located underneath the combined filter drain. This carrier drain system will also accept the surface water runoff from the above-described junction 20a and Bury Lane bridge. The carrier drain system will then discharge off the A12 mainline and north into a proposed attenuation pond.

6.2.33 The above-described proposed attenuation pond is located to the north of the A12 mainline. The attenuation pond will discharge to Ordinary Watercourse 31 via a vortex flow control device. Ordinary Watercourse 31 discharges to the nearby River Ter. Brownfield discharge rates are applicable due to the online highway widening works.

Catchment S1-OU23

6.2.34 The S1-OU23 catchment extends for approximately 2.74km of the A12 mainline from a location just east of the proposed junction 21 dumbbell roundabout overbridge (A12 mainline chainage 17700) and extending east to Oliver's Bridge (A12 mainline chainage 20440). A portion of the existing B1389 local road, located to the north of the A12 mainline (near A12 mainline chainage 18300), is also drained into the S1-OU23 catchment. The proposed S1-OU23 catchment also accepts the attenuated flows from the proposed S1-OU23C and S1-OU24A catchments (refer to these catchment sub-sections for a full description of the proposed S1-OU23C and S1-OU24A). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. An emergency area is proposed within this catchment between A12 mainline chainage 18700 and 20200. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0806 to 0808 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU23 catchment.

6.2.35 The A12 mainline highway geometry has a primarily superelevated crossfall along its 2.74km length that encompasses the S1-OU23 catchment. However, there is a short 250m length of proposed highway with a balanced crossfall. A large amount of the 2.74km length of A12 mainline between the proposed junction 21 and Oliver's Bridge is in cutting. For the proposed S1-OU23 catchment, based on the above described crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with a combination of primarily combined filter drains, concrete surface water channels and / or linear slot drainage system, discharging at regular intervals to carrier drains located underneath. These carrier drains will discharge to the primary surface water carrier drain systems located within the A12 mainline central reserve and southern verge.

6.2.36 As described previously a large amount of the 2.74km length of A12 mainline between the proposed junction 21 and Oliver's Bridge is in cutting. The combined filter drains located in the northern and southern verges, which also drain the proposed carriageways at some locations, will also intercept and drain the proposed cutting slopes. Where external natural

catchment areas drain towards the proposed cutting slopes and embankment slopes, natural catchment drainage ditches are proposed at the top of the cutting slopes and at the embankment toes respectively to intercept the natural catchment areas. These natural catchment drainage ditches discharge into the proposed A12 mainline highway drainage system given that it is not practicable to discharge to a nearby watercourse due to topography constraints.

6.2.37 Once all the above-described linear slot drainage, combined filter drains, surface water channels, natural catchment drainage ditches and downstream carrier drains have discharged to the primary surface water carrier drains located in the southern verge, the carrier drains will continue to discharge south of the A12 mainline at approximate chainages 19350 and 19500 respectively and into a proposed attenuation pond. The attenuation pond will discharge to an existing outfall on a drainage ditch with the attenuation pond outlet pipe acting as the flow control. The existing drainage ditch ultimately discharges to Ordinary Watercourse 32. Brownfield discharge rates are applicable for this outfall location due to the online highway widening works.

Junction 21

6.2.38 As part of the proposed scheme, existing junction 20a and junction 20b are to be decommissioned and removed as they are considered substandard and do not satisfy modern highway design standards. As described in Section 6.2.32, the existing junction 20a slip road is to be disconnected from the A12 mainline and re-purposed as an access track for the proposed S1-OU18 catchment attenuation pond. The existing junction 20b is to be replaced by the proposed junction 21, situated east of Hatfield Peverel between the existing junction 20b and existing junction 21. An overview of the proposed junction 21 general arrangement is shown in Plate 6.2.

6.2.39 The proposed junction 21 has been designed as an elevated two-tier junction with a dumbbell layout with three local access roads and four slip roads merging with the A12 mainline. The three local access roads are as follows:

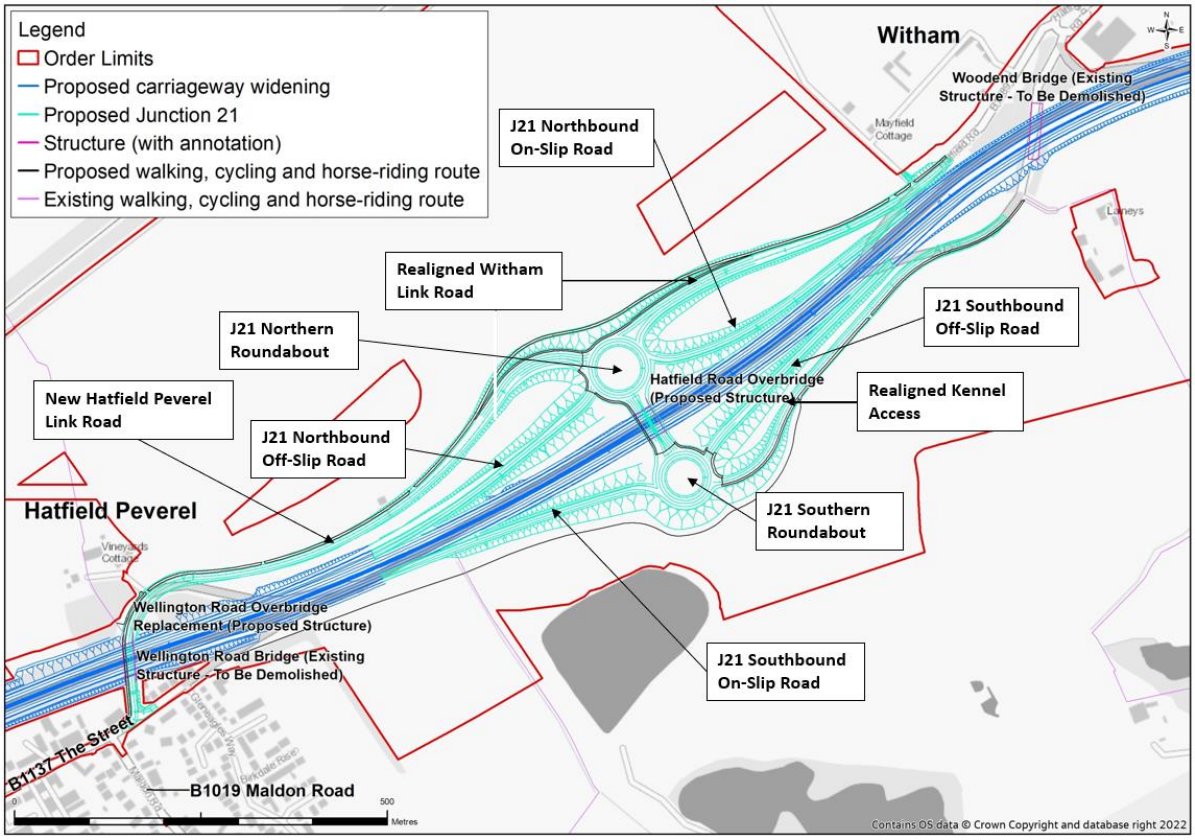
- A local road linking the northern roundabout to Witham, intended as the main access between the proposed scheme and the western side of Witham. This local road is referred to as the realigned Witham Link Road hereafter for the purposes of the highway drainage description.
- A local road originating from the northern roundabout, heading west and tying into the vicinity of the existing junction 20b (to be decommissioned). This local road is provided for a cluster of properties located north of Wellington Bridge. This local road is referred to as the new Hatfield Peverel Link Road hereafter for the purposes of the highway drainage description.
- A local access road originating from the southern roundabout and heading east to link to the Latney's Boarding Kennels, Cattery and Grooming Parlour site only. This local road is referred to as the realigned Kennel access road hereafter for the purposes of the highway drainage description.

6.2.40 The proposed junction 21 comprises seven main highway drainage catchments which discharge to proposed outfalls S1-OU19, S1-OU19C and S1-OU19C1, S1-OU23C, S1-OU23D, S1-OU24A and S1-OU24B. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the junction 21 drainage catchments described below are presented in Table B.1 in Annex B.

6.2.41 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing number HE551497-JAC-LDC-SCHW-DR-D-0806, illustrates the main drainage features and catchment extents for the aforementioned junction 21 drainage catchments. Section 7 (and associated Annex C)

presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types and diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield/ brownfield/ adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Plate 6.2 Overview of the proposed junction 21 general arrangement



Catchment S1-OU19

6.2.42 The S1-OU19 catchment includes a portion of the A12 mainline drainage catchment from chainage 17300 to 17700, the junction 21 northbound off-slip road drainage catchment and the junction 21 southbound on-slip road drainage catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU19 catchment. The proposed highway drainage arrangement for the A12 mainline (chainage 17300 to 17700) and the aforementioned slip roads are as follows:

- **A12 mainline (chainage 17300 to 17700)** – The A12 mainline highway geometry has a superelevated crossfall, falling from south to north across the full carriageway section. Therefore, the northbound

carriageway falls north towards the northern verge while the southbound carriageway falls north towards the central reserve. It is proposed to collect surface water runoff from the northbound and southbound carriageways primarily by a combination of surface water channels and linear slot drainage systems, discharging at regular intervals to carrier drains located beneath them. The aforementioned carrier drains serving both the northbound and southbound carriageways will discharge west to a cross-carriageway carrier drain at A12 mainline chainage 17300. This cross-carriageway carrier drain discharges south of the A12 mainline embankment towards a proposed attenuation pond. The cross-carriageway carrier drain drainage arrangement discharging off the A12 mainline is discussed further after the junction 21 northbound off-slip road and junction 21 southbound on-slip road highway drainage bullet point descriptions below.

- **Junction 21 northbound off-slip road** – The junction 21 northbound off-slip road has a superelevated crossfall, falling in a north-westerly orientation. It is proposed to collect the surface water runoff with a kerb and gully arrangement where there is a kerb line. In the absence of a proposed kerb line it is proposed to collect the surface water runoff with linear slot drainage, discharging at regular intervals to a carrier drain system located in the northern verge. This carrier drain system will discharge into the upstream end of the aforementioned A12 mainline cross-carriageway carrier drain at approximate chainage 17300.

- **Junction 21 southbound on-slip road** – The junction 21 southbound on-slip road has a superelevated crossfall, falling in a south-westerly orientation. It is proposed to collect the surface water runoff with a kerb and gully arrangement where there is a kerb line. In the absence of a proposed kerb line it is proposed to collect the surface water runoff with linear slot drainage, discharging at regular intervals to a carrier drain system located in the southern verge. This carrier drain system will discharge into the downstream end of the aforementioned A12 mainline cross-carriageway carrier drain at approximate chainage 17300.

6.2.43 Once the proposed highway drainage from the A12 mainline (chainage 17300 to 17700), the junction 21 northbound off-slip road and the junction 21 southbound on-slip road has converged to the A12 mainline cross-carriageway carrier drain at chainage 17300, the carrier drain continues south of the A12 mainline embankment, traverses under an existing drainage ditch (Ordinary Watercourse 7) and discharges to a proposed attenuation pond. The attenuation pond is located south of the proposed junction 21 and outfalls to a new outfall on an existing drainage ditch (Ordinary Watercourse 7) via an orifice plate flow control device. Brownfield discharge rates are applicable for this new outfall location due to the online highway widening works.

Catchment S1-OU19C and S1-OU19C1

6.2.44 The S1-OU19C / S1-OU19C1 catchment is the drainage catchment for the new Hatfield Peverel link road from its start point at the proposed junction 21 northern roundabout to its tie-in with the B1137 local road at the existing junction 20b (to be decommissioned) near Wellington Bridge. Catchment S1-OU19C is the eastern catchment located between the junction 21 northern roundabout and the Ordinary Watercourse 7 culvert crossing. Catchment S1-OU19C1 is the western catchment located between Wellington Bridge (in the west) and the Ordinary Watercourse 7 culvert crossing. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU19C / S1-OU19C1 catchment.

6.2.45 The new Hatfield Peverel link road has a balanced crossfall from the proposed junction 21 northern roundabout. The balanced highway cross-section falls north and south to the northern and southern verges. The balanced highway cross-section continues for the majority of the length of the new link road (i.e. approximately 630m of the 830m total length) heading west, then transitions to a superelevated south-easterly crossfall orientation at chainage 200m and eventually ties-in to the existing B1137 local road near Wellington Bridge. The longitudinal slope for the majority of the new link road is gentle and so it is proposed to collect surface water runoff from the carriageway via combined kerb drainage. This will discharge to carrier drains and combined filter drains located in both the northern and southern verges dependent on the highway crossfall orientation.

6.2.46 The ultimate low point on the new Hatfield Peverel link road occurs in the vicinity of the proposed Ordinary Watercourse 7 ditch diversion culvert under proposed junction 21 (A12 mainline chainage 17300). Therefore, the carrier drains and combined filters drains for the S1-OU19C and S1-OU19C1 catchments will discharge off the proposed highway embankment / cutting and drain north into two separate proposed attenuation ponds located immediately east and west of the Ordinary Watercourse 7 ditch diversion. The attenuation ponds are located immediately north of the new Hatfield Peverel link road. The two proposed attenuation ponds will discharge to new outfalls on the Ordinary Watercourse 7 ditch diversion via vortex flow control devices. The 5l/s minimum practicable discharge rate criteria is applicable for this proposed catchment given that the proposed Hatfield Peverel link road is located on a currently greenfield site. It should be noted that the S1-OU19C / S1-OU19C1 catchment proposed discharge rates have been adjusted with the adjacent proposed S1-OU19 catchment such that the combined proposed discharge rates are less than the existing case S1-OU19 allowable discharge rates.

Catchment S1-OU23C

6.2.47 The S1-OU23C drainage catchment is for the junction 21 northbound on-slip road portion from its start point at the proposed junction 21 northern

roundabout to approximate chainage 17830 on the A12 mainline. It should be noted that the proposed S1-OU23C catchment is an attenuated sub-catchment to the proposed S1-OU23 catchment on the A12 mainline. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU23C catchment.

6.2.48 The junction 21 northbound on-slip road highway geometry has a superelevated crossfall from the proposed junction 21 northern roundabout. The superelevated highway cross-section falls in a north-easterly orientation along its length from the northern roundabout to the A12 mainline chainage 17830. It is proposed to collect the surface water runoff with a kerb and gully arrangement where there is a kerb line. In the absence of a proposed kerb line it is proposed to collect the surface water runoff with linear slot drainage, discharging at regular intervals to a carrier drain system located in the northern verge. A filter drain system is required along the toe of the northbound on-slip road northern embankment slope to collect surface water runoff from the embankment slope and the natural catchment trapped between the proposed realigned Witham Link Road and the northbound on-slip road.

6.2.49 The aforementioned carrier drains and northern embankment slope filter drains will converge and discharge via a common carrier drain north, away from the proposed slip road, and into a proposed attenuation pond located within the open grassed space between the proposed realigned Witham Link Road and the junction 21 northbound on-slip road. The attenuation pond is located north-east of the proposed northbound on-slip road and will outfall to the proposed A12 mainline highway drainage system (i.e. the proposed S1-OU23 catchment described previously) at approximate chainage 17915 via a vortex flow control device. The 5l/s minimum practicable discharge rate criteria is applicable for this proposed sub-catchment to the proposed S1-OU23 catchment given that the proposed northbound on-slip road is located on a currently greenfield site.

Catchment S1-OU23D

6.2.50 The S1-OU23D catchment is the drainage catchment for the proposed realigned Witham Link Road from its start point at the proposed junction 21 northern roundabout to its tie-in with the B1389 local road near Witham. The catchment also includes the proposed junction 21 northern roundabout. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU23D catchment.

6.2.51 The proposed realigned Witham Link Road has a superelevated crossfall from the proposed junction 21 northern roundabout. The superelevated highway cross-section initially falls in a south-easterly orientation, then the highway transitions to a north-easterly orientation and eventually ties-in to the existing B1389 local road at the eastern end of the proposed highway alignment. It is proposed to collect the surface water runoff with a kerb and

gully arrangement where there is a kerb line. In the absence of a proposed kerbline it is proposed to collect the surface water runoff with linear slot drainage. The junction 21 northern roundabout drainage catchment also drains into the proposed realigned Witham Link Road highway drainage. For the northern roundabout it is proposed to collect the surface water runoff from the carriageway via combined kerb drainage, discharging to carrier drains and combined filter drains located in both the northern and southern verges of the realigned Witham Link Road dependent on the highway crossfall orientation.

6.2.52 The carrier drains and combined filters drains will discharge off the proposed highway and drain north into a proposed offline attenuation pond. The offline attenuation pond is located north of the proposed realigned Witham Link Road. The proposed attenuation pond discharges back into the proposed link road highway drainage system via an attenuation pond outlet pipe at approximate A12 mainline chainage 18100 using a vortex flow control device. Greenfield discharge rates are applicable for this local attenuation pond outlet pipe location given that the proposed highway drainage catchment upstream of the attenuation pond is located on a currently greenfield site. A small portion of the proposed realigned Witham Link Road extends east beyond the proposed attenuation pond and overlaps with the footprint of the existing B1389 local road. This portion of the highway will be attenuated to brownfield discharge rates with oversized pipes via an orifice plate flow control device due to spatial constraints. At present it is assumed that the proposed realigned Witham Link Road highway drainage will ultimately discharge to the existing highway drainage serving the B1389 local road. This assumption needs to be confirmed with more detailed drainage survey information as the project progresses.

Catchment S1-OU24A

6.2.53 The S1-OU24A catchment is the drainage catchment for the junction 21 southbound off-slip road from its start point at the proposed junction 21 southern roundabout to its merging with the A12 mainline at approximate chainage 18000. It should be noted that the proposed S1-OU24A catchment is an attenuated sub-catchment to the S1-OU23 catchment on the A12 mainline. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU24A catchment.

6.2.54 The junction 21 southbound off-slip road highway geometry has a superelevated crossfall from the proposed junction 21 southern roundabout. The superelevated highway cross-section falls in a south-easterly orientation along its length from the southern roundabout to its merging with the A12 mainline at approximate chainage 18000. It is proposed to collect the surface water runoff with a kerb and gully arrangement where there is a kerb line. In the absence of a proposed kerb line it is proposed to collect the surface water runoff with linear slot drainage, discharging to carrier drains located in the southern verge. A

drainage ditch alignment is required along the toe of the southbound off-slip road southern embankment slope to collect surface water runoff from the embankment slope and the natural catchment trapped between the proposed realigned Kennel access road and the southbound off-slip road.

6.2.55 The aforementioned carrier drain system located in the slip road southern verge will discharge south at intervals, off the proposed slip road embankment, and into the proposed drainage ditch alignment located along the toe of the junction 21 southbound off-slip road southern embankment. The drainage ditch will discharge to the east to a proposed attenuation pond located within the open grassed space between the proposed realigned Kennel access road and the A12 mainline. The attenuation pond will discharge via an orifice plate flow control device to an existing surface water carrier drain (to be retained) that discharges north into the A12 mainline highway drainage system (i.e. proposed S1-OU23 catchment previously described) at approximate chainage 18280. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to the existing case S1-OU24 outfall location which serves the existing A12 mainline.

Catchment S1-OU24B

6.2.56 The S1-OU24B catchment is the drainage catchment for the proposed realigned Kennel access road from its start point at the proposed junction 21 southern roundabout to its to its tie-in with the B1389 local road near Latney's Boarding Kennels, Cattery and Grooming Parlour site. The catchment also includes the proposed junction 21 southern roundabout. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0806 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU24B catchment.

6.2.57 The proposed realigned Kennel access road has a balanced crossfall throughout its entire length from the proposed junction 21 southern roundabout to its tie-in with the existing B1389 local road near Latney's Boarding Kennels, Cattery and Grooming Parlour site. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage positioned along the entire length of the proposed realigned Kennel access road. The junction 21 southern roundabout drainage catchment also drains into the proposed realigned Kennel access road highway drainage. For the southern roundabout it is proposed to collect the surface water runoff from the carriageway via combined kerb drainage. The combined kerb drainage located along the edge of the northern verge for the above-described proposed local road will discharge to carrier drains and combined filter drains located in the northern verge. The combined kerb drainage located along the edge of the southern verge for the above-described proposed local road and the southern roundabout highway drainage will discharge via carrier drains at multiple intervals into a proposed vegetated drainage ditch located adjacent to the southern edge of the proposed realigned Kennel access road. This vegetated drainage

ditch will also collect the surface water runoff from the proposed realigned Kennel access road southern embankment slope.

6.2.58 The carrier drains, combined filters drains and vegetated drainage ditch will discharge away from the proposed highway at a single location near the A12 mainline chainage 18080 and drain south into a proposed attenuation pond. The attenuation pond is located immediately south of the proposed realigned Kennel access road. A small portion of the existing highway drainage associated with the B1389 local road near Latney's Boarding Kennels, Cattery and Grooming Parlour site has to be retained and will discharge into the aforementioned attenuation pond. The proposed attenuation pond will discharge south-east to a new outfall on an existing drainage ditch via a vortex flow control device. This drainage ditch ultimately discharges to Ordinary Watercourse 32. The 5l/s minimum practicable discharge rate criteria is applicable for this proposed catchment given that the proposed realigned Kennel access road is located on a currently greenfield site.

Side roads

6.2.59 The proposed A12 mainline within the Drainage Section 1 highway drainage sub-section includes four side road drainage catchments which discharge to proposed outfalls S1-OU10A, S1-OU13A, S1-OU20 and S1-OU21. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the side road drainage catchments described below are presented in Table C.1 in Appendix C.

6.2.60 Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0802, 0804 and 0805 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the aforementioned Drainage Section 1 side road drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield / brownfield / adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Catchment S1-OU10A

6.2.61 The S1-OU10A catchment is the drainage catchment associated with the proposed Paynes Lane access road located immediately south of the A12 mainline at chainage 11300. The existing Paynes Lane access road is proposed to be replaced with a bridleway access to a proposed Walking Cycling and Horse Riding (WCH) overbridge at A12 mainline carriageway

chainage 11300. The drainage catchment start point is located immediately south of the A12 mainline carriageway and extends as far as its tie-in with the B1137 local road. It should be noted that a small portion of the existing B1137 local road carriageway contributes to the S1-OU10A catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0802 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU10A catchment.

6.2.62 The proposed Paynes Lane highway geometry has a balanced crossfall throughout. It is proposed to collect the surface water runoff via combined kerb drainage located adjacent to the eastern and western verges. The combined kerb drainage will discharge at regular intervals to a carrier drain system located within the western verge. The carrier drain system will discharge south, down Paynes Lane, to a cross-carriageway carrier drain which crosses the existing B1137 local road (i.e. near the proposed Paynes Lane tie-in to the B1137) and connects into the existing highway drainage system serving the B1137 local road.

6.2.63 Regarding the existing B1137 local road portion draining into the S1-OU10A catchment, the existing highway geometry has a superelevated crossfall. The superelevated highway cross-section falls in a south-easterly orientation along its length. It is proposed to collect the surface water runoff via combined kerb drainage located adjacent to the B1137 southbound verge. The combined kerb drainage will discharge at regular intervals to carrier drains located to the north of the existing B1137 carriageway. The aforementioned carrier drain serving the B1137 carriageway will discharge into the previously described cross-carriageway carrier drain at the proposed Paynes Lane tie-in to the existing B1137 local road.

6.2.64 The outfall discharge rates will be controlled by a vortex flow control device with the flow backing up into the proposed highway drainage system and into an offline underground geocellular attenuation storage system located just north of the existing B1137 local road. Brownfield discharge rates are applicable for this outfall location given that the existing Paynes Lane site is currently paved.

6.2.65 There is an existing external natural catchment area located to the immediate north-west of the proposed Paynes Lane. This external natural catchment is proposed to be intercepted by a natural catchment drainage ditch which will discharge into the proposed Paynes Lane highway drainage system to maintain the effective drainage of this external natural catchment area.

Catchment S1-OU13A

6.2.66 The S1-OU13A catchment is the drainage catchment associated with the 210m length of the B1137 local road located immediately south of the A12 mainline from chainage 15230 to 15440. The drainage catchment start point is at the proposed works tie-in with the existing B1137 carriageway (i.e. approximately 165m east of the existing Crix Bridge overbridge) and extends as far as Ordinary Watercourse 28. Highway improvement works

are required for this portion of the existing B1137 as an existing slip road to the A12 mainline is to be removed. Therefore, an existing B1137 catchment has been separated from the proposed S1-OU13 catchment due to the different maintenance liabilities for the B1137 side road (i.e. Essex Highways) and the A12 mainline (i.e. National Highways). Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0804 and 0805 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S1-OU13A catchment.

6.2.67 The proposed B1137 local road highway geometry has a balanced crossfall along the length of the proposed highway works. The balanced carriageway cross-section falls north-east and south-east along its length. It is proposed to collect the surface water runoff from the proposed B1137 northbound carriageway via combined kerb drainage. The combined kerb drainage alignment will discharge at regular intervals to a carrier drain system located within the northern verge. The aforementioned carrier drain serving the B1137 northbound carriageway will discharge east into the upstream end of a proposed vegetated drainage ditch. An orifice plate flow control device is provided at the vegetated drainage ditch outlet to utilise the online attenuation storage capacity. The proposed vegetated drainage ditch will discharge east into a proposed cross-carriageway carrier drain located at approximate A12 mainline chainage 15440. Regarding the B1137 southbound carriageway, given that the carriageway widening works are minor along the southern edge of the B1137 southbound carriageway, it is proposed that the surface runoff will be collected by the existing kerb and gully arrangement which discharges into an existing carrier drain located within the retained southern verge. The existing carrier drain serving the B1137 southbound carriageway will discharge east to the aforementioned proposed cross-carriageway carrier drain at A12 mainline chainage 15440.

6.2.68 Once the proposed highway drainage from the B1137 northbound and southbound carriageways has converged to the above-described cross-carriageway carrier drain, the cross-carriageway carrier drain discharges south of the B1137 embankment to the existing S1-OU13 catchment outfall (to be retained) on Ordinary Watercourse 28. Brownfield discharge rates are applicable due to online highway widening works. The ultimate receptor for the proposed S1-OU13A catchment is the River Ter.

Catchment S1-OU20

6.2.69 The S1-OU20 catchment is the drainage catchment associated with the Station Road overbridge in Hatfield Peverel. The Station Road overbridge located across the A12 mainline is proposed to be replaced to accommodate the widened proposed A12 mainline carriageway. The drainage catchment start point is at the proposed bridge deck high point midway along the Station Road overbridge replacement as far as the tie-in with the existing Station Road carriageway north of the proposed overbridge replacement. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0805 of the Drainage and Surface Water Plans

[TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU20 catchment.

6.2.70 The proposed Station Road overbridge replacement geometry has a balanced crossfall along the length of the proposed works. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units located on either side of the balanced overbridge carriageway cross-section. The proposed Station Road overbridge bridge deck drainage will then discharge north via carrier drains to the existing highway drainage system serving Station Road. Attenuation storage is not required as the proposed highway works only involve the refurbishment of the existing Station Road overbridge.

Catchment S1-OU21

6.2.71 The S1-OU21 catchment is the drainage catchment associated with the Station Road overbridge. The Station Road overbridge located above the A12 mainline is proposed to be replaced to accommodate the widened proposed A12 mainline carriageway. The drainage catchment start point is at the proposed bridge deck high point midway along the Station Road overbridge replacement as far as the tie-in with the existing Station Road carriageway south of the proposed overbridge replacement. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0805 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S1-OU21 catchment.

6.2.72 The proposed Station Road overbridge replacement geometry has a balanced crossfall along the length of the proposed works. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units located on either side of the balanced overbridge carriageway cross-section. The proposed Station Road overbridge bridge deck drainage will then discharge south via carrier drains to the existing highway drainage system serving Station Road. Attenuation storage is not required as the proposed highway works only involve the refurbishment of the existing Station Road overbridge.

6.3 Drainage Section 2 highway drainage proposals

Junction 22

6.3.1 The proposed junction 22 is located north-east of the existing junction 22 (i.e. between approximate A12 mainline chainages 22800 and 23800) and has an elevated dumbbell layout. The proposed scheme would deliver the following improvements with regard to the proposed junction 22:

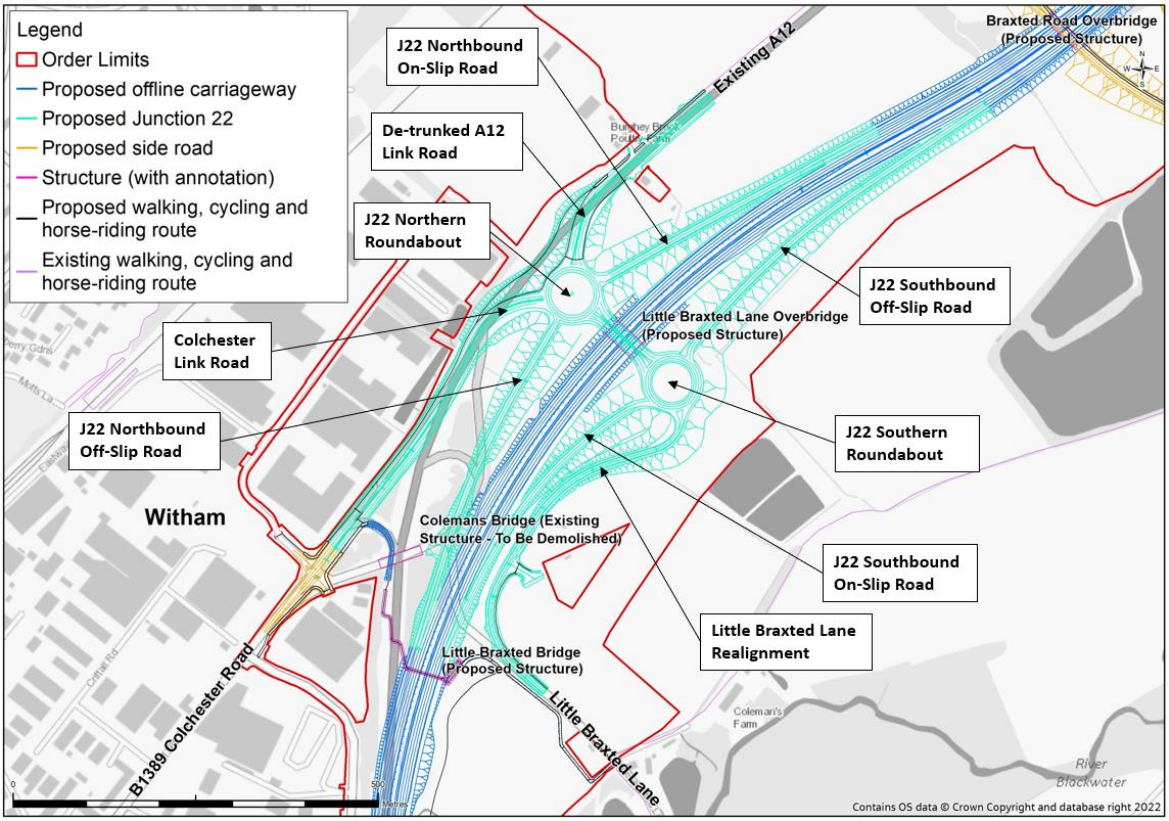
- Proposed northern roundabout with northbound on-slip road and northbound off-slip road providing access to the A12 mainline northbound carriageway
- Two proposed local access roads off the northern roundabout, using the existing A12 to link to Witham and Rivenhall End
- Proposed southern roundabout with southbound on-slip road and southbound off-slip road providing access to the A12 mainline northbound carriageway
- A single proposed local access road off the southern roundabout, providing access to the realigned Little Braxted Lane and the existing Colemans Quarry
- The junction 22 roundabout overbridge which connects the proposed northern and southern roundabouts

6.3.2 An overview of the proposed junction 22 general arrangement is shown in Plate 6.3. The proposed junction 22 comprises five main highway drainage catchments which discharge to proposed outfalls S2-OU9, S2-OU10, S2-OU11, S2-OU14 and S2-OU15A. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. It should be noted that an emergency area is contained within the proposed S2-OU15A catchment. The emergency area located in this catchment is proposed to be drained by combined kerb drainage. The combined kerb drainage will discharge at regular intervals to the main carrier drain system to serve the proposed catchment. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the junction 22 drainage catchments described below, are presented in Table B.2 in Annex B.

6.3.3 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing number HE551497-JAC-LDC-SCHW-DR-D-0810, illustrates the main drainage features and catchment extents for the aforementioned junction 22 drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and catchment-specific comments regarding the

greenfield / brownfield / adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Plate 6.3 Overview of the proposed junction 22 general arrangement



Catchment S2-OU9

6.3.4 Catchment S2-OU9 is a drainage catchment associated with the new offline alignment of the A12 mainline between proposed junction 22 and existing junction 23. The drainage catchment includes a portion of the A12 mainline (chainage 22660 to 23150), the entire southbound on-slip road and the entire northbound off-slip road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0810 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU9 catchment.

- **A12 mainline (chainage 22660 to 23150)** – The A12 mainline highway geometry has a superelevated crossfall, falling from west to east across the full carriageway section. The northbound carriageway falls east towards the central reserve while the southbound carriageway falls east towards the eastern verge. It is proposed to collect the surface water runoff from this portion of the proposed S2-OU9 catchment by a combination of linear slot drainage and combined filter drains, discharging at regular intervals to carrier drains

located beneath them which ultimately discharge east of the A12 mainline cutting to a proposed attenuation pond.

- **J22 northbound off-slip road** – The northbound off-slip road has a superelevated crossfall, falling in a south-westerly orientation towards the western verge. It is proposed to collect the surface water runoff from this portion of the proposed S2-OU9 catchment by a combination of combined kerb drainage and linear slot drainage. These will discharge to a carrier drain system which discharges south-west to the proposed S2-OU9 highway drainage serving the A12 mainline.

- **J22 southbound on-slip road** – The southbound on-slip road has a superelevated crossfall, falling in a south-easterly orientation towards the southern verge. It is proposed to collect the surface water runoff from this portion of the proposed S2-OU9 catchment by a combination of combined kerb drainage and linear slot drainage. These will discharge to a carrier drain system which discharges south-west to the proposed S2-OU9 highway drainage serving the A12 mainline.

6.3.5 Once the proposed highway drainage from the A12 mainline (chainage 22660 to 23150), the northbound off-slip road and the southbound on-slip road has converged to the primary A12 mainline surface water carrier drains, the carrier drains continue east of the A12 mainline and discharge to a proposed attenuation pond. The attenuation pond is located east of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 10 via a vortex flow control device. Greenfield discharge rates are applicable as the proposed offline A12 mainline portion drained by the S2-OU9 highway drainage is located on a currently greenfield site.

Catchment S2-OU10

6.3.6 Catchment S2-OU10 is the drainage catchment for the proposed local access road off the junction 22 southern roundabout which provides access to the realigned Little Braxted Lane. The drainage catchment also includes the entire proposed junction 22 southern roundabout and a portion of the junction 22 overbridge between the northern and southern roundabouts. The proposed works also include highway improvement works to the existing Little Braxted Lane highway portion to be retained. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0810 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU10 catchment.

6.3.7 The proposed realigned Little Braxted Road has a superelevated crossfall from the proposed junction 22 southern roundabout. The superelevated highway cross-section initially falls in a south-westerly orientation for a short distance and then transitions to a south-easterly crossfall orientation for the majority of its length and eventually ties-in to the existing Little Braxted Lane. It is proposed to collect the surface water runoff from the proposed S2-OU10 catchment by a combination of a kerb and gully arrangement and combined kerb drainage filter drains, discharging to a carrier drain system.

The junction 22 southern roundabout drainage catchment also drains into the proposed realigned Little Braxted Road highway drainage system. Regarding the proposed junction 22 overbridge, it has a balanced crossfall. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units which will discharge into the southern roundabout highway drainage system.

6.3.8 The ultimate low point on the proposed realigned Little Braxted road occurs at the tie-in to the existing Little Braxted Lane. Therefore, the aforementioned carrier drains and combined filters drains will discharge off the proposed highway embankment and drain south into a proposed attenuation pond located to the southwest of Little Braxted Lane. The proposed attenuation pond will discharge to a new outfall on Ordinary Watercourse 10 via a vortex flow control device as the existing outfall serving Little Braxted Lane was not identified due to a lack of drainage survey information. Brownfield discharge rates are applicable for this new outfall location given the proposed highway improvement works to the existing Little Braxted Lane**.**

Catchment S2-OU11

6.3.9 Catchment S2-OU11 is the drainage catchment for the proposed junction 22 local road which provides access to the A12 mainline northbound carriageway from Colchester Road (referred to as the Colchester Road Link Road herein). Drawing number HE551497-JAC-LDC-SCHW-DR-D-0810 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU11 catchment.

6.3.10 The Colchester Road Link Road initially has a balanced crossfall from the proposed junction 22 northern roundabout. The balanced highway cross-section then transitions to a superelevated cross-section with a north-westerly crossfall orientation for the majority of its length and eventually ties-in to the existing Colchester Road. It is proposed to collect the surface water runoff from the proposed S2-OU11 catchment with a kerb and gully arrangement. The gullies will discharge to carrier drains located in both the western and eastern verges dependent on the highway crossfall orientation.

6.3.11 The ultimate low point on the proposed Colchester Link Road occurs approximately midway along the highway alignment. Therefore, the aforementioned carrier drains will converge at the low point, discharge east of the proposed highway and drain east into a proposed attenuation pond located between the proposed Colchester Link Road and junction 22 northbound off-slip road. The proposed attenuation pond will discharge north-east to Ordinary Watercourse 11 via a vortex flow control device. Brownfield discharge rates are applicable given that the proposed highway drainage to serve the proposed local road portion that ties into Colchester Road and the highway improvement works on Colchester Road itself is discharging to a new outfall location on Ordinary Watercourse 11 which currently accepts surface water runoff from the existing A12 mainline.

Catchment S2-OU14

6.3.12 Catchment S2-OU14 is the drainage catchment for the proposed junction 22 local road which provides access to the proposed offline A12 mainline northbound carriageway from the existing de-trunked A12 (referred to as the de-trunked A12 link road herein). The drainage catchment also includes the entire proposed junction 22 northern roundabout and a portion of the junction 22 overbridge between the northern and southern roundabouts. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0810 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU14 catchment.

6.3.13 The de-trunked A12 link road initially has a balanced crossfall from the proposed junction 22 northern roundabout. The balanced highway cross-section then transitions to a superelevated cross-section with a south-easterly crossfall orientation for the majority of its length and eventually ties-in to the existing A12 carriageway. It is proposed to collect the surface water runoff from the proposed S2-OU14 catchment with a kerb and gully arrangement. The gullies will discharge to carrier drains located in both the western and eastern verges dependent on the highway crossfall orientation. A short alignment of combined filter drain is required at the north-eastern end of the proposed de-trunked A12 link road where it ties in to the existing A12 given that the highway is in cutting at this location. The junction 22 northern roundabout drainage catchment also drains into the proposed de-trunked A12 link road highway drainage. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units. The overbridge bridge deck drainage units will discharge into the northern roundabout highway drainage system.

6.3.14 Once the aforementioned carrier drains and combined filter drains converge to the common proposed surface water carrier drain system, the carrier drains will discharge south-east of the proposed highway and subsequently drain north-east to a proposed attenuation pond located between the proposed offline A12 mainline and the existing A12 carriageway at approximate A12 mainline chainage 23800. The proposed attenuation pond will discharge to a new outfall location on the diverted Ordinary Watercourse 12 via a vortex flow control device. A new outfall is required on the diverted Ordinary Watercourse 12 due to spatial constraints at the existing outfall location where the provision of an attenuation pond is not practicable. Brownfield discharge rates are applicable due to the online highway improvement works on the existing A12 portion that currently discharges to an existing outfall on Ordinary Watercourse 12.

Catchment S2-OU15A

6.3.15 The S2-OU15A catchment extends for approximately 600m of the proposed offline A12 mainline from chainage 23160 and heading north-east to proposed culvert CL-12B (chainage 23160 to 23760). An offline dual three-lane carriageway is proposed for this section of the highway for the

proposed scheme. The drainage catchment includes a portion of the A12 mainline (chainage 23160 to 23760), the entire northbound on-slip road and the entire southbound off-slip road at proposed junction 22. This catchment also includes an emergency area on the northbound carriageway near A12 mainline chainage 23050. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0810 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15A catchment.

- **A12 mainline (chainage 23160 to 23760)** – The A12 mainline highway geometry has a superelevated crossfall, falling from north-west to south-east across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of combined filter drains, linear slot drainage and concrete surface water channels, discharging at regular intervals to carrier drains located beneath them. The aforementioned carrier drains serving both the northbound and southbound carriageways will converge and discharge north of the A12 mainline to a proposed attenuation pond.

- **J22 northbound on-slip road** – The northbound on-slip road has a superelevated crossfall, falling in a north-easterly orientation. It is proposed to collect the surface water runoff from the slip road with a combination of combined kerb drainage and linear slot drainage, discharging to a carrier drain system located in the northern verge. This carrier drain system will discharge east to the proposed S2-OU15A highway drainage serving the A12 mainline.

- **J22 southbound off-slip road** – The southbound off-slip road has a superelevated crossfall, falling in a south-easterly orientation. It is proposed to collect the surface water runoff from the slip road with a combination of combined kerb drainage and linear slot drainage, discharging to a carrier drain system located in the southern verge. This carrier drain system will discharge east to the proposed S2-OU15A highway drainage serving the A12 mainline.

6.3.16 It should be noted that the proposed junction 22 northbound on-slip road embankment slope and the southbound-off-slip road embankment slope which drain down into the A12 mainline are intercepted by the aforementioned combined filter drains serving the A12 mainline highway. A proposed drainage ditch intercepts the northbound on-slip road northern embankment slope and discharges it into the S2-OU15A catchment. Once the proposed highway drainage from the A12 mainline (chainage 23160 to 23760), the northbound on-slip road and the southbound off-slip road have converged to the primary A12 mainline surface water carrier drains, the carrier drains continue north of the A12 mainline and discharge to a proposed attenuation pond. The attenuation pond is located north of the A12 mainline and outfalls to a new outfall on a proposed diverted Ordinary Watercourse 12 via a vortex flow control device. Greenfield discharge rates

are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

A12 mainline

6.3.17 The A12 mainline encompassed by the Drainage Section 2 highway drainage
sub-section is a total length of 7.1km from junction 21 (south-west of Witham) to the existing junction 23 (south of Kelvedon). It is proposed that between proposed junction 21 and proposed junction 22, online widening works would be undertaken to the existing A12 carriageway, upgrading the current two-lane dual carriageway to a three-lane dual carriageway in each direction. From a location just south of the existing junction 22, there is an offline highway alignment proposed, bypassing the urban area of Rivenhall End to the south-east and subsequently crossing the existing A12 carriageway to the east of Rivenhall End and then rejoining the existing A12 carriageway at Cranes Bridge to the west of Kelvedon (i.e. approximately A12 mainline chainage 26100m).

6.3.18 The proposed A12 mainline within the Drainage Section 2 highway drainage sub-section comprises nine main highway drainage catchments which discharge to proposed outfalls S2-OU3, S2-OU4, S2-OU5, S2-OU8, S2-OU9A, S2-OU15C, S2-OU15C1, S2-OU15G and S2-OU19. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. It should be noted that emergency areas are contained within the proposed S2-OU4, S2-OU8, S2-OU15C, S2-OU15G and S2-OU19 catchments. The emergency areas located in these catchments are proposed to be drained by combined kerb drainage. The combined kerb drainage will discharge at regular intervals to the main carrier drain system to serve the proposed catchments. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the A12 mainline (Drainage Section 2) drainage catchments described below are presented in Table B.2 in Annex B.

6.3.19 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0808 to 0812), illustrate the main drainage features and catchment extents for the aforementioned A12 mainline (Drainage Section 2) drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types and diameters employed for the proposed highway drainage systems and catchment-specific comments regarding the greenfield / brownfield / adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Catchment S2-OU3

6.3.20 The S2-OU3 catchment extends for approximately 140m of the proposed online A12 mainline between Oliver's Bridge and Benton's Bridge (A12 mainline chainage 20480 to 20620). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0808 of the Surface Water Drainage Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU3 catchment.

6.3.21 The A12 mainline highway geometry has a superelevated crossfall, falling from south to north across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of surface water channels and linear slot drainage, discharging at regular intervals to carrier drains located underneath. Oliver's Bridge forms the upstream end of the S2-OU3 catchment. The bridge alignment will be drained by bridge deck drainage, which will drain to the aforementioned carrier drain system.

6.3.22 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge north-east of the A12 mainline to an existing outfall located adjacent to Benton's Bridge on Ordinary Watercourse 9 via an orifice plate flow control device. Attenuation storage is provided by the aforementioned carrier drain system which has been designed as oversized pipes due to spatial constraints. Brownfield discharge rates are applicable for this outfall location due to the proposed online highway widening works.

Catchment S2-OU4

6.3.23 The S2-OU4 catchment extends for approximately 540m of the proposed online A12 mainline between Benton's Bridge and Brain's Bridge (A12 mainline chainage 20620 to 21160). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. This catchment also includes an emergency area on the southbound carriageway near A12 mainline chainage 20950. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0808 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU4 catchment.

6.3.24 The A12 mainline highway geometry has a superelevated crossfall, falling in a north-westerly orientation across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of concrete surface water channels and linear slot drainage, discharging at regular intervals to carrier drains located beneath them. Benton's Bridge forms the upstream end of the S2-OU4 catchment. The bridge will be drained by bridge deck drainage units which will drain to the aforementioned carrier drain system.

6.3.25 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge south-east of the A12 mainline embankment to a proposed attenuation pond. The attenuation pond is

located east of the A12 mainline and discharges north to a new outfall on the River Brain via an orifice plate flow control device. Brownfield discharge rates are applicable due to the online highway widening works and given that the River Brain currently accepts surface water runoff from the existing A12 mainline. It should be noted that the proposed discharge rates for the S2-OU4 catchment have been additionally restricted below the existing case allowable discharge rates at the existing S2-OU4 outfall. This is to compensate for the higher proposed discharge rates from the adjacent S2-OU5 outfall (described below) which discharges at a similar location on the River Brain.

Catchment S2-OU5

6.3.26 The S2-OU5 catchment extends for approximately 340m of the proposed online A12 mainline from Brain's Bridge and heading north to A12 mainline chainage 21500 (chainage 21160 to 21500). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0808 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU5 catchment.

6.3.27 The A12 mainline highway geometry has a superelevated crossfall, falling in a westerly orientation across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of concrete surface water channels and linear slot drainage, discharging at regular intervals to carrier drains located beneath them. Brain's Bridge forms the upstream end of the S2-OU5 catchment. The bridge alignment will be drained by bridge deck drainage units which will drain to the aforementioned carrier drain system.

6.3.28 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge east of the A12 mainline embankment, via an orifice plate flow control device, to a proposed carrier drain ditch that runs along the toe of the earthworks on the southbound A12. This proposed carrier drain runs underneath the proposed drainage ditch subsequently drains south (against the highway longitudinal fall) to an existing outfall on the River Brain. Attenuation storage is provided by the aforementioned carrier drain system which has been designed as oversized pipes due to spatial constraints (i.e. potential presence of nature reserve adjacent to the proposed S2-OU5 catchment). However, the proposed discharge rates could not be fully attenuated to the existing case S2-OU5 allowable discharge rates due to the spatial constraints (i.e potential presence of nature reserve adjacent to catchment S2-OU5) that limited the maximising of the attenuation storage. Therefore, the S2-OU5 catchment discharge rates have been compensated relative to the adjacent proposed S2-OU4 catchment discharge rates (which also discharges at similar a location on River Brain). Brownfield discharge rates applicable due to the online highway widening works.

Catchment S2-OU8

6.3.29 The S2-OU8 catchment extends for approximately 1.08km of the proposed online A12 mainline from chainage 21500 to retained existing culvert CL-10 (chainage 21500 to 22580). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. This catchment also includes emergency areas on the northbound carriageway near A12 mainline chainage 21750 and on the southbound carriageway near A12 mainline chainage 22150. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0809 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU8 catchment.

6.3.30 The A12 mainline highway geometry is primarily balanced with small sections of superelevated highway at the southern and northern extremes of the highway alignment. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of combined filter drains, concrete surface water channels and / or linear slot drainage systems. Surface water channels and / or linear slot drainage systems are used where the proposed highway is on embankment or at-grade and combined filter drains are used where the proposed highway is in cutting. The aforementioned edge collection features will discharge at regular intervals to carrier drains located underneath them. The proposed A12 mainline cutting slopes along this proposed highway alignment will drain to the aforementioned combined filter drains which drain to the proposed highway drainage system.

6.3.31 The proposed carrier drains serving both the northbound and southbound carriageways will converge at the low point of the proposed highway (i.e. approximately midway along the highway alignment) and discharge east of the A12 mainline to an existing outfall located on Ordinary Watercourse 9a via an orifice plate flow control device. Attenuation storage is provided by the aforementioned carrier drain system which has been designed as oversized pipes due to spatial constraints (i.e. potential presence of nature reserve and potential floodplain adjacent to the S-OU8 catchment). Brownfield discharge rates are applicable for this outfall location due to the proposed online highway widening works.

Catchment S2-OU9A

6.3.32 The S2-OU9A catchment extends for approximately 80m of the proposed offline A12 mainline from retained existing culvert CL-10 and heading north (A12 mainline chainage 22580 to 22660). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0809 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU9A catchment.

6.3.33 The A12 mainline highway geometry has a superelevated crossfall, falling in an easterly orientation across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound

carriageways with a combination of linear slot drainage and combined filter drains, discharging at regular intervals to carrier drains located beneath them. The proposed A12 mainline cutting slope along the eastern side of this proposed highway alignment will drain to the aforementioned combined filter drains which drain to the proposed highway drainage system.

6.3.34 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge east of the A12 mainline to a repositioned existing outfall on the Ordinary Watercourse 10 via an orifice plate flow control device. The repositioned existing S2-OU9 catchment outfall is required due to the extended culvert CL-10 (i.e. A12 online widening works). Attenuation storage is provided by the aforementioned carrier drain system which has been designed as oversized pipes due to spatial constraints. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to the repositioned existing S2-OU9 catchment outfall on Ordinary Watercourse 10.

Catchment S2-OU15C

6.3.35 The S2-OU15C catchment extends for approximately 780m of the proposed offline A12 mainline from proposed culvert CL-12B and heading north-east to A12 mainline chainage 24540 (chainage 23760 to 24540). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. The drainage catchment includes a portion of the A12 mainline (chainage 23760 to 24540) and the realigned Henry Dixon Road (located immediately north-west of the A12 mainline). This catchment also includes an emergency area on the northbound carriageway near A12 mainline chainage 24500. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15C catchment.

- **A12 mainline (chainage 23760 to 24540)** – The A12 mainline highway geometry has a superelevated crossfall, falling from south-east to north-west across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of linear slot drainage, concrete surface water channels and combined filter drains, discharging at regular intervals to carrier drains located beneath them. The aforementioned carrier drains serving both the northbound and southbound carriageways will converge and discharge south-east of the A12 mainline to a proposed attenuation pond.

- **Realigned Henry Dixon Road** – The proposed realigned road has a balanced cross-section. Where the proposed side road is on embankment or at-grade it is proposed to collect the surface water runoff from the carriageway via combined kerb drainage. Where the proposed side road is in cutting it is proposed to collect surface water runoff from the carriageway via combined filter drains. The

aforementioned edge collection features will discharge to a carrier drain system. These carrier drains will then converge and discharge south-east into the proposed S2-OU15C highway drainage serving the A12 mainline at approximate chainage 24270.

6.3.36 It should be noted that the proposed A12 mainline and realigned Henry Dixon Road cutting slopes, where present, will drain to the aforementioned combined filter drains which drain to the proposed highway drainage system. Once the proposed highway drainage from the A12 mainline (chainage 23760 to 24540) and the realigned Henry Dixon Road have converged to the primary A12 mainline surface water carrier drains, the carrier drains continue south-east of the A12 mainline embankment and discharge to a proposed attenuation pond. The attenuation pond is located south-east of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 13 via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S2-OU15C1

6.3.37 The S2-OU15C1 catchment extends for approximately 100m of the proposed offline A12 mainline from A12 mainline chainage 24540 to the existing Rivenhall Brook culvert (chainage 24540 to Ch 24640). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15C1 catchment.

6.3.38 The A12 mainline highway geometry has a superelevated crossfall, falling from east to west across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of combined filter drains, concrete surface water channels and / or linear slot drainage systems, discharging at regular intervals to carrier drains located beneath them. The proposed A12 mainline cutting slope along the western side of this proposed highway alignment will drain to the aforementioned combined filter drains.

6.3.39 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge to a proposed attenuation pond. The attenuation pond is located south-east of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 15a via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S2-OU15G

6.3.40 The S2-OU15G catchment extends for approximately 1.19km of the proposed offline A12 mainline from the existing Rivenhall Brook culvert to A12 mainline chainage 25830 (chainage 24640 to 25830). An offline dual

three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes emergency areas on the northbound carriageway near A12 mainline chainage 25700 and on the southbound carriageway near A12 mainline chainages 25050. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15G catchment.

6.3.41 The A12 mainline highway geometry has a superelevated crossfall, falling from north-west to south-east across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways with a combination of concrete combined filter drains, surface water channels and / or linear slot drainage systems, discharging at regular intervals to carrier drains located beneath them. The proposed A12 mainline cutting slope located along a short length of the eastern side of the proposed southbound carriageway will drain to the aforementioned combined filter drains.

6.3.42 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge south-east of the A12 mainline to a proposed attenuation pond. The attenuation pond is located south-east of the A12 mainline and discharges to a new outfall on Rivenhall Brook via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S2-OU19

6.3.43 The S2-OU19 catchment extends for approximately 510m of the proposed offline A12 mainline from A12 mainline chainage 25830 to existing junction 23 (chainage 25830 to 26340). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. It should be noted that the existing S2-OU19 catchment has been divided up between the proposed S2-OU19 catchment (i.e. draining the proposed A12 mainline) and the proposed S2-OU27 catchment (i.e. draining the proposed B1024 local road). The proposed S2-OU27 catchment is described subsequently in Sections 6.3.68 to 6.3.69. This catchment also includes an emergency area on the southbound carriageway near A12 mainline chainage 25900.Drawing number HE551497-JAC-LDC-SCHW-DR-D-0812 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU19 catchment.

6.3.44 The A12 mainline highway geometry has a superelevated crossfall, falling from north-west to south-east across the full carriageway section. It is proposed to collect surface water runoff from the northbound and southbound carriageways via concrete surface water channels and / or linear slot drainage systems, discharging at regular intervals to carrier drains located underneath.

6.3.45 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge south-east of the A12 mainline embankment to a proposed attenuation pond. The attenuation pond is located south of the A12 mainline and discharges to a new outfall on the River Blackwater via a vortex flow control device. A new outfall is required as the proposed S2-OU19 catchment attenuation pond needs to be located outside the potential River Blackwater floodplain. Brownfield discharge rates are applicable given that the highway drainage from the proposed A12 mainline is discharging to the River Blackwater which currently accepts surface water runoff from the existing A12 mainline and the B1024 local road.

Side roads

6.3.46 The proposed A12 mainline within the Drainage Section 2 highway drainage sub-section includes ten side road drainage catchments which discharge to proposed outfalls S2-OU15D, S2-OU15D1, S2-OU15E, S2-OU15H, S2-OU17, S2-OU18, S2-OU24, S2-OU24A, S2-OU26 and S2-OU27. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the side road drainage catchments described below are presented in Table B.2 in Annex B.

6.3.47 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0811 and 0812, illustrate the main drainage features and catchment extents for the aforementioned Drainage Section 2 side road drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and catchment-specific comments regarding the greenfield / brownfield / adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Catchment S2-OU15D

6.3.48 The S2-OU15D catchment extends for approximately 225m of the realigned Braxted Road portion located south of the Braxted Road overbridge across the A12 mainline (chainage 24080). Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15D catchment.

6.3.49 The above-described realigned Braxted Road portion primarily has a balanced cross-section. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. The combined kerb drainage and gullies will discharge to carrier drains. These carrier drains will then converge and discharge north-west to a proposed attenuation pond. The attenuation pond is located to the north-east of the realigned Braxted Road and outfalls to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges to Ordinary Watercourse 13. Greenfield discharge rates are applicable for this outfall location given that the proposed highway is located on a currently greenfield site.

Catchment S2-OU15D1

6.3.50 The S2-OU15D1 catchment extends for approximately 55m of the realigned Braxted Road portion located south-east of the Braxted Road overbridge across the A12 mainline (chainage 24080). The S2-OU15D1 catchment is located immediately south-east of the previously described S2-OU15D catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15D1 catchment.

6.3.51 The above-described realigned Braxted Road portion has a balanced cross-section. It is proposed to collect the surface water runoff from both carriageways via a kerb and gully arrangement. The gullies will discharge to carrier drains located in both verges on either side of the road. These carrier drains will then converge and discharge north-east of the proposed highway to an existing highway drainage system serving Braxted Road. The proposed highway drainage will discharge unattenuated to the existing highway drainage system serving Braxted Lane. The existing outfall arrangement for the existing highway drainage system serving Braxted Road is to be retained. The proposed S2-OU15D1 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case S2-OU15D1 allowable discharge rates without the use of a formal means of attenuation storage. This is due to the fact that the proposed case catchment area for S2-OU15D1 has been reduced. Brownfield discharge rates are applicable due to the online highway widening works to the existing Braxted Road.

Catchment S2-OU15E

6.3.52 The S2-OU15E catchment includes the Realigned Braxted Road portion located north-west of the Braxted Road overbridge across the A12 mainline (chainage 24080), the Braxted Road overbridge, the proposed Rivenhall End West Roundabout and the online highway works to the existing A12. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15E catchment.

- **Realigned Braxted Road (north-west of Braxted Road overbridge)** – The Realigned Braxted side road portion has a balanced cross-section. It is proposed to collect the surface water runoff from both carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. The combined kerb drainage and gullies will discharge to carrier drains located in both verges on either side of the road.

- **Braxted Road overbridge** – The proposed Braxted Road overbridge geometry has a balanced crossfall. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units located on either side of the balanced overbridge carriageway, discharging via carrier drains to the proposed highway

drainage system serving the Realigned Braxted Road to the north-west of the A12 mainline.

- **Rivenhall End West Roundabout** – The Rivenhall End West Roundabout highway drainage catchment also drains into the proposed Rivenhall End side road highway drainage located to the south-east of the roundabout. It is proposed to collect the surface water runoff from the roundabout carriageways using combined kerb drainage, discharging to carrier drains located within the proposed roundabout footprint. These carrier drains will converge and discharge south-east into the proposed Realigned Braxted Road highway drainage located to the south-east of the roundabout.

6.3.53 The online highway works to the existing A12 approaching and exiting the Rivenhall End West Roundabout result in a superelevated highway crossfall. The proposed online highway works crossfall has a north-east to south-west orientation. It is proposed to collect surface water runoff from the northbound and southbound carriageways via combined kerb drainage, discharging at regular intervals to a carrier drain system. The aforementioned carrier drains serving both the northbound and southbound carriageways will converge and discharge south-east into the proposed Realigned Braxted Road highway drainage.

6.3.54 Once the proposed highway drainage from the Braxted Road overbridge, Rivenhall End West Roundabout and the online highway works to the existing A12 approaching and has converged to the primary surface water carrier drains serving the Realigned Braxted Road, the carrier drains continue south-west of the Realigned Braxted Road and discharge to a proposed attenuation pond. The attenuation pond discharges to a new outfall on Ordinary Watercourse 12a via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that it is a new outfall location.

Catchment S2-OU15H

6.3.55 The S2-OU15H catchment is a portion of the new B1024 Link Road from the existing B1024 to Rivenhall End located to the south-west. The proposed road portion extends for a length of 650m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0812 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU15H catchment.

6.3.56 The proposed B1024 Link Road has a balanced cross-section. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage. The combined kerb drainage will discharge to carrier drains located in both verges on either side of the road. These carrier drains will then converge and discharge north-west into a proposed attenuation pond. The attenuation pond is located north-west of the proposed side road and discharges to a new outfall on a proposed drainage ditch immediately upstream of proposed culvert CL-17B.1 via a vortex flow control device. Culvert CL-17B.1 subsequently conveys the discharged

surface water runoff to Ordinary Watercourse 17 further downstream. Greenfield discharge rates are applicable for this outfall location given that the proposed offline side road is located on a currently greenfield site.

Catchment S2-OU17

6.3.57 The S2-OU17 catchment constitutes a small portion of the existing B1024 side road (northbound carriageway) located north-east of existing junction 23. The side road portion extends for a length of 55m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0812 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU17 catchment.

6.3.58 The existing side road has a balanced cross-section. It is proposed to collect the surface water runoff from this northbound carriageway portion via combined kerb drainage located on the northern verge. The combined kerb drainage will discharge to carrier drains located in the northern verge. These carrier drains discharge north-east into the existing highway drainage serving the B1024 side road. The surface water discharges will be unattenuated given that the catchment area in the proposed case is less than that in the existing case resulting in reduced surface water runoff rates. Brownfield discharge rates are applicable for this outfall location as the highway proposals are online highway works.

Catchment S2-OU18

6.3.59 The S2-OU18 catchment includes a portion of the existing B1024 side road and a portion of the proposed offline B1024 Link Road extension from the existing B1024 to Rivenhall End located to the south-west. The side road catchment extends for a length of 380m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0812 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU18 catchment.

6.3.60 The proposed B1024 side road has a balanced cross-section. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and combined filter drains, discharging to carrier drains located in both verges on either side of the road. These carrier drains will then converge and discharge north to a proposed offline attenuation pond. The offline attenuation pond is located north of the proposed B1024 side road and discharges back into the proposed B1024 side road highway drainage system via a vortex flow control device. The proposed highway drainage system subsequently connects into an existing filter drain alignment to the east which discharges directly to the River Blackwater at an existing outfall location. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an existing outfall on the River Blackwater which currently accepts surface water runoff from the existing B1024 side road.

Catchment S2-OU24

6.3.61 The S2-OU24 catchment is a portion of the new B1024 Link Road from the existing B1024 to Rivenhall End located to the south-west. The drainage catchment also includes the Rivenhall End East Roundabout. The proposed road portion extends for 200m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU24 catchment.

6.3.62 The proposed link road has a balanced cross-section. For the link road alignment to the north-east of the Rivenhall End East Roundabout, it is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to the proposed roundabout carrier drain system. The Rivenhall End East Roundabout drainage catchment also drains into the proposed B1024 Link Road. It is proposed to collect the surface water runoff from the roundabout carriageways via combined kerb drainage, which will discharge to carrier drains located within the roundabout footprint. These carrier drains discharge south-west into the proposed B1024 Link Road highway drainage located to the south-west of the proposed roundabout. For the link road alignment (i.e. de-trunked A12) to the south-east of the Rivenhall End East Roundabout, it is proposed that the surface water runoff from the carriageway be collected via combined kerb drainage which will discharge to carrier drains located in the link road verges.

6.3.63 The above-described carrier drains will then converge and discharge north-west via an orifice plate flow control device to a retained existing outfall on Ordinary Watercourse 15. The existing outfall may need to be repositioned locally on Ordinary Watercourse 15. Online attenuation storage is provided with oversized pipes. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an existing outfall on Ordinary Watercourse 15. The existing outfall may need to be repositioned locally on Ordinary Watercourse 15.

Catchment S2-OU24A

6.3.64 The S2-OU24A catchment is a portion of the proposed offline new B1024 Link Road from the existing B1024 to Rivenhall End located to the south-west. The proposed side road portion extends 315m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0811 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU24A catchment.

6.3.65 The proposed link road has a balanced cross-section. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and combined filter drains, discharging to carrier drains located in verges on both sides of the road. These carrier drains will then converge and discharge north-west of the proposed link road into a proposed attenuation pond, located north-west of the proposed B1024 Link Road. This discharges to a new outfall on a proposed drainage ditch via a

vortex flow control device. The proposed drainage ditch ultimately discharges to Ordinary Watercourse 15 to the south-west. Greenfield discharge rates are applicable for this outfall location given that the proposed offline side road is located on a currently greenfield site.

Catchment S2-OU26

6.3.66 The S2-OU26 catchment is a portion of a proposed offline side road from the existing B1024 (near junction 23) to an existing access road to the Essex County Fire and Rescue Service Headquarters south-west of junction 23. The proposed side road will provide access to the Essex County Fire and Rescue Service Headquarters in the proposed site condition. The proposed side road is located on a portion of the footprint of the existing A12 which is to be de-trunked and converted to a no-through route. The footprint of the proposed side road is less than that of the existing A12 to be de-trunked and so the excess existing A12 paved area could potentially be removed and returned to natural ground. The proposed side road portion extends 590m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0812 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU26 catchment.

6.3.67 The proposed side road has a balanced cross-section. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to carrier drains located in both side road verges. These carrier drains will then converge and discharge unattenuated to the south-west of the proposed side road to an existing repositioned outfall on Ordinary Watercourse 17. Attenuation storage is not required given that the excess existing A12 paved area could potentially be removed and returned to natural ground which would result in reduced proposed case discharge rates compared to the existing case allowable discharge rates. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an existing outfall on Ordinary Watercourse 17 which currently accepts surface water runoff from the existing A12 mainline.

Catchment S2-OU27

6.3.68 The S2-OU27 catchment is a portion of a proposed offline side road from the existing B1024 side road (near junction 23) to an existing access road to the Essex County Fire and Rescue Service Headquarters south-west of junction 23. The proposed side road portion involves minor online widening works of a 120m length of the existing B1024 side road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0812 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S2-OU27 catchment.

6.3.69 The proposed side road has a balanced cross-section. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to a carrier drain system. These carrier drains will then converge and discharge south of the proposed side road to an

existing highway drainage system serving the B1024 side road (i.e. located south of Crane's Bridge). The aforementioned existing highway drainage system subsequently discharges east to the River Blackwater. The proposed S2-OU27 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case allowable discharge rates without the use of a formal means of attenuation storage. This is due to the fact that the proposed catchment area for S2-OU27 has reduced from that in the existing case. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an existing outfall on the River Blackwater which currently accepts surface water runoff from the existing A12 mainline.

6.4 Drainage Section 3 highway drainage proposals

Junction 24

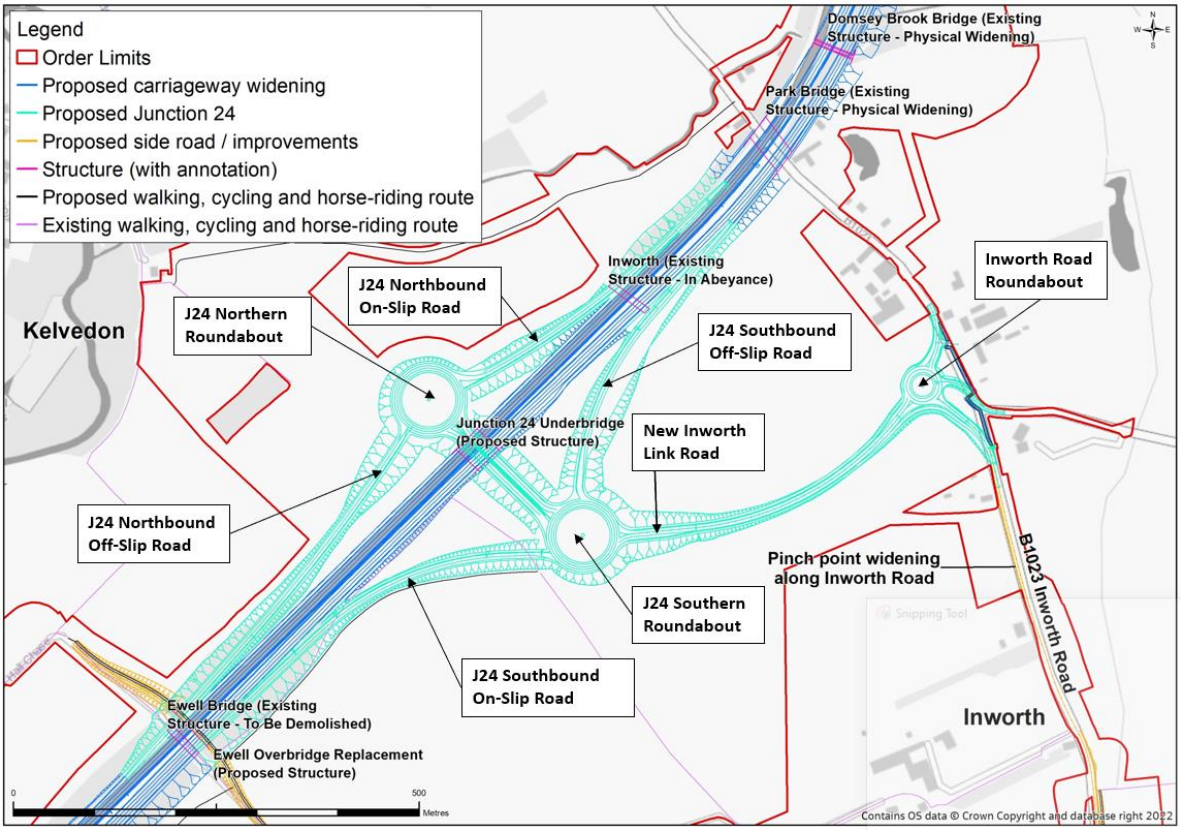
6.4.1 The proposed junction 24 is located south-east of Kelvedon between approximate A12 mainline chainages 30900 and 31600. The junction 24 upgrade is part of the A12 online widening works from dual two-lane carriageway to a dual three-lane carriageway from Ashman's Bridge to a location on the A12 mainline (Drainage Section 3) just south-east of Kelvedon after which the proposed scheme goes offline. The proposed junction 24 has a two-tiered dumbbell layout. A single link road would provide access between the proposed scheme and neighbouring towns, such as Kelvedon and Tiptree, via a new roundabout on the locally realigned B1023 (Inworth Road). The proposed junction is to be in cutting with the proposed scheme A12 mainline travelling over the dumbbell link road. The proposed scheme would deliver the following improvements with regard to the proposed junction 24:

- A roundabout north of the proposed A12 mainline (referred to as the northern roundabout hereafter) with two slip roads (on and off) to the A12 mainline northbound carriageway
- A roundabout south of the proposed A12 mainline (referred to as the southern roundabout hereafter) with two slip roads (on and off) to the A12 mainline southbound carriageway
- The junction 24 roundabout underpass which connects the proposed northern and southern roundabouts. This underpass crosses the A12 mainline near chainage 31260
- A third roundabout located immediately west of Inworth Road which connects the proposed A12 mainline to Inworth Road and Kelvedon Road. This will be referred to as the Inworth Roundabout hereafter
- A proposed link road that connects the proposed junction 24 southern roundabout to the proposed Inworth Roundabout near Inworth Road. This will be referred to as the Inworth Road Link Road hereafter

6.4.2 An overview of the proposed junction 24 general arrangement is shown in Plate 6.4. The proposed junction 24 comprises seven main highway drainage catchments which discharge to proposed outfalls: S3-OU6, S3-OU7A, S3-OU8A, S3-OU8B, S3-OU8C, S3-OU8D, S3-OU8E. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the junction 24 drainage catchments described below are presented in Table B.3 in Annex B.

6.4.3 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing number HE551497-JAC-LDC-SCHW-DR-D-0814, illustrates the main drainage features and catchment extents for the aforementioned junction 24 drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types and diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield, brownfield and adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Plate 6.4 Overview of the Proposed junction 24 General Arrangement



Catchment S3-OU6

6.4.4 The S3-OU6 catchment extends for approximately 50m of the proposed junction 24 southbound on-slip road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU6 catchment.

6.4.5 The proposed slip road geometry at this location has a superelevated crossfall with a north-west to south-east crossfall orientation. The slip road is also located in cutting. It is proposed to collect the surface water runoff

from the slip road using combined filter drains discharging at regular intervals to carrier drains located beneath. The slip road cutting slopes will be drained by the combined filter drains serving the slip road carriageway.

6.4.6 The proposed carrier drains serving the proposed southbound on-slip road will converge and discharge south-east of the slip road to a chamber on proposed culvert CL-21A (i.e. Ordinary Watercourse 21a). No attenuation storage is required for this minor proposed S3-OU6 catchment as the unattenuated proposed discharge rates are less than the existing case allowable discharge rates. The proposed S3-OU6 catchment discharges to Ordinary Watercourse 21a which currently accepts surface water from the existing S3-OU6 A12 catchment. Therefore, brownfield discharge rates for the existing S3-OU6 catchment are used as the allowable discharge rates.

Catchment S3-OU7A

6.4.7 The S3-OU7A catchment extends for approximately 125m of the proposed junction 24 northbound off-slip road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU7A catchment.

6.4.8 The proposed slip road geometry at this location has a superelevated crossfall with a south-east to north-west crossfall orientation. The slip road is also located in cutting. It is proposed to collect the surface water runoff from the slip road via combined filter drains located adjacent to the northern verge discharging at regular intervals to carrier drains located beneath. The slip road cutting slopes will be drained by the combined filter drains serving the slip road carriageway.

6.4.9 The proposed carrier drains serving the proposed northbound off-slip road will converge and discharge north-west off the slip road to a chamber on proposed culvert CL-21A (i.e. Ordinary Watercourse 21a). No attenuation storage is required for this minor catchment as the unattenuated proposed discharge rates for the S3-OU7A catchment are less than the existing case allowable discharge rates. The proposed S3-OU7A catchment discharges to Ordinary Watercourse 21a which currently accepts surface water from the existing S3-OU7 A12 catchment. Therefore, brownfield discharge rates for the existing S3-OU7 catchment have been used as the allowable discharge rates.

Catchment S3-OU8A

6.4.10 The S3-OU8A catchment encompasses the vast majority of the proposed junction 24 with the only exclusions being the above-described slip road portions within the proposed S3-OU6 and S3-OU7A catchments. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU8A catchment. The proposed highway drainage arrangements for the proposed junction 24 and the associated slip roads are as follows:

- **Junction 24 northbound off-slip road** – The junction 24 northbound off-slip road has a superelevated crossfall, falling in a south-east to north-west crossfall orientation towards the northern verge. It is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in the northern verge. The carrier drains will discharge north-east down the slip road and into the proposed highway drainage serving the junction 24 northern roundabout.
- **Junction 24 southbound on-slip road** – The junction 24 southbound on-slip road has a superelevated crossfall, falling in a north to south orientation towards the southern verge. It is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in the southern verge. The carrier drains will discharge east down the slip road and into the proposed highway drainage serving the junction 24 southern roundabout.
- **Junction 24 northbound on-slip road** – The junction 24 northbound on-slip has a superelevated crossfall, falling in a south-east to north-west crossfall orientation towards the northern verge. It is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in the northern verge. The carrier drains will discharge south-west down the slip road and into the proposed highway drainage serving the junction 24 northern roundabout.
- **Junction 24 southbound off-slip road** – The junction 24 southbound off-slip road has a superelevated crossfall, falling in a north-west to south-east orientation towards the eastern verge. It is proposed to collect the surface water runoff from the carriageway via combined kerb drains which will discharge to carrier drains located in the eastern verge. The carrier drains will discharge south down the slip road and into the proposed highway drainage serving the junction 24 southern roundabout.
- **Inworth Link Road –** Approximately two-thirds of the proposed Inworth Link Road adjoining the junction 24 southern roundabout, drains into the S3-OU8A catchment. The Inworth Link Road has a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in both verges. The carrier drains will discharge west down the link road and into the proposed highway drainage serving the junction 24 southern roundabout.
- **Junction 24 northern and southern roundabouts –** The proposed junction 24 northern and southern roundabout carriageways fall outward to the outer circle of the roundabouts. It is proposed to collect the surface water runoff from the roundabout carriageways via combined filter drains, which will discharge to carrier drains located beneath. The road linking the northern and southern roundabouts will

also primarily be drained by combined filter drains. The exception is the underpass portion which crosses under the A12 mainline. This underpass will be drained by combined kerb drains which will discharge to the carrier drains serving the link road.

6.4.11 Once the proposed highway drainage from the above-described slip roads, Inworth Link Road, and the junction 24 northern and southern roundabouts has converged to the primary surface water carrier drains serving the proposed junction 24, the carrier drains continue north-west off the northern roundabout and discharge to a proposed attenuation pond located north-west of the proposed junction 24. This discharges to a new outfall on Domsey Brook via a vortex flow control device. It should be noted that the attenuation pond also accepts surface water runoff from the proposed S3-OU7 catchment on the A12 mainline (described in Sections 6.4.32 to 6.4.33 below). Given that the proposed S3-OU8A attenuation pond also accepts the brownfield surface water discharges from the proposed S3-OU7 catchment on the A12 mainline, the resulting higher proposed discharge rates for the S3-OU8A catchment have been compensated for by the reduced proposed discharge rates for the adjacent S3-OU6 and S3-OU7A catchments as the ultimate receptor is Domsey Brook.

Catchment S3-OU8B

6.4.12 The S3-OU8B catchment is part of the junction 24 upgrade and encompasses the majority of the proposed Inworth Roundabout and the remaining one-third of the Inworth Link Road. It should be noted that the proposed S3-OU8B catchment also accepts the attenuated surface water flows from the adjacent proposed S3-OU8D catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU8B catchment.

6.4.13 The Inworth Link Road geometry has a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in both verges. The carrier drains will discharge north-east down the link road and into the proposed highway drainage serving the proposed Inworth Roundabout. The proposed Inworth Roundabout carriageways fall outward to the outer circle of the roundabout. It is proposed to collect the surface water runoff from the roundabout carriageways via combined kerb drains which will discharge to a carrier drain system. The proposed Inworth Link Road cutting slopes are drained by the aforementioned combined filter drains serving the link road carriageways.

6.4.14 Once the proposed carrier drains from the above-described Inworth Link Road and the Inworth Roundabout have converged, the carrier drains discharge west off the Inworth Roundabout to a proposed attenuation pond, located west of the proposed Inworth Road Roundabout and discharging to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch ultimately discharges to Domsey Brook.

Greenfield discharge rates are applicable for this outfall location given that the proposed highway is located on a currently greenfield site.

Catchment S3-OU8C

6.4.15 The S3-OU8C catchment is part of the junction 24 upgrade and encompasses a minor link road off the proposed Inworth Roundabout that connects into the existing Kelvedon Road to the east. This minor link road is referred to as Realigned Kelvedon Road hereafter. There are also some highway improvement works on the adjoining existing Inworth Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU8C catchment.

6.4.16 The realigned Kelvedon Road geometry has a superelevated crossfall with a west to east crossfall orientation. It is proposed to collect the surface water runoff from the carriageway via a kerb and gully arrangement, discharging to carrier drains located in the eastern verge. The carrier drains will discharge south-east down the link road to a new outfall on an existing drainage ditch adjacent to Inworth Road. Online attenuation storage in the form of oversized pipes is provided due to spatial constraints. A vortex flow control device is used to restrict the discharge rates. Brownfield discharge rates are applicable for the proposed S3-OU8C catchment given that the proposed highway improvement works are on the existing Inworth Road portion located within the proposed catchment.

6.4.17 There is a small external natural catchment draining into the S3-OU8C catchment, trapped between the Realigned Kelvedon Road and the Realigned Inworth Road which is intercepted by a natural catchment drainage ditch. The natural catchment drainage ditch discharges into the proposed highway drainage serving the Realigned Kelvedon Road.

Catchment S3-OU8D

6.4.18 The S3-OU8D catchment is part of the junction 24 upgrade and encompasses a minor link road off the proposed Inworth Roundabout that connects into the existing Inworth Road. This minor link road is referred to as the Realigned Inworth Road (south) hereafter. There are also some highway improvement works on the adjoining existing Inworth Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU8D catchment.

6.4.19 The proposed realigned Inworth Road (south) has a balanced crossfall. It is proposed to collect surface water runoff from the carriageways with a combination of combined kerb drainage and combined filter drains, discharging at regular intervals to carrier drains located beneath them. The aforementioned carrier drains serving both carriageways will converge, drain north-west along the highway alignment and subsequently discharge south-west to a proposed attenuation pond. The attenuation pond discharges to the upstream end of the proposed S3-OU8B attenuation pond via a vortex flow control device.

Catchment S3-OU8E

6.4.20 The S3-OU8E catchment is part of the junction 24 upgrade and encompasses a minor link road off the proposed Inworth Roundabout that connects into the existing Inworth Road and a small portion of the aforementioned roundabout. This minor link road is referred to as the Realigned Inworth Road (north) hereafter. There are also some highway improvement works on the adjoining existing Inworth Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU8E catchment.

6.4.21 The Realigned Inworth Road (north) has a balanced crossfall. It is proposed to collect the surface water runoff from the carriageways with a kerb and gully arrangement which will discharge at regular intervals to carrier drains located in both verges. A small portion of the proposed Inworth Road Roundabout also drains into the upstream end of the proposed minor link road (north). The proposed Inworth Roundabout carriageways fall outward to the outer circle of the roundabout. It is proposed to collect the surface water runoff from the roundabout carriageways via combined kerb drainage which will discharge to a carrier drain system serving the roundabout.

6.4.22 The aforementioned carrier drains serving the proposed minor link road (north) and the proposed Inworth Road Roundabout will converge, drain north along the highway alignment and subsequently discharge south-west to a proposed attenuation pond and discharging to the existing highway drainage system serving Inworth Road via a vortex flow control device. Brownfield discharge rates are applicable for the proposed S3-OU8E catchment given that the proposed highway improvement works are on the existing Inworth Road portion located within the proposed catchment.

A12 mainline

6.4.23 The A12 mainline encompassed by the Drainage Section 3 highway drainage sub-section is a total length of 9.5km from just east of the existing junction 23 (i.e. Ashman's Bridge at A12 mainline chainage 26360) to junction 25 at Marks Tey. The proposed scheme comprises approximately 9.5km of carriageway upgrade from a location south of Kelvedon to Marks Tey, where the proposed scheme ends. There is approximately 1.7km of proposed online widening works after which the carriageway subsequently goes offline between junction 24 and junction 25. The remainder of Drainage Section 3 after junction 25 consists of proposed online widening works through Marks Tey. The proposed scheme boundary extends to the north of junction 25 to allow for temporary traffic management and roadside works in the verges, such as new signage and works associated with the proposed junction 25 highway improvements. There are two junction upgrades within the Drainage Section 3 highway drainage sub-section at junction 24 and junction 25.

6.4.24 The proposed A12 mainline within the Drainage Section 3 highway drainage sub-section comprises thirteen main highway drainage catchments which discharge to proposed outfalls S3-OU1, S3-OU2, S3-OU7, S3-OU8, S3-OU9, S3-OU10, S3-OU18, S3-OU21, S3-OU26, S3-OU26A, S3-OU26B, S3-OU30 and S3-OU30A. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. It should be noted that emergency areas are contained within the proposed S3-OU1, S3-OU2, S3-OU8, S3-OU10, S3-OU21, S3-OU26, S3-OU26A, S3-OU30 and S3-OU30A catchments. The emergency areas located in these catchments are proposed to be drained by combined kerb drainage. The combined kerb drainage will discharge at regular intervals to the main carrier drain system to serve the proposed catchments. The existing and proposed paved catchment areas and any permeable catchment area draining into the proposed highway drainage systems for the A12 mainline (Drainage Section 3) drainage catchments described below are presented in Table B.3 in Annex B.

6.4.25 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0813 to 0819, illustrate the main drainage features and catchment extents for the aforementioned A12 mainline (Drainage Section 3) drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield / brownfield / adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Catchment S3-OU1

6.4.26 The S3-OU1 catchment extends for approximately 790m of the proposed online A12 mainline between Ashman's Bridge and retained existing culvert CL-21 (A12 mainline chainage 26340 to 27130). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. This catchment also includes an emergency area on the northbound carriageway near A12 mainline chainage 26800. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0813 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU1 catchment.

6.4.27 The A12 mainline highway geometry has a superelevated crossfall along the proposed highway alignment encompassed by the S3-OU1 catchment with a crossfall transition occurring. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways primarily with a combination of combined filter drains, concrete surface water channels and / or linear slot drainage systems, discharging at regular intervals to carrier drains located beneath them. Ashman's Bridge is also included within this highway alignment. The proposed Ashman's Bridge geometry has a superelevated crossfall. It is proposed to collect the surface water runoff from the bridge carriageway via bridge deck drainage units which will discharge to the eastern end of the bridge and subsequently discharge east via carrier drains to the proposed highway drainage system serving the A12 mainline. It should be noted that the majority of this A12 mainline alignment is in cutting. Therefore, the previously described combined filter drains will also intercept and drain the proposed cutting slopes where required.

6.4.28 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge north of the A12 mainline to a proposed attenuation pond. The attenuation pond is located north of the A12 mainline and discharges to an existing outfall on the River Blackwater (near Maldon Road) via an orifice plate flow control device. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an existing outfall on the River Blackwater which currently accepts surface water runoff from the existing A12 mainline.

Catchment S3-OU2

6.4.29 The S3-OU2 catchment extends for approximately 1.03km of the proposed online A12 mainline between retained existing culvert CL-21 and junction 24 (A12 mainline chainage 30045 to 31070). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. This catchment also includes an emergency area on the southbound carriageway near A12 mainline chainage 30100. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0813 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU2 catchment.

6.4.30 The A12 mainline highway geometry initially has a superelevated crossfall and transitions to a balanced crossfall along the proposed highway alignment encompassed by the S3-OU2 catchment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways primarily with a combination of combined filter drains, concrete surface water channels and / or linear slot drainage systems, discharging at regular intervals to carrier drains located underneath. Small portions of the junction 24 southbound on-slip and northbound off-slip road also drain into the proposed A12 mainline within the S3-OU2 catchment. These small portions of the aforementioned slip roads are drained by combined filter drains. It should be noted that the majority of this A12 mainline alignment is in cutting. Therefore, the previously described combined filter drains will also intercept and drain the proposed cutting slopes where required.

6.4.31 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge north of the A12 mainline to a proposed attenuation pond. The attenuation pond is located north of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 21 via a complex flow control device (orifice plate and weir combination). A new outfall is required as the existing highway drainage outfall to existing culvert CL-21 needs to be abandoned due to the online highway widening works. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to Ordinary Watercourse 21 which currently accepts surface water runoff from the existing A12 mainline.

Catchment S3-OU7

6.4.32 The S3-OU7 catchment extends for approximately 215m of the proposed online A12 mainline from proposed culvert CL-21A to a location under the proposed underpass between the junction 24 northern and southern roundabouts (A12 mainline chainage 31060 to 31275). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU7 catchment.

6.4.33 The A12 mainline highway geometry at this location has a balanced crossfall. It is proposed to collect surface water runoff from the northbound and southbound carriageways via concrete surface water channels and / or linear slot drainage systems, discharging at regular intervals to carrier drains located underneath. The proposed carrier drains serving both the northbound and southbound carriageways will converge, drain south-west and subsequently discharge north-west of the A12 mainline to the proposed S3-OU8A catchment attenuation pond (previously described in Section 6.4.10 to Section 6.4.11). Brownfield discharge rates are applicable due to the proposed online highway widening works and given that Domsey Brook already accepts surface water runoff from the existing A12 mainline.

Catchment S3-OU8

6.4.34 The S3-OU8 catchment extends for approximately 490m of the proposed online A12 mainline between the proposed junction 24 underpass and the existing Park Bridge (A12 mainline chainage 31275 to 31765). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. This catchment also includes an emergency area on the southbound carriageway near A12 mainline chainage 31300. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU8 catchment.

6.4.35 The A12 mainline highway geometry initially has a balanced crossfall and transitions to a superelevated crossfall along the proposed highway alignment encompassed by the S3-OU8 catchment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways primarily with concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains located beneath.

6.4.36 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge north-west of the A12 mainline to a proposed attenuation pond. The attenuation pond is located north-west of the A12 mainline and discharges to a new outfall on Domsey Brook via an orifice plate flow control device. An existing outfall serving the A12 mainline was not identified on Domsey Brook due to a lack of drainage survey in the area. Therefore, a new outfall was assumed to be required. Brownfield discharge rates are applicable for this new outfall location given the proposed online widening works and the proximity of the existing A12 mainline to the nearby Domsey Brook.

Catchment S3-OU9

6.4.37 The S3-OU9 catchment extends for approximately 150m of the proposed online A12 mainline between Park Bridge and the retained existing Domsey Brook culvert (A12 mainline chainage 31765 to 31915). Highway widening works are required for this section of the highway as part of the overall A12 online widening works. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU9 catchment.

6.4.38 The A12 mainline highway geometry at this location has a superelevated crossfall with a north-westerly crossfall orientation. It is proposed to collect the surface water runoff from the northbound and southbound carriageways with concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains located beneath. Park Bridge is also included within this highway alignment. The proposed Park Bridge geometry has a superelevated crossfall falling in a north-westerly orientation. It is proposed to collect the surface water runoff

from the proposed bridge carriageway via bridge deck drainage units which will discharge to the northern end of the bridge and will then subsequently discharge north via carrier drains to the proposed highway drainage system serving the A12 mainline.

6.4.39 The proposed carrier drains serving both the northbound and southbound carriageways will converge and discharge east of the A12 mainline to a proposed attenuation pond. The attenuation pond is located east of the A12 mainline and discharges to an existing outfall location on the realigned Domsey Brook via an orifice plate flow control device. The existing outfall serving the A12 mainline locally needs to be repositioned on Domsey Brook due to the proposed online widening works. Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to Domsey Brook which currently accepts surface water runoff from the existing A12 mainline.

Catchment S3-OU10

6.4.40 The S3-OU10 catchment extends for approximately 900m of the proposed offline A12 mainline from the retained existing Domsey Brook culvert to proposed culvert CL-23 (chainage 31915 and 32815). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes an emergency area on the northbound carriageway near A12 mainline chainage 32315. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0814 and 0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S3-OU10 catchment.

6.4.41 The A12 mainline highway geometry has a superelevated crossfall along the proposed highway alignment encompassed by the S3-OU10 catchment with a crossfall transition occurring. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with combined filter drains, concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains located beneath. It should be noted that a large portion of this A12 mainline alignment is in cutting. Therefore, the previously described combined filter drains will also intercept and drain the proposed cutting slopes where required.

6.4.42 The proposed carrier drains serving both the northbound and southbound carriageways will converge, drain south down the highway alignment and discharge east of the A12 mainline to a proposed attenuation pond. The attenuation pond is located east of the A12 mainline and discharges to a new outfall on Domsey Brook via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU21

6.4.43 The S3-OU21 catchment extends for approximately 705m of the proposed offline A12 mainline from proposed culvert CL-23 to proposed culvert CL-24

(chainage 32815 to 33520). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes an emergency area on the southbound carriageway near A12 mainline chainage 33000. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU21 catchment.

6.4.44 The A12 mainline highway geometry initially has a superelevated crossfall and transitions to a balanced crossfall along the proposed highway alignment encompassed by the S3-OU21 catchment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains located beneath.

6.4.45 The proposed carrier drains serving both the northbound and southbound carriageways will converge, drain south down the highway alignment and discharge east of the A12 mainline to a proposed attenuation pond. The attenuation pond is located east of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 23 via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU26

6.4.46 The S3-OU26 catchment extends for approximately 480m of the proposed offline A12 mainline from proposed culvert CL-24 to A12 mainline chainage 34000 (chainage 33520 to 34000). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes an emergency area just north-east of proposed culvert CL-24. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0815 and 0816 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S3-OU26 catchment.

6.4.47 The A12 mainline highway geometry at this location has a balanced crossfall. Approximately half of the proposed highway alignment is on embankment while the other half is located in cutting. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff with a combination of combined filter drains, concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains located beneath. Where the proposed highway alignment is in cutting, the cut slopes are intercepted by the aforementioned combined filter drains.

6.4.48 The proposed carrier drains serving both the northbound and southbound carriageways will converge, drain south-west down the highway alignment and discharge north of the A12 mainline embankment to a proposed attenuation pond. The attenuation pond is located north of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 24 via a vortex

flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU26A

6.4.49 The S3-OU26A catchment extends for approximately 1.23km of the proposed offline A12 mainline from A12 mainline chainage 34000 to Ordinary Watercourse 38 (chainage 34000 to 35230). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes three emergency areas located at the north-eastern and south-western extremes of the S3-OU26A catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0816 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU26A catchment.

6.4.50 The A12 mainline highway geometry at this location has a balanced crossfall. The majority of the proposed highway alignment is located in cutting with a small portion located on embankment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff primarily with combined filter drains. Concrete surface water channels and / or linear slot drainage systems are required to drain a smaller portion of the proposed catchment, discharging at regular intervals to carrier drains located beneath. Where the proposed highway alignment is in cutting, the cut slopes are intercepted by the aforementioned combined filter drains.

6.4.51 The aforementioned carrier drains serving both the northbound and southbound carriageways will converge, drain south-west down the highway alignment and discharge south-east of the A12 mainline to a proposed attenuation pond. The attenuation pond is located south-east of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 37 via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU26B

6.4.52 The S3-OU26B catchment extends for approximately 170m of the proposed offline A12 mainline from A12 mainline chainage 35230 to Ordinary Watercourse 38b (chainage 35230 to 35400). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0817 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU26B catchment.

6.4.53 The A12 mainline highway geometry at this location has a balanced crossfall. The proposed highway alignment is located on embankment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways

with concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains located beneath.

6.4.54 The aforementioned carrier drains serving both the northbound and southbound carriageways will converge, drain to the midpoint of the highway alignment and discharge south-east of the A12 mainline to a proposed attenuation pond. The attenuation pond is located south-east of the A12 mainline and discharges to a new outfall on Ordinary Watercourse 38 via a vortex flow control device. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU30

6.4.55 The S3-OU30 catchment extends for approximately 1.60km of the proposed offline A12 mainline between Ordinary Watercourse 38b and A12 mainline chainage 37000 (chainage 35400 to 37000). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes an emergency area located on the south-west side of the Wishing Well overbridge. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0817 and 0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S3-OU30 catchment.

6.4.56 Within the proposed S3-OU30 catchment the A12 mainline highway geometry initially has a balanced crossfall and transitions to a superelevated crossfall with a number of crossfall transitions along the proposed highway alignment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with a combination of combined filter drains, surface water channels and / or linear slot drainage systems discharging at regular intervals to carrier drains located beneath. Where the proposed highway alignment is in cutting, the cut slopes are intercepted by the aforementioned combined filter drains.

6.4.57 The aforementioned carrier drains serving both the northbound and southbound carriageways will converge, drain south-west down the highway alignment and discharge south-east of the A12 mainline to a proposed attenuation pond which is located south-east of the A12 mainline and discharges to a new outfall on Domsey Brook via a vortex flow control device. Greenfield discharge rates are applicable for this outfall given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU30A

6.4.58 The S3-OU30A catchment extends for approximately 1.45km of the proposed offline A12 mainline between A12 mainline chainage 36255 and proposed culvert CL-26A (chainage 36255 to 37700). An offline dual three-lane carriageway is proposed for this section of the highway for the proposed scheme. This catchment also includes an emergency area located on the north-east side of the Wishing Well overbridge. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0817 and 0818 of the

Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for S3-OU30A catchment.

6.4.59 Within the proposed S3-OU30A catchment the A12 mainline highway geometry initially has a balanced crossfall and transitions to a superelevated crossfall with a number of crossfall transitions along the proposed highway alignment. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways primarily by a combination of combined filter drains, surface water channels and / or linear slot drainage systems. The edge collection systems will discharge at regular intervals to carrier drains located beneath. Where the proposed highway alignment is in cutting, the cut slopes are intercepted by the aforementioned combined filter drains.

6.4.60 The aforementioned carrier drains serving both the northbound and southbound carriageways will converge, drain south-west down the highway alignment and discharge north-west of the A12 mainline to a proposed attenuation pond. The attenuation pond is located north-west of the A12 mainline and discharges via a vortex flow control device to a new outfall at the upstream end of a proposed vegetated swale alignment. The proposed vegetated swale discharges south-west to the Domsey Brook. Greenfield discharge rates are applicable for this outfall location given that the proposed offline highway is located on a currently greenfield site.

Catchment S3-OU18

6.4.61 The S3-OU18 catchment extends for approximately 620m of the proposed online A12 mainline from the existing Roman River culvert (culvert CL-31) to A12 mainline chainage 40000 (A12 mainline chainage 39380 to 40000). Highway widening works are required for this section of the highway as part of the overall A12 online widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0819 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU18 catchment.

6.4.62 The A12 mainline highway geometry at this location has a balanced crossfall. It should be noted that only the southbound carriageway is to be widened at this location with the northbound carriageway to remain as per the current site condition. The existing northbound carriageway is drained by a kerb and gully arrangement which drains at regular intervals to a carrier drain located in the northern verge. This northbound carriageway drainage is to be retained. It is proposed to collect surface water runoff from the widened southbound carriageway via proposed concrete surface water channels and / or linear slot drainage systems which will discharge at regular intervals to carrier drains beneath.

6.4.63 The aforementioned carrier drains serving both the northbound and southbound carriageways will converge, drain south-west and north-east towards the midpoint of the highway alignment and subsequently discharge south of the A12 mainline to an existing outfall on the Roman River. Online attenuation storage is provided in the form of oversized pipes, using two

separate orifice plate flow control devices, due to spatial constraints. Brownfield discharge rates are applicable for this outfall location given that the proposed highway works involve online widening and the proposed highway drainage is discharging to an existing outfall on the Roman River which currently accepts surface water runoff from the existing A12 mainline.

Junction 25

6.4.64 The proposed junction 25 is located near Marks Tey between approximate A12 mainline chainages 37560 and 39300. The junction 25 upgrade is part of the A12 online widening works from dual two-lane carriageway to a dual three-lane carriageway after the proposed scheme offline highway works rejoin at Marks Tey interchange. The proposed junction 25 is a two-tier split dumbbell layout, connecting with surrounding roads in Marks Tey including the A120, London Road (B1408) and Station Road at Marks Tey. It is proposed that the A120 Marks Tey interchange bridge would be retained to connect the junction roundabouts. The junction 25 improvement works include the introduction of two new roundabouts that link the upgraded junction 25 to the existing A12 (de-trunked) and the Hall Chase local road in addition to modifying the two existing roundabouts and the associated connecting roads to provide better connectivity and reduce traffic congestion. The proposed scheme would deliver the following improvements with regard to the proposed junction 25:

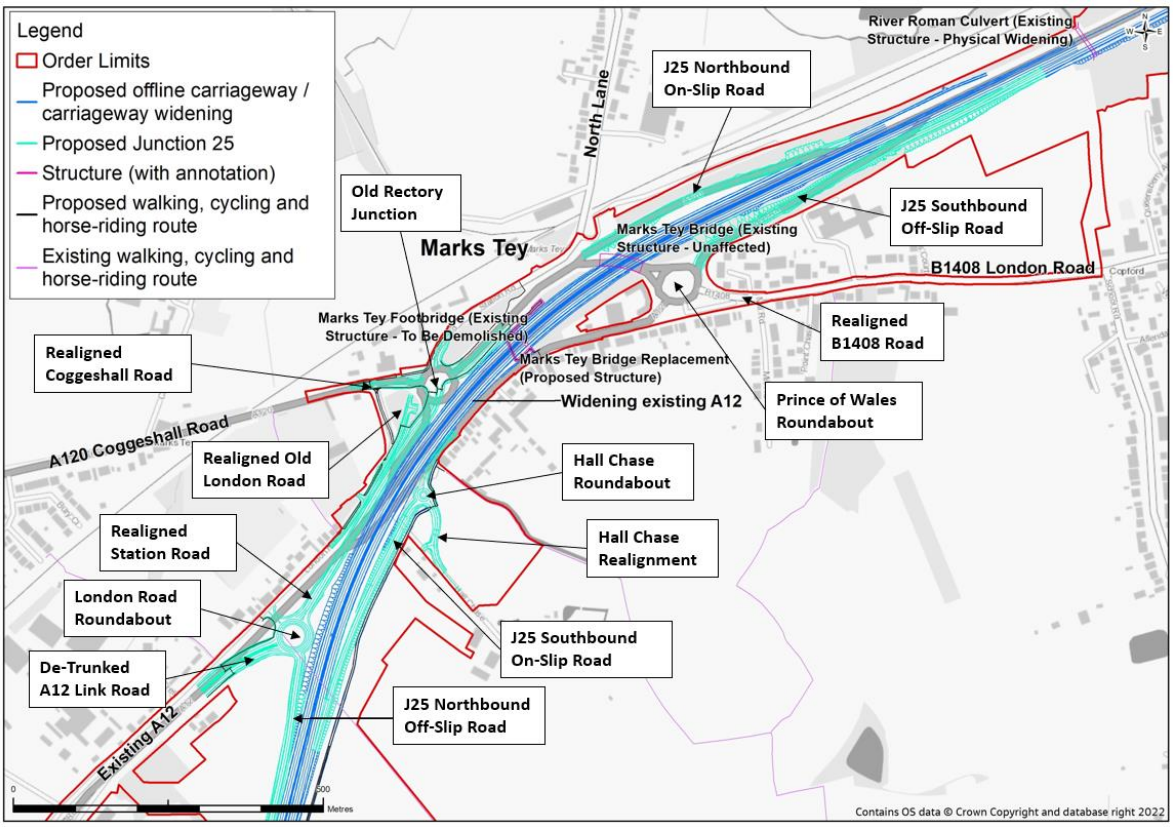
- The introduction of a new roundabout (referred to as London Road Roundabout hereafter) near A12 mainline chainage 37800 with two slip roads (on and off) to connect to the proposed offline A12 mainline northbound carriageway. The proposed on-slip road will be referred to as the ‘junction 25 northbound off-slip road’ hereafter while the off-slip road will be referred to as the ‘realigned Station Road’ hereafter. The new roundabout also has two proposed link roads, one of which connects to the existing A12 mainline (de-trunked) and the other connecting to the Old London Road. These proposed link roads will be referred to as the ‘de-trunked A12 link road’ and the ‘Realigned Old London Road’ respectively.
- The introduction of a new roundabout (referred to as Hall Chase Roundabout hereafter) near A12 mainline chainage 38000 with two slip roads (on and off) to connect to the existing London Road. The proposed on-slip road will be referred to as the ‘junction 25 southbound on-slip road’ hereafter while the off-slip road will be referred to as the ‘London Road northern slip road’ hereafter. There is also a proposed link road to the existing Hall Chase. This will be referred to as the ‘Realigned Hall Chase Road’ hereafter.
- Improvement works to the existing Marks Tey roundabout near A12 mainline chainage 38200 that involve converting it to a signalised junction to provide better traffic flows through adjoining Old London Road, Coggeshall Road, A120 and Station Road at Marks Tey.

- Improvement works to the existing Prince of Wales Roundabout near A12 mainline chainage 38600 that involve widening works to the existing on-slip road adjoining from the east and improvement works to the adjoining London Road (B1048) to provide better traffic flows between London Road and the A12 mainline.
- Improvement of the existing Marks Tey Roundabout off-slip road between A12 mainline chainage 38500 to 38870.

6.4.65 An overview of the proposed junction 25 general arrangement is shown in Plate 6.5. The proposed junction 25 comprises six main highway drainage catchments which discharge to proposed outfalls S3-OU15, S3-OU15A, S3-OU15B, S3-OU15C, S3-OU16 and S3-OU17. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 3.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the junction 25 drainage catchments described below, are presented in Table B.3 in Annex B.

6.4.66 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0818 and 0819, illustrate the main drainage features and catchment extents for the aforementioned junction 25 drainage catchments. Section 7 (and associated Annex C) present the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield, brownfield and adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A.

Plate 6.5 Overview of the Proposed junction 25 General Arrangement



Catchment S3-OU15

6.4.67 The S3-OU15 catchment is part of the junction 25 upgrade and encompasses the proposed London Road Roundabout, approximately one-third of the proposed realigned Station Road, a small portion of the de-trunked A12 link road and the Realigned Old London Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU15 catchment. The proposed highway drainage arrangements for the proposed London Road Roundabout, the associated slip road and link roads are as follows:

- **Realigned Station Road** – Approximately one-third of the proposed realigned Station Road adjoining the proposed London Road Roundabout drains into the S3-OU15 catchment. The proposed realigned Station Road has a balanced crossfall. Given that the realigned road is located entirely in cutting, it is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in both verges. The carrier drains will discharge south down the proposed realigned Station Road towards the proposed London Road Roundabout.
- **De-trunked A12 link road** – The de-trunked A12 link road portion draining to the S3-OU15 catchment has a superelevated crossfall, falling from south to north towards the northern verge. Based on the

carriageway geometry it is proposed to collect the surface water runoff from the carriageway via combined kerb drainage. The combined kerb drainage will discharge to carrier drains located in the northern verge. The carrier drains will discharge north-east towards the proposed London Road Roundabout.

- **Old London Road connection from London Road Roundabout** – The proposed Old London Road connection from the London Road Roundabout has a balanced crossfall. Based on the carriageway geometry it is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to carrier drains located in both verges. The carrier drains will discharge north-west down the proposed highway towards the existing Old London Road.
- **London Road Roundabout** – The proposed London Road Roundabout carriageways fall inwards to the inner circle of the roundabout. It is proposed to collect the surface water runoff from the roundabout carriageways via combined kerb drainage which will discharge to carrier drains located within the roundabout footprint. The carrier drains will discharge north-west down the proposed Old London Road connection towards the existing Old London Road.

6.4.68 Once the proposed highway drainage from the above-described realigned Station Road, link roads and roundabout has converged to the primary surface water carrier drains serving the S3-OU15 catchment, the carrier drains continue north-west of the proposed Old London Road stub road and discharge unattenuated to existing culvert CL-26 (ultimately Ordinary Watercourse 26). The proposed S3-OU15 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case S3-OU15 allowable discharge rates. This is due to the fact that the proposed catchment area for S3-OU15 has been reduced. Brownfield discharge rates are applicable for this outfall location as the proposed highway drainage is discharging to existing culvert CL-26 serving the existing A12 mainline.

Catchment S3-OU15A

6.4.69 The S3-OU15A catchment is part of the junction 25 upgrade and encompasses the proposed Hall Chase Roundabout, a portion of the A12 mainline from proposed culvert CL-26A (chainage 37700 to 38030), the junction 25 southbound on-slip road and the Realigned Hall Chase Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU15A catchment. The proposed highway drainage arrangements for the proposed Hall Chase Roundabout (including the associated slip road and link road) and the A12 mainline are as follows:

- **A12 mainline (chainage 37700 to 38030)** – The A12 mainline highway geometry has a superelevated crossfall. Based on the

carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with a combination of concrete surface water channels and linear slot drainage. These will discharge at regular intervals to carrier drains located beneath. The carrier drains serving the A12 mainline drain north and subsequently discharge east into the proposed Hall Chase Roundabout highway drainage system.

- **Junction 25 southbound on-slip road** – The proposed junction 25 southbound on-slip road has a superelevated crossfall falling from west to east. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to carrier drains located in the eastern verge. The carrier drains will discharge north down the slip road into the proposed Hall Chase Roundabout highway drainage system.
- **Hall Chase Roundabout** – The proposed Hall Chase Roundabout carriageways fall outwards to the outer circle of the roundabout. It is proposed to collect the surface water runoff from the roundabout carriageways via combined kerb drainage which will discharge to carrier drains located within the roundabout footprint.
- **Realigned Hall Chase Road –** The proposed Hall Chase realignment has a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via combined filter drains, which will discharge to carrier drains located in both verges.

6.4.70 Once the proposed highway drainage from the above-described A12 mainline portion, slip road, link road and roundabout has converged to the primary surface water carrier drains serving the S3-OU15A catchment, the carrier drains continue east of the proposed highway and discharge to a proposed attenuation pond. The attenuation pond is located east of the proposed link road and discharges north-west to the proposed S3-OU16 catchment highway drainage system via a vortex flow control device. The S3-OU16 catchment is described subsequently as part of the junction 25 upgrade highway drainage proposals. Greenfield discharge rates are applicable for this outfall location given that the proposed highways are located on a currently greenfield site.

Catchment S3-OU15B

6.4.71 The S3-OU15B catchment is part of the junction 25 upgrade and encompasses the proposed junction 25 northbound off-slip road only. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU15B catchment.

6.4.72 The proposed slip road has a superelevated crossfall with an east to west crossfall orientation. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage discharging at regular intervals to a proposed drainage ditch located adjacent to the western side of the proposed slip road. The drainage ditch will discharge north to a

proposed attenuation pond, located west of the proposed slip road and discharges via a vortex flow control device to a new outfall on a proposed drainage ditch which ultimately discharges to Ordinary Watercourse 26. Greenfield discharge rates are applicable for this outfall location given that the proposed highway is located on a currently greenfield site.

Catchment S3-OU15C

6.4.73 The S3-OU15C catchment is part of the junction 25 upgrade and encompasses the proposed de-trunked A12 link road only. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU15C catchment.

6.4.74 The proposed de-trunked A12 link road has a balanced crossfall with the northbound carriageway located on embankment and the southbound carriageway located in cutting. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the southbound carriageways with a combination of combined kerb drainage and combined filter drains, which will discharge at regular intervals to carrier drains located beneath. The proposed carrier drains serving both carriageways will converge, drain north-east along the highway alignment and subsequently discharge south of the proposed link road to a proposed attenuation pond. The attenuation pond is located south-east of the proposed link road and discharges to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch ultimately discharges to Ordinary Watercourse 26. Greenfield discharge rates are applicable for this outfall location given that the proposed highway is located on a currently greenfield site.

Catchment S3-OU16

6.4.75 The S3-OU16 catchment is part of the junction 25 upgrade and encompasses a portion of the proposed A12 mainline from chainage 38030 to 38100, the proposed London Road slip road, the realigned Station Road, the improved Old London Road and the realigned roads adjoining the proposed Old Rectory signalised junction (i.e. Coggeshall Road from the west and the A120 from the east). As described previously, the proposed S3-OU16 catchment attenuation pond also receives the attenuated flows from the adjacent proposed S3-OU15A catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU16 catchment. The proposed highway drainage arrangements are as follows:

- **A12 mainline (chainage 38030 to 38100)** – The A12 mainline highway geometry has a superelevated crossfall. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with a combination of concrete surface water channels and linear slot

drainage, discharging at regular intervals to carrier drains located beneath them.

- **London Road slip road** – The proposed London Road slip road has a superelevated crossfall falling from west to east. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to carrier drains located in the eastern verge. The carrier drains will discharge north-west into the above-described proposed highway drainage serving the A12 mainline.
- **Realigned Station Road** – Approximately two-thirds of the proposed road between the proposed London Road Roundabout and the proposed Old Rectory signalised junction drains into the S3-OU16 catchment (the other one-third drains to the S3-OU15 catchment as described previously). The proposed realigned Station Road has a balanced crossfall. The realigned road is located primarily on embankment / at-grade with a portion in cutting as it approaches the proposed Marks Tey signalised junction. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and combined filter drains, discharging to carrier drains located beneath them. The carrier drains will discharge north towards the proposed signalised junction highway drainage.
- **Realigned Old London Road** – The realigned Old London Road has a balanced crossfall. Given that the proposed road is located on embankment / at-grade, it is proposed to collect the surface water runoff from the carriageway via a kerb and gully arrangement. The proposed gullies will discharge to carrier drains located in both verges.
- **Realigned Coggeshall Road** – The realigned Coggeshall Road has a balanced crossfall. The proposed road is located on embankment / at-grade. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage. The combined kerb drainage will discharge to carrier drains located in both verges.
- **Realigned A120 road** – The realigned A120 road has a balanced crossfall. The proposed road is located on embankment / at-grade. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to carrier drains located in both verges.

6.4.76 Once the proposed highway drainage from the above-described highway proposals has converged to the primary surface water carrier drains serving the proposed S3-OU16 catchment, the carrier drains discharge to a proposed attenuation pond. The attenuation pond is located west of the proposed Old Rectory signalised junction and discharges north-west to the existing highway drainage system serving Coggeshall Road via an orifice plate flow control device. Brownfield discharge rates are applicable for this

outfall location given that the proposed highway drainage is discharging to an existing highway drainage system serving Coggeshall Road.

Catchment S3-OU17

6.4.77 The S3-OU17 catchment is part of the junction 25 upgrade and encompasses the proposed A12 mainline from chainage 38100 to existing culvert CL-31 (chainage 38100 to 39380), widening works to the junction 25 southbound off-slip road adjoining the Prince of Wales Roundabout from the east, and improvement works to the junction 25 northbound on-slip road between A12 mainline chainage 38500 to 38870. The existing drainage to be retained within the proposed S3-OU17 catchment includes that on the existing Prince of Wales Roundabout, the existing Station Road, the existing London Road adjoining the Prince of Wales Roundabout and the A120 road portion located between the Marks Tey Roundabout and Prince of Wales Roundabout (Marks Tey interchange). Drawing number HE551497-JAC-LDC-SCHW-DR-D-0819 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the proposed S3-OU17 catchment. The proposed highway drainage arrangements are as follows:

- **A12 mainline (chainage 38100 to 39380)** – The proposed A12 mainline highway geometry initially has a superelevated crossfall from chainage 38100 and transitions to a balanced crossfall at chainage 38620. The superelevated carriageway has a west to east crossfall orientation. Based on the carriageway crossfall geometry it is proposed to collect the surface water runoff from the northbound and southbound carriageways with a combination of concrete surface water channels, combined filter drains and linear slot drainage, discharging at regular intervals to carrier drains located beneath them.
- **Junction 25 southbound off-slip road** – The Junction 25 southbound off-slip road (subject to highway widening works) has a superelevated crossfall falling in a south-easterly orientation towards the southern verge. It is proposed to collect the surface water runoff from the carriageway via combined filter drains which will discharge to carrier drains located beneath. The carrier drains will discharge east along the slip road alignment and into the above-described proposed highway drainage serving the A12 mainline.
- **Junction 25 northbound on-slip road** – The improved junction 25 northbound on-slip road (between A12 mainline chainage 38500 and 38870) has a superelevated crossfall falling in a south-easterly orientation towards the southern verge. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge to carrier drains located in the southern verge. The carrier drains will discharge east along the slip road and into the above-described proposed highway drainage serving the A12 mainline.

- **Existing drainage to be retained** – The existing drainage to be retained within the proposed S3-OU17 catchment includes that on the existing Prince of Wales Roundabout, the existing Station Road, the existing London Road adjoining the Prince of Wales Roundabout and the A120 road portion located between the Marks Tey Roundabout and Prince of Wales Roundabout (Marks Tey interchange). The existing Prince of Wales Roundabout is drained by kerb inlet gullies which discharge to carrier drains located within the roundabout footprint. The existing Station Road is drained by kerb inlet gullies which discharge to carrier drains. The existing London Road adjoining the Prince of Wales Roundabout is drained by a kerb and gully arrangement which discharges to carrier drains that ultimately drain west into the highway drainage system that drains the aforementioned roundabout. The A120 road portion located between the existing Marks Tey Roundabout and Prince of Wales Roundabout is drained by kerb inlet gullies which discharge to carrier drains. The carrier drains appear to ultimately discharge to the existing highway drainage serving the adjacent A12 mainline and Prince of Wales Roundabout.

6.4.78 Once the proposed highway drainage from the above-described highway proposals and the existing highway drainage to be retained, has converged to the primary surface water carrier drains serving the A12 mainline, the carrier drains discharge north-east along the A12 mainline highway alignment towards the Roman River culvert crossing (existing culvert CL-31) and discharge to a proposed attenuation pond. The attenuation pond is located south of the A12 mainline and discharges to a repositioned existing outfall on the adjacent Roman River via a vortex flow control device. The existing outfall has to be repositioned locally along the Roman River due to the proposed online widening works to the A12 mainline. Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an existing outfall on the Roman River.

Side roads

6.4.79 The proposed A12 mainline within the Drainage Section 3 highway drainage sub-section includes seventeen side road drainage catchments which discharge to proposed outfalls S3-OU3, S3-OU4, S3-OU5, S3-OU13, S3-OU14, S3-OU19, S3-OU20, S3-OU22, S3-OU23, S3-OU24, S3-OU27, S3-OU27A, S3-OU28, S3-OU29, S3-OU3, S3-OU32 and S3-OU33. These highway drainage catchments are described below under the relevant catchment headers. The proposed edge collection systems described for the proposed highway catchments are informed by the proposed highway geometry and the drainage design philosophy described in Section 4.3. The existing and proposed paved catchment areas and any permeable catchment areas draining into the proposed highway drainage systems for the side road drainage catchments described below are presented in Table B.3 in Annex B.

6.4.80 The Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0813 to 0818), illustrate the main drainage features and catchment extents for the aforementioned Drainage Section 3 side road drainage catchments. Section 7 (and associated Annex C) presents the proposed discharge rates, the proposed attenuation storage volumes, the flow control device types / diameters employed for the proposed highway drainage systems and the catchment-specific comments regarding the greenfield, brownfield and adjusted discharge rate criteria. Section 9 presents the exceedance flow assessment findings for the proposed highway drainage systems. The associated Exceedance Flow Analysis Maps are presented in Annex A. In summary, the Drainage Section 3 sub-section proposed side road improvements are as follows:

- **Highfields Lane** – The existing Highfields Lane is subject to highway improvement works to provide better traffic flows and connectivity to Maldon Road. It is encompassed by the proposed S3-OU3 and S3-OU4 catchments.
- **Maldon Road** – The existing Maldon Road is proposed to be realigned near where it crosses over the A12 mainline at chainage 26885. The existing Maldon Road paved area will be made redundant and removed. It is encompassed by the proposed S3-OU5 catchment.
- **Ewell Hall Chase** – The existing Ewell Hall Chase is proposed to be realigned near where it crosses the A12 mainline at chainage 30770. The existing Ewell Hall Chase paved area will be made redundant and removed where applicable. It is encompassed by the S3-OU13 and S3-OU14 catchments.
- **Prested Hall access bridge** – The proposed Prested Hall access bridge near the existing junction 24 is a new highway development that provides access between the Threshelfords Rural Business Park, the Prested Hall complex, the de-trunked A12 and the existing London Road. A new roundabout is also part of this proposed development. It

is encompassed by the proposed S3-OU19, S3-OU20, S3-OU22, S3-OU23 and S3-OU24 catchments.

- **Easthorpe Road access bridge** – This proposed highway development is part of a new connection between the de-trunked A12 and the existing Easthorpe Road and is called the Easthorpe Road access bridge. A new roundabout on the de-trunked A12 is also part of this proposed development. The proposed Easthorpe Road overbridge crosses over the proposed offline A12 mainline at approximate chainage 34830. It is encompassed by the proposed S3-OU27, S3-OU27A, S3-OU28 and S3-OU29 catchments.
- **Easthorpe Green and Wishing Well access roads** – This is a proposed offline highway connection between the de-trunked A12 and local access roads serving the Easthorpe Green Farm and Wishing Well Farm respectively. The proposed Wishing Well overbridge (i.e. crosses over the proposed offline A12 mainline at 36330) is part of this development. This offline highway connection is required to maintain access and egress to the aforementioned farms due to the proposed offline A12 mainline severing the existing local access roads. It is encompassed by the proposed S3-OU31, S3-OU32 and S3-OU33 catchments.

Catchment S3-OU3

6.4.81 The S3-OU3 catchment is located on Highfields Lane near A12 mainline chainage 26885. The existing Highfields Lane is subject to highway improvement works to provide better traffic flows and connectivity to Maldon Road. The catchment extends for approximately 370m of the Highfields Lane side road portion located west of the Highfields overbridge across the A12 mainline (chainage 26885). Drawing number HE551497-JAC-LDC-SCHW-DR-D-0813 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU3 catchment.

6.4.82 The above-described Highfields Lane side road portion has a balanced cross-section and is located on embankment. The existing highway drainage serving this Highfields Lane road portion will be completely removed and replaced with a proposed new highway drainage system. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement, discharging to carrier drains located in both verges. These carrier drains will then converge, drain south-west down the highway alignment and subsequently discharge north-west to a proposed attenuation pond located to the north-west of the Highfields Lane side road and discharging to a new outfall on Ordinary Watercourse 18 via a vortex flow control device. A new outfall was assumed to be required as an existing outfall serving Highfields Lane locally could not be identified due to a lack of drainage survey in the area. Therefore, brownfield allowable discharge rates are assumed to be applicable for this new outfall location on the basis that an existing outfall is assumed to be present.

Catchment S3-OU4

6.4.83 The S3-OU4 catchment is located on Highfields Lane near A12 mainline chainage 26900. The existing Highfields Lane is subject to highway improvement works to provide better traffic flows and connectivity to Maldon Road. The catchment extends for approximately 225m of the Highfields Lane side road portion located east of the Highfields overbridge across the A12 mainline (chainage 26885). Drawing number HE551497-JAC-LDC-SCHW-DR-D-0813 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU4 catchment.

6.4.84 The above-described Highfields Lane side road portion has a balanced cross-section and is located on embankment. The existing highway drainage serving this Highfields Lane road portion will be completely removed and replaced with a proposed new highway drainage system. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. The carrier drains will then converge, drain east along the highway alignment and subsequently discharge south to a proposed attenuation pond located south of the Highfields Lane side road, discharging to a new outfall on Ordinary Watercourse 21 via a vortex flow control device. A new outfall was assumed to be required as an existing outfall serving Highfields Lane locally could not be identified due to a lack of drainage survey in the area. Therefore, brownfield allowable discharge rates are assumed to be applicable for this new outfall location on the basis that an existing outfall is assumed to be present.

Catchment S3-OU5

6.4.85 The S3-OU5 catchment comprises the proposed realigned Maldon Road near A12 mainline chainage 26885. The existing Maldon Road will be made redundant and removed. The catchment also includes the proposed Highfields overbridge which crosses over the A12 mainline. The catchment extends for approximately 280m of the proposed realigned Maldon Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0813 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU5 catchment.

6.4.86 The above-described proposed Maldon Road portion has a balanced cross-section and is located on embankment. The existing highway drainage serving the existing Maldon Road will be removed given that the road portion in question will be made redundant and removed. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. The proposed Highfields overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units which will discharge via carrier

drains to the proposed highway drainage system serving the realigned Maldon Road.

6.4.87 The above-described carrier drains serving the realigned Maldon Road and the Highfields overbridge will then converge, drain north along the highway alignment and subsequently discharge east to a proposed attenuation pond. The attenuation pond is located to the east of the realigned Maldon Road and discharges to a new outfall on the River Blackwater via a vortex flow control device. A new outfall was assumed to be required as an existing outfall serving Maldon Road locally could not be identified due to a lack of drainage survey in the area. Therefore, brownfield allowable discharge rates are assumed to be applicable for this new outfall location on the basis that an existing outfall is assumed to be present.

Catchment S3-OU13

6.4.88 The S3-OU13 catchment comprises one portion of the proposed realigned Ewell Hall Chase (i.e. north-west of the A12 mainline) near A12 mainline chainage 30770. The existing Ewell Hall Chase will be made redundant and removed where applicable. The catchment also includes approximately half of the proposed Ewell Hall Chase overbridge which crosses over the A12 mainline. The catchment extends for approximately 180m of the proposed realigned Ewell Hall Chase. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0813 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU13 catchment.

6.4.89 The above-described proposed portion of Ewell Hall Chase has a balanced cross-section and is located on embankment. The existing highway drainage serving the existing Ewell Hall Chase will be removed where the existing road will be made redundant. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. The proposed Ewell Hall Chase overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units which will discharge via carrier drains to the proposed highway drainage system serving the proposed realigned road to the north-west.

6.4.90 The above-described carrier drains serving the realigned Ewell Hall Chase and the associated overbridge will then converge, drain north-west along the highway alignment and subsequently discharge north-west to a proposed attenuation pond. The attenuation pond is located to the north-west of the realigned Ewell Hall Chase and discharges to a new outfall on an existing drainage ditch via a vortex flow control device. The ultimate discharge location is assumed to be the nearby River Blackwater. Greenfield discharge rates are applicable as this proposed portion of Ewell Hall Chase is located on a currently greenfield site.

Catchment S3-OU14

6.4.91 The S3-OU14 catchment comprises one portion of the proposed realigned Ewell Hall Chase (i.e. south-east of the A12 mainline) near A12 mainline chainage 30770. The existing Ewell Hall Chase will be made redundant and removed where applicable. The catchment also includes approximately half of the proposed Ewell Hall Chase overbridge which crosses over the A12 mainline. The catchment extends for approximately 150m of the proposed realigned Ewell Hall Chase. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU14 catchment.

6.4.92 The above-described proposed portion of Ewell Hall Chase has a balanced cross-section and is located on embankment. The existing highway drainage serving the existing Ewell Hall Chase will be removed where the existing road will be made redundant. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. The proposed Ewell Hall Chase overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units which will discharge via carrier drains to the proposed highway drainage system serving the proposed realigned road to the south-east.

6.4.93 The above-described carrier drains serving the realigned Ewell Hall Chase and the associated overbridge will then converge, drain south-east along the highway alignment and subsequently discharge east to a proposed attenuation pond which is located to the east of the realigned Ewell Hall Chase and discharges to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges north-east to Ordinary Watercourse 21a. Greenfield discharge rates are applicable as this proposed portion of Ewell Hall Chase is located on a currently greenfield site.

Catchment S3-OU19

6.4.94 The S3-OU19 catchment comprises the proposed realigned Threshelfords access road located near the existing junction 24. The realigned access road provides access to the Threshelfords Rural Business Park. It should be noted that the realigned access road is located on the footprint of the existing A12. The existing A12 paved area and the associated highway drainage will be removed where the existing road will be made redundant. The catchment extends for approximately 420m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU19 catchment.

6.4.95 The above-described proposed realigned Threshelfords access road has a balanced cross-section and is located on embankment. It is proposed to

collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement which will discharge to carrier drains located in both verges.

6.4.96 The above-described carrier drains will then converge, drain south along the proposed realigned access road and subsequently discharge south to a proposed attenuation pond. The attenuation pond is located to the south of the proposed realigned access road and outfalls to a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges south to Domsey Brook. Brownfield discharge rates are applicable given that the proposed realigned Threshelfords access road to be drained by the S3-OU19 highway drainage system also drains the existing A12 mainline.

Catchment S3-OU20

6.4.97 The S3-OU20 catchment comprises a new small farm access road. It is a stub road off the proposed realigned Prested Hall access road. The catchment extends for approximately 90m of the new farm access road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU20 catchment.

6.4.98 The above-described new farm access road has a balanced cross-section and is located on embankment. It is proposed to collect the surface water runoff from both carriageways via a kerb and gully arrangement. The gullies will discharge down the embankment slopes via carrier drains to proposed swales located on either side of the new farm access road. The new farm access road embankment slopes are also intercepted by the proposed swales. The swales discharge to a new outfall at the upstream end of a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges south to Domsey Brook. Greenfield discharge rates are applicable given that the new farm access road is located on a currently greenfield site.

Catchment S3-OU22

6.4.99 The S3-OU22 catchment comprises the proposed realigned Prested Hall access road located near the existing junction 24. The realigned Prested Hall access road provides access to the Prested Hall complex. The catchment extends for approximately 380m. The catchment also includes the proposed Prested Hall/Threshelfords overbridge which crosses over the A12 mainline. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU22 catchment.

6.4.100 The above-described proposed realigned Prested Hall access road has a balanced cross-section and is located on embankment. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement which will discharge to carrier drains located in both verges. The proposed Prested

Hall/Threshelfords overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units located on either side of the balanced overbridge carriageway. The bridge deck drainage units will discharge via carrier drains to the proposed highway drainage system serving the proposed realigned Prested Hall access road.

6.4.101 The above-described carrier drains will then drain north-east along the proposed realigned access road, converge and subsequently discharge east to a proposed attenuation pond. The attenuation pond is located to the east of the proposed realigned Prested Hall access road and discharges to a new outfall on a watercourse (located north of Prested Hall)via a vortex flow control device. The watercourse located north of Prested Hall further discharges south to Domsey Brook. Greenfield discharge rates are applicable given that the proposed realigned Prested Hall access road is located on a currently greenfield site.

Catchment S3-OU23

6.4.102 The S3-OU23 catchment comprises one portion of the proposed Prested Hall access bridge (the western arm) near the existing junction 24. The joint access bridge western arm connects the proposed Prested Hall overbridge to the existing London Road located to the north-west. It should be noted that this portion of the proposed access bridge is located on the footprint of the existing A12 (to be made redundant). The existing A12 paved area and the associated highway drainage will be removed where the existing road will be made redundant. The catchment extends for approximately 380m of the proposed joint access bridge. The proposed S3-OU23 catchment also includes a small portion of the existing London Road. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU23 catchment.

6.4.103 The above-described proposed joint access bridge portion has a balanced cross-section and is located both on embankment and in cutting. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. The existing London Road portion within the drainage catchment is balanced. It is proposed to provide combined kerb drainage adjacent to both verges as part of the local highway improvement works. The combined kerb drainage will discharge to carrier drains located in both verges. The proposed carrier drains will discharge south-west into the proposed highway drainage serving the proposed joint access bridge (western arm).

6.4.104 The above-described carrier drains for the proposed joint access bridge (western arm) will then drain to the midpoint of the joint access bridge alignment, converge and subsequently discharge south-east of the joint access bridge alignment to a proposed attenuation pond. The attenuation pond is located to the east of the proposed joint access bridge and discharges to a new outfall on a proposed drainage ditch via a vortex flow

control device. The proposed drainage ditch discharges to proposed culvert CL-23 which discharges east under the proposed A12 mainline to Ordinary Watercourse 23. Greenfield discharge rates are applicable given that the proposed Prested Hall-Threshelfords Rural Business Park joint access bridge (western arm) is discharging to a new outfall location.

Catchment S3-OU24

6.4.105 The S3-OU24 catchment is located near the existing junction 24. It comprises a portion of the modified existing London Road, a portion of New Lane, a portion of the modified existing A12, a new road connecting to an existing local road to the south and a new proposed roundabout on the existing A12. Two new lanes have been added, connecting to the existing New Lane from the north-east and south-west. It should be noted that this portion of the proposed joint access bridge works is located on the footprint of the existing junction 24 (to be made redundant). The existing junction 24 paved area and the associated highway drainage will be removed where the existing roads will be made redundant. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0815 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU24 catchment.

6.4.106 The above-described proposed highways adjoining the new roundabout all have a balanced cross-section and are located on embankment. The existing highway drainage serving the existing highways will be removed as it is made redundant by the proposed highway realignment works. Therefore, it is proposed to collect the surface water runoff from all the carriageways via combined kerb drainage alignments located adjacent to the verges of the above-described highways. The combined kerb drainage will discharge to carrier drains located in the verges of the various highways.

6.4.107 The above-described carrier drains for the proposed highways adjoining the new roundabout, drain into the proposed highway drainage serving the new roundabout and then subsequently discharge south-east to a proposed attenuation pond. The attenuation pond is located to the south-east of the new roundabout / adjoining highways and discharges to a new outfall on Ordinary Watercourse 23 via a vortex flow control device. Greenfield discharge rates are applicable as the proposed roundabout and adjoining roads to be drained by the S3-OU24 highway drainage system are discharging to a new outfall.

Catchment S3-OU27

6.4.108 The S3-OU27 catchment is located near the existing Easthorpe Road at approximate A12 mainline chainage 34830. This catchment encompasses a proposed offline highway connection between the existing Easthorpe Road and the proposed Easthorpe Road overbridge that crosses over the proposed offline A12 mainline at chainage 34830. The proposed highway is part of a new connection between the de-trunked A12 and the existing Easthorpe Road and is called the Easthorpe Road access bridge. The

catchment extends for approximately 235m of the proposed Easthorpe Road access bridge. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0816 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU27 catchment.

6.4.109 The above-described Easthorpe Road access bridge portion has a balanced cross-section and is located on embankment. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. These carrier drains will then drain south-east down the highway alignment, converge and subsequently discharge south-west to a proposed attenuation pond. The attenuation pond is located to the south-west of the proposed Easthorpe Road access bridge and discharges to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges east via proposed culvert CL-29B to Ordinary Watercourse 39. Greenfield discharge rates are applicable as this proposed Easthorpe Road access bridge portion is located on a currently greenfield site.

Catchment S3-OU27A

6.4.110 The S3-OU27A catchment is located adjacent to the existing Easthorpe Road between approximate A12 mainline chainages 34370 and 34500. This catchment encompasses the proposed realigned Easthorpe Link Road between the existing Easthorpe Road and an existing local access road to the west. This proposed realigned Easthorpe Link Road is required as the proposed offline A12 mainline severs the existing junction between the existing Easthorpe Road and the local access road. The catchment extends for approximately 150m. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0816 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU27A catchment.

6.4.111 The above-described realigned Easthorpe Link Road has a balanced cross-section and is located primarily on embankment. It is proposed to collect the surface water runoff from both carriageways via a kerb and gully arrangement. The gullies will discharge south across the highway alignment at multiple intervals to a proposed swale. The swale provides attenuation storage and is located a short distance to the south of the proposed realigned Easthorpe Link Road and discharges to a new outfall on an existing drainage ditch (Ordinary Watercourse 40) via a vortex flow control device. Greenfield discharge rates are applicable as the proposed realigned Easthorpe Link Road is located on a currently greenfield site.

Catchment S3-OU28

6.4.112 The S3-OU28 catchment is located adjacent to the existing Easthorpe Road at approximate A12 mainline chainage 34860. This catchment encompasses a proposed offline highway connection between the existing Easthorpe Road and the proposed Easthorpe Road overbridge that crosses

over the proposed offline A12 mainline at approximate chainage 34830. The proposed highway is part of a new connection between the de-trunked A12 and the existing Easthorpe Road and is called the Easthorpe Road Access Bridge. The catchment extends for approximately 175m of the proposed Easthorpe Road access bridge. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0816 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU28 catchment.

6.4.113 The above-described Easthorpe Road access bridge portion has a balanced cross-section and is located either on embankment or at-grade. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement, discharging north across the highway alignment at multiple intervals to a proposed swale. The swale provides attenuation storage and is located a short distance to the north of the proposed Easthorpe Road access bridge and discharges to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges south-east to Ordinary Watercourse 39. Greenfield discharge rates are applicable as this proposed Easthorpe Road access bridge portion is located on a currently greenfield site.

Catchment S3-OU29

6.4.114 The S3-OU29 catchment is located between the de-trunked A12 and the proposed offline A12 mainline near the existing Easthorpe Road. It comprises a new roundabout on the de-trunked A12, small portions of the existing A12 adjoining the new roundabout, the proposed Easthorpe Road access bridge portion between the de-trunked A12 and the proposed A12 mainline, a small portion of Domsey Chase and the proposed Easthorpe Road overbridge. It should be noted that the new roundabout is the high point on the de-trunked A12 locally and so there will be no additional existing highway drainage from the de-trunked A12 to the north-east and south-west contributing to the proposed S3-OU29 catchment. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0816 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU29 catchment.

6.4.115 The above-described proposed highways adjoining the new roundabout all have a balanced cross-section and are located on embankment. It is proposed to collect the surface water runoff from all the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in the verges of the various highways. The new roundabout carriageway falls inwards to the inner circle of the roundabout. Therefore, combined kerb drainage will be provided and will discharge to carrier drains located within the footprint of the roundabout. The proposed Easthorpe overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck

drainage units which will discharge via carrier drains to the proposed highway drainage system serving the new roundabout to the north-west.

6.4.116 The above-described carrier drains for the proposed highways adjoining the new roundabout, drain into the proposed highway drainage serving the new roundabout and then subsequently discharge south-east to a proposed attenuation pond. The attenuation pond is located to the south-east of the new roundabout and adjoining highways, and discharges to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges north-east to the Domsey Brook. Greenfield discharge rates are applicable as the proposed roundabout and adjoining roads to be drained by the S3-OU29 highway drainage system are discharging to a new outfall location.

Catchment S3-OU31

6.4.117 The S3-OU31 catchment is located immediately south of the proposed offline A12 mainline between approximate A12 mainline chainage 36000 and 36330. This catchment encompasses a proposed offline highway connection between the proposed Wishing Well overbridge (i.e. crosses over the A12 mainline at 36330) and the existing Easthorpe Green Farm local access road. The proposed highway is part of a new connection between the de-trunked A12 and the existing Easthorpe Green Farm local access road. The catchment extends for approximately 385m and includes a portion of the Wishing Well overbridge. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0817 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU31 catchment.

6.4.118 The above-described proposed offline highway portion, referred to realigned Easthorpe Green access road, has a balanced cross-section and is located on embankment. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement, discharging to carrier drains located in both verges. The proposed Wising Well overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck drainage units which will discharge via carrier drains to the proposed highway drainage system serving the offline highway portion to the south.

6.4.119 The proposed carrier drains will then drain south-west down the highway alignment, converge and subsequently discharge south of the highway to a proposed attenuation pond. The attenuation pond is located to the south of the proposed offline highway and discharges to a new outfall on a proposed drainage ditch via a vortex flow control device. The proposed drainage ditch discharges south-west to the Domsey Brook. Greenfield discharge rates are applicable as this proposed offline highway portion is located on a currently greenfield site.

Catchment S3-OU32

6.4.120 The S3-OU32 catchment is located immediately south of the proposed offline A12 mainline between approximate A12 mainline chainages 36330 and 36880. This catchment encompasses a proposed offline highway connection between the proposed Wishing Well overbridge (i.e. crosses over the A12 mainline at 36330) and the existing Wishing Well Farm local access road. The proposed highway is part of a new connection between the de-trunked A12 and the existing Wishing Well Farm local access road. The catchment extends for approximately 645m. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0817 and 0818 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S3-OU32 catchment.

6.4.121 The above-described proposed offline highway portion, referred to realigned Wishing Well access road, has a balanced cross-section and is located either on embankment or at-grade. It is proposed to collect the surface water runoff from the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in both verges. The carrier drains will then drain north-east and south-west towards the midpoint of the highway alignment, converge and subsequently discharge south of the highway to a proposed attenuation pond. The attenuation pond is located to the south of the proposed offline highway and discharges to a new outfall on an existing drainage ditch (Ordinary Watercourse 41) via a vortex flow control device. Greenfield discharge rates are applicable as this proposed offline highway portion is located on a currently greenfield site.

Catchment S3-OU33

6.4.122 The S3-OU33 catchment is located between the de-trunked A12 and the proposed offline A12 mainline near the proposed Wishing Well overbridge. It comprises the new Wishing Well Farm roundabout on the de-trunked A12, small portions of the existing A12 adjoining the new roundabout, a proposed offline highway portion between the de-trunked A12 and the proposed A12 mainline and the proposed Wishing Well overbridge. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0817 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-OU33 catchment.

6.4.123 The above-described proposed highways adjoining the new roundabout all have a balanced cross-section and are located on embankment. It is proposed to collect the surface water runoff from all the carriageways with a combination of combined kerb drainage and a kerb and gully arrangement. These will discharge to carrier drains located in the verges of the various highways. The new roundabout carriageway falls inwards to the inner circle of the roundabout. Therefore, combined kerb drainage will be provided, discharging to carrier drains located within the footprint of the roundabout. The proposed Wishing Well overbridge geometry has a balanced crossfall along its length. It is proposed to collect the surface water runoff from the proposed overbridge carriageway via bridge deck

drainage units which will discharge via carrier drains to the proposed highway drainage system serving the offline highway portion to the north.

6.4.124 The above-described carrier drains for the proposed highways adjoining the new roundabout, drain towards the proposed highway drainage serving the new roundabout and then subsequently discharge south-west along the adjoining A12 (south-western portion) to the existing highway drainage system serving the de-trunked A12. A proposed offline attenuation pond is located to the east of the new roundabout and adjoining highways to attenuate a portion of the catchment via a vortex flow control device. Brownfield discharge rates are applicable given that a portion of the existing de-trunked A12 is to be retained as part of the proposed catchment.

Inworth Road

General

6.4.125 The Inworth Road proposed catchments are located along a length of Inworth Road (B1023) from the proposed Inworth roundabout (part of the junction 24 upgrade) to Perrywood Garden Centre heading south. The proposed Inworth Road highway improvement works are required due to the A12 mainline online widening works and the associated junction 24 upgrade which will likely see greater volumes of traffic using Inworth Road. Drawings numbers HE551497-JAC-LDC-SCHW-DR-D-0814 and 0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the proposed Inworth Road.

6.4.126 It should be noted that there is currently limited topographic and drainage survey information available for the existing case Inworth Road therefore suitable design assumptions have been made to inform the proposed highway drainage. Due to the aforementioned lack of survey information, it was not practicable to undertake hydraulic modelling of the proposed Inworth Road highway drainage. Therefore, the existing case allowable discharge rates have been calculated using a spreadsheet-based assessment to inform the proposed case discharge rates. The spreadsheet-based assessment uses the FEH Statistical Method to determine greenfield runoff rates where applicable and the Modified Rational Method where brownfield runoff rates from existing paved areas are applicable. As the project progresses through to the detailed design stage, these allowable discharge rate estimates may be subject to change on receipt of more detailed topographic and drainage survey information becoming available for Inworth Road. The proposed flow control device type has not been stated for the proposed catchment descriptions below, given that hydraulic modelling has not been undertaken. The appropriate type of flow control device will be determined in subsequent design stages when sufficient survey information becomes available to undertake hydraulic modelling.

6.4.127 Due to the lack of detailed survey information, a conservative design assumption has been made that the existing highway drainage system

serving Inworth Road is a combined drainage system which accepts surface water runoff from Inworth Road itself and overland flows from the adjacent natural catchments located on either side of Inworth Road. The proposed highway drainage design aims to separate the highway drainage system by proposing new outfalls and attenuation ponds to serve Inworth Road, whilst using natural catchment ditches and proposed flood compensation storage areas to intercept natural catchment overland flows as needed.

Catchment S3-IWR-OU1

6.4.128 The S3-IWR-OU1 catchment is located between an existing drainage ditch that discharges to the nearby Ordinary Watercourse 34 and the proposed Inworth Road minor roundabout slip road (part of the junction 24 upgrade). It comprises a portion of the existing Inworth Road highway and minor proposed highway widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0814 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-IWR-OU1 catchment.

6.4.129 The geometry for this portion of the proposed Inworth Road has a balanced crossfall across its length. It is proposed to collect the surface water runoff from the carriageway via a proposed kerb and gully arrangement which will discharge directly into a proposed drainage ditch located within the eastern verge. The aforementioned proposed drainage ditch will then drain south along the highway and subsequently discharge to an existing drainage ditch located adjacent to Inworth Road. A flow control device will limit the discharge rates and enable the attenuation of the collected surface water runoff within the existing drainage ditch.

Catchment S3-IWR-OU2

6.4.130 The S3-IWR-OU2 catchment is located between proposed culvert CL-IWR-6 and an existing drainage ditch that discharges to the nearby Ordinary Watercourse 34. It comprises a portion of the existing Inworth Road highway and minor proposed highway widening. Drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0814 and 0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the main drainage features and catchment extents for the S3-IWR-OU2 catchment.

6.4.131 The geometry for this portion of the proposed Inworth Road alternates between a superelevated crossfall and a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via a proposed kerb and gully arrangement which will discharge directly to an existing drainage ditch within the eastern verge. The aforementioned drainage ditch will then drain north-west along the highway and subsequently discharge east of the highway to a proposed attenuation pond located to the east of Inworth Road. The proposed attenuation pond outfalls via a flow control device to a new outfall on an existing drainage ditch.

Catchment S3-IWR-OU3

6.4.132 The S3-IWR-OU3 catchment is located between proposed culvert CL-IWR-4A and proposed culvert CL-IWR-6. It comprises a portion of the existing Inworth Road highway and minor proposed highway widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-IWR-OU3 catchment.

6.4.133 The geometry for this portion of the proposed Inworth Road has a balanced crossfall across its length. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge directly to a highway drainage ditch located within the southern verge. The highway drainage ditch will then drain north along the highway, discharging east of the highway and into a proposed attenuation pond located to the east of Inworth Road and sized to facilitate the additional restriction of the proposed S3-IWR-OU3 catchment discharge rates to compensate for the unattenuated flows from the upstream proposed S3-IWR-OU4 catchment. The proposed attenuation pond outfalls to a new outfall on an existing drainage ditch to be diverted.

Catchment S3-IWR-OU4

6.4.134 The S3-IWR-OU4 catchment is located between proposed culvert CL-IWR-5 and proposed culvert CL-IWR-4A. It comprises a portion of the existing Inworth Road highway and minor proposed highway widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-IWR-OU4 catchment.

6.4.135 The geometry for this portion of the proposed Inworth Road alternates between a superelevated crossfall and a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge directly into an existing carrier drain system (to be retained). The carrier drain system discharges north-east and subsequently discharges to a cross carriageway culvert (i.e. proposed culvert CL-IWR-4A). Proposed culvert CL-IWR-4A subsequently discharges east, unattenuated, to a proposed diverted watercourse. The proposed surface water discharges are unattenuated due to spatial constraints that prevent attenuation storage being provided. Therefore, the proposed discharge rates will exceed the existing case allowable discharge rates. However, this will be compensated for by attenuating the adjacent S3-IWR-OU3 catchment using a proposed attenuation pond.

Catchment S3-IWR-OU5

6.4.136 The S3-IWR-OU5 catchment is located between assumed existing culvert CL-IWR-9 and proposed culvert CL-IWR-5. It comprises the existing Inworth Road highway and minor proposed highway widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-IWR-OU5 catchment.

6.4.137 The geometry for this portion of the proposed Inworth Road alternates between a superelevated crossfall and a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via combined kerb drainage which will discharge at regular intervals to proposed carrier drains. The carrier drains will then drain north-west along the highway alignment and subsequently discharge to proposed culvert CL-IWR-5, which will subsequently discharge north-east via a proposed new chamber connection to an existing culvert that runs along the eastern side of Inworth Road. A flow control device will be provided on the chamber upstream to the aforementioned proposed culvert CL-IWR-5 which will enable the collected surface water runoff from Inworth Road to back-up into a proposed offline attenuation pond.

6.4.138 The external natural catchment to the east is intercepted by an existing minor watercourse to be diverted, and discharges to the proposed S3-IWR-OU5 catchment via proposed stub connection to the existing culvert that runs adjacent to the eastern side of Inworth Road. The external natural catchment to the west is intercepted by the proposed natural catchment drainage ditch adjacent to the western side of Inworth Road. The proposed natural catchment drainage ditch discharges to proposed culvert CL-IWR-5 where it will enter the S3-IWR-OU5 catchment.

Catchment S3-IWR-OU6

6.4.139 The S3-IWR-OU6 catchment is located between proposed culvert CL-IWR-2 and the assumed existing CL-IWR-9. It comprises existing Inworth Road highway and minor proposed highway widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-IWR-OU6 catchment.

6.4.140 The geometry for this portion of the proposed Inworth Road alternates between a superelevated crossfall and a balanced crossfall. It is proposed to collect the surface water runoff from the carriageway via a proposed kerb and gully arrangement, discharging directly into a proposed carrier drain system. Attenuation storage is provided via oversized pipes due to spatial constraints. The aforementioned carrier drains will then drain north and subsequently discharge via a new outfall to a proposed ditch. A flow control device will limit the proposed discharge rates.

Catchment S3-IWR-OU7

6.4.141 The S3-IWR-OU7 catchment is located between existing culvert CL-IWR-1A and proposed CL-IWR-2. It comprises a portion of the existing Inworth Road highway and minor proposed highway widening. Drawing number HE551497-JAC-LDC-SCHW-DR-D-0820 of the Drainage and Surface Water Plans [TR010060/APP/2.13] illustrates the main drainage features and catchment extents for the S3-IWR-OU7 catchment.

6.4.142 The existing and proposed Inworth Road geometry has a primarily superelevated crossfall which falls towards the western verge, with short lengths of balanced crossfall. It is proposed to collect the surface water

runoff from the carriageway via a kerb and gully arrangement, discharging directly to a proposed drainage ditch located within the eastern verge. The proposed drainage ditch will then drain north-west and subsequently discharge north-east of the highway to a proposed attenuation pond. The attenuation pond is located north-east of Inworth Road and discharges via a flow control device, to a new outfall on diverted Watercourse 34C just upstream of proposed culvert CL-IWR-2.

7 Discharge rates and attenuation storage volumes

7.1.1 In conjunction with Annex C, this section presents the proposed catchment discharge rates, the associated flow control devices used to achieve the proposed discharge rates, the attenuation storage used, and the resulting modelled attenuation storage volume estimates. This is to demonstrate that the highway drainage proposals for the proposed scheme do not increase flood risk. The summary presented in Table 7.1 below details the Drainage and Surface Water Plans [TR010060/APP/2.13] within which the proposed catchments, their associated attenuation storages and the downstream outfalls can be identified. This is to aid with finding the spatial location of the proposed outfalls and proposed attenuation storage locations relative to the discharge rate and attenuation storage volume summary table information presented in Annex C within Table C.1 to Table C.4.

Table 7.1 Proposed catchment identification within the Drainage and Surface Water Plans

Drawing number	Proposed catchments
Drainage Section 1	
HE551497-JAC-LDC-SCHW-DR-D-0801	S1-OU1 and S1-OU7A
HE551497-JAC-LDC-SCHW-DR-D-0802	S1-OU1, S1-OU7A, S1-OU10, S1-OU10A, S1-OU11 and S1-OU12
HE551497-JAC-LDC-SCHW-DR-D-0803	S1-OU12 (No attenuation storage present)
HE551497-JAC-LDC-SCHW-DR-D-0804	S1-OU13 / S1-OU14 and S1-OU13A (No attenuation storage present)
HE551497-JAC-LDC-SCHW-DR-D-0805	S1-OU13, S1-OU13A, S1-OU14, S1-OU15, S1-OU17 / S1-OU18, S1-OU20 and S1-OU21
HE551497-JAC-LDC-SCHW-DR-D-0806	S1-OU17 / S1-OU18, S1-OU19, S1-OU19C, S1-OU19C1, S1-OU23, S1-OU23C, S1-OU23D, S1-OU24A and S1-OU24B
HE551497-JAC-LDC-SCHW-DR-D-0807	S1-OU23, S1-OU23D and S1-OU24B
HE551497-JAC-LDC-SCHW-DR-D-0808	S1-OU23
Drainage Section 2	
HE551497-JAC-LDC-SCHW-DR-D-0808	S2-OU3, S2-OU4, S2-OU5 and S2-OU8

Drawing number	Proposed catchments
HE551497-JAC-LDC-SCHW-DR-D-0809	S2-OU5, S2-OU8, S2-OU9, S2-OU9A and S2-OU10
HE551497-JAC-LDC-SCHW-DR-D-0810	S2-OU9, S2-OU9, S2-OU9A, S2-OU10, S2-OU11, S2-OU14, S2-OU15A, S2-OU15C, S2-OU15D and S2-OU15E
HE551497-JAC-LDC-SCHW-DR-D-0811	S2-OU15A, S2-OU15C, S2-OU15C1, S2-OU15D, S2-OU15D1, S2-OU15E, S2-OU15G, S2-OU15H, S2-OU24, S2-OU24A and S2-OU26
HE551497-JAC-LDC-SCHW-DR-D-0812	S2-OU15G, S2-OU15H, S2-OU17, S2-OU18, S2-OU19, S2-OU24A, S2-OU26 and S2-OU27
Drainage Section 3	
HE551497-JAC-LDC-SCHW-DR-D-0813	S3-OU1, S3-OU2, S3-OU3, S3-OU4, S3-OU5, S3-OU13 and S3-OU14
HE551497-JAC-LDC-SCHW-DR-D-0814	S3-OU2, S3-OU6, S3-OU7, S3-OU7A, S3-OU8, S3-OU8A, S3-OU8B / S3-OU8D, S3-OU8C, S3-OU8E, S3-OU9, S3-OU10, S3-OU13, S3-OU14, S3-OU19, S3-IWR-OU1 and S3-IWR-OU2
HE551497-JAC-LDC-SCHW-DR-D-0815	S3-OU10, S3-OU19, S3-OU20, S3-OU21, S3-OU22, S3-OU23, S3-OU24 and S3-OU26
HE551497-JAC-LDC-SCHW-DR-D-0816	S3-OU26, S3-OU26A, S3-OU26B, S3-OU27, S3-OU27A, S3-OU28 and S3-OU29
HE551497-JAC-LDC-SCHW-DR-D-0817	S3-OU26A, S3-OU26B, S3-OU30, S3-OU30A, S3-OU31, S3-OU32 and S3-OU33
HE551497-JAC-LDC-SCHW-DR-D-0818	S3-OU15, S3-OU15A, S3-OU15B, S3-OU15C, S3-OU16, S3-OU30, S3-OU30A and S3-OU32
HE551497-JAC-LDC-SCHW-DR-D-0819	S3-OU16, S3-OU17 and S3-OU18
HE551497-JAC-LDC-SCHW-DR-D-0820	S3-IWR-OU2, S3-IWR-OU3, S3-IWR-OU4, S3-IWR-OU5, S3-IWR-OU6 and S3-IWR-OU7
HE551497-JAC-LDC-SCHW-DR-D-0821	S3-OU7 and S3-OU8A

7.2 Discharge rates

7.2.1 Presented in Table C.1 to Table C.4 in Annex C is a summary of the outfall locations for the proposed highway drainage systems contained within the Drainage Section 1, Drainage Section 2 and Drainage Section 3 highway drainage sub-sections for the proposed scheme (refer to Section 2.2 for the highway drainage sub-sections description). The modelled proposed case peak discharge rates for the 1 in 1-year, 1 in 2-year, 1 in 5-year and 1 in 100-year return period storm events (plus 20% climate change allowance) for the critical storm event are presented. The discharge rates from the proposed natural catchment drainage ditch outfalls or other existing outfalls where there is no change to the existing highway drainage system or flow expected as a result of the proposed scheme are not presented as there is no change to the catchment characteristics. Section 4.8 explains how the allowable discharge rates have been calculated. The Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the proposed attenuation storage locations and the associated outfalls with the proposed catchments labelled accordingly.

7.2.2 The minimum allowable discharge rate used to inform the proposed highway drainage design is 5l/s for practicable drainage system operation and maintenance reasons (i.e. to minimise blockage risk) described previously in Section 4.8. Therefore, where a proposed catchment is subject to discharging at greenfield discharge rate estimates (i.e. new development on greenfield site or proposed catchments subject to adjusted discharge rates at receptors with multiple proposed new outfalls) and the runoff estimates fall below 5l/s, a minimum practicable allowable discharge rate of 5l/s has been adopted.

7.2.3 For some proposed outfall locations the use of a minimum practicable discharge rate of 5l/s would result in a slight increase in discharge rates in comparison to the existing site allowable discharge rates or greenfield runoff rates. Such increases in proposed discharge rates have been adjusted (reduced) with adjacent proposed catchments with the same receptors to ensure that there is no overall increase to the existing site allowable discharge rates and there is no potential change in flood risk. However, there is a small number of proposed outfall locations where this adjustment has not been possible. These proposed outfall locations have been assessed in the Flood Risk Assessment (ES Appendix 14.5 of the ES ([TR010060/APP/6.3]), which identifies a negligible impact on the surface water drainage flood risk, generally as a result of the existing flows within the watercourses into which the 5l/s discharges flow into being larger than the change in flows that would result from the proposed scheme. The proposed catchments that require adjusted allowable discharge rates are described in Annex C.

7.3 Attenuation storage volumes

7.3.1 In addition to the modelled peak discharge rates previously described, the attenuation storage volumes determined from the hydraulic modelling for

the proposed highway drainage systems contained within the Drainage Section 1, Drainage Section 2 and Drainage Section 3 highway drainage sub-sections for the proposed scheme are also presented in Table C.1 to Table C.4 in Annex C. The attenuation storage volume has been determined for design events up to and including the 1 in 100-year return period storm event (plus 20% climate change allowance) and the associated critical storm duration for the attenuation storage locations. The attenuation storage type and the associated flow control type are also presented in the aforementioned tabular data. Section 4.9 describes how the attenuation storage volumes have been estimated. The Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the proposed attenuation storage locations and the associated outfalls with the proposed catchments labelled accordingly.

7.3.2 At the preliminary design stage, it was assumed that there are no water losses as a result of infiltration or evaporation and water is permanently present within the attenuation ponds. This is to determine the most conservative attenuation storage size with respect to land take requirements and given that the ground investigation is yet to be fully completed. Section 8 (infiltration potential assessment) discusses the available preliminary ground investigation data (i.e. infiltration rates, groundwater levels, contaminated land, etc.) relative to the proposed attenuation storage locations.

8 Infiltration potential assessment

8.1.1 This section describes the assessment of the recorded groundwater levels, infiltration rates and contaminated land presence throughout the proposed scheme based on preliminary ground investigation. It should be noted that no ground investigation has been undertaken within the proposed attenuation storage locations along Inworth Road. As the proposed scheme progresses through to the detailed design stage, supplementary GI will be undertaken along the proposed drainage ditch alignments, proposed swales and proposed attenuation pond locations (including Inworth Road) to gain a complete understanding of the ground conditions in the vicinity of the aforementioned proposed highway drainage features prior to the detailed design stage...

8.1.2 Along the proposed scheme highway alignment, the preliminary GI includes ground permeability testing to inform the feasibility of using infiltration techniques in the development of the proposed highway drainage design. The infiltration rates determined from the ground permeability testing were generally poor to practically impervious and in a number of cases there was an insufficient fall in the water level during the permeability testing to calculate the infiltration rates. The preliminary GI along the proposed scheme highway alignment indicates that the superficial geology comprises Head deposits (clay, silt and sand), Brickearth and localised Alluvium (clay, silt and sand), River Terrace Deposits (variably silty sand and gravel, slightly gravelly fine to coarse sand or clayey sandy silt), Lowestoft Formation (formed of Diamicton, predominately cohesive), Glaciofluvial deposits (sand and gravel) and Interglacial Silt and Clay / Glaciolacustrine materials (clays and silts). The Kesgrave Catchment Subgroup (sand and gravel) is only present in the north of the site area. The preliminary GI test data indicate that drainage conditions are generally poor to practically impervious in the Lowestoft and London Clay Formations. Approximately 75% of tests undertaken in the River Terrace, Glaciofluvial and Kesgrave Sand and Gravel Deposits indicate potentially good to very good drainage characteristics in these materials. It must be noted that shallow groundwater is commonly encountered within the proposed scheme extents, particularly in low-lying areas. Therefore, once additional supplementary GI information becomes available the use of infiltration techniques at locations with potentially shallow groundwater will be assessed at the detailed design stage due to the potential risk of inundation. Although River Terrace, Glaciofluvial, Kesgrave Sand and Gravel Deposits etc. are present throughout the proposed scheme, they can be highly variable and often contain a significant percentage of fines (i.e. clay and silt). The presence of clay and silt material within a coarser matrix (sands and gravels) can significantly reduce permeability and therefore make infiltration generally unfeasible.

8.1.3 Regarding the proposed attenuation storage locations, there are 63 proposed attenuation ponds along the proposed scheme. This excludes the four proposed attenuation storage ponds associated with the Inworth Road

drainage catchments due to the lack of available GI information locally for the reasons stated above. The remaining proposed catchments are attenuated by other forms of attenuation storage such as swales, drainage ditches and oversized pipes or are unattenuated as described previously in detail within Sections 6 and 7. For clarity, summarised below are the proposed catchments for which attenuation ponds are not used and hence are not assessed in this section with respect to ground drainage conditions (i.e. soil infiltration rates, groundwater levels and contaminated land issues) at this stage of the proposed scheme design:

- **Drainage Section 1** – The proposed catchments, not attenuated by attenuation ponds but by alternative methods of attenuation storage, or unattenuated, are S1-OU10, S1-OU10A, S1-OU13A, S1-OU14, S1-OU15, S1-OU17, S1-OU20 and S1-OU21. Hence 14 proposed catchments are attenuated by attenuation ponds and are assessed in this section.
- **Drainage Section 2** – The proposed catchments, not attenuated by attenuation ponds but by alternative methods of attenuation storage, or unattenuated, are S2-0U3, S2-OU5, S2-OU8, S2-OU9A, S2-OU15D1, S2-OU17, S2-OU24, S2-OU26 and S2-OU27. Hence 15 proposed catchments are attenuated by attenuation ponds and are assessed in this section.
- **Drainage Section 3** – The proposed catchments not attenuated by attenuation ponds but by alternative methods of attenuation storage, or unattenuated, are S3-OU6, S3-OU7A, S3-OU8C, S3-OU15, S3-OU18, S3-OU20, S3-OU27A and S3-OU28. Hence 34 proposed catchments are attenuated by attenuation ponds and are assessed in this section.

8.1.4 The groundwater levels, infiltration potential and contaminated land assessment findings in addition to initial impermeable liner recommendations for the proposed attenuation storage locations, based on the assessment of the aforementioned ground drainage condition variables, are presented in Annex E within Table E.1 to Table E.3 respectively. These three summary tables cover the ground drainage conditions assessment for the proposed attenuation storage locations associated with the Drainage Section 1, Drainage Section 2 and Drainage Section 3 proposed highway drainage for the proposed scheme (refer to Section 2.2 for the highway drainage sections description). Please note the following assessment determinations to interpret the assessment findings correctly:

- **Yes / No** – Proposed scheme preliminary GI and *in situ* test results are available at or in close proximity to the proposed attenuation pond locations.
- **Likely / Unlikely** – Proposed scheme preliminary GI and *in situ* test results are not available at the proposed attenuation pond location. However, adequate readily available GI information from various

sources is present at or in the vicinity of proposed attenuation ponds (e.g. British Geological Survey data, historic borehole logs, etc.).

- **N/A** – *in situ* preliminary GI information is not available presently.

8.1.5 The groundwater levels, infiltration potential and contaminated land assessment findings presented in Table F.1 to Table F.3 are based on the detailed geotechnical assessment results of the preliminary GI results. These detailed assessment results summary tables for the preliminary GI are presented in Annex D and include descriptions of the local geology models, exploratory hole details, infiltration rates (where available or practicable), groundwater recordings, etc.

8.1.6 Table 8.1 below presents an overarching summary (based on findings presented in Tables E.1 to E.3 in Annex E) of the number of proposed attenuation storage locations where an impermeable liner is not required and/or where infiltration is feasible. It is generally found across the proposed scheme that a number of proposed attenuation storage locations require no impermeable liner and a lesser number can rely on infiltration due to the generally poor to practically impervious ground drainage conditions identified by the preliminary GI assessment to date, as stated previously in Section 8.1.2. However, where no (or limited or inconclusive) preliminary GI data were available, or the location of drainage assets have been subject to change, then supplementary GI will be undertaken and assessed accordingly at the detailed design stage as part of the proposed attenuation storage design refinement. The recommendations for the use of an impermeable liner are provisional at present given the preliminary GI undertaken to date. The recommendations for the use of an impermeable liner will be reviewed at the detailed design stage when further GI data becomes available regarding soil infiltration rates, contaminated land issues and groundwater levels to ensure there are no adverse environmental impacts due to the proposed scheme.

Table 8.1 Attenuation storage locations (no impermeable liner requirement and infiltration potential summary)

Drainage section	Total number of attenuation ponds	Total number of attenuation swales	Number of attenuation storage locations (no liner)	Number of attenuation storage locations (infiltration feasible)	Comments
Section 1	14	0	10	1	Based on the preliminary GI, an impermeable liner is not required for ten of the 14 proposed attenuation ponds in Drainage Section 1, as high groundwater levels and contaminated land are not issues at these attenuation storage locations. However, infiltration is likely not feasible at the nine proposed attenuation ponds which require no impermeable liner. This is due to one or a combination of the following reasons: • The fact that the ground drainage conditions are generally poor to practically impervious • The presence of high groundwater • The presence of contaminated land • A sensitive Secondary A aquifer associated with River Terrace Deposits underlies a number of the proposed attenuation pond locations.
Section 2	15	0	10	2	Based on the preliminary GI, an impermeable liner is required for five proposed attenuation ponds in Drainage Section 2. Infiltration is likely not feasible at the four proposed attenuation ponds which require no impermeable liner. This is due to one or a combination of the following reasons: • The presence of high groundwater • The presence of contaminated land

Drainage section	Total number of attenuation ponds	Total number of attenuation swales	Number of attenuation storage locations (no liner)	Number of attenuation storage locations (infiltration feasible)	Comments
					• A sensitive Secondary A aquifer associated with River Terrace Deposits underlies a number of the proposed attenuation pond locations
Section 3	34	2	17	1	An impermeable liner is not required for 17 of the 34 attenuation ponds in Drainage Section 3, as high groundwater levels and contaminated land are not issues at these attenuation storage locations. Impermeable liners are required at the two proposed swales. However, infiltration is feasible at only one proposed attenuation pond location (i.e. S3-OU26) and none of the swales. Infiltration is unlikely to be feasible at the fourteen proposed attenuation ponds which require no impermeable liner. This is due to one or a combination of the following reasons: • The fact that the ground drainage conditions are generally poor to practically impervious • The presence of high groundwater • The presence of contaminated land • A sensitive Secondary A aquifer associated with River Terrace Deposits underlies a number of the proposed attenuation pond locations

9 Exceedance flow assessment

9.1 Assessment methodology

9.1.1 This section presents the exceedance flow assessment findings for all the proposed highway drainage systems that serve the highway development proposals that comprise the proposed scheme. In light of the level of service described in Section 4.5 and Section 4.9, the proposed highway drainage systems have been assessed for the following design events in regard to the exceedance flow assessment:

- The 1 in 100-year return period storm event (plus 20% climate change allowance) for storm durations ranging from 15 minutes to 24 hours to establish the critical storm duration.
- The 1 in 100-year return period storm event (plus 40% climate change allowance) for storm durations ranging from 15 minutes to 24 hours to establish the critical storm duration.

9.1.2 As stated in Section 4.4, the above 1 in 100-year return period storm events plus climate change allowances are assessed to ensure that there is no increased surface water drainage flood risk to road users and to the third-party land outside the proposed scheme permanent acquisition of land boundary as a result of the proposed scheme.

9.1.3 The FloodFlow module in MicroDrainage has been used to undertake the assessment of exceedance flows from the proposed highway drainage systems. The results of the exceedance flow assessment are presented in the form of Exceedance Flow Analysis Maps which are found in Annex A. The flood risk information presented on the Exceedance Flow Analysis Maps includes the following:

- **Flood extents** – The existing and proposed case flood extents
- **Flood depths** – The proposed case flood depths are presented. The existing case flood depths are not presented for information presentation clarity purposes
- **Critical storm duration flood extents** – The existing and proposed case flood extent critical storm durations
- **Potential mitigation measures** – Where the 1 in 100-year return period storm event plus 20% and 40% climate change allowance flood extents encroach outside the proposed scheme permanent acquisition of land boundary (including the proposed earthworks) and can reach a potential receptor (e.g. nearby watercourse or drainage ditch) via the topography, potential mitigation measures (e.g. exceedance flows collected and attenuated by earthworks drainage ditches) are documented on the Exceedance Flow Analysis Maps accordingly

9.1.4 It should be noted that no Exceedance Flow Analysis Maps are provided for the proposed Inworth Road drainage catchments (Catchments

S3-IWR-OU1 to S3-IWR-OU7) shown on the Drainage and Surface Water Plans HE551497-JAC-LDC-SCHW-DR-D-0814 and 0820). This is as a result of no hydraulic modelling being undertaken for these proposed catchments due to a lack of topographical and drainage survey information as stated in Section 6.4.126. Exceedance Flow Analysis Maps will be developed for the proposed Inworth Road drainage catchments at the detailed design stage once the additional topographic survey and drainage survey become available, enabling hydraulic models to be developed.

9.1.5 The summary tables presented in Table 9.1 and Table 9.2 below detail the Exceedance Flow Analysis Maps (in Annex A) within which the proposed catchments, their associated attenuation storage locations, the downstream outfalls and the associated surface water flood extents can be identified. This is to aid with finding the relevant proposed catchments and their associated flood extents with greater ease.

Table 9.1 Proposed catchment identification within Exceedance Flow Analysis Maps (100-year plus 20% climate change event)

Drawing number	Proposed catchments and flood extents
Drainage Section 1	
HE551497-JAC-LDC-S1-DR-D-0831	S1-OU1, S1-OU7 and S1-OU7A
HE551497-JAC-LDC-S1-DR-D-0832	S1-OU10, S1-OU10A, S1-OU11 and S1-OU12
HE551497-JAC-LDC-S1-DR-D-0833	S1-OU13, S1-OU13A, S1-OU14 and S1-OU15
HE551497-JAC-LDC-S1-DR-D-0834	S1-OU17, S1-OU18 and S1-OU19C1
HE551497-JAC-LDC-S1-DR-D-0835	S1-OU19, S1-OU19C and S1-OU23C
HE551497-JAC-LDC-S1-DR-D-0836	S1-OU23, S1-OU23D, S1-OU24A and S1-OU24B
Drainage Section 2	
HE551497-JAC-LDC-S2-DR-D-0837	S2-OU3, S2-OU4, S2-OU5, S2-OU8 and OU9A
HE551497-JAC-LDC-S2-DR-D-0838	S2-OU9, S2-OU10 and S2-OU11
HE551497-JAC-LDC-S2-DR-D-0839	S2-OU14 and S2-OU15A
HE551497-JAC-LDC-S2-DR-D-0840	S2-OU15C, S2-OU15D, S2-OU15D1 and S2-OU15E
HE551497-JAC-LDC-S2-DR-D-0841	S2-OU15C1, S2-OU15G, S2-OU15H, S2-OU24, S2-OU24A and S2-OU26
HE551497-JAC-LDC-S2-DR-D-0842	S2-OU17, S2-OU18, S2-OU19 and S2-OU27

Drawing number	Proposed catchments and flood extents
Drainage Section 3	
HE551497-JAC-LDC-S3-DR-D-0843	S3-OU1, S3-OU3, S3-OU4 and S3-OU5
HE551497-JAC-LDC-S3-DR-D-0844	S3-OU2, S3-OU6, S3-OU7A, S3-OU13 and S3-OU14
HE551497-JAC-LDC-S3-DR-D-0845	S3-OU7, S3-OU8, S3-OU8A, S3-OU8B, S3-OU8C, S3-OU8D and S3-OU8E
HE551497-JAC-LDC-S3-DR-D-0846	S3-OU9, S3-OU10, S3-OU19 and S3-OU20
HE551497-JAC-LDC-S3-DR-D-0847	S3-OU21, S3-OU22, S3-OU23 and S3-OU24
HE551497-JAC-LDC-S3-DR-D-0848	S3-OU26, S3-OU26A, S3-OU27, S3-OU27A, S3-OU28 and S3-OU29
HE551497-JAC-LDC-S3-DR-D-0849	S3-OU26B, S3-OU30, S3-OU30A, S3-OU31, S3-OU32 and S3-OU33
HE551497-JAC-LDC-S3-DR-D-0850	S3-OU15, S3-OU15A, S3-OU15B, S3-OU15C and S3-OU16
HE551497-JAC-LDC-S3-DR-D-0851	S3-OU17
HE551497-JAC-LDC-S3-DR-D-0852	S3-OU18

Table 9.2 Proposed catchment identification within Exceedance Flow Analysis Maps (100-year plus 40% climate change event)

Drawing number	Proposed catchments and flood extents
Drainage Section 1	
HE551497-JAC-LDC-S1-DR-D-0861	S1-OU1, S1-OU7 and S1-OU7A
HE551497-JAC-LDC-S1-DR-D-0862	S1-OU10, S1-OU10A, S1-OU11 and S1-OU12
HE551497-JAC-LDC-S1-DR-D-0863	S1-OU13, S1-OU13A, S1-OU14 and S1-OU15
HE551497-JAC-LDC-S1-DR-D-0864	S1-OU17, S1-OU18 and S1-OU19C1
HE551497-JAC-LDC-S1-DR-D-0865	S1-OU19, S1-OU19C and S1-OU23C
HE551497-JAC-LDC-S1-DR-D-0866	S1-OU23, S1-OU23D, S1-OU24A and S1-OU24B

Drawing number	Proposed catchments and flood extents
Drainage Section 2	
HE551497-JAC-LDC-S2-DR-D-0867	S2-OU3, S2-OU4, S2-OU5, S2-OU8 and S2-OU9A
HE551497-JAC-LDC-S2-DR-D-0868	S2-OU9, S2-OU10 and S2-OU11
HE551497-JAC-LDC-S2-DR-D-0869	S2-OU14 and S2-OU15A
HE551497-JAC-LDC-S2-DR-D-0870	S2-OU15C, S2-OU15D, S2-OU15D1 and S2-OU15E
HE551497-JAC-LDC-S2-DR-D-0871	S2-OU15C1, S2-OU15G, S2-OU15H, S2-OU24, S2-OU24A and S2-OU26
HE551497-JAC-LDC-S2-DR-D-0872	S2-OU17, S2-OU18, S2-OU19 and S2-OU27
Drainage Section 3	
HE551497-JAC-LDC-S3-DR-D-0873	S3-OU1, S3-OU3, S3-OU4 and S3-OU5
HE551497-JAC-LDC-S3-DR-D-0874	S3-OU2, S3-OU6, S3-OU7A, S3-OU13 and S3-OU14
HE551497-JAC-LDC-S3-DR-D-0875	S3-OU7, S3-OU8, S3-OU8A, S3-OU8B, S3-OU8C, S3-OU8D and S3-OU8E
HE551497-JAC-LDC-S3-DR-D-0876	S3-OU9, S3-OU10, S3-OU19 and S3-OU20
HE551497-JAC-LDC-S3-DR-D-0877	S3-OU21, S3-OU22, S3-OU23 and S3-OU24
HE551497-JAC-LDC-S3-DR-D-0878	S3-OU26, S3-OU26A, S3-OU27, S3-OU27A, S3-OU28 and S3-OU29
HE551497-JAC-LDC-S3-DR-D-0879	S3-OU26B, S3-OU30, S3-OU30A, S3-OU31, S3-OU32 and S3-OU33
HE551497-JAC-LDC-S3-DR-D-0880	S3-OU15, S3-OU15A, S3-OU15B, S3-OU15C and S3-OU16
HE551497-JAC-LDC-S3-DR-D-0881	S3-OU17
HE551497-JAC-LDC-S3-DR-D-0882	S3-OU18

9.2 Exceedance flow assessment summary (1 in 100-year plus 20% climate change allowance)

9.2.1 Following the exceedance flow assessment, Sections 9.2.3 to 9.2.11 of this report, summarise the Drainage Section 1, Drainage Section 2 and Drainage Section 3 proposed highway drainage catchments for which, in the 1 in 100-year return period storm event plus 20% climate change allowance:

- No surface water drainage flooding occurs
- Surface water drainage flooding does occur but is contained within the proposed scheme permanent acquisition of land boundary
- Surface water drainage flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary

9.2.2 The Exceedance Flow Analysis Maps in Annex A show the surface water flood extents spatially and the associated flood depths. Where the exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary, these have been assessed and discussed within the Flood Risk Assessment (ES Appendix 14.5 [TR010060/APP/6.3]). The assessment has been undertaken to identify any change in flows to receiving watercourses, land areas and/or any new receptors as a result of surface water drainage flooding. This assessment has identified that where exceedance flows leave the proposed scheme permanent acquisition of land boundary and flow into adjacent fields or roads, it is only in areas where there is already an existing risk of surface water drainage flooding. The flows and volumes of flood water are in all instances either maintained or reduced by the proposed scheme. In all instances where flood water would discharge directly into watercourses, the total volume of surface flood water predicted to flow off the proposed scheme into individual watercourses has been reduced (although it should be noted that these surface water flows are sometimes located a few metres away from the equivalent existing flow path that they are being compared against). As such, the Flood Risk Assessment (ES Appendix 14.5 [TR010060/APP/6.3]) has assessed that the surface water flows from the proposed scheme have negligible impact on flood risk and the proposed scheme would generally result in a small reduction in flood risk from this source.

Drainage Section 1 proposed highway drainage catchments

No surface water drainage flooding

9.2.3 The proposed drainage catchments for which the exceedance flow analysis shows no surface water drainage flooding for the 1 in 100-year return period storm event plus 20% climate change allowance, are S1-OU7A, S1-OU10,

S1-OU10A, S1-OU13A, S1-OU15, S1-OU19C, S1-OU19C1, S1-OU23C, S1-OU23D, S1-OU24A and S1-OU24B. The Flood Exceedance Analysis Maps in Annex A show the aforementioned proposed catchments spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (contained within the proposed scheme permanent acquisition of land boundary)

9.2.4 The proposed drainage catchments for which surface water drainage flooding occurs but is contained within the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 20% climate change allowance, are S1-OU11, S1-OU12, S1-OU13, S1-OU14, S1-OU17 and S1-OU19. The Flood Exceedance Analysis Maps in Annex A identify the surface water flood extents spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary)

9.2.5 The proposed drainage catchments for which surface water drainage flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 20% climate change allowance, are S1-OU1, S1-OU7, S1-OU18 and S1-OU23. The Flood Exceedance Analysis Maps in Annex A shows the surface water flood extents spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Drainage Section 2 proposed highway drainage catchments

No surface water drainage flooding

9.2.6 The proposed drainage catchments for which the exceedance flow analysis shows no surface water drainage flooding for the 1 in 100-year return period storm event plus 20% climate change allowance, are S2-OU3, S2-OU4, S2-OU9A, S2-OU9, S2-OU10, S2-OU11, S2-OU14, S2-OU15C, S2-OU15D, S2-OU15D1, S2-OU15E, S2-OU15C1, S2-OU24A, S2-OU26, S2-OU15H, S2-OU17, S2-OU18 and S2-OU27. The Flood Exceedance Analysis Maps in Annex A show the proposed catchments spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (contained within the proposed scheme permanent acquisition of land boundary)

9.2.7 The proposed drainage catchments for which surface water drainage flooding occurs but is contained within the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event

plus 20% climate change allowance, are S2-OU5, S2-OU15A, S2-OU15G, S2-OU19 and S2-OU24. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary)

9.2.8 The proposed drainage catchment for which surface water drainage flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 20% climate change allowance is the S2-OU8 catchment. The Flood Exceedance Analysis Maps in Annex A identify the surface water flood extents spatially. Refer to Table 9.1 to identify catchment S2-OU8 on the Exceedance Flow Analysis Map set.

Drainage Section 3 proposed highway drainage catchments

No surface water drainage flooding

9.2.9 The proposed drainage catchments for which the exceedance flow analysis shows no surface water drainage flooding for the 1 in 100-year return period storm event plus 20% climate change allowance, are S3-OU3, S3-OU4, S3-OU5, S3-OU6, S3-OU13, S3-OU14, S3-OU8B, S3-OU8C, S3-OU8D, S3-OU8E, S3-OU9, S3-OU19, S3-OU20, S3-OU22, S3-OU23, S3-OU24, S3-OU26A, S3-OU27, S3-OU27A, S3-OU28, S3-OU26B, S3-OU30A, S3-OU31, S3-OU32, S3-OU33, S3-OU15B and S3-OU16. The Flood Exceedance Analysis Maps in Annex A show the aforementioned proposed catchments spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (contained within the proposed scheme permanent acquisition of land boundary)

9.2.10 The proposed drainage catchments for which surface water drainage flooding occurs but is contained within the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 20% climate change allowance, are S3-OU1, S3-OU2, S3-OU7, S3-OU7A, S3-OU8, S3-OU8A, S3-OU10, S3-OU15, S3-OU15A, S3-OU21, S3-OU26 and S3-OU30. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.1 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary)

9.2.11 The proposed drainage catchments for which surface water drainage flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 20% climate change allowance, are S3-OU17 and S3-OU18. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.1 to identify the S3-OU17 and S3-OU18 catchments on the Exceedance Flow Analysis Map set.

9.3 Exceedance flow assessment summary (1 in 100 Year plus 40% climate change allowance)

9.3.1 Following the exceedance flow assessment, Sections 9.3.3 to 9.3.11 of this report summarise the Drainage Section 1, Drainage Section 2 and Drainage Section 3 proposed highway drainage catchments for which, in the 1 in 100-year return period storm event plus 40% climate change allowance:

- No surface water drainage flooding occurs
- Surface water drainage flooding does occur but is contained within the proposed scheme permanent acquisition of land boundary
- Surface water drainage flooding occurs with exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary

9.3.2 The Exceedance Flow Analysis Maps in Annex A show the surface water flood extents spatially and the associated flood depths. Where the exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary, these have been assessed and discussed within the Flood Risk Assessment (ES Appendix 14.5 [TR010060/APP/6.3]). The assessment has been undertaken to identify any change in flows to receiving watercourses, land areas and/or any new receptors as a result of surface water drainage flooding. This assessment has identified that where exceedance flows leave the proposed scheme permanent acquisition of land boundary and flow into adjacent fields or roads, it is only in areas where there is already an existing risk of surface water drainage flooding. The flows and volumes of flood water are in all instances either maintained or reduced by the proposed scheme. In all instances where flood water would discharge directly into watercourses, the total volume of surface flood water predicted to flow off the proposed scheme into individual watercourses has been reduced (although it should be noted that these surface water flows are sometimes located a few metres away from the equivalent existing flow path that they are being compared against). As such the FRA (ES Appendix 14.5 [TR010060/APP/6.3]) has assessed that the surface water flows off the proposed scheme have negligible impact on flood risk and the proposed

scheme would generally result in a small reduction in flood risk from this source of flooding.

Drainage Section 1 proposed highway drainage catchments

No surface water drainage flooding

9.3.3 The proposed drainage catchments for which the exceedance flow analysis shows no surface water drainage flooding for the 1 in 100-year return period storm event plus 40% climate change allowance, are S1-OU10A, S1-OU13A, S1-OU15, S1-OU19C1, S1-OU23C and S1-OU24A. The Flood Exceedance Analysis Maps in Annex A show these proposed catchments spatially. Refer to Table 9.2 to identify the catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (contained within the proposed scheme permanent acquisition of land boundary)

9.3.4 The proposed drainage catchments for which surface water drainage flooding occurs but is contained within the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 40% climate change allowance, are S1-OU7A, S1-OU10, S1-OU11, S1-OU13, S1-OU14, S1-OU17, S1-OU19, S1-OU19C, S1-OU23D and S1-OU24B. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.2 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary)

9.3.5 The proposed drainage catchments for which surface water flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 40% climate change allowance, are S1-OU1, S1-OU7, S1-OU12, S1-OU18 and S1-OU23. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.2 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Drainage Section 2 proposed highway drainage catchments

No surface water drainage flooding

9.3.6 The proposed drainage catchments for which the exceedance flow analysis for the 1 in 100-year return period storm event plus 40% climate change allowance shows no surface water drainage flooding are S2-OU9A, S2-OU11,S2-OU15C1, S2-OU15D, S2-OU15D1, S2-OU15E, S2-OU15C1, S2-OU24A, S2-OU26, S2-OU15H, S2-OU17, S2-OU18 and S2-OU27. The

Flood Exceedance Analysis Maps in Annex A show the aforementioned proposed catchments spatially. Refer to Table 9.2 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (contained within the proposed scheme permanent acquisition of land boundary)

9.3.7 The proposed drainage catchments for which surface water drainage flooding occurs but is contained within the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 40% climate change allowance, are S2-OU3, S2-OU4, S2-OU5, S2-OU9, S2-OU10, S2-OU14, S2-OU15A, S2-OU15C, S2-OU15G, S2-OU19 and S2-OU24. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.2 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary)

9.3.8 The proposed drainage catchments for which surface water drainage flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 40% climate change allowance, is S2-OU8. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.2 to identify the S2-OU8 catchment on the Exceedance Flow Analysis Map set.

Drainage Section 3 proposed highway drainage catchments

No surface water drainage flooding

9.3.9 The proposed drainage catchments for which the exceedance flow analysis shows no surface water drainage flooding for the 1 in 100-year return period storm event plus 40% climate change allowance are S3-OU3, S3-OU4, S3-OU5, S3-OU6, S3-OU13, S3-OU14, S3-OU8B, S3-OU8C, S3-OU8D, S3-OU8E, S3-OU9, S3-OU20, S3-OU22, S3-OU24, S3-OU27, S3-OU27A, S3-OU28, S3-OU26B, S3-OU32, S3-OU33 and S3-OU15B. The Flood Exceedance Analysis Maps in Annex A show the aforementioned proposed catchments spatially. Refer to Table 9.2 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (contained within the proposed scheme permanent acquisition of land boundary)

9.3.10 The proposed drainage catchments for which surface water drainage flooding occurs but is contained within the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 40% climate change allowance, are S3-OU1, S3-OU2, S3-OU7, S3-OU7A, S3-OU8, S3-OU8A, S3-OU10, S3-OU19, S3-OU23, S3-OU26,

S3-OU26A, S3-OU29, S3-OU30A, S3-OU31, S3-OU15, S3-OU15A, S3-OU15C and S3-OU16. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.2 to identify the aforementioned catchments on the Exceedance Flow Analysis Map set.

Surface water drainage flooding occurs (exceedance flood extents encroach outside the proposed scheme permanent acquisition of land boundary)

9.3.11 The proposed drainage catchments for which surface water drainage flooding occurs with the exceedance flood extents encroaching outside the proposed scheme permanent acquisition of land boundary for the 1 in 100-year return period storm event plus 40% climate change allowance, are S3-OU17 and S3-OU18. The Flood Exceedance Analysis Maps in Annex A show the surface water flood extents spatially. Refer to Table 9.2 to identify the S3-OU17 and S3-OU18 catchments on the Exceedance Flow Analysis Map set.

10 Proposed natural catchment drainage

10.1 Overview

10.1.1 This section describes the natural catchment drainage principles. The A12 crosses through natural terrain and therefore either obstructs or intercepts natural catchment flow paths. This requires natural catchment drainage measures in the form of proposed drainage ditches and/or filter drains to mitigate flood risk. The A12 also crosses a number of existing watercourses previously referenced in Section 2.4. These watercourses need to be conveyed under the A12. The natural catchment drainage ditch, filter drain and culvert design standards and level of service are described previously in Section 4.5.9 and Section 4.5.13. The external natural catchment drainage requirements are illustrated in the Drainage and Surface Water Plans [TR010060/APP/2.13] (i.e. natural catchment drainage ditches and filter drains that intercept natural catchments such as agricultural fields, scrubland, etc. located outside the proposed highway footprint but which drain towards it). Where natural catchment drainage is not illustrated adjacent to the proposed highway alignments located in cutting (i.e. at the top of cutting slopes) then this indicates that the adjacent external natural catchments drain away naturally from the proposed scheme to a nearby watercourse and/or land drainage system. As far as reasonably practicable, the proposed drainage ditches and filter drains will be designed to maintain the existing natural drainage catchment areas that drain to the natural watercourses.

10.2 Embankment toe and cutting slope drainage ditches and filter drains

10.2.1 The proposed scheme highway development proposals will cross natural terrain and therefore either obstruct or intercept natural catchment flow paths depending on whether the highway alignment is on embankment or in cutting. Therefore, surface water runoff from the natural catchments draining towards the proposed scheme will be intercepted by various types of natural catchment drainage measures including drainage ditches or filter drains at the toe of embankments and drainage ditches or filter drains at the top of cutting slopes. Intercepting the natural catchment surface water runoff will help to limit the size of the proposed highway drainage systems and avoid its unnecessary attenuation. The design constraints that determine whether drainage ditches or filter drains are used include the following:

- **Drainage ditches / filter drains at the toe of embankments** – Drainage ditches can be used at the toe of embankments where there are no spatial constraints and where the drainage ditch depth heading downstream does not exceed 1m. Otherwise, a filter drain system will be required in more spatially constrained locations or where design depths in excess of 1m are encountered.

- **Drainage ditches / filter drains at the top of cutting slopes** – Drainage ditches can be used at the top of cutting slopes where there are no spatial constraints and where the drainage ditch depth heading downstream does not exceed 1m. Otherwise, a filter drain system will be required in more spatially constrained locations or where design depths in excess of 1m are encountered.

10.2.2 The intercepted natural catchment surface water runoff will be conveyed to the nearest watercourse (e.g. Main River, Ordinary Watercourse, local land drainage, etc.) by the aforementioned natural catchment drainage measures with the intention of maintaining the existing natural drainage catchment distribution as far as reasonably practicable. The potential risk of earthworks failure associated with employing drainage ditches or filter drains near embankments and cutting slopes is to be assessed geotechnically at the subsequent detailed design stages.

10.2.3 The indicative drainage ditch and filter drain alignments at the toe of embankments and top of cutting slopes are illustrated on the Drainage and Surface Water Plans [TR010060/APP/2.13]. The natural catchment drainage ditch and filter drain design standards and level of service are described previously in Sections 4.5.10 to Section 4.5.12.

10.3 Culverts

10.3.1 There are a number of existing culverts located within the footprint of the A12 highway development proposals which will be impacted by the online widening works associated with the proposed scheme. These existing culverts convey flows for various watercourses under the A12 including Main Rivers, Ordinary Watercourses and local land drainage ditches. Where these existing culverts are retained, they will need to be extended to accommodate the online highway development proposals such that they continue to convey flow downstream.

10.3.2 The proposed scheme offline highway development proposals will cross natural terrain that includes a number of existing watercourses and existing local land drainage ditches in addition to crossing proposed drainage ditches and filter drains. Therefore, new culvert crossings will be required. These new culvert crossings are described as follows:

- **Existing watercourses and existing land drainage ditches** – New culvert crossings are required at existing watercourses and existing land drainage ditches to ensure that the offline highway development proposals do not block watercourse and natural catchment flow paths which convey flows downstream.
- **Proposed drainage ditches and filter drains** – New drainage culverts will also be required at various locations across the proposed scheme (particularly at proposed junctions and attenuation pond maintenance access tracks) to ensure that proposed embankment toe drainage ditches and filter drains, and top of cutting drainage ditches

and filter drains are conveyed under the various junction slip roads, side roads and maintenance access tracks.

10.3.3 The locations of the existing culverts to be retained and extended in addition to the location of new culverts throughout the proposed scheme are shown on the Drainage and Surface Water Plans [TR010060/APP/2.13]. The existing culverts to be retained and new culverts to be provided are summarised and described in tabular format within the Flood Risk Assessment for the proposed scheme found in ES Appendix 14.5 [TR10060/APP/6.3]. The culvert data presented in the Flood Risk Assessment include the culvert type, culvert diameters, culvert lengths, the watercourse affected, location coordinates, etc. The existing and proposed culvert design standards and level of service are described previously in Section 4.5.13 to Section 4.5.14.

11 Water quality

11.1 Surface water treatment measures

11.1.1 In order to protect the receiving waterbodies from a potential increased pollution risk as a result of the proposed scheme, water quality treatment measures are provided within the proposed highway drainage systems for some drainage catchments. The aim of this Surface Water Drainage Strategy is to provide treatment measures using SuDS principles where practicable.

11.1.2 Water quality assessments have been undertaken for the proposed scheme in accordance with the National Highways (previously Highways England) Water Risk Assessment Tool (HEWRAT) and the standards outlined in the DMRB, with specific reference to DMRB LA 113: Road Drainage and the Water Environment (RDWE) Revision 1 (Highways England, 2020b), to assess the potential risk to the water quality of receiving waterbodies and provide recommendations for mitigation measures as appropriate. A report with detailed findings of the HEWRAT water quality assessment is contained within the Water Quality Assessment Report (ES Appendix 14.1 [TR010060/APP/6.3]). The Water Quality Assessment Report concludes that between all single and cumulative HEWRAT routine surface water runoff assessments (simple and detailed) undertaken, the proposed highway drainage design and the mitigation measures (i.e. SuDS features) that are incorporated within it, the overall impact to receiving surface waters during operation of proposed scheme is anticipated to be 'Not Significant'. In light of this water quality assessment conclusion, Tables 11.1 to 11.3 below provide a high-level summary of the surface water runoff treatment measures used for each of the proposed highway drainage systems contained within the Drainage Section 1, Drainage Section 2 and Drainage Section 3 highway drainage sub-sections that comprise the proposed scheme.

11.1.3 In addition to the water quantity and biodiversity benefits, the inherent nature of the proposed SuDS features used on the proposed scheme, namely attenuation ponds, swales or vegetated drainage ditches and filter drains will provide treatment of surface water runoff prior to discharge to the receiving watercourse. The SuDS features incorporated within the proposed scheme highway drainage systems can provide the following surface water treatment benefits:

- **Attenuation ponds** – Sediment forebays are to be provided at the inlet of all proposed attenuation ponds which will provide effective pre-treatment (i.e. removal of coarse sediments) and ensure ease of maintenance during the removal of any such collected coarse sediments. The main storage compartment, after the sediment forebay, for all of the proposed attenuation ponds is to have a 300mm depth permanent water pool which will act as the main surface water treatment zone. Where required, the proposed attenuation ponds can also be cascaded (i.e. contain multiple storage compartments) to

increase the residence time and enable the additional sedimentation of particulate matter to occur. In addition, the proposed attenuation ponds will be planted with vegetation which would provide additional water quality treatment benefits.

- **Swales and vegetated ditches** – The vegetation in swales and vegetated ditches, provided the flow is at or below the level of the vegetation, can slow the surface water flow rate thereby increasing water residence time in the swale and forcing sediments and other potential pollutants to settle out. Check dams can also be provided to maximise the level of treatment. Check dam provision would be assessed at the detailed design stage. Where practicable, swales and vegetated ditches are provided from the outlet of some proposed attenuation ponds as an added level of treatment prior to the surface water discharging to the receiving watercourse. However, the provision of swales and vegetated ditches is dictated by the local topography, attenuation pond depth and depth safety constraints as excessively deep swales and vegetated ditches are a safety risk to the public and maintenance staff.
- **Filter drains** – Where used, filter drains should provide some treatment by filtering out fine sediments as the surface water runoff percolates down through the trench fill material overlying the perforated filter drain.

11.1.4 It should be noted that for all the highway drainage catchments across the proposed scheme, silt traps in chambers and gullies should provide a degree of pollution control (i.e. suspended particulate matter retention), assuming they are sufficiently maintained.

11.1.5 The water quality assessment referenced above has determined that the surface water treatment measures described in general above and summarised for each proposed drainage catchment in Table 11.1 to Table 11.3 below, provide an acceptable level of surface water treatment for diffuse pollution.

11.2 Accidental spillage risk

11.2.1 In the event of a rare major pollution incident such as a hydrocarbon spillage there is a risk that the pollutants could discharge to a nearby watercourse via the highway drainage system. A water quality spillage risk assessment has been undertaken and shows in summary that for all outfalls throughout the proposed scheme, results are deemed to be within acceptable limits in accordance with DMRB LA 113 Road Drainage and the Water Environment (RDWE) Revision 1 (Highways England, 2020b) when compared to the most sensitive threshold (0.5% AEP or a return period of over 200 years). The overall environmental significance is classified as ‘Not Significant’ for all outfalls throughout the proposed scheme. The Water Quality Assessment Report (ES Appendix 14.1 [TR010060/APP/6.3]) provides a detailed description of the spillage risk assessment methodology and the associated assessment results.

11.2.2 Nonetheless, where necessary, isolation chambers fitted with penstock valves will be provided immediately downstream of proposed attenuation storage locations at the downstream end of the proposed highway drainage systems to have a means of isolating any potential accidental spillage of pollutants within the highway drainage system, thereby avoiding the pollution of receiving watercourses. Isolation chambers will also be provided immediately upstream of proposed attenuation storage inlets to provide a means of preventing the inflow of surface water runoff into the attenuation storage during maintenance operations. This is to prevent inundation whilst maintenance operatives are working within the attenuation ponds and mitigate drowning risk. Where an attenuation storage facility is not required at the downstream end of a proposed highway drainage system, an isolation chamber will be provided immediately upstream of the outfall location.

Table 11.1 Drainage Section 1 surface water treatment measures within proposed highway drainage systems

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S1-OU1	✓	-	✓	✓	Attenuation pond (single compartment) in conjunction with four upstream underground geocellular attenuation storage systems and filter drains (where required in cutting)
S1-OU7	N/A	N/A	N/A	N/A	Proposed highway works are minimal. Existing traditional piped highway drainage system to be retained
S1-OU7A	✓	-	✓	✓	Attenuation pond (single compartment) in conjunction with a single upstream underground geocellular attenuation storage system and filter drains (where required in cutting)
S1-OU10	-	-	-	✓	Underground geocellular attenuation storage system (Single)

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S1-OU10A	-	-	-	✓	Underground geocellular attenuation storage system (Single)
S1-OU11	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S1-OU12	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S1-OU13	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S1-OU13A	-	✓	-	-	Online attenuation storage. A portion of the proposed catchment drains to a vegetated ditch. The majority is attenuated within the piped drainage system
S1-OU14	-	-	-	-	Unattenuated proposed catchment as the catchment area has reduced sizably from the existing case. The piped highway drainage includes gully pots and catchpits
S1-OU15	-	-	-	-	Unattenuated proposed catchment as the catchment area has reduced sizably from the existing case. The piped highway drainage includes gully pots and catchpits
S1-OU17	-	-	✓	-	Unattenuated proposed catchment as the catchment area has reduced from the existing case. The piped highway drainage includes gully pots and

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
					catchpits in conjunction with filter drains (where required in cutting)
S1-OU18	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S1-OU19	✓	-	-	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment
S1-OU19C	✓	-	-	-	Attenuation pond (single compartment)
S1-OU19C1	✓	-	-	-	Attenuation pond (single compartment)
S1-OU20	-	-	-	-	Unattenuated proposed catchment as the proposed works involve refurbishment of the existing Station Road overbridge. The piped highway drainage includes gully pots and catchpits
S1-OU21	-	-	-	-	Unattenuated proposed catchment as the proposed works involve refurbishment of the existing Station Road overbridge. The piped highway drainage includes gully pots and catchpits
S1-OU23	✓	-	✓	-	Cascaded attenuation pond (triple compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
					upstream filter drains (where required in cutting)
S1-OU23C	✓	-	-	-	Attenuation pond (single compartment)
S1-OU23D	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S1-OU24A	✓	✓	-	-	Attenuation pond (single compartment) in conjunction with upstream vegetated ditch
S1-OU24B	✓	✓	✓	-	Attenuation pond (single compartment) in conjunction with an upstream vegetated ditch and filter drains (where required in cutting)

Notes:

1. The HEWRAT assessment has informed whether or not the treatment measures employed in the listed proposed catchments provide an acceptable level of surface water runoff treatment.
2. The proposed discharge rate and attenuation storage volume summary tables in Annex C state the watercourses that the listed proposed catchments discharge to. The watercourses are also labelled on the Drainage and Surface Water Plans [TR010060/APP/2.13].

Table 11.2 Drainage Section 2 surface water treatment measures within proposed highway drainage systems

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S2-OU3	-	-	-	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits
S2-OU4	✓	-	-	-	Attenuation pond (single compartment)
S2-OU5	-	-	-	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits
S2-OU8	-	-	✓	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits in conjunction with filter drains (where required in cutting)
S2-OU9	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S2-OU9A	-	-	✓	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits in conjunction with filter drains (where required in cutting)
S2-OU10	✓	✓	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting) and vegetated drainage ditch
S2-OU11	✓	-	-	-	Attenuation pond (single compartment)
S2-OU14	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S2-OU15A	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)
S2-OU15C	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S2-OU15C1	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S2-OU15D	✓	-	-	-	Attenuation pond (single compartment)
S2-OU15D1	-	-	-	-	Unattenuated proposed catchment as the proposed discharge rates are less than the existing case discharge rates. The piped highway drainage includes gully pots and catchpits
S2-OU15E	✓	-	-	-	Attenuation pond (single compartment) provides an acceptable level of surface water treatment
S2-OU15G	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S2-OU15H	✓	-	-	-	Attenuation pond (single compartment) provides an acceptable level of surface water treatment
S2-OU17	-	-	-	-	Unattenuated proposed catchment as the proposed discharge rates are less than the existing case discharge rates. The piped highway drainage includes gully pots and catchpits

Proposed catchment	Proposed treatment measures				Comments[1, 2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S2-OU18	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S2-OU19	✓	-	-	-	Attenuation pond (single compartment)
S2-OU24	-	-	✓	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits in conjunction with filter drains (where required in cutting)
S2-OU24A	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S2-OU26	-	-	-	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits
S2-OU27	-	-	-	-	Unattenuated proposed catchment as the proposed discharge rates are less than the existing case discharge rates. The piped highway drainage includes gully pots and catchpits

Notes:

1. The HEWRAT assessment has informed whether or not the treatment measures employed in the listed proposed catchments provide an acceptable level of surface water runoff treatment.
2. The proposed discharge rate and attenuation storage volume summary tables in Annex C state the watercourses that the listed proposed catchments discharge to. The watercourses are also labelled on the Drainage and Surface Water Plans [TR010060/APP/2.13].

Table 11.3 Drainage Section 3 surface water treatment measures within proposed highway drainage systems

Proposed catchment	Proposed treatment measures				Comments[1,2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S3-OU1	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S3-OU2	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)
S3-OU3	✓	-	-	-	Attenuation pond (single compartment)
S3-OU4	✓	-	-	-	Attenuation pond (single compartment)
S3-OU5	✓	-	-	-	Attenuation pond (single compartment)
S3-OU6	-	-	✓	-	Unattenuated proposed catchment as the proposed discharge rates are less than the existing case discharge rates. The piped highway drainage includes catchpits in conjunction with filter drains (where required in cutting)
S3-OU7	✓	-	-	-	The S3-OU7 catchment discharges into the proposed S3-OU8A attenuation pond Attenuation pond (single compartment)
S3-OU7A	-	-	✓	-	Unattenuated proposed catchment as the proposed discharge rates are less than the existing case discharge rates. The piped highway drainage includes catchpits in conjunction with filter drains (where required in cutting)

Proposed catchment	Proposed treatment measures				Comments[1,2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S3-OU8	✓	-	-	-	Attenuation pond (single compartment)
S3-OU8A	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S3-OU8B	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S3-OU8C	-	✓	-	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits and discharges to a downstream vegetated ditch
S3-OU8D	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S3-OU8E	✓	-	-	-	Attenuation pond (single compartment)
S3-OU9	✓	-	-	-	Attenuation pond (single compartment)
S3-OU10	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S3-OU13	✓	-	-	-	Attenuation pond (single compartment)
S3-OU14	✓	-	-	-	Attenuation pond (single compartment)

Proposed catchment	Proposed treatment measures				Comments[1,2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S3-OU15	-	-	-	-	Unattenuated proposed catchment as the proposed discharge rates are less than the existing case discharge rates. The piped highway drainage includes gully pots and catchpits
S3-OU15A	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S3-OU15B	✓	-	-	-	Attenuation pond (single compartment)
S3-OU15C	✓	-	-	-	Attenuation pond (single compartment)
S3-OU16	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S3-OU17	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S3-OU18	-	-	-	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits
S3-OU19	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S3-OU20	-	✓	-	-	Swale flow conveyance system

Proposed catchment	Proposed treatment measures				Comments[1,2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S3-OU21	✓	-	-	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment
S3-OU22	✓	-	-	-	Attenuation pond (single compartment)
S3-OU23	✓	-	-	-	Attenuation pond (single compartment)
S3-OU24	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with filter drains (where required in cutting)
S3-OU26	✓	-	✓	-	Attenuation pond (single compartment) in conjunction with upstream filter drains (where required in cutting)
S3-OU26A	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)
S3-OU26B	✓	-	-	-	Attenuation pond (single compartment)
S3-OU27	✓	-	-	-	Attenuation pond (single compartment)
S3-OU27A	-	✓	-	-	Swale flow conveyance system
S3-OU28	-	✓	-	-	Swale flow conveyance system

Proposed catchment	Proposed treatment measures				Comments[1,2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
S3-OU29	✓	-	-	-	Attenuation pond (single compartment)
S3-OU30	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)
S3-OU30A	✓	-	✓	-	Cascaded attenuation pond (double compartment) provided to increase the residence time and enhance the surface water treatment. This is provided in conjunction with upstream filter drains (where required in cutting)
S3-OU31	✓	-	-	-	Attenuation pond (single compartment)
S3-OU32	✓	-	-	-	Attenuation pond (single compartment)
S3-OU33	✓	-	-	-	Attenuation pond (single compartment)
S3-IWR-OU1	-	✓	-	-	Vegetated ditch flow conveyance system
S3-IWR-OU2	✓	✓	-	-	Attenuation pond (single compartment) in conjunction with upstream vegetated ditch
S3-IWR-OU3	✓	✓	-	-	Attenuation pond (single compartment) in conjunction with upstream vegetated ditch
S3-IWR-OU4	-	-	-	-	Online attenuation storage (oversized pipes). Surface water runoff is

Proposed catchment	Proposed treatment measures				Comments[1,2]
	Attenuation pond (with sediment forebay)	Swale / vegetated ditch	Filter drains	Underground geocellular attenuation storage system	
					attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits
S3-IWR-OU5	✓	-	-	-	Attenuation pond (single compartment)
S3-IWR-OU6	-	✓	-	-	Online attenuation storage (oversized pipes). Surface water runoff is attenuated within the piped drainage system. The piped highway drainage includes gully pots and catchpits and discharges to a downstream vegetated ditch
S3-IWR-OU7	✓	✓	-	-	Attenuation pond (single compartment) in conjunction with upstream vegetated ditch

Notes:

1. The HEWRAT assessment has informed whether or not the treatment measures employed in the listed proposed catchments provide an acceptable level of surface water runoff treatment.
2. The proposed discharge rate and attenuation storage volume summary tables in Annex C state the watercourses that the listed proposed catchments discharge to. The watercourses are also labelled on the Drainage and Surface Water Plans [TR010060/APP/2.13].

12 Landscape and ecology

12.1.1 In addition to minimising the impacts from a proposed scheme on the quantity and quality of the surface water runoff, another objective of SuDS features is to maximise the landscape and biodiversity opportunities. The potential landscape and biodiversity opportunities associated with the SuDS features used on the proposed scheme highway drainage are as follows:

- **Attenuation ponds** – The attenuation ponds can be designed to maximise their biodiversity value. For example, providing suitable planting and retaining a shallow pool of water in the attenuation pond below the outlet pipe invert level can encourage the growth of localised wildlife habitats. The SuDS Manual C753 (CIRIA, 2015) states that a range of vegetation types (such as wildflowers and other nectar-rich plants, grasses, drought-tolerant species, marginal-aquatics and wet grasslands) are suitable for use in swales and attenuation ponds in the UK. It is currently proposed to provide a 300mm depth shallow surface water pool below the outlet pipe invert level of all proposed attenuation ponds across the proposed scheme. The vegetation and the presence of a shallow surface water pool in the attenuation ponds should encourage the growth of localised wildlife habitats within the vegetated highway drainage infrastructure. It should be noted that during dry weather periods before heavy rainfall events the aforementioned shallow pool of water will likely partially evaporate. As the designs of the attenuation ponds are developed, consideration will be given to the planting arrangements, with inputs from a landscape team, to maximise the benefits in terms of biodiversity that can be provided by the attenuation ponds SuDS features.

  Given that the proposed scheme is a major highway development with live road traffic, the proposed attenuation ponds will have limited amenity value. However, the planting of vegetation as described in Section 11 and the retention of a shallow surface water pool should contribute to the aesthetic value of the proposed scheme. The potential to use ‘soft’ geometries with curved boundaries and undulating margins local to the proposed attenuation ponds can also enhance the environmental aesthetics along the proposed scheme.

- **Swales and vegetated drainage ditches** – The proposed swales and vegetated drainage ditches could also be designed to maximise their aesthetic and biodiversity benefits. As described above, a range of vegetation types are suitable for use in swales and attenuation ponds in the UK. The potential to use ‘soft’ geometries with curved boundaries and undulating margins local to the proposed swales and vegetated drainage ditches can further enhance the environmental aesthetics along the proposed scheme in conjunction with the attenuation ponds.

- **Underground highway drainage** – The proposed underground highway drainage systems including oversized pipes (i.e. attenuation storage), filter drains and geocellular attenuation storage systems will not provide any biodiversity, landscape or amenity benefits locally given that they are buried drainage elements.

12.1.2 The highway drainage design for the proposed scheme will be developed through the various design stages to integrate them into the landscape and reduce visual intrusion from the proposed highway drainage systems and their associated SuDS features.

13 Operation and maintenance

13.1 Overview

13.1.1 This section discusses the proposed highway drainage maintenance authority ownership allocation, the maintenance access requirements and the maintenance requirements associated with the various highway drainage elements contained within the proposed scheme.

13.2 Maintenance authority ownership allocation

13.2.1 The various drainage elements that comprise the highway drainage systems for the proposed scheme will require periodic maintenance. The responsibility for the maintenance of the highway drainage and the SuDS features such as the attenuation ponds, swales, vegetated drainage ditches, filter drains and underground geocellular attenuation storage systems will be undertaken by National Highways and Essex Highways. National Highways will likely take responsibility for the proposed highway drainage including SuDS features located along and within the proposed A12 mainline permanent acquisition of land boundary (including the proposed junction slip roads). Essex Highways will take responsibility for the proposed highway drainage including SuDS features related to any proposed local side roads (i.e. primarily related to new side road additions adjoining the proposed junctions) and any retained de-trunked sections of the A12. The Drainage and Surface Water Plans [TR010060/APP/2.13] illustrate the proposed highway drainage including the proposed SuDS features and outfalls. Consultation is ongoing with National Highways and Essex Highways to discuss and agree the ownership allocation between both parties for the proposed highway drainage including SuDS attenuation features and the associated downstream outfalls within the Order Limits of the proposed scheme.

13.3 Maintenance access provision

13.3.1 In order to provide a safe means of access and egress to the proposed attenuation storage locations for general maintenance, in particular attenuation ponds and underground geocellular attenuation storage systems located off the proposed highway alignment, access tracks have been provided at these attenuation storage locations. This vehicular access to the proposed attenuation storage locations and nearby outfall structures will be provided primarily off local side roads. This is to avoid interaction between the maintenance vehicles and the high-speed traffic likely to be on the A12 mainline.

13.4 Maintenance requirements

13.4.1 The typical maintenance requirements for each drainage element on the proposed scheme in accordance with the SuDS Manual C753 (CIRIA, 2015) are presented in Table 13.1 below. Prior to the construction stage a detailed Operation and Maintenance Plan must be produced in

consultation with National Highways and Essex Highways for the proposed highway drainage. This consultation is required to discuss the long-term maintenance arrangements and requirements for the surface water drainage elements included within the proposed scheme, to inform the production of the Operation and Maintenance Plan.

13.4.2 The Operation and Maintenance Plan must detail the operation and maintenance requirements for each surface water drainage element included within the proposed scheme, including (but not limited to):

- Edge collection systems (i.e. gullies, filter drains, concrete surface water channels, combined kerb drainage, linear slot drainage)
- Piped conveyance systems (i.e. carrier drains, combined filter drains, filter drains, chambers and headwalls / outfall structures)
- Attenuation ponds (including sediment forebays)
- Oversized pipes (i.e. online attenuation)
- Underground geocellular attenuation storage systems
- Flow control devices
- Swales / vegetated drainage ditches
- Embankment toe drainage and cut-off drains (i.e. drainage ditches and filter drains)
- Culverts

Table 13.1 Maintenance requirements for the proposed highway drainage and associated SuDS features

Required maintenance	Typical maintenance frequency
Attenuation ponds (location: scheme-wide)	
Remove accumulated litter and debris.	Monthly (or as required)
Inspect inlets, outlets, side slopes, pipework, structures, etc. for any evidence of blockage or physical damage.	Monthly
Inspect sediment accumulation rates in the sediment forebays and in the main compartments of the attenuation pond. Undertake contaminants testing of the sediment to inform management and disposal options.	Half-yearly
Remove accumulated sediment from sediment forebays.	Every one to five years or as required

Required maintenance	Typical maintenance frequency
Remove accumulated sediment from the main compartments within attenuation ponds when the permanent water pool volume is sufficiently low.	With effective pre-treatment this should only rarely be required (i.e. every 25 to 50 years)
Inspect the permanent water pool for signs of poor water quality.	Monthly
Inspect marginal and side slope vegetation. Remove any nuisance vegetation or weeds (for the first three years).	Monthly (at the start and then as required)
Hand-cut submerged and emergent aquatic plants at a minimum of 0.10m above pond base.	Annually
Remove 25% of side slope vegetation from the water's edge to a minimum of 1m above water level.	Annually
Tidy all dead vegetation growth (scrub clearance) before the start of growing season.	Annually
Check any mechanical devices such as penstock and flow controls that are built into attenuation ponds.	Half-yearly (or as required)
Inspect the attenuation pond safety fencing for any breaches or damage. If the aforementioned issues are identified, then the fencing should be repaired accordingly.	Monthly (or as required)
Swales and vegetated ditches (location: scheme-wide)	
Remove accumulated litter and debris.	Monthly (or as required)
Grass cutting to retain grass height within the specified design range.	Monthly (during growing season) or as required
Inspect marginal and side slope vegetation. Remove any nuisance vegetation or weeds.	Monthly (at the start and then as required)
Inspect vegetation coverage.	Monthly for six months, quarterly for two years, half-yearly thereafter
Inspect inlet, outlets and any overflows for blockages and clear if required.	Monthly
Inspect inlets, outlets and channel section for any accumulated sediment and remove as required.	Half-yearly

Required maintenance	Typical maintenance frequency
Where control structures (e.g. check dams) are installed within swales and vegetated ditches inspection of the inlet / outlet pipework and any associated control systems should be undertaken for blockages, clogging, standing water and structural damage.	Monthly
Repair erosion or any other damage by re-turfing or re-seeding.	As required
Re-level any uneven surfaces and reinstate to design levels.	As required
Filter drains and combined filter drains (location: scheme-wide)	
Remove accumulated litter (including leaf litter) and debris from the filter drain and combined filter drain surface material and access chambers.	Monthly (or as required)
Inspect the filter drain and combined filter drain surface material, inlet/outlet pipework and any associated control systems for blockages, clogging, standing water and structural damage.	Monthly
Inspect the perforated pipework and inlets for sediment accumulation and remove if required.	Half-yearly
Clear the perforated pipework of any blockages.	As required
Remove tree roots where they are encroaching into the sides of the filter drains and combined filter drains using suitable methods.	As required
At locations with high pollution loads, remove the surface geotextile material and replace in addition to washing or replacing the overlying filter media.	Five-yearly (or as required)
Underground geocellular attenuation storage systems (location: junction 19)	
Remove debris from the contributing catchment surface where it may cause a risk to the operation and performance of the underground geocellular attenuation storage system.	Monthly
Remove accumulated sediment from any pre-treatment structures.	Annually (or as required)
Repair / rehabilitate inlets, outlets, overflows and vent pipes.	As required
Inspect / check all inlets, outlets, overflows and vent pipes to ensure they are in good condition and operating as designed.	Annually

Required maintenance	Typical maintenance frequency
Survey the inside of the underground geocellular attenuation storage system for any sediment build-up and remove if necessary.	Every five years (or as required)
Remove tree roots where they are encroaching into the sides of the underground geocellular attenuation storage system using suitable methods.	As required
Clear the inlets, outlets and vent pipes of any blockages.	As required
Concrete surface water channels (location: scheme-wide)	
Remove accumulated litter (including leaf litter) and debris from the concrete channel section and access chambers.	Monthly (or as required)
Inspect the surface water channel concrete surface and inlet / outlet pipework for standing water, structural damage, blockages and clogging.	Monthly
Inspect the concrete surface water channel for sediment accumulation and remove sediment if required.	Half-yearly
Inspect the concrete surface water channel internal gully and / or chamber gratings for damage or signs of lifting out of place, and secure if necessary.	Monthly (or as required)
Combined kerb drainage / linear slot drainage / carrier drains (scheme-wide)	
Inspect the combined kerb drainage and linear slot drainage inlet / outlet pipework and any associated control systems for blockages, clogging, standing water and structural damage.	Monthly
Inspect the carrier drains, combined kerb drainage and linear slot drainage for sediment accumulation and remove if required.	Half-yearly
Clear the carrier drains, combined kerb drainage and linear slot drainage of any blockages.	As required
Remove accumulated litter (including leaf litter) and debris from the combined kerb drainage inlet nodes and the linear slot drainage inlet located at the ground surface.	Monthly (or as required)

Required maintenance	Typical maintenance frequency
Inspect the combined kerb drainage and linear slot drainage internal chamber gratings for damage or signs of lifting out of place and secure if necessary.	Monthly (or as required)
Manhole chambers / flow control chambers / isolation chambers (location: scheme-wide)	
Inspect the chambers, inlet / outlet pipework and any associated control systems for blockages, clogging, standing water and structural damage.	Half-yearly
Inspect the chambers for sediment accumulation and remove if required.	Half-yearly
Clear the chambers of any blockages.	As required
Inspect chamber gratings / covers for damage or signs of lifting out of place and secure if necessary.	Monthly (or as required)
Outfall structures / headwalls (location: scheme-wide)	
Inspect the incoming pipework and any associated control systems (e.g. flap valves, trash screens, etc.) to outfall structures / headwall units for blockages, clogging and structural damage.	Half-yearly
Inspect the outfall structures / headwall units for signs of erosion or scouring in the vicinity of the watercourse bank they are installed in.	Annually
Clear the outfall structure / headwall unit incoming pipework of any blockages.	As required
If any erosion or scouring has occurred in the vicinity of the outfall structures or headwall units, suitable remediation must be undertaken to avoid failure (i.e. reinstatement of eroded bank slopes with suitable erosion protection installed, etc.).	As required
For any outfall structures or headwalls that have erosion protection measures, these should be inspected for any potential structural damage. If structural damage is identified, then this should be repaired accordingly.	As required
Drainage culverts (location: junction slip roads, side roads, maintenance access track crossings, etc.)	

Required maintenance	Typical maintenance frequency
Inspect the drainage culverts for sediment accumulation and remove if required.	Half-yearly
Clear the drainage culverts of any blockages.	As required
Where trash screens are used on drainage culvert inlets these will need to be cleared of any debris build-up	As required

14 Safety and risk assessment

14.1 Overview

14.1.1 The purpose of this section is to detail the primary safety hazards associated with the proposed highway drainage systems for the proposed scheme. These are covered below together with potential mitigation measures. Consideration has been given to the design phase, the construction phase, the operational and maintenance phase and the demolition phase. Safe arrangements for mitigating the primary safety hazards associated with the proposed highway drainage systems must be considered and presented in the Operation and Maintenance Plan to be produced in consultation with National Highways and Essex Highways prior to the handover to operations stage.

14.1.2 With regard to the health and safety hazards during the construction stage identified below in Section 14.2, the Contractors will be made aware of these construction risks on the appropriate Health and Safety Files and in the safety, health and environmental information that would be provided on the construction drawings. It will be the responsibility of the Contractor(s) to employ appropriate construction methods / practices on site to mitigate the identified health and safety risks during the construction stage. The identified risks are not exhaustive and represent those hazards and work areas that are considered non-routine, significant and/or difficult to manage.

14.2 Safety and risks during construction

14.2.1 **Contaminated groundwater and contaminated land** – Examination of existing constraints shows areas of localised contamination. There may be a risk of contact with potentially contaminated land and groundwater through the methods used in the construction of the proposed highway drainage. To mitigate this risk, the proposed highway drainage is designed to be as shallow as reasonably practicable to minimise the chance of intersecting with potentially contaminated land and groundwater. The proposed highway drainage will also be lined with an impermeable liner where required to prevent the mobilisation and / or the ingress of potential contaminants.

14.2.2 **Shallow groundwater –** Early borehole tests have indicated that there is the potential for shallow groundwater at certain locations along the proposed scheme, therefore there is a potential for groundwater inundation and flood risk within excavations. This risk cannot be completely eliminated.

14.2.3 **Flood risk from nearby watercourses –** In a number of cases the proposed attenuation storage ponds and their associated access tracks are located near watercourses and existing land drains. This cannot be completely avoided as the proposed scheme needs to discharge collected surface water runoff to such waterbodies.

14.2.4 **Cutting slope stability at the highway drainage interface –** For sections of the proposed scheme located in cutting, the installation of the proposed piped drainage alignments at the bottom of the cutting slope and the natural catchment drainage ditches / filter drains at the top of the cutting slope could result in cutting slope instability. This risk of cutting slope instability cannot be completely eliminated in the design and the proposed scheme constraints demand the co-location of these elements.

14.2.5 **Existing surface water drainage residual pollutants –** At some locations across the proposed scheme the proposed highway drainage is to discharge to existing surface water drainage infrastructure. There is the potential for residual pollutants to be present within existing surface water drainage infrastructure. This cannot be avoided in certain situations where a watercourse is not nearby or where infiltration methods are an inappropriate means of discharging collected surface water runoff.

14.2.6 **Existing drainage ditch regrading works –** In some locations across the proposed scheme, existing land drainage ditches may require depth increases to facilitate the outfalls from the proposed highway drainage systems. Therefore, there is the potential for collapse of the drainage ditch side slopes to occur if they are not battered back to an appropriate angle and create a work-at-height environment for the workforce close to the land drainage ditches. The risk of drainage ditch side slope collapse cannot be completely eliminated.

14.2.7 **Existing statutory undertakers' plant and equipment –** Depending on the work type, the presence of statutory undertakers' (SU) plant and equipment should be examined and assessed before any work commences. It has been established that the proposed highway drainage crosses the alignment of various existing SU plant and equipment (e.g. gas mains, underground electricity cables, telecommunications cables, foul drainage pipework, other overhead services, etc.). During the design stage the proposed highway drainage infrastructure has been coordinated with existing underground utilities to minimise the number of crossing conflicts as far as reasonably practicable. In each case of an identified conflict, the existing service is expected to be diverted or to have suitable protection measures provided to avoid harm and to mitigate potential damage. This information is based on the plans provide by the SUs and the locations of services are therefore subject to confirmation prior to the commencement of the works.

14.2.8 **Confined space working conditions** – Excavations and chambers should be treated as confined spaces. This approach to accessing/working in confined spaces should follow the requirements and guidance of the Construction (Design and Management) Regulations 2015. Suitable assessments and the development of safe systems of work should be undertaken by trained and supervised personnel to mitigate the hazards associated with working in confined spaces such as access, potential lack of oxygen, noxious gas accumulation and contaminated water ingress in confined spaces.

14.3 Safety and risks during operation and maintenance

14.3.1 **Record of as-built information** – The review of the as-built information produced for the constructed scheme should be an essential part of preparing safe systems of work for any maintenance activity.

14.3.2 **Access –** Access to assets will generally require some form of segregation at the location of interest. This may vary from simple temporary barriers for the immediate work zone, to extensive traffic management arrangements for access to assets in the carriageway or verge next to live traffic. An appropriate assessment must be undertaken.

14.3.3 **Contaminated groundwater and contaminated land** – There may be a risk of coming into contact with potentially contaminated land and groundwater. To mitigate this risk, the proposed highway drainage is designed to be as shallow as reasonably practicable to minimise the chance of intersecting potentially contaminated land, thereby preventing contaminated groundwater ingress into the proposed highway drainage infrastructure. Where required, the proposed highway drainage will also include the provision of an impermeable liner to prevent the mobilisation of potential contaminants and/or the ingress of potential contaminants.

14.3.4 **Highway drainage residual pollutants accumulation –** Over the design life of the proposed scheme, there is the potential for residual pollutants to accumulate over time in the proposed highway drainage systems. As far as reasonably practicable, measures have been taken to reduce the accumulation of residual pollutants (e.g. provision of silt traps at gullies, sumps in manholes chambers, etc.). However, some drainage infrastructure is designed to settle out suspended material in the collected surface water (e.g. attenuation ponds, swales, etc.). Therefore, given that the accumulation of pollutants within the proposed surface water drainage systems could occur during the design life of the proposed scheme, suitable safety precautions should be undertaken by the maintenance operatives during maintenance works. Also, accumulated sediment has the potential to be contaminated. Therefore, the accumulated sediment may need to be disposed of and treated at an appropriate waste management facility. Similarly, maintenance operatives would need to take suitable safety precautions in the removal of any accumulated sediments from the proposed highway drainage systems and their subsequent transportation to a waste management facility.

14.3.5 **Confined space working conditions –** Surface water drainage infrastructure such as manholes, catchpits, underground geocellular attenuation storage systems, will need maintenance over their design life. These are considered confined spaces. Their use cannot be avoided in the provision of an effective highway drainage system to drain the proposed scheme. To mitigate the risks associated with confined spaces such as lack of oxygen, potential noxious gas accumulation and groundwater ingress, suitable safety precautions in accordance with the Construction (Design and Management) Regulations 2015 and guidance should be undertaken by the supervisory team and maintenance operatives.

14.3.6 **Flood risk from nearby watercourses –** A number of the proposed highway drainage systems, the associated attenuation storage features, their associated maintenance access tracks and portions of the proposed scheme itself are located near watercourses and existing land drains. This cannot be completely avoided as the proposed scheme needs to discharge collected surface water to such waterbodies. The maintenance operatives should be made aware of the potential flood risk in the appropriate Health and Safety Files post-construction.

14.3.7 **Statutory undertakers' plant and equipment** – Depending on the work type, the presence of SU plant and equipment should be examined and assessed before any work commences.

14.4 Safety and risks during decommissioning and demolition

14.4.1 **Record of as-built information** – The review of the as-built information produced for the constructed scheme should be an essential part of preparing safe systems of work for any access, repair, modification or demolition.

14.4.2 **Decommissioning and demolition –** At the end of the design life of the proposed highway drainage infrastructure for the proposed scheme, safety and risks during the decommissioning and demolition phase will be similar to those outlined for the construction phase described above. The exception would be existing drainage ditch regrading works (paragraph 14.2.6), which would not be applicable during the demolition phase.

14.4.3 **Partial demolition, modification and major repair –** The safety and risks during repair or modification will be similar to those outlined for the construction phase described above. Examination of the planned work during the design phase to identify the specific hazards should take place followed by the development of an appropriate safe system of work.

14.4.4 **Statutory undertakers' plant and equipment –** Depending on the work type, the presence of SU plant and equipment should be examined and assessed before any work commences.

Abbreviations and acronyms

Abbreviation and Acronyms	Term
AOD	Above Ordnance Datum
AEP	Annual Exceedance Probability
BGS	British Geological Survey
CCTV	Closed Circuit Television
CIRIA	Construction Industry Research and Information Association
DCO	Development Consent Order
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
ECC	Essex County Council
ES	Environmental Statement
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
GI	Ground Investigation
IWR	Inworth Road
LLFA	Lead Local Flood Authority
NNNPS	National Networks National Policy Statement
OU	Outfall
PED	Pre-Earthworks Drainage
ProW	Public right of way
RIS	Road Investment Strategy
SRN	Strategic Road Network
SU	Statutory undertaker
SuDS	Sustainable drainage systems
S1	Drainage Section 1 Proposed Drainage Catchment/Outfall reference number labels prefix
S2	Drainage Section 2 Proposed Drainage Catchment/Outfall reference number labels prefix
S3	Drainage Section 3 Proposed Drainage Catchment/Outfall reference number labels prefix
WCH	Walking, cycling and horse riding
UKCP09	United Kingdom Climate Projections 2009
UKCP18	United Kingdom Climate Projections 2018

Glossary

Term	Definition
Attenuation storage	Attenuation storage is a means of temporarily storing surface water runoff. This is achieved by means of flow restriction at the drainage system outlet with the surface water backing up into storage upstream. The surface water is then released downstream at a controlled rate to a watercourse or sewer system.
Attenuation pond	An attenuation pond is a landscaped and vegetated depression in the ground that can contain a shallow pool of water below the outlet pipe invert level. An attenuation pond provides both the attenuation and treatment of surface water runoff. The attenuation storage is provided above the shallow pool of water.
Aquifer	An aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials.
Brownfield	A previously developed parcel of land which is or was occupied by permanent structures.
Bypass oil separator	Bypass oil separators are structures designed to separate gross amounts of oil and large-size suspended solids from surface water. They do this by allowing the light non-aqueous phase liquids (LNAPL) to float and large sediment particles to sink. The separated oils and sediment particles are then removed manually as required.
Carrier drain	A carrier drain is a closed conduit / pipe that conveys collected surface water runoff. Typical materials used include clay, high-density polyethylene, concrete and ductile iron.
Catchment area	A catchment area is a contributing area from which surface runoff flows off the ground topography and into to a drainage system located at the catchment low point. The drainage system can be a river, drainage ditch or a formal engineered drainage system (with pipework, flow control structures, etc.).
Catchpit	A catchpit is a chamber installed in a drainage system at regular intervals to intercept suspended silt and debris in surface water runoff. It also facilitates changes in pipe direction. Materials used typically include precast concrete or high-density polyethylene.
Combined kerb drainage	Combined kerb drainage uses kerb units that contain openings at regular intervals along their front face to intercept surface water runoff draining towards the combined kerb drainage. A linear channel is cast within the combined kerb drainage unit to convey the surface water runoff downstream.

Term	Definition
Combined filter drain	A combined filter drain system drains the highway surface, any adjacent grassed catchments (e.g. cutting slopes and external natural catchments) and highway subsurface drainage.
Critical storm event	The critical storm event is the design storm which provides the largest surface water discharges and/or surface water drainage flooding volume or extent. A critical storm duration analysis is required to estimate representative peak discharge rates, flood volumes and flood extents.
Culvert	A culvert is a structural conduit that conveys water from a river or drainage ditch past and under an obstacle such as a highway embankment, railway embankment, etc. Culverts come in many shapes including round, elliptical, flat-bottomed, open-bottomed, pear-shaped, and box-like constructions.
Drainage CCTV survey	A drainage CCTV survey is a camera drain survey that enables the viewing of the structural integrity of drainage pipework, the identification of potential blockages and the investigation of drainage system routes.
Environment Agency	The Environment Agency is a public body with responsibilities relating to the protection and enhancement of the environment in England and Wales.
Environmental Statement	An environmental statement (ES) is an assessment of the likely significant environmental effects of any proposed scheme / development.
Filter drain	Filter drains are shallow trenches filled with stone/gravel that create temporary subsurface storage for attenuation, conveyance and filtration of surface water runoff. A perforated pipe is provided at the base of the filter drain to collect and convey the water to downstream drainage components.
Flood Risk Assessment	A flood risk assessment is an assessment of the risk of flooding to and from a proposed scheme from all flooding mechanisms. It also includes the identification of flood mitigation measures where required.
Greenfield	An undeveloped parcel of land that has not been built upon previously. It is usually agricultural land, but can be undeveloped land in a city or rural area.
Gully	A gully (in the context of a highway drainage system) is a discrete surface water edge collection unit with an open grated top, a gully chamber and an outlet pipe to one or more sides.

Term	Definition
Vortex flow control device	A vortex flow control device relies on the upstream hydraulic head to generate an air-filled vortex within the centre of the flow control device casing, thereby enabling the restriction of surface water flows.
Impermeable liner	An impermeable liner is a membrane that does not allow water or waterborne contaminants to pass through the structure which it is wrapped around. They are used to retain water and/or prevent the ingress of water into a structure.
Infiltration	Infiltration is the process by which surface water either flowing or ponding on the ground surface drains into the soil naturally
Lead Local Flood Authority	The local authority responsible for taking the lead on local flood risk management. Its duties are set out in the Flood and Water Management Act 2010.
LiDAR	Light Detection and Ranging is a remote sensing method that can be used to examine the surface of the Earth. In this instance it can enable the mapping of the ground topography for the determination of drainage catchments.
Linear slot drainage	Linear slot drainage systems drain water along their entire length, rather than at one discrete point like a gully does. They comprise an enclosed channel with some form of grating placed over the top.
Main River	A watercourse for which the Environment Agency has responsibilities and powers.
MicroDrainage	MicroDrainage is a hydraulic drainage design software package from the software company, Innovyze, that models / optimises the performance and effectiveness of drainage systems, including SuDS.
Ordinary Watercourse	Watercourses that are not designated as Main River. Local authorities or, where they exist, internal drainage boards (IDBs) have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
Orifice plate	An orifice plate is typically a circular or rectangular opening of a prescribed shape and size that allows a controlled rate of outflow from the drainage system outlet when the orifice is submerged.
QMED	QMED is the median annual maximum flood. QMED has an annual exceedance probability of 0.5% and a return period of two years.

Term	Definition
Return period	An estimate of the interval between storm events of a certain intensity or size, in this instance between rainfall events. It is a statistical measurement denoting the average recurrence interval of a storm event over an extended period of time.
Soakaway	A soakaway is essentially a pit in the ground which contains drainage units (e.g. geocellular crates, perforated concrete rings, etc.) that contain perforations which enable the collected surface water runoff to infiltrate into the ground.
Statutory undertaker	A statutory undertaker is a body that has been given statutory powers in relation to functions that are of a public character. Statutory undertakers may have the right to carry out certain works without obtaining the normal permissions, and obligations such as the supply of utilities.
SuDS	SuDS (sustainable drainage systems) are drainage management practices and drainage control structures that are designed to drain surface water in a more sustainable manner (e.g. swales, filter drains, attenuation ponds) than conventional drainage techniques (e.g. pipes).
Surface water drainage strategy	A surface water drainage strategy is a document which assesses how a development is proposed to be drained of surface water.
Surface water runoff	Rainwater (including snow and other forms of precipitation) which is present on the surface of the ground after a precipitation event (whether or not it is flowing or ponding) and has not yet entered a watercourse, drainage system or public sewer.
Surface water drainage flooding	Flooding as a result of surface water runoff due to high intensity rainfall when the water cannot enter an underground drainage system or drainage channel because they are full to capacity.
Swale	Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. When incorporated into a site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits.
Underground geocellular attenuation storage system	Underground geocellular attenuation storage systems are used to create a below-ground void for the temporary storage of surface water runoff before its infiltration or controlled discharge. The individual geocellular units are typically modular/honeycomb in nature and can be combined to create geocellular attenuation storage in various shapes.

Term	Definition
Vegetated ditch	A vegetated ditch is a grassed channel excavated into the ground to enable the collection and conveyance of surface water runoff from an adjacent development or natural catchment, and is typically of trapezoidal or triangular cross-section.

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Annex A. Exceedance Flow Analysis Maps

Drawing Number	Drawing Title	Revision
PART 1		
HE551497-JAC-LDC-S1-DR-D-0831	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S1-OU1, OU7 & OU7A	P01
HE551497-JAC-LDC-S1-DR-D-0832	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S1-OU10, OU10A, OU11 & OU12	P01
HE551497-JAC-LDC-S1-DR-D-0833	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S1-OU13, OU13A, OU14 & OU15	P01
HE551497-JAC-LDC-S1-DR-D-0834	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S1-OU17, OU18 & OU19C1	P01
HE551497-JAC-LDC-S1-DR-D-0835	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S1-OU19, OU19C & OU23C	P01
HE551497-JAC-LDC-S1-DR-D-0836	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S1-OU23, OU23D, OU24A & OU24B	P01
HE551497-JAC-LDC-S2-DR-D-0837	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S2-OU3, OU4, OU5, OU8 & OU9A	P01
HE551497-JAC-LDC-S2-DR-D-0838	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S2-OU9, OU10 & OU11	P01
HE551497-JAC-LDC-S2-DR-D-0839	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S2-OU14 & OU15A	P01
HE551497-JAC-LDC-S2-DR-D-0840	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S2-OU15C, OU15D, OU15D1 & OU15E	P01

Drawing Number	Drawing Title	Revision
HE551497-JAC-LDC-S2-DR-D-0841	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S2- OU26, OU15C1, OU15G, OU15H,OU24 & 24A	P01
HE551497-JAC-LDC-S2-DR-D-0842	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 20% CC EVENT PROPOSED CATCHMENTS S2-OU17, OU18, OU19 & OU27	P01
PART 2		
HE551497-JAC-LDC-S3-DR-D-0843	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU1, OU3, OU4 & OU5	P01
HE551497-JAC-LDC-S3-DR-D-0844	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU2, OU6, OU7A, OU13 & OU14	P01
HE551497-JAC-LDC-S3-DR-D-0845	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU8A, OU8B, OU8C, OU8D, OU8E, OU8 & OU7	P01
HE551497-JAC-LDC-S3-DR-D-0846	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU9, OU10, OU19 & OU20	P01
HE551497-JAC-LDC-S3-DR-D-0847	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU21, OU22, OU23 & OU24	P01
HE551497-JAC-LDC-S3-DR-D-0848	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU26, OU26A, OU27, OU27A, OU28 & OU29	P01
HE551497-JAC-LDC-S3-DR-D-0849	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU30, OU26B, OU30A, OU31, OU32 & OU33	P01
HE551497-JAC-LDC-S3-DR-D-0850	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU15, OU15A, OU15B, OU15C & OU16	P01

Drawing Number	Drawing Title	Revision
HE551497-JAC-LDC-S3-DR-D-0851	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU17	P01
HE551497-JAC-LDC-S3-DR-D-0852	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU18	P01
PART 3		
HE551497-JAC-LDC-S1-DR-D-0861	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S1-OU1, OU7 & OU7A	P01
HE551497-JAC-LDC-S1-DR-D-0862	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S1-OU10, OU10A, OU11 & OU12	P01
HE551497-JAC-LDC-S1-DR-D-0863	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S1-OU13, OU13A, OU14 & OU15	P01
HE551497-JAC-LDC-S1-DR-D-0864	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S1-OU17, OU18 & OU19C1	P01
HE551497-JAC-LDC-S1-DR-D-0865	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S1-OU19, OU19C & OU23C	P01
PART 4		
HE551497-JAC-LDC-S1-DR-D-0866	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S1-OU23, OU23D, OU24A & OU24B	P01
HE551497-JAC-LDC-S2-DR-D-0867	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S2-OU3, OU4, OU5, OU8 & OU9A	P01
HE551497-JAC-LDC-S2-DR-D-0868	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S2-OU9, OU10 & OU11	P01
HE551497-JAC-LDC-S2-DR-D-0869	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S2-OU14 & OU15A	P01

Drawing Number	Drawing Title	Revision
HE551497-JAC-LDC-S2-DR-D-0870	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S2-OU15C, OU15D, OU15D1 & OU15E	P01
HE551497-JAC-LDC-S2-DR-D-0871	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S2- OU26, OU15C1, OU15G, OU15H,OU24 & 24A	P01
HE551497-JAC-LDC-S2-DR-D-0872	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S2-OU17, OU18, OU19 & OU27	P01
HE551497-JAC-LDC-S3-DR-D-0873	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU1, OU3, OU4 & OU5	P01
HE551497-JAC-LDC-S3-DR-D-0874	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU2, OU6, OU7A, OU13 & OU14	P01
HE551497-JAC-LDC-S3-DR-D-0875	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU8A, OU8B, OU8C, OU8D, OU8E, OU8 & OU7	P01
PART 5		
HE551497-JAC-LDC-S3-DR-D-0876	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU9, OU10, OU19 & OU20	P01
HE551497-JAC-LDC-S3-DR-D-0877	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU21, OU22, OU23 & OU24	P01
HE551497-JAC-LDC-S3-DR-D-0878	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU26, OU26A, OU27, OU27A, OU28 & OU29	P01
HE551497-JAC-LDC-S3-DR-D-0879	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU30, OU26B, OU30A, OU31, OU32 & OU33	P01

Drawing Number	Drawing Title	Revision
HE551497-JAC-LDC-S3-DR-D-0880	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU15, OU15A, OU15B, OU15C & OU16	P01
HE551497-JAC-LDC-S3-DR-D-0881	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU17	P01
HE551497-JAC-LDC-S3-DR-D-0882	EXCEEDANCE FLOW ANALYSIS 100YR PLUS 40% CC EVENT PROPOSED CATCHMENTS S3-OU18	P01

Annex B. Paved and Permeable Catchment Area Summary Tables

Table B.1 Drainage Section 1 retained existing paved area and total proposed paved / permeable catchment areas

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU1	7.356 (6.726)	0.984	7.710	5.403	Proposed highway improvement works in the vicinity of junction 19. This includes the A12 mainline online highway widening works from chainage 9450 to 11300, the junction 19 southbound off-slip road, the junction 19 northbound off-slip road, a portion of the existing Boreham Interchange Roundabout and a portion of the adjoining A130 to the south-east, the southbound lane of the A130 between the existing Boreham Interchange Roundabout and Generals Lane Roundabout, widening works to the Generals Lane Roundabout, the A138 adjoining Generals Lane Roundabout and the proposed realigned Beaulieu Park Radial Distributor Road (i.e. located north of Generals Lane Roundabout). The existing paved area (7.356ha) is associated with the existing S1-OU1 catchment that has been divided up between the proposed S1-OU1 catchment and the proposed S1-OU7A catchment (i.e. 6.726ha will be retained within the proposed S1-OU1 catchment boundary while 0.63ha will be drained to the proposed S1-OU7A catchment).

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU7A	0 (0.630)	0.210	0.840	0.565	Proposed highway improvement works around the existing junction 19 (online widening to the existing Boreham Bridge portion within the proposed catchment, online widening of the junction 19 southern roundabout and adjoining slip road). The existing paved area is associated with the existing S1-OU1 catchment portion contained within the proposed S1-OU7A catchment boundary (see the catchment-specific comments for the proposed S1-OU1 catchment).
S1-OU10	0.531	0.127	0.658	0.102	Proposed online widening works on the B1137 local road. The existing paved area is associated with the existing B1137 local road footprint contained within the proposed S1-OU10 catchment boundary
S1-OU10A	0.011	0.099	0.110	0.014	Proposed online highway improvement works to Paynes Lane. The existing paved area is associated with the existing Paynes Lane footprint contained within the proposed S1-OU10A catchment boundary
S1-OU11	0 (0.942)	0.670	1.612	4.170	Proposed A12 mainline online highway widening works and new offline slip road connection from junction 19 to the existing A12 mainline (i.e. junction 19 northbound on-slip road) The existing paved area is associated with the existing S1-OU12 catchment contained within the proposed S1-OU11 catchment boundary (see catchment-specific comments for the proposed S1-OU12 catchment)

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU12	3.409 (2.467)	0.068	2.535	2.386	Proposed A12 mainline online highway widening works The existing paved area (3.409ha) is associated with the existing S1-OU12 catchment that has been divided up between the proposed S1-OU11 catchment and the proposed S1-OU12 catchment (i.e. 2.467ha will be retained within the proposed S1-OU12 catchment boundary while 0.942ha will be drained by the proposed S1-OU11 catchment).
S1-OU13	0.437 (3.852)	0.012	3.864	3.380	Proposed A12 mainline online highway widening works. The existing S1-OU13 catchment paved area (0.437ha) is associated with the existing A12 mainline that has been divided up between the proposed S1-OU13 catchment (0.125ha) and the proposed S1-OU13A catchment (0.091ha) with the remaining existing paved area portion (0.221ha) to be made redundant. The proposed S1-OU13 catchment also intercepts a sizable portion of the existing paved area catchment (3.727ha) draining to the retained existing S1-OU15 outfall. This results in an increase to the retained existing paved area of 3.852ha (i.e. 0.125ha plus 3.727ha) within the proposed S1-OU13 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU13A	0.122 (0.213)	0	0.213	0.065	Highway improvement works required for the existing B1137 local road (between Crix Bridge and Ordinary Watercourse 28) as an existing slip road to the A12 mainline is to be de-trunked. The existing paved area is associated with the existing B1137 local road catchment (0.091ha) that has been separated out from existing S1-OU13 catchment and a portion of the retained existing paved area (0.122ha) within the proposed S1-OU13A catchment boundary.
S1-OU14	0.472	0.010	0.482	0.348	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 mainline footprint contained within the proposed S1-OU14 catchment boundary.
S1-OU15	4.383 (0.656)	0.046	0.702	0.156	Proposed A12 mainline online highway widening works. The existing paved area (4.383ha) is associated with the existing A12 mainline footprint that currently discharges to the existing S1-OU15 catchment outfall. The proposed S1-OU13 catchment intercepts a sizable portion of the existing paved area catchment (3.727ha) draining to the retained existing S1-OU15 outfall. This results in a reduction to the retained existing paved area (0.656ha) contributing to the proposed S1-OU15 catchment.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU17	4.763 (3.225)	1.220	4.445	3.200	Proposed A12 mainline online highway widening works. The existing paved area (4.763ha) is associated with the existing S1-OU17 catchment (i.e. existing A12) that has been divided up between the proposed S1-OU17 catchment and the proposed S1-OU18 catchment. 3.225ha will be retained within the proposed S1-OU17 catchment while 1.538ha will be drained to the proposed S1-OU18 catchment. The new paved area is associated with the existing A12 online highway widening works and a small portion of the proposed offline slip roads to the new proposed offline junction 21 contained within the proposed S1-OU17 catchment boundary.
S1-OU18	0 (1.538)	0.582	2.120	1.527	The proposed S1-OU18 catchment includes the proposed A12 mainline online highway widening works, a portion of the replaced Bury Lane Bridge and the existing slip road at junction 20a (potentially de-trunked and converted into an attenuation pond access track). The existing paved area (1.538ha) is associated with the existing S1-OU17 catchment paved area contained within the proposed S1-OU18 catchment boundary (see catchment-specific comments for the proposed S1-OU17 catchment). The new paved area is associated with the existing A12 online highway widening works contained within the proposed S1-OU18 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU19	1.140	0.450	1.590	0.520	Proposed A12 mainline online highway widening works in addition to two new offline slip roads adjoining the proposed junction 21 (i.e. junction 21 southbound on-slip road and northbound off-slip road). The existing paved area is associated with the existing A12 mainline footprint contained within the proposed S1-OU19 catchment boundary.
S1-OU19C	0	0.580	0.580	0.331	New Hatfield Peverel Link Road portion adjoining the proposed junction 21. There is no existing paved area within the proposed S1-OU19C catchment as the existing site condition is currently greenfield.
S1-OU19C1	0	0.560	0.560	0.500	New Hatfield Peverel Link Road portion off proposed junction 21. There is no existing paved area within the proposed S1-OU19C1 catchment as the existing site condition is currently greenfield.
S1-OU23	7.148	1.285	8.433	6.620	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 mainline contained within the proposed S1-OU23 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S1-OU23C	0	0.130	0.130	1.010	Proposed junction 21 northbound on-slip road. There is no existing paved area within the proposed S1-OU23C catchment as the existing site condition is currently greenfield.
S1-OU23D	0.120	1.200	1.320	0.830	Proposed realigned Witham Link Road adjoining the proposed junction 21. The existing paved area is located at the eastern end of the proposed S1-OU23D catchment. It is the existing B1389 road portion at the tie-in location between the new offline local road and the existing B1389 local road.
S1-OU24A	0	0.360	0.360	0.990	Proposed junction 21 southbound off-slip road. There is no existing paved area within the proposed S1-OU24A catchment as the existing site condition is currently greenfield.
S1-OU24B	0.170	1.000	1.170	1.650	Proposed realigned Kennel access road adjoining the proposed junction 21. The existing paved area is located at the eastern end of the proposed S1-OU24B catchment. It is the existing B1389 road portion to be retained to maintain access to Latney's Kennels, Cattery and Grooming Parlour.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	

Notes:

1. The first paragraph of the proposed highway drainage catchment descriptions in Sections 6.2.4 to 6.2.71 state the relevant Drainage and Surface Water Plan to locate and identify the proposed catchment.
2. For some proposed catchments the retained existing paved area contained within the proposed catchment boundary differs to that in the existing site condition. This is due to the retained existing paved area's adjustment to neighboring catchments where required due to site constraints and/or the loss of existing paved area due to potential redundant pavement removal in the proposed case. The retained existing paved area within the proposed catchment boundary is presented in brackets in the 'Existing paved area' column where applicable and is included in the total proposed paved area summation.
3. The total proposed paved area is the sum of the existing paved area (adjusted existing paved area where applicable) to be retained and the additional new paved area which will form the proposed highway drainage catchment areas across the proposed scheme. The existing and additional new paved areas are illustrated in the Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 to 0821.
4. Permeable catchment areas include grassed verges, grassed roundabout centre islands, cut slopes, embankment slopes, etc. that drain into the proposed highway drainage systems.

Table B.2 Drainage Section 2 retained existing paved area and total proposed paved / permeable catchment areas

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU3	0.329	0.126	0.455	0.063	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 highway contained within the proposed S2-OU3 catchment boundary.
S2-OU4	1.306	0.471	1.777	1.281	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 highway contained within the proposed S2-OU4 catchment boundary.
S2-OU5	0.844	0.279	1.123	0.541	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 highway contained within the proposed S2-OU5 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU8	3.099	0.337	3.436	2.022	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 highway contained within the proposed S2-OU8 catchment boundary.
S2-OU9	2.925	2.851	2.851	1.733	Proposed A12 mainline offline highway portion and new offline slip roads off proposed junction 22 are located largely on a greenfield site. The new paved area is associated with the proposed S2-OU9 catchment. The existing paved area is associated with the existing S2-OU9 catchment which includes a portion of the existing A12, the existing junction 22 and associated existing slip roads that are considered to be potential future redundant pavements (i.e. existing paved area assumed to be removed in the proposed case). Therefore, the total proposed paved area does not take into account the paved area associated with the existing S2-OU9 catchment.
S2-OU9A	0.129	0.177	0.306	0.090	Proposed A12 mainline online highway widening works. The existing S2-OU9A catchment paved area is associated with the existing S2-OU9 paved area that includes a portion of existing A12 mainline highway contained within the proposed S2-OU9A catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU10	0.093 (0.031)	0.997	1.028	0.894	Proposed new offline junction 22 southern roundabout and a proposed offline local road portion that ties into the existing Little Braxted Lane. A portion of the existing Little Braxted Lane contained within the proposed S2-OU10 catchment boundary is subject to online highway widening works. The proposed highway is located on a currently greenfield site. The existing paved area (0.093ha) is associated with the existing S2-OU10 catchment which includes the existing Little Braxted Lane connection from the existing junction 22. A portion of this existing paved area (0.062ha) will be made redundant and another portion of this will be contained within the proposed S2-OU9 catchment (i.e. proposed offline A12 mainline) This results in an existing retained paved area (0.031ha) forming part of the proposed S2-OU10 catchment.
S2-OU11	0.898	0.093	0.991	0.568	Proposed Colchester Link Road from the new offline junction 22 that ties into the existing Colchester Road. Includes highway improvement works on Colchester Road. The existing paved area (0.898ha) is associated with Colchester Road and is currently part of the existing S2-OU9 catchment. It should be noted that the aforementioned Colchester Road existing paved area will now discharge through a new outfall location for the proposed S2-OU11 catchment and hence is accounted for within the total proposed paved area for the S2-OU11 catchment. It should be noted that a portion of the Colchester Road existing permeable catchment area will be retained as part of the proposed S2-OU11 catchment.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU14	0.714 (0.462)	0.621	1.083	0.531	Proposed offline junction 22 northern roundabout and proposed de-trunked A12 link road. The proposed junction 22 northern roundabout catchment portion of the proposed S2-OU14 catchment is located on a currently greenfield site. The proposed highway improvement works on the existing A12 are also included. The existing paved area (0.714ha) associated with the existing S2-OU14 catchment includes the existing A12, a portion (0.252ha) of which will be made redundant resulting in an existing retained paved area (0.462ha) forming part of the proposed S2-OU14 catchment.
S2-OU15A	0	2.819	2.819	5.543	Proposed offline A12 mainline portion. There is no existing paved area within the proposed S2-OU15A catchment as the existing site condition is currently greenfield.
S2-OU15C	0	3.694	3.694	1.646	Proposed offline A12 mainline portion. There is no existing paved area within the proposed S2-OU15C catchment as the existing site condition is currently greenfield.
S2-OU15D	0	0.309	0.309	0.663	The proposed realigned Braxted Road portion is largely located on a greenfield site, hence the proposed S2-OU15D catchment is largely an offline catchment. The new paved area includes a small portion of the existing paved area associated with existing Braxted Road contained within the proposed S2-OU15D catchment boundary at the highway tie-in location.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU15E	0.474 (0.378)	0.243	0.621	0.351	Proposed offline local road (Realigned Braxted Road) and the new Rivenhall End (West) Roundabout on the existing A12 mainline. The existing paved area (0.474ha) is associated with the existing A12 mainline, a portion (0.378ha) of which will be retained within the proposed S2-OU15E catchment boundary.
S2-OU15C1	0	0.480	0.480	0.276	Proposed offline A12 mainline portion. There is no existing paved area within the proposed S2-OU15C1 catchment as the existing site condition is currently greenfield.
S2-OU15D1	0.077 (0.039)	0	0.039	0.055	The proposed catchment includes a small portion of the existing Braxted Road. Potential reduction in the proposed paved area (0.038ha) is due to a portion of the existing Braxted Road paved area being drained by the adjacent proposed S2-OU15D catchment.
S2-OU15G	0	4.213	4.213	1.676	Proposed offline A12 mainline portion. There is no existing paved area within the proposed S2-OU15G catchment as the existing site condition is currently greenfield.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU15H	0	0.999	0.999	0.445	New B1024 Link Road portion. There is no existing paved area within the proposed S2-OU15H catchment as the existing site condition is currently greenfield.
S2-OU17	0.215 (0.028)	0	0.028	0.402	Proposed B1024 Link Road portion. The existing paved area (0.215ha) is associated with existing S2-OU17 catchment that will be largely drained to the adjacent proposed S2-OU18 catchment. This has resulted in a potential reduction of 0.187ha in the paved area associated with the proposed S2-OU17 catchment.
S2-OU18	0.251 (0.438)	0.161	0.599	0.402	New B1024 Link Road portion plus highway improvement works to the existing B1024 local road. The existing paved area (0.251ha) is associated with the existing S2-OU18 catchment which encompasses the existing B1024 local road / London Road portion. The existing paved area adjusted from the adjacent existing S2-OU17 catchment (0.187ha) will be part of the proposed S2-OU18 catchment. This results in a potential increase in the existing paved area (0.438ha) draining to the proposed S2-OU18 catchment.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU19	1.68 (1.123)	0.520	1.643	0.725	Proposed A12 mainline online highway widening works. The existing paved area (1.68ha) is associated with the existing S2-OU19 catchment of which a portion (0.328ha) will potentially be made redundant. The remainder of the existing paved area (1.352ha) has been divided up between the proposed S2-OU19 catchment (draining the proposed A12 mainline) and the proposed S2-OU27 catchment (draining the B1024 local road). An existing paved area portion (1.123ha) will be retained within the proposed S2-OU19 catchment boundary while the remaining portion (0.229ha) will become part of proposed S2-OU27 catchment. The new paved area is associated with online highway widening works to the existing A12.
S2-OU27	0.229	0	0.229	0.318	Proposed Essex Fire and Rescue access road portion. Catchment-specific comments for the proposed S2-OU19 catchment are also applicable to this catchment. The proposed retained paved area (0.229ha) is the existing paved area portion separated out from existing S2-OU19 catchment.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S2-OU24	1.079 (0.208)	0.212	0.420	0.175	New B1024 Link Road portion. The existing paved area (1.079ha) is associated with the combined existing S2-OU24 catchment and existing S2-OU25 catchment which form part of the existing A12. A portion of the existing paved area (0.871ha) will be made redundant while another portion will form part of the proposed S2-OU15G catchment (i.e. proposed offline A12 mainline). This results in an existing retained paved area (0.208ha) forming part of proposed the S2-OU24 catchment.
S2-OU24A	0	0.442	0.442	0.257	New B1024 Link Road portion. There is no existing paved area within the proposed S2-OU24A catchment as the existing site condition is currently greenfield.
S2-OU26	1.903	0	0.780	0.192	Proposed Essex Fire and Rescue access road portion. The existing paved area is associated with the existing S2-OU26 catchment serving the existing A12. There is a potential reduction in the existing paved area (1.123ha) due to a loss of existing paved area from potential redundant pavements associated with the existing A12 (assumed removal of existing paved area in the proposed case). This results in a total proposed paved area of 0.78ha.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	

Notes:

1. Refer to the first paragraph of the proposed highway drainage catchment descriptions in Sections 6.3.4 to Section 6.3.69 which state the relevant Drainage and Surface Water Plan to locate and identify the proposed catchment.
2. For some proposed catchments the retained existing paved area contained within the proposed catchment boundary differs to that in the existing site condition. This is due to the retained existing paved area's adjustment to neighbouring catchments where required due to site constraints and/or the loss of existing paved area due to potential redundant pavement removal in the proposed case. The retained existing paved area within the proposed catchment boundary is presented in brackets in the 'Existing paved area' column where applicable and is included in the total proposed paved area summation.
3. The total proposed paved area is the sum of the existing paved area (adjusted existing paved area where applicable) to be retained and the additional new paved area which will form the proposed highway drainage catchment areas across the proposed scheme. The existing and additional new paved areas are illustrated in the Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 to 0821.
4. Permeable catchment areas include grassed verges, grassed roundabout centre islands, cut slopes, embankment slopes, etc. that drain into the proposed highway drainage systems.

Table B.3 Drainage Section 3 retained existing paved area and total proposed paved / permeable catchment areas

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU1	2.032 (1.924)	0.922	2.846	1.947	Proposed A12 mainline online highway widening works. The existing paved area (2.032ha) is associated with the existing S3-OU1 catchment that has been divided up between the proposed S3-OU1 catchment and the proposed S3-OU2 catchment (i.e. 0.425ha will be retained within the proposed S3-OU1 catchment boundary while 1.606ha will be drained by the proposed S3-OU2 catchment). It should be noted that the existing S2-OU20 catchment would become part of the proposed S3-OU1 catchment. Hence the existing paved area (1.499ha) associated with the existing S2-OU20 catchment would be contained within the proposed S3-OU1 catchment boundary in addition to the existing paved area portion (0.425ha) retained from the existing S3-OU1 catchment. This results in an adjusted retained existing paved area of 1.924ha contained within the proposed S3-OU1 catchment. The new paved area is associated with the existing A12 online highway widening contained within the proposed S3-OU1 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU2	0 (1.606)	2.559	4.165	3.980	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing S3-OU1 catchment paved area portion (1.606ha) contained within the proposed S3-OU2 catchment boundary (see catchment-specific comments for the proposed S3-OU1 catchment). The new paved area is associated with the existing A12 online highway widening and a small portion of the proposed offline slip roads to the new offline junction 24 contained within the proposed S3-OU2 catchment. It should be noted that a portion of the existing A12 permeable catchment area will be retained as part of the proposed S3-OU2 catchment.
S3-OU3	0.319	0.095	0.414	0.520	Proposed Highfields Lane highway realignment works. The existing paved area is associated with the existing Highfields Lane contained within the proposed S3-OU3 catchment boundary.
S3-OU4	0.220	0.037	0.257	0.499	Proposed Highfields Lane highway realignment works. The existing paved area is associated with the existing Highfields Lane contained within the proposed S3-OU4 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU5	0.219	0.077	0.296	0.773	Proposed Highfields Lane overbridge and realigned Maldon Road. The existing paved area is associated with the existing Maldon Road and existing Highfields Lane overbridge that is contained within the proposed S3-OU5 catchment boundary.
S3-OU6	0	0.040	0.040	0.082	The new paved area is for a portion of a proposed junction 24 southbound on-slip road. The new paved area is located on a currently greenfield site.
S3-OU7	0.150 (0.313)	0.358	0.671	0.092	Proposed A12 mainline online highway widening works. The existing paved area (0.150ha) is associated with the existing S3-OU7 catchment (i.e. existing A12) contained within the proposed S3-OU7 catchment boundary. The existing paved area also includes a paved area portion (0.163ha) from the existing S3-OU6 catchment that would be contained within the proposed S3-OU7 catchment boundary. This results in an adjusted retained existing paved area of 0.313ha contained within the proposed S3-OU7 catchment.
S3-OU7A	0	0.110	0.110	0.389	Proposed junction 24 northbound off-slip road. There is no existing paved area within the proposed S3-OU7A catchment as the existing site condition is currently greenfield.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU8	0.598 (0.762)	1.288	2.050	0.969	Proposed A12 mainline online highway widening works. The existing paved area (0.598ha) is associated with the existing S3-OU8 catchment (i.e. existing A12) contained within the proposed S3-OU8 catchment boundary. The existing paved area also includes a paved area portion (0.085ha) from the existing S3-OU6 catchment and a paved area portion (0.080ha) from the existing S3-OU9 catchment that would be contained within the proposed S3-OU8 catchment boundary. This results in an adjusted retained existing paved area of 0.762ha for the proposed S3-OU8 catchment.
S3-OU8A	0	2.027	2.027	6.038	Proposed offline junction 24 and the associated new slip roads off proposed junction 24. There is no existing paved area within the proposed S3-OU8A catchment as the existing site condition is currently greenfield.
S3-OU8B+8D	0	0.406	0.406	0.360	New Inworth Link Road portion and a new Inworth Road Roundabout connecting the link road to Inworth Road. There is no existing paved area within the proposed S3-OU8B+8D catchment as the existing site condition is currently greenfield.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU8C	0.028	0.040	0.068	0.115	The total proposed paved area includes the new paved area for the proposed Inworth Link Road (located on a greenfield site) and a portion of the existing paved area associated with Inworth Road that would be contained within the proposed S3-OU8C catchment boundary.
S3-OU8E	0.064	0.101	0.165	0.223	The total proposed paved area includes the new paved area for the proposed Inworth Link Road (located on a greenfield site) and a portion of the existing paved area associated with Inworth Road that would be contained within the proposed S3-OU8E catchment boundary.
S3-OU9	0.260	0.330	0.590	0.315	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 contained within the proposed S3-OU9 catchment boundary.
S3-OU10	0	3.190	3.190	2.284	Proposed offline A12 mainline portion is largely located on a currently greenfield site. Hence the proposed S3-OU10 catchment is considered as an offline proposed catchment.
S3-OU13	0	0.125	0.125	0.287	Proposed Ewell Hall Chase local road portion. There is no existing paved area within the proposed S3-OU13 catchment as the existing site condition is currently greenfield.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU14	0	0.090	0.090	0.042	Proposed Ewell Hall Chase local road portion. There is no existing paved area within the proposed S3-OU14 catchment as the existing site condition is currently greenfield.
S3-OU15	0.671 (0.424)	0.084	0.508	0.290	Proposed de-trunked A12 link road and the new offline London Road Roundabout which is partially located on a greenfield site. The existing paved area (0.671ha) is associated with existing S3-OU15 catchment of which a portion (0.288ha) will be retained within the proposed S3-OU15 catchment boundary, a portion (0.074ha) has been separated out to proposed S3-OU15C catchment and the remaining portion (0.309ha) will be made redundant. The existing paved area also includes a portion (0.136ha) from existing S3-OU16 catchment that would be contained within the proposed S3-OU15 catchment boundary. Therefore, the total retained existing paved area within the proposed S3-OU15 catchment boundary is 0.424ha (i.e. 0.288ha plus 0.136ha).
S3-OU15A	0 (0.259)	1.031	1.290	1.254	Proposed offline A12 mainline and adjoining link roads are located largely on a greenfield site. The existing paved area (0.259ha) contained within the proposed S3-OU15A catchment boundary is separated out from the existing S3-OU16 catchment.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU15B	0	0.150	0.150	0.194	Proposed junction 25 northbound off-slip road is located on a currently greenfield site. Hence the proposed S3-OU15B catchment is considered as an offline proposed catchment.
S3-OU15C	0.074	0.082	0.156	0.099	A portion of the proposed de-trunked A12 link road paved area (0.082ha) is located on a currently greenfield site. The proposed S3-OU15C catchment also includes a portion of the existing S3-OU15 catchment paved area (0.074ha) to be retained.
S3-OU16	1.878 (0.699)	0.337	1.036	1.002	Proposed A12 mainline online highway widening works and proposed highway improvement works to the adjoining London Road and Coggeshall Road. The existing paved area (1.878ha) is associated with existing S3-OU16 catchment of which a portion (0.784ha) would be made redundant. The remainder of the existing S3-OU16 catchment paved area has been separated out between the proposed S3-OU15 catchment (0.136ha) and the proposed S3-OU15A (0.259ha) catchment. This results in a retained existing paved area portion (0.699ha) being contained within the proposed S3-OU16 catchment boundary.
S3-OU17	6.124	1.318	7.442	4.810	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 contained within the proposed S3-OU17 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU18	1.517	0.269	1.786	0.643	Proposed A12 mainline online highway widening works. The existing paved area is associated with the existing A12 contained within the proposed S3-OU18 catchment boundary.
S3-OU19	0.096	0.358	0.454	0.196	Proposed realigned Threshelfords access road is partially located on a greenfield site. The existing paved area is associated with the existing A12 contained within the proposed S3-OU19 catchment boundary.
S3-OU20	0	0.045	0.045	0.241	Proposed Prested Hall - Threshelfords access bridge (New Farm Access) is an offline proposed catchment. There is no existing paved area within the proposed S3-OU20 catchment as the existing site condition is currently greenfield.
S3-OU21	0	2.270	2.270	1.186	Proposed offline A12 mainline portion. There is no existing paved area within the proposed S3-OU21 catchment as the existing site condition is currently greenfield.
S3-OU22	0	0.448	0.448	0.266	Proposed realigned Prested Hall access road is an offline proposed catchment. There is no existing paved area within the proposed S3-OU22 catchment as the existing site condition is currently greenfield.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU23	0.286	0.274	0.560	0.480	Proposed Prested Hall - Threshelfords Access Bridge (western arm) portion is partially located on greenfield site. The existing paved area is associated with the existing A12 and junction 24 adjoining roads contained within the proposed S3-OU23 catchment boundary.
S3-OU24	0.914	0.286	1.200	0.598	Proposed roundabout and highway improvement works largely located on the existing A12 (junction 24) and adjoining roads. The existing paved area is associated with the existing A12 (junction 24) and adjoining roads contained within the proposed S3-OU24 catchment boundary.
S3-OU26	0	1.466	1.466	0.616	Proposed offline A12 mainline portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU26 catchment boundary.
S3-OU26A	0	3.580	3.580	3.621	Proposed offline A12 mainline portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU26A catchment boundary.
S3-OU26B	0	0.490	0.490	0.257	Proposed offline A12 mainline portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU26B catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU27	0	0.277	0.277	0.714	Proposed Easthorpe Road Realignment portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU27 catchment boundary.
S3-OU27A	0	0.082	0.082	0.243	Proposed realigned Easthorpe Link Road is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU27A catchment boundary.
S3-OU28	0	0.180	0.180	0.167	Proposed Easthorpe Road Realignment portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU28 catchment boundary.
S3-OU29	0.251	0.239	0.490	0.189	Proposed Easthorpe Road connection to the existing A12 is partially located on a greenfield site with a new roundabout also located on the existing A12 footprint. The existing paved area (0.251ha) is associated with the existing A12 paved area contained within the proposed S3-OU29 catchment boundary.
S3-OU30	0	3.856	3.856	1.419	Proposed offline A12 mainline portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU30 catchment boundary.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-OU30A	0	3.705	3.705	2.515	Proposed offline A12 mainline portion is located on a currently greenfield site. There is no existing paved area within the proposed S3-OU30A catchment boundary.
S3-OU31	0	0.390	0.390	0.158	Proposed realigned Easthorpe Green Farm access road. There is no existing paved area within the proposed S3-OU31 catchment as the existing site condition is currently greenfield.
S3-OU32	0	0.572	0.572	0.123	New Wishing Well Farm access road. There is no existing paved area within the proposed S3-OU32 catchment as the existing site condition is currently greenfield.
S3-OU33	3.134	0.367	3.501	0.269	Proposed offline local road portion is located on a currently greenfield site while the new roundabout portion is located on the existing A12. The existing paved area is associated with existing A12 catchment that is contained within proposed S3-OU33 catchment boundary.
S3-IWR-OU1	0.096	0.007	0.103	0	Minor highway improvement works to the existing Inworth Road.
S3-IWR-OU2	0.146	0.006	0.152	0.002	Minor highway improvement works to the existing Inworth Road.

Proposed catchment[1]	Existing paved area[2]	New paved area	Total proposed paved area[3]	Total proposed permeable area[4]	Catchment-specific comments
	(ha)	(ha)	(ha)	(ha)	
S3-IWR-OU3	0.080	0.040	0.120	0.002	Minor highway improvement works to the existing Inworth Road in addition to proposed offline walking, cycling and horse-riding (WCH) route access provision.
S3-IWR-OU4	0.142	0.005	0.147	0.005	Minor highway improvement works to the existing Inworth Road.
S3-IWR-OU5	0.118	0.002	0.120	0	Minor highway improvement works to the existing Inworth Road.
S3-IWR-OU6	0.084	0.001	0.085	0	Minor highway improvement works to the existing Inworth Road.
S3-IWR-OU7	0.115	0	0.115	0	No online highway widening works proposed within the proposed S3-IWR-OU7 catchment boundary.

Notes:

1. The first paragraph of the proposed highway drainage catchment descriptions in Section 6.4.4 to Section 6.4.143 state the relevant Drainage and Surface Water Plan to locate and identify the proposed catchment.
2. For some proposed catchments the retained existing paved area contained within the proposed catchment boundary differs to that in the existing site condition. This is due to the retained existing paved area's adjustment to neighbouring catchments where required due to site constraints and/or the loss of existing paved area due to potential redundant pavement removal in the proposed case. The retained existing paved area within the proposed catchment boundary is presented in brackets in the 'Existing paved area' column where applicable and is included in the total proposed paved area summation.
3. The total proposed paved area is the sum of the existing paved area (adjusted existing paved area where applicable) to be retained and the additional new paved area which will form the proposed highway drainage catchment areas across the proposed scheme. The existing and additional new paved areas are illustrated in the Drainage and Surface Water Plans [TR010060/APP/2.13], drawing numbers HE551497-JAC-LDC-SCHW-DR-D-0801 to 0821.
4. Permeable catchment areas include grassed verges, grassed roundabout centre islands, cut slopes, embankment slopes, etc. that drain into the proposed highway drainage systems.

Annex C. Discharge Rate and Attenuation Storage Volume Summary Tables

Table C.1 Drainage Section 1 proposed site condition outfall discharge rates and attenuation storage volumes

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S1-OU1	River Chelmer	A	510.4	533.3	605.0	925.9	Orifice plate (243mm)	Underground geocellular attenuation storage No.1	151	Brownfield discharge rates are applicable due to the online highway widening works at A12 mainline, slip roads and adjoining junction 19 improvement works. Catchment S1-OU1 attenuation pond will require a new outfall to the River Chelmer. The existing underground geocellular attenuation storage is installed in the junction 19 Generals Lane Roundabout as part of the junction 19 upgrade for the Beaulieu Park development which precedes the proposed scheme. This attenuation storage is to be retained. An additional new underground geocellular attenuation storage is required to meet the requirements for the proposed scheme.
							Geocellular system outlet pipe (300mm)	Underground geocellular attenuation storage No. 2	176	
		P	254.5	338.2	439.9	597.9	Existing hydrobrake to be retained	Existing underground attenuation storage	289	
							Orifice plate (238mm)	Underground geocellular attenuation	63	

								storage No. 3		
							Pond outlet pipe (750mm)	Attenuation pond	2,069	
S1-OU7A	Ordinary Watercourse 2	A	(See comments)				Existing hydrobrake (assumed 150mm)	Existing underground attenuation storage	72	The proposed S1-OU7A drainage catchment was part of existing S1-OU1 drainage catchment. However, it is now separated out due to potential spatial constraints in providing attenuation storage for the proposed S1-OU7A catchment and other site-specific constraints (i.e. potential clash with existing culvert CL-02 crossing). A new outfall for the proposed S1-OU7A catchment to Ordinary Watercourse 2 will be required which is restricted to a minimum practicable discharge rate of 5l/s for operation and maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table. An existing underground geocellular attenuation storage is installed in the junction 19 Generals Farm Roundabout as part of the junction 19 upgrade for the Beaulieu Park development which precedes the proposed scheme. This attenuation storage is to be retained.
		P	5.0	5.0	5.0	5.0	Hydrobrake (107mm)	Attenuation pond	693	

S1-OU10	Existing highway drainage system serving the B1137 road	A	84.8	81.6	105.4	179.4	Orifice plate (240mm)	Underground geocellular attenuation storage	138	Brownfield discharge rates are applicable due to online highway widening works. Underground geocellular attenuation storage has been used due to spatial constraints on site in addition to the proposed highway drainage system being relatively deep at its downstream end (i.e. avoids a deep attenuation pond). Outfalls into an existing chamber located on highway drainage system serving the B1137 road.
		P	81.0	80.2	84.3	122.1				
S1-OU10A	Existing highway drainage system serving the B1137 road	A	6.5	6.3	8.9	16.7	Hydrobrake (107mm)	Underground geocellular attenuation storage	56	Brownfield discharge rates are applicable given that the existing Paynes Lane site is currently paved and the proposed S1-OU10A highway drainage is discharging to the B1137 local road highway drainage system. Underground geocellular attenuation storage has been used. Outfalls into an existing chamber located on highway drainage system serving the B1137 road.
		P	5.0	5.0	5.0	5.0				

S1-OU11	Boreham Brook	A	(See Comments)				Orifice plate (224mm)	Attenuation pond	1,291	Brownfield discharge rates are applicable due to online highway widening works. The existing case S1-OU12 catchment has been divided up in the proposed case due to the proposed highway geometry. The existing S1-OU12 catchment allowable discharge rates are apportioned between the proposed case S1-OU11 and S1-OU12 catchments. A new outfall for S1-OU11 to Boreham Brook will be required.
		P	40.0	51.7	60.7	90.8				
S1-OU12	Boreham Brook	A	402.8	390.5	536.4	909.0	Orifice plate (595mm)	Attenuation pond	590	Brownfield discharge rates are applicable due to online highway widening works. The catchment-specific comments for the proposed S1-OU11 catchment are applicable to the proposed S1-OU12 catchment. The existing outfall needs to be repositioned on Boreham Brook. The combined proposed discharge rates from the proposed S1-OU11 and S1-OU12 catchments are less than the existing case S1-OU12 allowable discharge rates.
		P	183.2	207.1	284.8	571.2				

Combined S1-OU11 and S1-OU12	Boreham Brook	A	402.8	390.5	536.4	909.0	N/A	N/A	N/A	The combined proposed discharge rates from the proposed S1-OU11 and S1-OU12 catchments are less than existing case S1-OU12 allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Boreham Brook.
		P	223.2	258.8	345.5	662.0				
S1-OU13	Ordinary Watercourse 28 (ultimately River Ter)	A	(See comments)				Orifice plate (385mm)	Attenuation pond	2,069	As described in Section 6.2.19, spatial constraints prevent attenuation pond provision for the adjacent proposed S1-OU15 catchment. The proposed S1-OU13 catchment intercepts a sizable portion of the existing catchment draining to S1-OU15 outfall resulting in higher discharge rates from the proposed S1-OU13 catchment. The ultimate receptor for the proposed S1-OU13, S1-OU13A, S1-OU14 and S1-OU15 catchments is the River Ter. Although the combined discharge rates from the proposed S1-OU13 and S1-OU13A catchments are higher than the existing case S1-OU13 allowable discharge rates, this is compensated for by discharge rate reductions in the adjacent proposed S1-OU15 catchment. A new outfall for S1-OU13 to River Ter will be required.
		P	80.4	120.7	162.0	265.5				

S1-OU14	Ordinary Watercourse 28 (ultimately River Ter)	A	78.7	75.0	104.6	194.2	None, unattenuated	None	-	Brownfield discharge rates are applicable due to online highway works. Existing S1-OU14 outfall to be retained. Attenuation pond provision is not possible for the proposed S1-OU14 catchment due to site-specific constraints. The attenuation storage required for the proposed S1-OU14 catchment has been mitigated for with the adjacent proposed S1-OU13 catchment attenuation pond.
		P	63.8	60.9	82.9	187.0				
S1-OU13A	Ordinary Watercourse 28 (ultimately River Ter)	A	60.4	41.7	57.1	133.6	Orifice plate (180mm)	Vegetated ditch	16	Brownfield discharge rates are applicable due to online highway works. Highway improvement works required for the existing B1137 (between Crix Bridge and Ordinary Watercourse 28) as an existing slip road to the A12 mainline is to be removed. Therefore, an existing B1137 catchment has been separated from the proposed S1-OU13 catchment due to the maintenance liability differences for the B1137 side road and the A12 mainline. The proposed S1-OU13A catchment utilises the existing S1-OU13 outfall.
		P	49.0	47.2	61.9	82.2				

S1-OU15	River Ter	A	416.7	422.5	532.3	731.8	None, unattenuated	None	-	Brownfield discharge rates are applicable due to online highway widening works. The catchment-specific comments for the proposed S1-OU13 catchment are applicable to the proposed S1-OU15 catchment. The existing S1-OU15 catchment outfall is to be retained.
		P	134.4	128.4	177.6	407.6				
Combined S1-OU13, S1-OU13A, S1-OU14 and S1-OU15	River Ter	A	555.8	539.2	694.0	1,059.6	N/A	N/A	N/A	The combined proposed discharge rates from the proposed S1-OU13, OU13A, OU14 and S1-OU15 catchments are less than the combined existing case S1-OU13, S1-OU14 and S1-OU15 allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as River Ter.
		P	327.6	357.2	484.4	942.3				

S1-OU17	River Ter	A	518.3	526.0	733.5	1,246.1	None, unattenuated	None	-	Brownfield discharge rates are applicable due to online highway widening works. Attenuation pond provision is not possible for the proposed S1-OU17 catchment due to site-specific space constraints. The attenuation storage required for the proposed S1-OU17 catchment is mitigated for by the adjacent proposed S1-OU18 attenuation pond. The receptor for the proposed S1-OU17 and S1-OU18 catchments is the River Ter. The combined proposed discharge rates from the proposed S1-OU17 and S1-OU18 catchments are less than the existing case S1-OU17 allowable discharge rates. The existing S1-OU17 catchment outfall is to be retained.
		P	512.6	518.7	635.3	1,122.1				
S1-OU18	Ordinary Watercourse 31 (ultimately River Ter)	A	(See comments)				Hydrobrake (107mm)	Attenuation pond	1,750	Brownfield discharge rates are applicable due to online highway widening works. The catchment-specific comments for the proposed S1-OU17 catchment are applicable to the proposed S1-OU18 catchment. A new outfall will be required.
		P	5.0	5.0	5.0	5.0				

Combined S1-OU17 and S1-OU18	River Ter	A	518.3	526.0	733.5	1246.1	N/A	N/A	N/A	The combined proposed discharge rates from the proposed S1-OU17 and S1-OU18 catchments are less than the existing case S1-OU17 allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as River Ter.
		P	517.6	523.7	641.3	1127.1				
S1-OU19	Ordinary Watercourse 7	A	151.2	150.0	149.1	294.1	Orifice plate (290mm)	Attenuation pond	657	Brownfield discharge rates are applicable due to online highway widening works. The combined proposed discharge rates from the S1-OU19, S1-OU19C and S1-OU19C1 catchments are less than the existing case S1-OU19 allowable discharge rates. A new outfall will be required. Ordinary Watercourse 7 may need minor regrading to increase the drainage ditch depth and improve the outfall pipe gradient.
		P	21.6	55.5	70.7	123.9				

S1-OU19C	Ordinary Watercourse 7	A	Greenfield (QMED) = 0.63				Hydrobrake (111mm)	Attenuation pond	560	Greenfield discharge rates are applicable as the proposed junction 21 Hatfield Peverel Link Road to be drained by the S1-OU19C highway drainage system is located on a currently greenfield site. The proposed S1-OU19C catchment highway drainage will drain the proposed link road portion to the east of the Ordinary Watercourse 7 A new outfall will be required which is restricted to a minimum practicable discharge rate of 5l/s for operation and maintenance reasons stated in Section 4.8 and Section 7.2. The proposed case higher greenfield discharge rates have been compensated for by the restricted proposed discharge rates for the proposed S1-OU19 catchment which ultimately discharges to the same watercourse (i.e. Ordinary Watercourse 7).
		P	5.0	5.0	5.0	5.0				

S1-OU19C1	Ordinary Watercourse 7	A	Greenfield (QMED) = 0.73				Hydrobrake (108mm)	Attenuation pond	673	Greenfield discharge rates are applicable as the proposed junction 21 Hatfield Peverel Link Road to be drained by the S1-OU19C1 highway drainage system is located on a currently greenfield site. The proposed S1-OU19C1 catchment highway drainage system will drain the proposed link road portion located to the west of Ordinary Watercourse. A new outfall will be required which is restricted to a minimum practicable discharge rate of 5l/s for operation and maintenance reasons stated in Section 4.8 and Section 7.2. The proposed case higher greenfield discharge rates have been compensated for by the restricted proposed discharge rates for the proposed S1-OU19 catchment which ultimately discharges to the same watercourse (i.e. Ordinary Watercourse 7).
		P	5.0	5.0	5.0	5.0				
Combined S1-OU19, S1-OU19C and S1-OU19C1	Ordinary Watercourse 7	A	151.2	150.0	149.1	294.1	N/A	N/A	N/A	The combined proposed discharge rates from proposed S1-OU19, S1-OU19C and S1-OU19C1 catchments are less than the existing case S1-OU19 allowable discharge rates. This would ensure there would be no

		P	31.6	65.5	80.7	133.9				adverse flood risk impact, considering that these catchments have a common ultimate receptor as Ordinary Watercourse 7.
S1-OU23	Existing drainage ditch (ultimately Ordinary Watercourse 32)	A	523.6	525.6	576.7	694.9	Pond outlet pipe (675mm)	Attenuation pond	3,975	Brownfield discharge rates are applicable due to the online highway widening works. The proposed S1-OU23 catchment also intercepts attenuated flows from the proposed S1-OU23C and S1-OU24A catchments. The attenuation pond outlet pipe acts as the flow control at the proposed S1-OU23 catchment outfall location. Existing outfall to be retained. The existing outfall location to an existing ditch is to be confirmed through further drainage survey.
		p	143.8	211.8	275.7	450.2				
S1-OU23C	Proposed highway drainage	A	Greenfield (QMED) = 0.78				Hydrobrake (108mm)	Attenuation pond	591	Proposed S1-OU23C catchment is a sub-catchment to the S1-OU23 catchment. Greenfield discharge rates are applicable given that the proposed

	system S1-OU23	P	5.0	5.0	5.0	5.0				junction 21 north-eastern slip road to be drained by the proposed S1-OU23C highway drainage system is located on a currently greenfield site.
S1-OU23D	Existing highway drainage system serving the B1389 road	A	18.6	12.2	16.6	40.1	Hydrobrake (107mm) and orifice plate (90mm)	Attenuation pond and oversized pipes	855 and 12	Greenfield discharge rates are applicable for the proposed junction 21 realigned Witham Link Road portion that extends from the northern roundabout as far as the proposed attenuation pond. The majority of the link road is located on a currently greenfield site. For the link road portion extending east beyond the attenuation pond and tying into the B1389, brownfield discharge rates are applicable due to the overlap with the B1389. This small portion of the proposed realigned Witham Link Road is attenuated by oversized pipes and an orifice plate.
		P	11.9	11.9	13.3	20.9				
S1-OU24A	Proposed highway drainage system S1-OU23	A	82.7	79.0	107.2	159.7	Orifice plate (200mm)	Attenuation pond	352	Proposed S1-OU24A catchment is a sub-catchment to the S1-OU23 catchment. Brownfield discharge rates are applicable given that the existing case S1-OU24 catchment outfall

		P	19.3	25.9	34.1	52.9				location is to be retained. This existing outfall discharges to the A12 mainline in the existing case and hence the proposed S1-OU24A catchment will discharge to the A12 mainline highway drainage system similarly (i.e. the proposed S1-OU23 catchment).
S1-OU24B	Existing drainage ditch (ultimately to Ordinary Watercourse 32)	A	Greenfield (QMED) = 1.95				Hydrobrake (107mm)	Attenuation pond	1,291	Greenfield discharge rates are applicable given that the proposed Kennel access road to be drained by the S1-OU24B highway drainage system is located on a currently greenfield site and will discharge via a new outfall to an existing drainage ditch. The new outfall is restricted to a minimum practicable discharge rate of 5l/s for operation and maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
		P	5.0	5.0	5.0	5.0				

Notes:

1. Where there is no nearby receiving watercourse locally (i.e. Main River, Ordinary Watercourse, existing drainage ditch or proposed drainage ditch), the proposed catchments in such situations discharge to the nearest available existing highway drainage system which will ultimately discharge to a watercourse further downstream.

2. FEH2013 rainfall data have been used in the hydraulic modelling of the proposed highway drainage systems for the proposed scheme. FEH2013 rainfall cannot be used for the assessment of the 1 in 1-year return period storm event. Therefore, FEH1999 rainfall data have been used for the assessment of the 1 in 1-year return period storm event. Section 4.6 provides further details on the rainfall data inputs.
3. The existing case allowable discharge rates do not include a climate change allowance given that current climatic conditions are required to inform the discharge rates for the proposed highway drainage systems. Where applicable the brownfield allowable discharge rates have been determined based on the information available from the drainage surveys undertaken at the Stage 3 Preliminary Design. It is noted that the drainage surveys were found to have gaps in the information and/or were found to be incomplete and as such appropriate design assumptions have been made where necessary. These assumptions, including the potential impact to the current brownfield discharge rate estimates presented in this summary table, would need to be reviewed at detailed design stage.
4. The proposed case discharge rates include a climate change allowance as described in Section 4.4.
5. The modelled proposed case attenuation storage volumes are determined for the 1 in 100-year return period storm event plus a 20% climate change allowance.
6. For the proposed drainage catchments subject to online highway widening works, the modelled allowable discharge rates are modelled brownfield discharge rates for the existing paved area footprint (to be retained) only and do not take into account the greenfield discharge rates for the proposed highway widening catchment portion (i.e. 'New paved area' from the paved area summary tables in Annex B). This is a conservative design approach to determine the maximum attenuation storage volume requirements to inform the proposed scheme land take requirements.
7. The use of a minimum practicable discharge rate of 5l/s at proposed outfall locations S1-OU7A and S1-OU24B would result in a slight increase in discharge rates in comparison to the existing site allowable discharge rates or greenfield runoff rates. These proposed outfall locations have been assessed in the Flood Risk Assessment (ES Appendix 14.5 of the ES ([TR010060/APP/6.3]).The Flood Risk Assessment identifies a negligible impact on the surface water drainage flood risk at these proposed outfall locations.

Table C.2 Drainage Section 2 proposed site condition outfall discharge rates and attenuation storage volumes

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU3	Ordinary Watercourse 9	A	62.1	66.5	87.9	158.7	Orifice plate (230mm)	Oversized pipes	55	Brownfield discharge rates are applicable due to online highway widening works. Existing outfall to be retained. Oversized pipes have been used for attenuation storage due to spatial constraints at the site.
		P	61.3	59.6	69.0	131.7				
S2-OU4	River Brain	A	161.4	154.2	187.4	257.0	Orifice plate (315mm)	Attenuation pond	1,094	Brownfield discharge rates are applicable due to online highway widening works. The proposed S2-OU4 catchment will discharge to a new outfall on the River Brain. The River Brain currently accepts surface water runoff from the existing A12 mainline. The proposed discharge rates have been additionally restricted below the existing

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	42.6	62.4	84.0	147.8				case allowable discharge rates at the S2-OU4 outfall. This is to compensate for the higher proposed discharge rates from the adjacent S2-OU5 outfall which discharges at a similar location on the River Brain (see S2-OU5 comments). Therefore, the combined proposed discharge rates for the S2-OU4 and S2-OU5 catchments are less than the combined existing case allowable discharge rates.
S2-OU5	River Brain	A	116.5	112.8	143.6	284.3	Orifice plate (400mm)	Oversized pipes	67	Brownfield discharge rates are applicable due to online highway widening works. Outfalls to an existing outfall on the River Brain which accepts surface water runoff from the existing A12. Oversized pipes have been used for attenuation storage due to spatial constraints at the site (i.e. presence of a nature reserve to the east and a dense urban area to the west of the proposed S2-OU5 catchment). The proposed discharge rates are greater than the existing case allowable discharge rates at S2-OU5. However, this increase

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	179.3	170.8	210.2	361.7				in discharge rates has been compensated by additionally restricting the proposed discharge rates for S2-OU4 which discharges at a similar location on the River Brain. Therefore, the combined proposed discharge rates for the S2-OU4 and S2-OU5 catchments are less than the combined existing case allowable discharge rates.
Combined S2-OU4 and S2-OU5	River Brain	A	277.9	267.0	331.0	541.3	N/A	N/A	N/A	The combined proposed discharge rates for the proposed S2-OU4 and S2-OU5 catchments are less than the combined existing case allowable discharge rates. This would ensure there would be no

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	221.9	233.2	294.2	509.5				adverse flood risk impact, considering that these catchments have a common ultimate receptor as River Brain.
S2-OU8	Ordinary Watercourse 9a	A	266.4	269.2	342.8	604.9	Orifice plate (440mm)	Oversized pipes	274	Brownfield discharge rates are applicable due to online highway widening works. Outfalls to an existing outfall on Ordinary Watercourse 9a which currently accepts surface water runoff from the existing A12 mainline. Oversized pipes have been used for attenuation storage due to spatial constraints at the site (i.e. presence of a nature reserve and a potential flood plain to the east, and a dense urban area to the west of the proposed S2-OU8 catchment).
		P	250.6	259.0	325.5	554.3				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU9A	Ordinary Watercourse 10	A	142.9	149.2	174.8	183.7	Orifice plate (325mm)	Oversized pipes	12	Brownfield discharge rates are applicable given that the proposed S2-OU9A highway drainage is discharging to Ordinary Watercourse 10. Oversized pipes have been used for attenuation storage due to spatial constraints at the site. The proposed S2-OU9A catchment utilises an existing S2-OU9 outfall location that needs to be repositioned locally on Ordinary Watercourse 10. The S2-OU9A catchment allowable discharge rates use the existing case S2-OU9 catchment allowable discharge

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	70.1	60.9	80.8	160.7				rates. The proposed S2-OU9A discharge rates do not take into account the potential future redundant pavements (i.e. existing paved area assumed to be removed) which currently includes a portion of existing A12 mainline, the existing junction 22 and associated slip roads.
S2-OU9	Ordinary Watercourse 10	A	Greenfield (QMED) = 3.2				Hydro brake (107mm)	Attenuation pond	2,789	Greenfield discharge rates are applicable as the proposed offline A12 mainline portion and new slip roads to proposed junction 22 drained by the S2-OU9 highway drainage are located on a currently greenfield site. A new outfall on Ordinary Watercourse 10 will be required.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				The proposed S2-OU9, S2-OU9A and S2-OU10 catchments discharge to the same watercourse (Ordinary Watercourse 10). The combined proposed discharge rates from the proposed S2-OU9, S2-OU9A and S2-OU10 catchments have been restricted below the existing case S2-OU9 catchment allowable discharge rates.
S2-OU10	Ordinary Watercourse 10	A	19.6	18.5	25.2	53.8	Hydrobrake (107mm)	Attenuation pond	845	Greenfield discharge rates are applicable for the junction 22 southern roundabout and local road portion that ties into the existing Little Braxted Lane. This is due to the majority of the local road being located on a currently greenfield site. For the Little Braxted Lane highway improvement works, brownfield discharge rates are applicable. The existing outfall serving Little Braxted Lane was not identified due to lack of drainage survey. A new outfall is assumed to be required. Based on the above, brownfield discharge rates are assumed for this new outfall on Ordinary Watercourse 10. Discharge rates from the proposed S2-OU10 restricted to 5l/s.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
Combined S2-OU9, S2-OU9A and S2-OU10	Ordinary Watercourse 10	A	142.9	149.2	174.8	183.7	N/A	N/A	N/A	The combined proposed discharge rates for the proposed S2-OU9, S2-OU9A and S2-OU10 catchments are less than the existing case S2-OU9 allowable discharge rates to Ordinary Watercourse 10. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Ordinary Watercourse 10.
		P	80.1	70.9	90.8	170.7				
S2-OU11	Ordinary Watercourse 11	A	6.2	5.8	8.0	18.7	Hydrobrake (107mm)	Attenuation pond	784	Brownfield discharge rates are applicable given that the proposed highway drainage to serve the proposed Colchester Link Road and the highway improvement works on Colchester Road itself is discharging to a new outfall location on Ordinary Watercourse 11, which currently accepts surface water runoff from the existing A12 mainline.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
										The discharge rates from proposed S2-OU11 catchment have been restricted to 5l/s.
S2-OU14	Ordinary Watercourse 12	A	114.1	105.4	141.4	302.0	Hydrobrake (107mm)	Attenuation pond	703	Greenfield discharge rates are applicable for the junction 22 northern roundabout and the adjoining proposed de-trunked A12 link road. This is due to the fact that the majority of the proposed link road is located on a currently greenfield site. For the highway improvement works on the existing A12 that currently discharges to an existing outfall on Ordinary Watercourse 12, brownfield discharge rates are applicable. However, due to spatial constraints at the existing outfall location where the provision of an attenuation pond is not practicable, a new outfall will be required on the diverted Ordinary Watercourse 12. Therefore, the allowable discharge rates for the proposed S2-OU14 catchment have been restricted to 5l/s.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU15A	Ordinary Watercourse 12	A	Greenfield (QMED) = 9.4				Hydrobrake (144mm)	Attenuation pond	3,502	Greenfield discharge rates are applicable given that the proposed offline A12 mainline portion to be drained by the S2-OU15A highway drainage system is located on a currently greenfield site. A new outfall on Ordinary Watercourse 12 will be required.
		P	8.1	9.4	9.4	9.4				
S2-OU15C	Ordinary Watercourse 13 (ultimately Ordinary Watercourse 12)	A	Greenfield (QMED) = 6.0				Hydrobrake (107mm)	Attenuation pond	3,502	Greenfield discharge rates are applicable given that the proposed offline A12 mainline portion to be drained by the S2-OU15C highway drainage system is located on a currently greenfield site. A new outfall on Ordinary Watercourse 13 will be required.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU15D	Proposed drainage ditch (ultimately Ordinary Watercourse 12)	A	Greenfield QMED = 1.1				Hydrobrake (111mm)	Attenuation pond	345	Greenfield discharge rates are applicable given that the proposed realigned Braxted Road portion to be drained by the S2-OU15D highway drainage system is located on a currently greenfield site. The proposed case higher greenfield discharge rates have been compensated for by the restricted proposed discharge rates for the proposed S2-OU14 catchment which ultimately discharges to the same watercourse (i.e. Ordinary Watercourse 12). A new outfall to a proposed drainage ditch will be required.
		P	5.0	5.0	5.0	5.0				
S2-OU15E	Ordinary Watercourse 12a (ultimately Ordinary Watercourse 12)	A	38.3	35.5	50.9	92.1	Hydrobrake (107mm)	Attenuation pond	445	Greenfield discharge rates are applicable for the proposed Realigned Braxted Road portion that ties into the existing A12 given that it is located on a currently greenfield site. For the highway improvement works on the existing A12 that currently discharges to an existing outfall on Ordinary

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				Watercourse 12a, brownfield discharge rates are applicable. However, due to the proposed road geometry for the new Braxted Road portion, a new outfall will be required on Ordinary Watercourse 12a. Therefore, the allowable discharge rates for the proposed S2-OU15E catchment have been restricted to 5l/s.
S2-OU15C1	Ordinary Watercourse 15a (ultimately Rivenhall Brook)	A	Greenfield (QMED) = 0.9				Hydrobrake (107mm)	Attenuation pond	539	Greenfield discharge rates are applicable given that the proposed offline A12 mainline portion to be drained by the S2-OU15C1 highway drainage system is located on a currently greenfield site. The proposed case higher greenfield discharge rates of 5l/s have been compensated for by the reduced proposed discharge rates for the proposed S2-OU24 catchment which ultimately discharges to the same watercourse, Rivenhall Brook. A new outfall on Ordinary Watercourse 15a will be required.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU15D1	Braxted Road existing highway drainage system	A	12.9	12.3	16.7	35.3	None, unattenuated	None	-	Brownfield discharge rates are applicable due to online highway widening works to the existing Braxted Road. The existing outfall arrangement to the existing highway drainage system serving Braxted Road is to be retained. The proposed S2-OU15D1 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case S2-OU15D1 allowable discharge rates without the use of a formal means of attenuation storage. This is due to the proposed case catchment areas for S2-OU15D1 having been reduced, and mitigation storage provided within the adjacent proposed S2-OU15D catchment attenuation pond.
		P	6.5	6.2	7.9	13.1				
S2-OU15G	Rivenhall Brook	A	Greenfield (QMED) = 6.6				Hydrobrake (121mm)	Attenuation pond	3,692	Greenfield discharge rates are applicable given that the proposed offline A12 mainline portion to be drained by the S2-OU15G highway drainage system is located on a currently greenfield site.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	6.4	6.4	6.4	6.4				A new outfall on Rivenhall Brook will be required.
S2-OU15H	Proposed drainage ditch (ultimately Ordinary Watercourse 17	A	Greenfield (QMED) = 1.6				Hydrobrake (107mm)	Attenuation pond	920	Greenfield discharge rates are applicable given that the proposed new B1024 Link Road portion to be drained by the S2-OU15H highway drainage system is located on a currently greenfield site. The proposed case higher discharge rates have been compensated for by the restricted proposed discharge rates for proposed S2-OU26 catchment which ultimately discharges to the same watercourse (Ordinary Watercourse 17). A new outfall to the proposed ditch immediately upstream of proposed culvert CL-17B.1 will be required.
		P	4.9	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU26	Ordinary Watercourse 17	A	208.5	201.7	270.2	420.5	None, unattenuated	None	-	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to an existing outfall on Ordinary Watercourse 17. The existing outfall may need to be repositioned locally on Ordinary Watercourse 17. The proposed S2-OU26 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case S2-OU26 allowable discharge rates without the use of a formal means of attenuation storage. This is due to the catchment area for the proposed S2-OU26 catchment having been reduced relative to the existing case due to the potential removal of existing A12 redundant pavements.
		P	103.0	97.0	133.2	256.5				
S2-OU17	London Road (B1024) existing highway drainage system (ultimately to	A	33.6	31.6	41.2	60.6	None, unattenuated	None	-	Brownfield discharge rates are applicable due to online highway widening works to the existing London Road. The existing outfall arrangement to the existing highway drainage system serving London Road is to be retained

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
	River Blackwater)	P	9.7	9.1	12.6	28.6				The proposed S2-OU17 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case S2-OU17 allowable discharge rates without the use of a formal means of attenuation storage. This is due to the proposed case catchment area for S2-OU17 having been reduced and mitigation attenuation storage provided within the adjacent proposed S2-OU18 catchment attenuation pond.
S2-OU18	River Blackwater	A	76.7	73.2	89.4	133.8	Hydrobrake (111mm)	Attenuation pond	273	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to an existing outfall on the River Blackwater which currently accepts surface water runoff from the existing B1024 side road. The proposed S2-OU18 catchment attenuation pond is an offline attenuation pond restricted to 5l/s.
		P	52.7	49.4	61.2	82.3				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU19	River Blackwater	A	228.2	214.3	264.2	296.5	Hydrobrake (107mm)	Attenuation pond	1,585	Brownfield discharge rates are applicable given that the highway drainage from the proposed A12 mainline is discharging to the River Blackwater which currently accepts surface water runoff from the existing A12 mainline and the B1024 local road. The existing S2-OU19 catchment has been divided up between the proposed S2-OU19 catchment (draining proposed

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				A12 mainline) and the proposed S2-OU27 catchment (draining B1024 local road). The proposed S2-OU19 catchment attenuation pond needs to be located outside the potential River Blackwater floodplain which requires a new outfall to be provided on the River Blackwater. The existing case brownfield discharge rates for the S2-OU19 catchment have been adjusted with the proposed S2-OU27 catchment which discharges at a similar location on River Blackwater (See S2-OU27 catchment comments).

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU27	River Blackwater	A	(See comments)				None, unattenuated	None	-	Catchment-specific comments for the S2-OU19 catchment are also applicable to this catchment. The proposed S2-OU27 catchment requires no attenuation storage given that the proposed adjusted discharge rates are less than the existing case allowable discharge rates without the use of a formal means of attenuation storage. This is due to the fact that the proposed case catchment areas for S2-OU27 have been reduced and mitigation attenuation storage is provided at the adjacent proposed S2-OU19 catchment attenuation pond.
		P	69.8	79.1	108.8	230.3				
Combined S2-OU19 and OU27	River Blackwater	A	228.2	214.3	264.2	296.5	N/A	N/A	N/A	The combined proposed discharge rates for the proposed S2-OU19 and S2-OU27 catchments are less than the existing case allowable discharge rates to the

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	74.8	84.1	113.8	235.3				River Blackwater. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as River Blackwater.
S2-OU24	Ordinary Watercourse 15 (ultimately Rivenhall Brook)	A	66.5	66.5	86.1	123.8	Orifice plate (225mm)	Oversized pipes	14	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to an existing outfall on Ordinary Watercourse 15 which currently accepts surface water runoff from the existing A12 mainline. The existing outfall may need to be repositioned locally on Ordinary Watercourse 15. The existing allowable discharge rates include the existing S2-OU25 catchment that becomes part of the proposed S2-OU24 catchment.
		P	46.2	46.2	63.5	115.6				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU24A	Proposed drainage ditch (ultimately Ordinary Watercourse 15 and Rivehhall Brook)	A	Greenfield (QMED) = 0.8				Hydrobrake (107mm)	Attenuation pond	284	Greenfield discharge rates are applicable given that the new B1024 Link Road portion to be drained by the S2-OU24A highway drainage system is located on a currently greenfield site. A new outfall to the proposed drainage ditch immediately upstream of proposed Culvert CL-15B will be required. The proposed S2-OU24 and S2-OU24A catchments discharge to the same watercourse (Ordinary Watercourse 15). The combined proposed discharge rates from the S2-OU24, S2-OU24A and S2-OU15C1 catchments have been restricted below the existing case S2-OU24 catchment allowable discharge rates.
		P	5.0	5.0	5.0	5.0				
Combined S2-OU24, OU24A and	Ordinary Watercourse 15 and 15a (ultimately	A	66.5	66.5	86.1	123.8	N/A	N/A	N/A	The combined proposed discharge rates for the proposed S2-OU24, S2-OU24A and S2-OU15C1 catchments are less than the existing case

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S2-OU15C1	Rivenhall Brook)	P	56.2	56.2	73.5	120.6				S2-OU24 catchment allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Rivenhall Brook.

Notes:

1. Where there is no nearby receiving watercourse locally (i.e. Main River, Ordinary Watercourse, existing drainage ditch or proposed drainage ditch), the proposed catchments in such situations discharge to the nearest available existing highway drainage system which will ultimately discharge to a watercourse further downstream.
2. FEH2013 rainfall data have been used in the hydraulic modelling of the proposed highway drainage systems for the proposed scheme. FEH2013 rainfall cannot be used for the assessment of the 1 in 1-year return period storm event. Therefore, FEH1999 rainfall data have been used for the assessment of the 1 in 1-year return period storm event. Section 4.6 provides further details on the rainfall data inputs.
3. The existing case allowable discharge rates do not include a climate change allowance given that current climatic conditions are required to inform the discharge rates for the proposed highway drainage systems. Where applicable the brownfield allowable discharge rates have been determined based on the information available from the drainage surveys undertaken at the Stage 3 Preliminary Design. It is noted that the drainage surveys were found to have gaps in the information and/or were found to be incomplete and as such appropriate design assumptions have been made where necessary. These assumptions, including the potential impact to the current brownfield discharge rate estimates presented in this summary table, would need to be reviewed at detailed design stage.
4. The proposed case discharge rates include a climate change allowance as described in Section 4.4.
5. The modelled proposed case attenuation storage volumes are determined for the 1 in 100-year return period storm event plus a 20% climate change allowance.
6. For the proposed drainage catchments subject to online highway widening works, the modelled allowable discharge rates are modelled brownfield discharge rates for the existing paved area footprint (to be retained) only and do not take into account the greenfield discharge rates for the proposed highway widening catchment portion (i.e. 'New paved area' from the paved area summary tables in Annex B). This is a conservative design approach to determine the maximum attenuation storage volume requirements to inform the proposed scheme land take requirements.

Table C.3 Drainage Section 3 proposed site condition outfall discharge rates and attenuation storage volumes

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU1	River Blackwater	A	312.6	315.8	318.6	538.6	Orifice plate (400mm)	Attenuation pond	1,389	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to an existing outfall on the River Blackwater which currently accepts surface water runoff from the existing A12 mainline. The existing case allowable discharge rates for the proposed S3-OU1 catchment include the existing case discharge rates for the existing S2-OU20 catchment, given that the proposed S3-OU1 catchment boundary includes the existing S2-OU20 catchment

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	39.7	55.9	74.2	172.7				footprint. The existing S2-OU20 catchment outfall to the River Blackwater will be retained. However, the catchment area to be drained will reduce and would be limited to the retained earthworks only, given that the proposed highway will drain to the proposed S3-OU1 catchment outfall. The proposed attenuation pond outlet pipe will connect into an assumed existing 750mm diameter pipe discharging to River Blackwater. This 750mm diameter pipe is to be confirmed through further drainage survey.
S3-OU2	Ordinary Watercourse 21 (ultimately River Blackwater)	A	55.3	54.2	68.0	114.9	Orifice plate (270mm)	Attenuation pond	2,693	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to Ordinary Watercourse 21 which currently accepts surface water runoff from the existing A12 mainline.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	35.2	52.2	67.5	102.2				A new outfall to Ordinary Watercourse 21 will be required. The existing highway drainage outfall to existing culvert CL-21 needs to be abandoned due to the online highway widening works. A complex flow control device (orifice plate and weir combination) is required to ensure that the proposed discharge rates meet the existing case allowable discharge rates.
S3-OU3	Ordinary Watercourse 18	A	25.7	24.7	32.0	39.2	Hydrobrake (107mm)	Attenuation pond	317	The proposed improved Highfields Lane side road portion to be drained by the S3-OU3 highway drainage system is to discharge to a new outfall on Ordinary Watercourse 18. An existing outfall serving Highfields Lane locally could not be identified due to a lack of drainage survey in the area. Therefore, a new outfall was assumed to be required. Based on the above, brownfield allowable discharge rates are assumed to be applicable for this new outfall location. However, due to the lack of drainage survey confirming the existing outfall, a minimum practicable discharge rate of 5l/s is used.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU4	Ordinary Watercourse 21	A	27.8	27.5	29.7	31.9	Hydrobrake (107mm)	Attenuation pond	142	The proposed improved Highfields Lane side road portion to be drained by the S3-OU4 highway drainage system is to discharge to a new outfall on Ordinary Watercourse 21. An existing outfall serving Highfields Lane locally could not be identified due to a lack of drainage survey in the area. Therefore, a new outfall was assumed to be required. Based on the above, brownfield allowable discharge rates are assumed to be applicable for this new outfall location. However, due to lack of drainage survey confirming the existing outfall, a minimum practicable discharge rate of 5l/s is used.
		P	5.0	5.0	5.0	5.0				
S3-OU5	River Blackwater	A	35.1	33.6	45.2	100.5	Hydrobrake (107mm)	Attenuation pond	317	The proposed realigned Maldon Road to be drained by the S3-OU5 highway drainage system is to discharge to a new outfall location on the River Blackwater. An existing outfall serving Maldon Road locally could not be identified due to a lack of

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				drainage survey in the area. Therefore, a new outfall was assumed to be required. Based on the above, brownfield discharge rates are assumed to be applicable for this new outfall. However, due to lack of drainage survey confirming the existing outfall, a minimum practicable discharge rate of 5l/s is used.
S3-OU6	Ordinary Watercourse 21a (ultimately Domsey Brook)	A	60.5	56.0	75.0	139.9	None, unattenuated	None	-	Greenfield discharge rates would typically be applicable as the proposed junction 24 slip road portion drained by the S3-OU6 highway drainage system is located on a currently greenfield site. However, the proposed S3-OU6 catchment discharges to proposed culvert CL-21a on Ordinary Watercourse 21a which accepts surface water from the existing S3-OU6 A12 catchment. Therefore, brownfield discharge rates for the existing S3-OU6 catchment are used as the allowable discharge rates for the proposed S3-OU6 catchment. No attenuation storage is required for this catchment as the proposed discharge rates are less than the existing allowable discharge rates.
		P	14.2	13.7	18.4	38.5				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU7	Domsey Brook	A	47.8	44.7	57.6	96.4	None	None	-	Brownfield discharge rates are applicable due to the proposed online widening works and given that Domsey Brook already accepts surface water runoff from the existing A12 mainline. The proposed S3-OU7 catchment discharges to the proposed S3-OU8A catchment attenuation pond and uses the new outfall to Domsey Brook serving the proposed S3-OU8A catchment (see the S3-OU8A comments).
		P	(See comments)							
S3-OU7A	Ordinary Watercourse 21a (ultimately Domsey Brook)	A	47.8	44.7	57.6	96.4	None, unattenuated	None	–	Greenfield discharge rates would typically be applicable as the proposed junction 24 slip road portion, drained by the S3-OU7A highway drainage system, is located on a currently greenfield site. However, the proposed S3-OU7A catchment discharges to proposed culvert CL-21a on Ordinary Watercourse 21a which accepts surface water from the existing S3-OU7 A12

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	41.5	39.4	49.6	89.0				catchment. Therefore, existing case brownfield discharge rates for the existing S3-OU7 catchment have been utilised as the allowable discharge rates for the proposed S3-OU7A catchment. No attenuation storage is required for this minor catchment as the proposed discharge rates for the S3-OU7A catchment are less than the existing case allowable discharge rates.
S3-OU8A	Domsey Brook	A	Greenfield (QMED) = 10.0				Hydrobrake (319mm)	Attenuation pond	2,358	Greenfield discharge rates are applicable given that the portion of proposed junction 24 to be drained by the S3-OU8A highway drainage system is located on a currently greenfield site. A new outfall to Domsey Brook will be required. The proposed S3-OU8A attenuation pond also accepts the surface water discharge

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	52.0	57.0	57.9	57.9				from the proposed S3-OU7 catchment on the A12 mainline. The higher proposed discharge rates for the S3-OU8A catchment have been compensated for by the reduced proposed discharge rates for the proposed S3-OU6 catchment and S3-OU7A catchment, as the ultimate receptor for these catchments is Domsey Brook.
Combined S3-OU6, S3-OU7, S3-OU7A and S3-OU8A	Domsey Brook	A	118.3	110.7	142.6	246.3	N/A	N/A	N/A	The combined proposed discharge rates for the proposed S3-OU6, S3-OU7, S3-OU7A and S3-OU8A catchments are less than the existing case combined allowable discharge rates for the S3-OU6, S3-OU7A and S3-OU8A catchments. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Domsey Brook.
		P	107.7	110.1	125.9	185.4				
S3-OU8	Domsey Brook	A	101.5	93.4	125.6	188.3	Orifice plate (440mm)	Attenuation pond	875	An existing outfall serving the A12 mainline locally was not identified on Domsey Brook due to a lack of drainage survey in the area.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	39.1	55.1	74.5	186.6				Therefore, a new outfall was assumed to be required. Based on the above, brownfield discharge rates are applicable for this new outfall location given the proposed online widening works and the proximity of the existing A12 mainline to the nearby Domsey Brook.
S3-OU8B	Proposed drainage ditch (ultimately Domsey Brook)	A	Greenfield (QMED) = 1.0				Hydrobrake (107mm)	Attenuation pond	226	Greenfield discharge rates are applicable given that the new Inworth Link Road portion and a new Inworth Road Roundabout to be drained by the S3-OU8B highway drainage system, are located on a currently greenfield site. A new outfall to a proposed drainage ditch will be required. The S3-OU8B catchment also accepts attenuated flows from the S3-OU8D catchment. Greenfield runoff rate estimates are the combined greenfield runoff rates for the S3-OU8B and S3-OU8D catchments. The higher proposed discharge rates for the S3-OU8B catchment (which includes the proposed S3-OU8D catchment) have been compensated for by the reduced proposed discharge rates for the proposed S3-OU9 catchment as the ultimate receptor for both of
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
										these proposed catchments is Domsey Brook.
S3-OU8D	Proposed drainage system for S3-OU8B	A	(See comments)				Hydrobrake (107mm)	Attenuation pond	258	Greenfield discharge rates are applicable given that the new Inworth Link Road portion and a new mini roundabout to be drained by the S3-OU8B highway drainage system, are located on a currently greenfield site. The proposed S3-OU8D catchment is a sub-catchment to the S3-OU8B catchment (see S3-OU8B comments). Greenfield discharge rate estimates for the S3-OU8B catchment include the greenfield runoff rates for the S3-OU8D catchment. The discharge from the S3-OU8D attenuation pond has been restricted to 5l/s.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU8C	Existing drainage ditch adjacent to Inworth Road	A	6.0	5.7	7.7	15.9	Orifice plate (150mm) and hydrobrake (105mm)	Vegetated ditch and oversized pipes	45	Greenfield discharge rates are applicable for the new Inworth Link Road portion to be drained by the S3-OU8C highway drainage system which is located on a currently greenfield site. For the highway improvement works on the existing Inworth Road portion that currently discharges to an existing drainage ditch, brownfield discharge rates are applicable. Based on the above, brownfield discharge rates are applicable. However, due to lack of drainage survey confirming the existing drainage catchment, a minimum practicable discharge rate of 5l/s is used. A new outfall is required to an existing drainage ditch adjacent to Inworth Road.
		P	5.0	5.0	5.0	5.0				
S3-OU8E	Inworth Road existing highway drainage system	A	11.9	11.4	15.3	32.0	Hydrobrake (107mm)	Attenuation pond	94	Greenfield discharge rates are applicable, given that the new Inworth Link Road portion to be drained by the S3-OU8E highway drainage system is located on a currently greenfield site. For the highway improvement works on the existing Inworth Road portion

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				that currently discharges to an existing drainage system, brownfield discharge rates are applicable. Based on the above, brownfield discharge rates are applicable. The proposed highway drainage will retain connection to the existing highway drainage system on Inworth Road.
S3-OU9	Domsey Brook (West)	A	27.0	25.3	34.1	80.7	Orifice plate (200mm)	Attenuation pond	327	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to Domsey Brook which currently accepts surface water runoff from the existing A12 mainline. An existing outfall serving the A12 mainline locally needs to be repositioned on Domsey Brook due to the proposed online widening works.
		P	12.8	17.2	23.5	46.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
Combined S3-OU8B (OU8D) and S3-OU9	Domsey Brook (West)	A	27.0	25.3	34.1	80.7	N/A	N/A	N/A	A check has been undertaken to ensure that the combined proposed discharge rates for the proposed S3-OU8B catchment (includes the S3-OU8D catchment) and the proposed S3-OU9 catchment are less than the existing case allowable discharge rates for the S3-OU9 catchment, as the ultimate receptor for both of these proposed catchments is Domsey Brook.
		P	17.8	22.2	28.5	51.0				
S3-OU10	Domsey Brook (West)	A	Greenfield (QMED) = 6.8				Hydrobrake (122mm)	Attenuation pond	3,027	Greenfield discharge rates are applicable given that the proposed offline A12 mainline portion to be drained by the proposed S3-OU10 highway drainage system is located on a currently greenfield site. A new outfall on Domsey Brook will be required.
		P	6.6	6.6	6.6	6.6				
S3-OU13	Existing drainage ditch (ultimately	A	Greenfield (QMED) = 0.9				Hydrobrake (111mm)	Attenuation pond	136	Greenfield discharge rates are applicable as the proposed portion of Ewell Hall Chase to be drained by the S3-OU13 highway

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
	River Blackwater)	P	5.0	5.0	5.0	5.0				drainage system is located on a currently greenfield site. A new outfall to an existing drainage ditch will be required, restricted to a minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
S3-OU14	Proposed drainage ditch (ultimately Ordinary Watercourse 21a)	A	Greenfield (QMED) = 0.3				Hydrobrake (111mm)	Attenuation pond	59	Greenfield discharge rates are applicable as the proposed portion of Ewell Hall Chase to be drained by the S3-OU14 highway drainage system is located on a currently greenfield site. A new outfall to a proposed drainage ditch will be required. A minimum practicable discharge rate of 5l/s for operation and maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU15	Existing highway drainage system (ultimately Ordinary Watercourse 26)	A	124.4	120.5	155.2	256.2	None, unattenuated	None	–	Brownfield discharge rates are applicable for this outfall location as the proposed highway drainage is discharging to existing culvert CL-26 serving the existing A12 mainline. The proposed S3-OU15 catchment requires no attenuation storage given that the proposed discharge rates are less than the existing case S3-OU15 allowable discharge rates without the use of a formal means of attenuation storage. This is due to the fact that the proposed catchment area for S3-OU15 has been reduced and mitigation attenuation storage is provided at the adjacent proposed S3-OU15B catchment attenuation pond and the S3-OU15C catchment attenuation pond.
		P	84.7	81.7	106.7	181.4				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU15B	Proposed drainage ditch (ultimately Ordinary Watercourse 26)	A	Greenfield (QMED) = 0.5				Hydrobrake (111mm)	Attenuation pond	89	Greenfield discharge rates are applicable given that the proposed junction 25 northbound off-slip road to be drained by the S3-OU15B highway drainage system is located on a currently greenfield site. A new outfall to the proposed ditch will be required. A minimum practicable discharge rate of 5l/s is used for operation and maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table. The S3-OU15B catchment ultimately discharges to Ordinary Watercourse 26. Any increase in proposed discharge rates have been compensated for by the restricted proposed case discharge rates for adjacent S3-OU15 catchment that also discharges to Ordinary Watercourse 26.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU15C	Proposed drainage ditch (ultimately Ordinary Watercourse 26)	A	Greenfield (QMED) = 0.4				Hydrobrake (111mm)	Attenuation pond	89	Greenfield discharge rates are applicable given that the portion of proposed de-trunked A12 link road to be drained by the S3-OU15C highway drainage system is partially located on a currently greenfield site. For the highway improvement works on the existing A12 that currently discharges to Ordinary Watercourse 26, brownfield discharge rates are applicable. However, a new outfall to the proposed ditch will be required. Therefore, a minimum practicable discharge rate of 5l/s is used. The S3-OU15C catchment ultimately discharges to Ordinary Watercourse 26. The higher proposed discharge rates have been compensated for by the restricted proposed case discharge rates for the adjacent S3-OU15 catchment that also discharges to Ordinary Watercourse 26.
		P	5.0	5.0	5.0	5.0				
Combined S3-OU15, S3-OU15B and S3-OU15C	Ordinary Watercourse 26	A	124.4	120.5	155.2	256.2	N/A	N/A	N/A	The combined proposed discharge rates for the proposed S3-OU15, S3-OU15B and S3-OU15C catchments are less than the existing case allowable discharge rates for the S3-OU15 catchment as all three proposed catchments. This would ensure there would

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	94.7	91.9	116.7	191.4				be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Ordinary Watercourse 26.
S3-OU15A	Proposed S3-OU16 catchment highway drainage system	A	Greenfield (QMED) = 3.9				Hydrobrake (107mm)	Attenuation pond	1,133	The proposed S3-OU15A catchment is a sub-catchment to the proposed S3-OU16 catchment (See comments for S3-OU16). Greenfield discharge rates are applicable given that the proposed offline A12 mainline and adjoining link roads to be drained by the S3-OU15A highway drainage system are largely located on a currently greenfield site. The discharge from the S3-OU15A attenuation pond has been restricted to 5l/s. However, the ultimate outfall is the proposed S3-OU16 outfall.
		P	5.0	5.0	5.0	5.0				
S3-OU16	Coggeshall Road existing highway drainage system	A	270.8	261.6	327.4	558.7	Orifice plate (350mm)	Attenuation pond	273	Brownfield discharge rates are applicable for this outfall location given that the proposed highway drainage is discharging to an

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	55.5	67.4	86.0	159.2				existing highway drainage system serving Coggeshall Road. The proposed S3-OU16 catchment attenuation pond also receives the attenuated flows from the adjacent proposed S3-OU15A catchment.
S3-OU17	Roman River	A	502.6	512.2	590.9	784.6	Hydrobrake (107mm) and orifice plate (446mm)	Attenuation pond	1,585	Brownfield discharge rates are applicable for this outfall as the proposed highway drainage is discharging to an existing outfall on the Roman River. The existing outfall needs to be repositioned locally along the Roman River due to online widening works to the A12 mainline. The proposed S3-OU17 attenuation pond is an offline attenuation pond restricted to 5l/s. The A12 mainline catchment portion that

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	500.5	509.0	547.3	620.8				extends beyond the proposed attenuation pond is restricted by an orifice plate flow control device.
S3-OU18	Roman River	A	186.1	181.0	213.8	298.8	Two orifice plates (125mm)	Oversized pipes	72	Brownfield discharge rates are applicable given that the proposed highway drainage is discharging to an existing outfall on the Roman River which currently accepts surface water runoff from the existing A12 mainline. An orifice plate flow control device is required at two locations to ensure the proposed

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	165.4	164.6	206.5	436.4				discharge rates meet the existing case allowable discharge rates. The proposed S3-OU18 discharge rate for the 1 in 100-year return period storm event plus climate change is more than the existing case allowable discharge rate. This is adjusted by the reduced discharge rates for the nearby S3-OU17 catchment which also discharges to the Roman River.
Combined S3-OU17 and S3-OU18	Roman River	A	688.7	693.2	804.7	1083.4	N/A	N/A	N/A	The combined proposed discharge rates from S3-OU17 catchment and S3-OU18 catchment are less than combined existing case allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Roman River.
		P	665.9	673.6	753.8	1057.2				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU19	Proposed drainage ditch (ultimately Domsey Brook (West))	A	15.9	14.7	20.1	47.3	Hydrobrake (107mm)	Attenuation pond	310	Brownfield discharge rates are applicable given that the proposed realigned Threshelfords access road to be drained by the S3-OU19 highway drainage system also drains the existing A12 mainline. A new outfall to a proposed ditch is assumed to be required. Therefore, a minimum practicable discharge rate of 5l/s is used. The need for attenuation storage could be reduced subject to a review of potential connection to an existing outfall at the detailed design stage.
		P	5.0	5.0	5.0	5.0				
S3-OU20	Proposed drainage ditch (ultimately Domsey Brook (West))	A	Greenfield (QMED) = 0.4				Hydrobrake (109mm)	Swale	25	Greenfield discharge rates are applicable given that the proposed Prested Hall Access Bridge (New Farm Access) to be drained by the S3-OU20 highway drainage system is located on a currently greenfield site. A new outfall to a proposed drainage ditch will be

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				required. The higher proposed discharge rates have been compensated for by the restricted proposed case discharge rates for the adjacent S3-OU19 catchment that also ultimately discharges to same receptor in Domsey Brook.
Combined S3-OU19 and S3-OU20	Domsey Brook (West)	A	16.3	15.1	20.5	47.7	N/A	N/A	N/A	The proposed combined discharge rates from the proposed S3-OU19 and S3-OU20 catchments are less than combined existing case allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as Domsey Brook.
		P	10.0	10.0	10.0	10.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU21	Ordinary Watercourse 23 (ultimately to watercourse upstream of Prested Hall and to Domsey Brook)	A	Greenfield (QMED) = 4.3				Hydrobrake (107mm)	Attenuation pond	1,973	Greenfield discharge rates are applicable given that the proposed offline A12 mainline portion to be drained by the S3-OU21 highway drainage system is located on a currently greenfield site. A new outfall on Ordinary Watercourse 23 will be required. A minimum practicable discharge rate of 5l/s is used for operation and maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table. The proposed combined discharge rates from S3-OU21, S3-OU22, S3-OU23, S3-OU24, S3-OU26 and S3-OU26A catchments have been restricted below the combined existing case allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as watercourse upstream of Prested Hall.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU22	Proposed drainage ditch (ultimately to watercourse upstream of Prested Hall and to Domsey Brook)	A	Greenfield (QMED) = 0.9				Hydrobrake (80mm)	Attenuation pond	328	Greenfield discharge rates are applicable given that the proposed realigned Prested Hall access road to be drained by the S3-OU22 highway drainage system is located on a currently greenfield site. A new outfall will be required. The proposed discharge rate restricted to 2.5l/s to compensate higher proposed discharge rates for adjacent catchments (S1-OU21, S1-OU23 and S1-OU24) to ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as watercourse upstream of Prested Hall. The proposed discharge rate for S3-OU22 is less than a minimum practicable discharge rate of 5l/s considered elsewhere for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 & 8 at the bottom of this summary table.
		P	2.5	2.5	2.5	2.5				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU23	Proposed drainage ditch and Ordinary Watercourse 23 ((ultimately to watercourse upstream of Prested Hall and to Domsey Brook))	A	Greenfield (QMED) = 1.3				Hydrobrake (107mm)	Attenuation pond	539	Brownfield discharge rates would typically be applicable for the proposed S3-OU23 catchment given that the proposed Prested Hall-Threshelfords Rural Business Park Joint Access Bridge (western arm) is primarily located on the footprint of the existing A12 mainline and existing junction 24 slip roads. However, a new outfall to a proposed drainage ditch at culvert CL-23 will be required due to the proposed highway geometry. Therefore, greenfield discharge rates have been estimated for the whole S3-OU23 in light of the new outfall location. A minimum practicable discharge rate of 5l/s is used. The proposed combined discharge rates from S3-OU21, S3-OU22, S3-OU23, S3-OU24, S3-OU26 and S3-OU26A catchments have been restricted below the combined existing case allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as watercourse upstream of Prested Hall.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU24	Ordinary Watercourse 23 (ultimately to watercourse upstream of Prested Hall and to Domsey Brook)	A	Greenfield (QMED) = 2.2				Hydrobrake (107mm)	Attenuation pond	945	Brownfield discharge rates would typically be applicable for the proposed S3-OU24 catchment given that the proposed roundabout and adjoining roads are primarily located on the footprint of the existing A12 mainline and existing junction 24 slip roads. However, a new outfall to Ordinary Watercourse 23 will be required due to the proposed highway geometry. Therefore, greenfield discharge rates have been estimated for the whole S3-OU24 in light of

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				the new outfall location. A minimum practicable discharge rate of 5l/s is used. The proposed combined discharge rates from S3-OU21, S3-OU22, S3-OU23, S3-OU24, S3-OU26 and S3-OU26A catchments have been restricted below the combined existing case allowable discharge rates. This would ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as watercourse upstream of Prested Hall.
S3-OU26	Ordinary Watercourse 24 (ultimately to watercourse upstream of Prested Hall and to	A	Greenfield (QMED) = 2.6				Hydrobrake (107mm)	Attenuation pond	1,193	Greenfield discharge rates are applicable as the proposed offline A12 mainline portion to be drained by the S3-OU26 highway drainage system is located on a currently greenfield site.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
	Domsey Brook)	P	5.0	5.0	5.0	5.0				A new outfall on Ordinary Watercourse 24 will be required. A minimum practicable discharge rate of 5l/s is used The proposed case higher greenfield discharge rates have been compensated for by the restricted proposed discharge rates for the proposed S3-OU26A catchment which ultimately discharges to the same watercourse (i.e. watercourse upstream of Prested Hall).
S3-OU26A	Ordinary Watercourse 37 (ultimately to watercourse upstream of Prested Hall and to Domsey Brook)	A	Greenfield (QMED) = 9.0				Hydrobrake (107mm)	Attenuation pond	3,739	Greenfield discharge rates are applicable as the proposed offline A12 mainline portion to be drained by the S3-OU26A highway drainage system is located on a currently greenfield site. A new outfall on Ordinary Watercourse 37 will be required.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
Combined S3-OU21, S3-OU22, S3-OU23, S3-OU24, S3-OU26 and S3-OU26A	Ordinary Watercourse 23 & 37 (ultimately to watercourse upstream of Prested Hall and to Domsey Brook)	A	Greenfield (QMED) = 20.3				N/A	N/A	N/A	The higher proposed case discharge rates (the proposed combined discharge rates from the S3-OU21, S3-OU22, S3-OU23, S3-OU24, S3-OU26 and S3-OU26A catchments) against combined existing case allowable discharge rates have been compensated for by the existing case discharge rates from the redundant existing paved area catchment associated with the existing Prested Hall access (situated between A12 mainline and existing Junction 24) that ultimately discharges to the same receptor (watercourse upstream of Prested Hall).

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	27.5	27.5	27.5	27.5				The estimated minimum discharge rate for the one-year return period event from the redundant paved area in the existing case is 7.2l/s (i.e. resulting into combined existing site allowable discharge rate of 27.5l/s (20.3 l/s plus 7.2 l/s) which is used as to compare against the combined proposed discharge rates for the proposed S3-OU21,S3-OU22,S3-OU23,S3-OU24,S3-OU26 and S3-OU26A catchments to ensure there would be no adverse flood risk impact, considering that these catchments have a common ultimate receptor as watercourse immediately upstream of Prested Hall.
S3-OU26B	Ordinary Watercourse 38	A	Greenfield (QMED) = 0.9				Hydrobrake (107mm)	Attenuation pond	355	Greenfield discharge rates are applicable as the proposed offline A12 mainline portion to be drained by the S3-OU26B highway drainage system is located on a currently greenfield site New outfall on Ordinary Watercourse 38 will be required. A minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
										7.2. See Note 7 at the bottom of this summary table.
S3-OU27	Proposed drainage ditch (ultimately Ordinary Watercourse 39)	A	Greenfield (QMED) = 1.2				Hydrobrake (113mm)	Attenuation pond	307	Greenfield discharge rates are applicable as the proposed Easthorpe Road Realignment portion to be drained by the S3-OU27 highway drainage system is located on a currently greenfield site. A new outfall to a proposed drainage ditch will be required. A minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
		P	5.0	5.0	5.0	5.0				
S3-OU27A	Existing drainage ditch (Ordinary Watercourse 40)	A	Greenfield (QMED) = 0.4				Hydrobrake (113mm)	Swale	30	Greenfield discharge rates are applicable as the proposed realigned Easthorpe Link Road to be drained by the S3-OU27A highway drainage system is located on a currently greenfield site.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				A new outfall to an existing drainage ditch will be required. A minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
S3-OU28	Proposed drainage ditch (ultimately Ordinary Watercourse 39)	A	Greenfield (QMED) = 0.4				Hydrobrake (113mm)	Swale	20	Greenfield discharge rates are applicable as the proposed Easthorpe Road Realignment portion to be drained by the S3-OU28 highway drainage system is located on a currently greenfield site.
		P	5.0	5.0	5.0	5.0				A new outfall to a proposed drainage ditch will be required. A minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU29	Proposed drainage ditch (ultimately Domsey Brook (East))	A	Greenfield (QMED) = 0.9				Hydrobrake (107mm)	Attenuation pond	328	Greenfield discharge rates are applicable for the proposed S3-OU29 catchment portion located between the existing A12 and proposed offline A12 mainline as it is located on a currently greenfield site. Brownfield discharge rates would typically be applicable for the proposed S3-OU29 catchment portion (i.e. proposed roundabout) given that it is primarily located on the footprint of the existing A12. However, a new outfall to a proposed drainage ditch will be required due to the proposed highway geometry. Therefore, greenfield discharge rates have been estimated for the whole S3-OU29 catchment in light of the new outfall

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	5.0	5.0	5.0	5.0				location. A minimum practicable discharge rate of 5l/s is used. The higher proposed case discharge rates have been compensated for by a reduction in the discharge rates from the retained existing paved area catchment associated with the existing A12 which will be drained by the proposed S3-OU29 catchment. The estimated minimum discharge rate for the one-year return period event from the retained paved area in the existing case is 35l/s (i.e. greater than the proposed case discharge rate of 5l/s). The proposed S3-OU29 catchment ultimately discharges to the same receptor as per the existing case (Domsey Brook)
S3-OU30	Domsey Brook (East)	A	Greenfield (QMED) = 8.2				Hydrobrake (132mm)	Attenuation pond	3,312	Greenfield discharge rates are applicable as the proposed offline A12 mainline portion to be drained by the S3-OU30 highway drainage system is located on a currently greenfield site.

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
		P	7.9	7.8	7.8	7.9				A new outfall on Domsey Brook will be required.
S3-OU30A	Proposed swale (ultimately Domsey Brook (East))	A	Greenfield (QMED) = 9.6				Hydrobrake (140mm)	Attenuation pond	3,597	Greenfield discharge rates are applicable as the proposed offline A12 mainline portion to be drained by the S3-OU30A highway drainage system is located on a currently greenfield site. A new outfall to a proposed swale will be required.
		P	8.9	8.9	8.9	8.9				
S3-OU31	Proposed drainage ditch (ultimately	A	Greenfield (QMED) = 0.9				Hydrobrake (103mm)	Attenuation pond	487	Greenfield discharge rates are applicable as the proposed realigned Easthorpe Green Farm access road to be drained by the

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
	Domsey Brook (East))	P	5.0	5.0	5.0	5.0				S3-OU31 highway drainage system is located on a currently greenfield site. A new outfall to a proposed drainage ditch will be required. A minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
S3-OU32	Existing drainage ditch (Ordinary Watercourse 41)	A	Greenfield (QMED) = 1.1				Hydrobrake (107mm)	Attenuation pond	382	Greenfield discharge rates are applicable as the new Wishing Well Farm access road to be drained by the S3-OU32 highway drainage system is located on a currently greenfield site. A new outfall to an existing drainage ditch will be required, restricted to a minimum practicable discharge rate of 5l/s for maintenance reasons stated in Section 4.8 and Section 7.2. See Note 7 at the bottom of this summary table.
		P	5.0	5.0	5.0	5.0				

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				
S3-OU33	De-trunked A12 existing highway drainage system	A	170.9	169.8	230.8	487.6	Two orifice plates (200mm) and (420mm)	Attenuation pond	1,291	Greenfield discharge rates are applicable as the proposed offline highway portion to be drained by the S3-OU33 highway drainage system is located on a currently greenfield site. Brownfield discharge rates are applicable for the portion of existing highway drainage serving the de-trunked A12 section that would be retained as part of the S3-OU33 catchment. Based on the above, brownfield discharge rates have been used. The proposed S3-OU33 attenuation pond is an offline attenuation pond to attenuate a portion of the catchment via an orifice plate flow control device (i.e. attenuate runoff from the contributing existing highway catchments to compensate for the additional new paved area from the proposed highway additions).
		P	150.1	145.7	198.8	421.4				
Notes:										

Proposed catchment	Receiving watercourse[1]	Modelled peak discharge rates (l/s)[2] Allowable discharge rates (A)[3, 6] Proposed discharge rates (P)[4]					Flow control type (diameter)	Attenuation storage type	Modelled attenuation storage volume[5] (m^3)	Catchment-specific comments
		A/P	1yr	2yr	5yr	100yr				

1. Where there is no nearby receiving watercourse locally (i.e. Main River, Ordinary Watercourse, existing drainage ditch or proposed drainage ditch), the proposed catchments in such situations discharge to the nearest available existing highway drainage system which will ultimately discharge to a watercourse further downstream.
2. FEH2013 rainfall data have been used in the hydraulic modelling of the proposed highway drainage systems for the proposed scheme. FEH2013 rainfall cannot be used for the assessment of the 1 in 1-year return period storm event. Therefore, FEH1999 rainfall data have been used for the assessment of the 1 in 1-year return period storm event. Section 4.6 provides further details on the rainfall data inputs.
3. The existing case allowable discharge rates do not include a climate change allowance given that current climatic conditions are required to inform the discharge rates for the proposed highway drainage systems. Where applicable the brownfield allowable discharge rates have been determined based on the information available from the drainage surveys undertaken at the Stage 3 Preliminary Design. It is noted that the drainage surveys were found to have gaps in the information and/or were found to be incomplete and as such, appropriate design assumptions have been made where necessary. These assumptions, including the potential impact to the current brownfield discharge rate estimates presented in this summary table, would need to be reviewed at detailed design stage.
4. The proposed case discharge rates include a climate change allowance as described in Section 4.4.
5. The modelled proposed case attenuation storage volumes are determined for the 1 in 100-year return period storm event plus a 20% climate change allowance.
6. For the proposed drainage catchments subject to online highway widening works, the modelled allowable discharge rates are modelled brownfield discharge rates for the existing paved area footprint (to be retained) only and do not take into account the greenfield discharge rates for the proposed highway widening catchment portion (i.e. 'New paved area' from the paved area summary tables in Annex B). This is a conservative design approach to determine the maximum attenuation storage volume requirements to inform the proposed scheme land take requirements.
7. The use of a minimum practicable discharge rate of 5l/s at some proposed outfall locations would result in a slight increase in discharge rates in comparison to the existing site allowable discharge rates or greenfield runoff rates. These proposed outfall locations have been assessed in the Flood Risk Assessment (ES Appendix 14.5 of the ES ([TR010060/APP/6.3]). The Flood Risk Assessment identifies a negligible impact on the surface water drainage flood risk at these proposed outfall locations.
8. It is noted the minimum practicable discharge rate has been restricted to 5l/s to reduce blockage risk and maintenance requirements as stated in Section 4.8 and Section 7.2. An exception to this was the proposed outfall locations with ultimate receptor as immediate watercourse upstream of Prested Hall, where anecdotal reports suggest there has been historic flooding from the watercourse. As such any increase in flows could impact this receptor that has experienced flooding in the past, while any blockage would be likely to cause flooding to open fields. Therefore the increased blockage risk and additional maintenance required are considered appropriate in this instance and discharge rates have been reduced to 2.5l/s to ensure there would be no adverse flood risk impact.

Table C.4 Inworth road proposed site condition estimated discharge rates and attenuation storage volumes

Proposed catchment	Receiving watercourse[1]	Estimated existing site allowable discharge rates (l/s)[2, 3]				Attenuation storage type	Estimated attenuation storage volume[4] (m^3)	Catchment-specific comments
		1yr	2yr	5yr	100yr			
S3-IWR-OU1	Existing drainage ditch (ultimately Ordinary Watercourse 34)	6.2	7.6	12.1	25.0	Vegetated ditch	47	Minor highway improvement works on Inworth Road that currently discharges to an existing drainage ditch. Therefore, brownfield discharge rates are applicable. A new outfall is required to an existing ditch located adjacent to Inworth Road.
S3-IWR-OU2	Existing drainage ditch (ultimately Ordinary Watercourse 34)	24.7	30.3	48.1	99.4	Attenuation pond	171	Minor highway improvement works on Inworth Road which currently discharges to an existing drainage ditch. Therefore, brownfield discharge rates are applicable. A new outfall is required to an existing ditch located adjacent to Inworth Road.
S3-IWR-OU3	Existing drainage ditch (ultimately Ordinary Watercourse 34)	7.7	9.4	14.9	30.8	Attenuation pond	775	Minor highway improvement works on Inworth Road which currently discharges to an existing ditch, so brownfield discharge rates are applicable. A new outfall is required to an existing ditch located adjacent to Inworth Road. Spatial constraints prevent attenuation pond provision for the adjacent proposed

Proposed catchment	Receiving watercourse[1]	Estimated existing site allowable discharge rates (l/s)[2, 3]				Attenuation storage type	Estimated attenuation storage volume[4] (m^3)	Catchment-specific comments
		1yr	2yr	5yr	100yr			
								S3-IWR-OU4 catchment. Hence, the mitigation attenuation storage is provided within the proposed S3-IWR-OU3 catchment attenuation pond which results in a greater estimated attenuation storage volume.
S3-IWR-OU4	Ordinary Watercourse 34	52.1	63.7	101.1	209.1	Oversized pipes	79	Minor highway improvement works on Inworth Road which is currently assumed to discharge to Ordinary Watercourse 34. Therefore, brownfield discharge rates are applicable. Spatial constraints prevent attenuation pond provision for the proposed S3-IWR-OU4 catchment. The catchment-specific comment for the adjacent proposed S3-IWR-OU3 catchment is applicable with regard to the mitigation attenuation storage provision. A new outfall is assumed to be required to the diverted Ordinary Watercourse 34 located adjacent to Inworth Road.
S3-IWR-OU5	Ordinary Watercourse 34C	7.7	9.4	15.0	31.0	Attenuation pond	263	Highway improvement works on Inworth Road which currently discharges to an existing drainage ditch. Therefore, brownfield discharge rates are applicable.

Proposed catchment	Receiving watercourse[1]	Estimated existing site allowable discharge rates (l/s)[2, 3]				Attenuation storage type	Estimated attenuation storage volume[4] (m^3)	Catchment-specific comments
		1yr	2yr	5yr	100yr			
								A new outfall is required to diverted Ordinary Watercourse 34C located adjacent to Inworth Road. Spatial constraints prevent attenuation pond provision for the adjacent proposed S3-IWR-OU6 catchment. Hence the mitigation attenuation storage is provided within the proposed S3-IWR-OU5 catchment attenuation pond which results in a greater estimated attenuation storage volume.
S3-IWR-OU6	Proposed drainage ditch (ultimately Ordinary Watercourse 34C)	13.8	16.9	26.8	55.3	Oversized pipes	92	Highway improvement works on existing Inworth Road which currently discharges to an existing ditch. Therefore, brownfield discharge rates are applicable. Spatial constraints prevent attenuation pond provision for the proposed S3-IWR-OU6 catchment. The catchment-specific comment for the adjacent proposed S3-IWR-OU5 catchment is applicable with regard to the mitigation attenuation storage provision.

Proposed catchment	Receiving watercourse[1]	Estimated existing site allowable discharge rates (l/s)[2, 3]				Attenuation storage type	Estimated attenuation storage volume[4] (m^3)	Catchment-specific comments
		1yr	2yr	5yr	100yr			
								A new outfall to a proposed drainage ditch will be required.
S3-IWR-OU7	Ordinary Watercourse 34C	7.5	9.1	14.5	30.0	Attenuation pond	50	Existing catchment on Inworth Road which currently discharges to an existing ditch. Therefore, brownfield discharge rates are applicable. A new outfall is assumed to be required diverted to the Ordinary Watercourse 34C located adjacent to Inworth Road.

Notes:

1. Where there is no nearby receiving watercourse locally (i.e. Main River, Ordinary Watercourse, existing drainage ditch or proposed drainage ditch), the proposed catchments in such situations discharge to the nearest available existing highway drainage system which will ultimately discharge to a watercourse further downstream.
2. FEH2013 rainfall data have been used in the hydraulic calculations for the estimated peak discharge rates. FEH2013 rainfall cannot be used for the assessment of the 1 in 1-year return period storm event. Therefore, FEH1999 rainfall data have been used for the assessment of the 1 in 1-year return period storm event. Section 4.6 provides further details on the rainfall data inputs. It should be noted that the estimated peak discharge rates have been determined using spreadsheet-based calculations in the absence of existing site condition drainage survey information for Inworth Road.
3. The estimated peak discharge rates do not include a climate change allowance given that current climatic conditions are required to inform the discharge rates for the proposed highway drainage systems. It should be noted that there is limited survey information available with regard to the existing drainage arrangements

Proposed catchment	Receiving watercourse[1]	Estimated existing site allowable discharge rates (l/s)[2, 3]				Attenuation storage type	Estimated attenuation storage volume[4] (m^3)	Catchment-specific comments
		1yr	2yr	5yr	100yr			
(i.e. existing drainage catchments and outfalls) on Inworth Road and as such appropriate design assumptions have been made in the development of proposed drainage solutions for Inworth Road. These assumptions, including the potential impact to the current highway drainage proposals for the proposed catchments/outfall arrangements, the estimated peak discharge rates and the proposed attenuation storage measures presented in this summary table, would need to be reviewed upon the receipt of the drainage survey information for Inworth Road and subsequent hydraulic modelling of the proposed drainage highway drainage systems at the detailed design stage. 4. The estimated proposed case attenuation storage volumes are determined for the 1 in 100-year return period storm event plus a 20% climate change allowance.								

Annex D. Preliminary Ground Investigation Data

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S1-OU1	19 - 20	HEAD possibly underlain by RTD	TP1601	18.85	2.4	90	0.30- 1.30mbgl HEAD (clayey sandy SILT) 1.30- 2.40mbgl RTD (clayey very sandy GRAVEL)	9.3×10^{-6}	Dry	N/A	Only 1 test undertaken. Rate calculated by extrapolating timeline. Poor, potentially good drainage conditions.	Infiltration rates indicate borderline good/ poor drainage conditions. No groundwater data locally. Risk of inundation / uplift if levels are high. Soakaway drainage potentially feasible. Confirmatory GI recommended within the northern extent of the pond to confirm presence of Head deposits and long-term groundwater conditions. Chemical testing only undertaken in TP1601 - no soil data exceedances. Groundwater chemical testing was not undertaken. The RTD underlying the pond are classified as Secondary A aquifer. Run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway may be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
			TP1563	18.55	2.0	25	0.50- 0.60mbgl HEAD (clayey sandy SILT) 0.60- 2.00mbgl RTD (slightly clayey silty sandy GRAVEL to slightly clayey very sandy GRAVEL)	2.3×10^{-6}	Dry	N/A		
			TP1564	18.20	2.5	25	0.50- 1.30mbgl RTD (slightly silty sandy fine to coarse GRAVEL) 1.30- 2.50mbgl RTD (slightly clayey sandy fine to coarse GRAVEL with a low cobble content)	N/A	Dry	N/A	A provisional assessment based on log description indicates potentially good drainage conditions.	
			WS1515 and WS1515A	18.55	1.2	25	0.50- 0.80mbgl RTD (slightly clayey gravelly coarse SAND) 0.80- 1.20mbgl RTD (slightly clayey very sandy fine to coarse GRAVEL)	WS abandoned due to SPT refusal from base of hand inspection pit.				
S1-OU7A	24 - 25	GLLMP	TP1550	22.15	2.10	136	0.30- 0.70mbgl ISC (slightly sandy clayey SILT) 0.70- 1.20mbgl ISC (silty CLAY) 1.20- 1.90mbgl GFD (slightly clayey very sandy GRAVEL) 1.90- 2.10mbgl LC (CLAY)	Insufficient drop in level to calculate infiltration rate	Seepage at base of pit, water level at 1.95mbgl pre-soakaway test	N/A	Only 1 test undertaken. Practically impervious drainage conditions. Soakaway test indicates practically impervious drainage conditions.	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious drainage conditions. No water strikes, but monitoring indicates shallow ground water so there is a risk of inundation. Soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing only undertaken in TP1551 and TP1603 - no soil data exceedances.
			TP1551	23.80	4.0	148	0.30- 1.20mbgl ISC (sandy clayey SILT) 1.20- 2.55mbgl ISC (very sandy CLAY) 2.55- 4.00mbgl ISC (CLAY)	Insufficient drop in level to calculate infiltration rate	Dry	N/A	Only 1 test undertaken. Practically impervious drainage conditions.	
			TP1603	23.85	2.0	71	0.30- 0.85mbgl ISC (slightly gravelly sandy clayey SILT) 0.85- 1.20mbgl GFD (silty sandy GRAVEL) 1.20- 1.90mbgl LC (silty CLAY) 1.90- 4.40mbgl LC (CLAY)	6.3×10^{-6}	Dry	N/A	Only 1 test undertaken. Rate calculated by extrapolating timeline. Poor drainage conditions.	
			BH+RC1102	23.85	10.65	On	0.50- 1.20mbgl ISC (silty CLAY with frequent pockets of fine sand)	N/A	Not encountered		A provisional assessment based on log description	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							1.20- 1.55mbgl ISC slightly gravelly slightly sandy clayey SILT) 1.55- 4.00mbgl ISC (silty CLAY) 4.00- 9.70 ISC (clayey SILT)			Response zone 2.00 to 10.65: 0.51 (23.34mAOD)	indicates poor to practically impervious drainage conditions.	
S1-OU11	28 - 29	HEAD	TP1607	25.00	4.20	45	0.30- 0.80mbgl HEAD (sandy gravelly CLAY) 0.80- 4.20 LC (CLAY)	N/A	Dry	N/A	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious drainage conditions and shallow ground water and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing only undertaken in WS1404, TP1552 and BH+RC1104. WS1404 and TP1552 - no soil data exceedances. BH+RC1104 - Groundwater exceedances (cadmium, lead, nickel, sulphate, zinc). Due to the presence of contamination in groundwater, where groundwater lowering is required to enable construction of the pond, a Detailed Quantitative Risk Assessment (DQRA) is required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			TP1552	24.00	4.20	75	0.30- 2.60mbgl ALV (silty CLAY with pockets of sandy GRAVEL) 2.60- 4.20mbgl LC (CLAY with occasional pockets of sand)	Insufficient drop in level to calculate infiltration rate	4.15 (groundwater seepages encountered at 2.00mbgl and 2.60mbgl)	N/A	Only 1 test undertaken. Practically impervious drainage conditions.	
			BH+RC1104	25.35	30.45	55	0.40- 0.80mbgl HEAD (slightly gravelly sandy silty CLAY) 0.80- 6.90 LC (silty CLAY)	N/A	Dry	Response zone 1.50 to 5.00: 0.34 (25.01mAOD)	A provisional assessment based on log description indicates practically impervious drainage conditions.	
			WS1404	27.95	0.60	25	Exploratory hole terminated at 0.60m due to SPT refusal.					
S1-OU12	26 - 27	HEAD	TP1553	24.35	4.00	80	0.30- 1.40mbgl ALV (silty CLAY) 1.40- 2.70mbgl ALV (silty CLAY with pockets of slightly sandy gravel and lenses of sand) 2.70- 4.00mbgl LC (silty CLAY)	Insufficient drop in level to calculate infiltration rate	Dry	N/A	Only 1 test undertaken. Practically impervious drainage conditions. Located in different geology than the pond so results not relevant.	Potentially good drainage conditions in deposits ≤1.9mbgl. Soakaway drainage potentially feasible. Confirmatory GI recommended at the northern and southern extents of the proposed pond to confirm consistent ground conditions. GI to include infiltration tests and long-term groundwater monitoring. Chemical testing only undertaken in TP1553 and TP1611 - no soil data exceedances. The GFD located close to the pond are classified as Secondary A aquifer. Run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway may be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
			TP1611	26.90	4.00	14	0.30- 0.90mbgl GFD (slightly gravelly SAND) 0.90- 1.40mbgl GFD (gravelly SAND) 1.40- 1.90mbgl GFD (clayey very sandy GRAVEL) 1.90- 4.00mbgl LC (CLAY)	N/A	Dry	N/A	A provisional assessment based on log description indicates potentially good drainage conditions in deposits ≤1.9mbgl.	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
			WS1518 and WS1518A	26.90	0.92	On	0.30- 0.92mbgl HEAD (slightly gravelly slightly sandy SILT)	Exploratory hole terminated at 0.92m due to SPT refusal.				
S1-OU13	19 - 21	W side of pond is in HEAD while the E side is in ALV	TP1554A	19.95	2.50	15	0.30- 2.75mbgl ALV (slightly gravelly sandy clayey SILT) 2.75- 2.80mbgl GFD (clayey very gravelly fine to coarse SAND)	Insufficient drop in level to calculate infiltration rate	Dry	N/A	Only 1 test undertaken. Practically impervious drainage conditions.	Infiltration rates indicate practically impervious drainage conditions, but water strike and descriptions from other logs indicated potentially good drainage conditions. However, high risk of groundwater inundation and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing only undertaken in TP1554 and TP1565 - no soil data exceedances. TP1554 - no soil leachate data exceedances. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			TP1565	19.40	4.20	20	0.35- 1.10mbgl ALV (clayey SILT) 1.10 – 2.20mbgl ALV (thickly laminated black very clayey fine and medium SAND) 2.20 -2.60mbgl ALV (silty CLAY thickly laminated with silt) 2.60 -3.35mbgl GFD (sandy clayey coarse flint GRAVEL with high cobble content) 3.35 -4.20mbgl LC (CLAY)	N/A	Groundwater seepage at 2.25m. Strong inflow at 2.60m	N/A	A provisional assessment based on log description indicates potentially good drainage conditions in deposits ≥2.6mbgl.	
			WS1519	19.50	5.90	On	0.50 -2.70mbgl ALV (slightly sandy clayey SILT) 2.70- 3.80mbgl GFD (clayey sandy fine to coarse GRAVEL) 3.80- 5.90mbgl LC (CLAY)	N/A	Strike at 2.85m, rose to 1.91m after 20 mins.	Response zone 0.80 to 5.90: 1.11 (18.39mAOD)	A provisional assessment based on log description indicates potentially good drainage conditions in deposits ≥2.7mbgl.	
S1-OU18	20 - 23	GFD	TP1556	19.90	4.0	32	0.50- 1.10mbgl ALV (interlaminated gravelly clayey SILT with pockets of medium and coarse sand) 1.10- 4.00mbgl LC (CLAY with frequent pockets of orange silt)	Insufficient drop in level to calculate infiltration rate	Dry	N/A	Only 1 test undertaken. Practically impervious drainage conditions.	Infiltration rates and estimates from log descriptions indicate poor to practically impervious drainage conditions and a high risk of groundwater inundation and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing only undertaken in WS1522 and TP1628 - no soil data exceedances WS1522 - no soil leachate data exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP1628	24.60	3.70	5	0.50- 2.60mbgl ALV (clayey SILT) 2.60- 3.40mbgl ALV (slightly gravelly clayey fine and medium SAND) 3.40- 3.70mbgl LC (CLAY)	N/A	Slight groundwater seepage at 2.8m	N/A	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	
			WS1522	20.70	5.45	5	0.30- 3.70mbgl ALV (slightly sandy to sandy clayey SILT) 3.70- 5.45mbgl LC (CLAY)	N/A	Strike at 4.00m, rose to 3.95m after 20 mins	Response zone 0.80 to 5.45: 0.74 (19.96mAOD)		

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S1-OU19 S1-OU19A	S1-OU19: 42 S1-OU19A: 43	LOFT	TP1557	42.00	3.8	135	0.25- 3.80mbgl LOFT (slightly sandy gravelly silty CLAY)	Insufficient drop in level to calculate infiltration rate	Groundwater seepage recorded at 3.70m	N/A	Only 1 test undertaken. Poor to practically impervious drainage conditions.	Infiltration rates and estimates from log descriptions indicate poor to practically impervious drainage conditions and therefore soakaway drainage is unlikely to be feasible. No scheduled environmental testing. No significant potential source of land contamination identified within the pond area.
			TP1646	41.30	4.00	49 from S1-OU19, 69 from S1-OU19A	0.30- 1.00mbgl HEAD (sandy silty CLAY) 1.00- 2.00mbgl HEAD (sandy silty CLAY, locally clayey SAND) 2.00- 4.00mbgl LOFT (slightly sandy gravelly CLAY, with occasional lenses of SAND)	N/A	Slight groundwater ingress at 3.95 recorded	N/A	A provisional assessment based on log description indicates good, potentially poor drainage conditions.	
S1-OU19C	43	LOFT	TP1633	42.55	4.0	16	0.25- 0.95mbgl HEAD (slightly gravelly sandy clayey SILT) 0.95- 3.70mbgl LOFT (slightly sandy gravelly silty CLAY) 3.70- 4.00mbgl GFD (gravelly SAND)	3.0×10^{-6}	Water seepage recorded at 2.9m	N/A	Only 1 test undertaken. Rate calculated by extrapolating timeline. Good to poor drainage conditions.	The infiltration rate and estimates from log descriptions indicate good to poor drainage conditions. Only a thin layer (0.3m) of granular material is indicated on the BH log, and a high risk of groundwater inundation indicate that soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No scheduled environmental testing. No significant potential source of land contamination identified within the pond area. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			BH2031	42.95	20.45	22	0.50- 4.10mbgl LOFT (slightly sandy slightly gravelly CLAY) 4.10- 4.60mbgl GFD (clayey slightly gravelly fine to coarse SAND) 4.60- 6.40mbgl LOFT (slightly gravelly sandy CLAY)	N/A	Water strike at 4.10mbgl, rose to 3.20mbgl after 20mins.	Response zone 5.00 to 9.30: 1.14 (41.81mAOD)	A provisional assessment based on log description indicates potentially poor drainage conditions in deposits <4.10mbgl.	
S1-OU19C1	43- 44	E side of the pond is in LOFT while W side is in HEAD	TP1631	43.75	4.00	51	0.30- 3.45mbgl ISC (clayey SILT with frequent thick laminae of black organic CLAY) 3.45- 4.00mbgl ISC (silty CLAY with frequent thick laminae of black organic clay)	N/A	Seepage at 3.45	N/A	A provisional assessment based on log description indicates good, potentially poor drainage conditions.	Limited GI but estimates from local log descriptions indicate poor to practically impervious drainage conditions and therefore soakaway drainage is unlikely to be feasible. Chemical testing undertaken in TP1631- no soil data exceedances.
S1-OU23	17	RTD	TP1561	16.75	3.1	On	0.50- 0.90mbgl RTD (very sandy GRAVEL) 0.90- 1.95mbgl RTD (gravelly SAND) 1.95- 2.75mbgl RTD-CO (silty CLAY) 2.75- 3.10mbgl RTD (clayey very sandy GRAVEL)	1.4×10^{-6}	2.75	N/A	Only 1 test undertaken. Rate calculated by extrapolating timeline. Good to Poor drainage conditions.	The infiltration rate and estimates from log descriptions indicate good to poor drainage conditions, although there is a high risk of groundwater inundation and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift.

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
			WS1527	16.40	4.39	On	0.40- 2.00mbgl RTD (silty very sandy GRAVEL) 2.00- 4.39mbgl RTD (very sandy GRAVEL)	N/A	Strike at 2.40mbgl, rose to 1.52mbgl after 20 mins	Response zone 0.80 to 4.39: 0.63 (15.77mAOD)	A provisional assessment based on log description indicates good, potentially poor drainage conditions.	Chemical testing only undertaken in WS1527 - no soil data exceedances Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S1-OU23C	45- 46	LOFT	BH2030	45.35	20.45	18	0.50- 7.10mbgl LOFT (slightly sandy slightly gravelly CLAY)	N/A	None recorded	Response zone 7.00 to 20.45: 10.23 (35.12mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimates from log descriptions indicate poor to practically impervious drainage conditions and therefore soakaway drainage is unlikely to be feasible. Chemical testing undertaken in BH2030 - no soil data exceedances
S1-OU23D	45- 45.5	The very W side of the pond is shown to be in HEAD while the rest of the pond is in LOFT	BH2029	44.60	20.50	57	0.35- 0.50mbgl HEAD (slightly gravelly sandy clayey SILT) 0.50- 0.95mbgl LOFT (slightly gravelly slightly sandy silty CLAY) 0.95- 1.20mbgl LOFT (slightly gravelly sandy clayey SILT) 1.20- 5.00mbgl LOFT (slightly sandy slightly gravelly silty CLAY)	N/A	None recorded	Response zone 5.00 to 14.50: 9.64 (34.96mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimates from local log descriptions indicate poor to practically impervious drainage conditions and therefore soakaway drainage is unlikely to be feasible. No scheduled environmental testing.
S1-OU24A	43	LOFT	WS1512	44.65	10.00	24	0.30- 1.10mbgl MBRO (gravelly silty CLAY) 1.10- 1.20mbgl LOFT (slightly gravelly silty CLAY) 1.20- 3.10mbgl LOFT (slightly sandy gravelly silty CLAY) 3.10- 8.50mbgl LOFT (slightly sandy slightly gravelly silty CLAY)	N/A	None recorded	Response zone 0.80 to 4.00: 3.35 (41.30mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimates from local log descriptions indicate poor to practically impervious drainage conditions and shallow ground water and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No scheduled environmental testing for WS1512. BH+RC1182 located 70m from the pond recorded soil leachate exceedances (arsenic, lead, manganese, total cyanide). This is not anticipated to have any significant impact as not located directly on the pond and soakaway drainage is unlikely to be adopted. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
S1-OU24B	41- 42	LOFT	WS1511	42.25	5.00	45	0.60- 3.05mbgl LOFT (gravelly clayey SILT)	N/A	Water strike at 4.91, rose		A provisional assessment based on log description	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							3.05- 4.65mbgl LOFT (slightly gravelly silty CLAY with frequent pockets of light grey silt) 4.65- 5.00mbgl GFD (clayey gravelly SAND)		to 2.93 after 20min	Response zone 2.60 to 5.00: 1.65 (40.60mAOD)	indicates poor to practically impervious drainage conditions.	Estimates from local log descriptions indicate poor to practically impervious drainage conditions and shallow groundwater and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No scheduled environmental testing. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.

Notes

MBRO- Made Ground- Road Embankment, MG- Made Ground, ALV- Alluvium, BRK- Brickearth, HEAD- Head Deposits, RTD- River Terrace Deposits, ISC- Interglacial Silt and Clay, GFD- Glaciofluvial Deposits, GLLMP- Glaciolacustrine Deposits, LOFT- Lowestoft Formation, LC- London Clay Formation.

Groundwater and soil leachate exceedances – groundwater and soil leachate analysis results have been compared against Environmental Quality Standards (EQS, annual average) to assess the potential risks to controlled water receptors in close proximity to the scheme. Screening against the Drinking Water Standards (DWS) has also been undertaken in locations that are located within or close to a source protection zone.

Soil data exceedances –soil chemical analysis results have been screened against the Category 4 Screening Levels (C4SLs) and Suitable for Use Levels (S4Uls) generic assessment criteria for assessing potential risks to human health from exposure to contaminants in soil (in a commercial/industrial use scenario).

Soil waste classification - preliminary waste characterisation has been undertaken to classify soils tested as either hazardous or non-hazardous.

Uncontrolled discharge of groundwater to surrounding areas should be avoided if dewatering is required during construction.

[1] Approximate levels determined from EA Opensource LiDAR DTM level contours.

[2] Groundwater level data based on AGS data received August 2021.

[3] A preliminary assessment of groundwater levels and the risk of inundation / uplift has been provided. However, levels may vary, particularly where GI data is limited, and all attenuation ponds are to consider during detailed design the risk of inundation and or uplift pressures, and the requirement for discharge consents where groundwater lowering is required.

DF2 balancing pond number	Pond Elevation from LiDAR (1) (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory hole	Exploratory hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) (2)	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility (3)
S2-OU4	13- 14	RTD, with the northern boundary in ALV	WS1437B	17.10	3.23	68	GL – 3.23mbgl MBRO	Embankment fill only				No GI at the location of the pond. Estimated permeability rates indicate material varying from good to poor drainage conditions. No groundwater data locally. Risk of inundation / uplift if levels are found to be high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. A confirmatory GI is recommended including groundwater monitoring. Chemical testing was undertaken in WS1437B, TP1643 and TP1644. WS1437B - Not considered in this assessment as the materials are not representative of those likely to be encountered in or adjacent to the pond. TP1643 - no scheduled environmental testing. TP1644 - inert soil classification. No soil data exceedances. The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway may be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
			TP1643	12.40	3.00	56	0.80- 3.00mbgl RTD (slightly silty sandy GRAVEL)	N/A	Groundwater seepage at 2.30mbgl	N/A	A provisional assessment based on log description indicates potentially good drainage conditions.	
			TP1644	14.95	3.50	90	0.60- 0.80mbgl RTD (slightly sandy gravelly SILT with cobble content) 0.80- 2.80mbgl RTD (silty sandy GRAVEL with low cobble content) 2.80- 3.50mbgl RTD (sandy clayey GRAVEL with low cobble content)	N/A	Dry	N/A	A provisional assessment based on log description indicates poor to potentially good drainage conditions.	
S2-OU9	16- 16	RTD	BH+RC2620	21.65	20.45	120	0.20- 4.20mbgl MG (gravelly sandy SILT) 4.20- 5.70mbgl RTD (silty CLAY)	N/A	None recorded	1.0 to 5.0m response zone: Dry 6.0 to 9.0m response zone: 6.07m (15.58mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	No GI at or in close proximity to the pond location. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. BH+RC2620 - no scheduled environmental testing. The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
S2-OU10	17.5- 18	RTD	BH+RC2621	18.85	15.45	150	0.50- 0.80mbgl RTD (slightly gravelly sandy silty CLAY) 0.80- 1.20mbgl RTD (slightly clayey sandy fine to coarse GRAVEL) 1.20- 3.10mbgl RTD (slightly sandy slightly gravelly silty CLAY) 3.10- 3.85mbgl RTD (slightly gravelly sandy CLAY)	N/A	None recorded	No Installation	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	No GI at or in close proximity to the pond location. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing was undertaken in BH+RC2621- non-hazardous waste soil classification, no soil data exceedances. The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge

DF2 balancing pond number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory hole	Exploratory hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							3.85- 4.75mbgl RTD (slightly sandy clayey SILT)					via soakaway may be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
S2-OU11	20	RTD and IGLD	WS2412B	20.15	6.45	On	0.40- 0.90mbgl RTD (gravelly silty SAND) 0.90- 1.20mbgl RTD (slightly gravelly silty fine to coarse SAND) 1.20- 3.25mbgl RTD (slightly silty fine to medium SAND with rare gravel) 3.25- 6.45mbgl LOFT (slightly gravelly silty CLAY)	N/A	3.24 strike, rose to 2.60 after 20min	Install for permeability testing only. No monitoring data available.	A provisional assessment based on log description indicates potentially good to poor drainage conditions.	Limited GI at the pond location. The infiltration rate and estimates from log descriptions indicate good to poor conditions, but groundwater levels high and therefore soakaway drainage is unlikely to feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing was undertaken in WS2421b - no soil data exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S2-OU14	17	RTD	BH2649	16.55	14.45	68	0.30- 0.90mbgl RTD (slightly sandy silty CLAY) 0.90- 2.00mbgl RTD (sandy silty CLAY) 2.00- 6.40mbgl RTD (very sandy GRAVEL)	N/A	Dry	Only 1 set of results were available dated Nov 2020. 1.5m to 8.0m response zone: 5.67 (10.88mAOD) 9.0 to 14.0m response zone: 5.43 (11.12mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions in deposits ≤2.0mbgl, potentially good drainage conditions between 2.00- 6.40mbgl.	No GI at the location of the pond. Estimated permeability rates indicate generally good drainage conditions below 2mbgl. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing was undertaken in BH2649 - no soil data exceedance. Non-hazardous waste soil classification. The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
S2-OU15A	17- 18	RTD with the very W end in HEAD				23						
S2-OU15C	16.5	RTD	BH+RC2244	16.0	30.34	138	0.40- 0.65mbgl RTD (slightly gravelly SILT) 0.65- 1.20mbgl RTD (slightly gravelly SAND) 1.20- 2.00mbgl RTD (gravelly SAND) 2.00- 3.00mbgl RTD (slightly clayey gravelly SAND) 3.00- 4.05mbgl RTD (clayey very sandy GRAVEL)	N/A	None recorded	Borehole backfilled on completion	A provisional assessment based on log description indicates potentially good drainage conditions between 0.65- 3.00mbgl.	No GI at the location of the pond. Estimated permeability rates indicate potentially good drainage conditions. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing was undertaken in BH+RC2244, no soil data exceedances. Non-hazardous soil waste classification The RTD underlying the pond is classified as Secondary A aquifer. Run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.

DF2 balancing pond number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory hole	Exploratory hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S2-OU15C1	20- 21	HEAD	BH2263	21.95	15.00	86	0.40- 0.85mbgl RTD (slightly silty sandy GRAVEL) 0.85- 1.50mbgl RTD-CO (slightly sandy slightly gravelly clayey SILT with high cobble content) 1.50- 2.20mbgl RTD-CO (slightly gravelly clayey SILT) 2.20- 3.30mbgl RTD (sandy GRAVEL) 3.30- 5.20mbgl RTD (slightly clayey gravelly SAND)	N/A	None recorded	Dry	A provisional assessment based on log description indicates potentially poor to practically impervious drainage conditions <2.20mbgl. Potentially good drainage conditions >2.20mbgl.	No GI at the location of the pond. Estimated permeability rates indicate potentially good drainage conditions where more granular RTD is encountered. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Chemical testing was undertaken in BH2263 - no soil data exceedances. Non-hazardous waste soil classification. The RTD underlying the pond is classified as Secondary A aquifer. Run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
S2-OU15D	16.5	RTD	No GI within >250m of the pond									No groundwater data locally. Risk of inundation if levels are found to be high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
S2-OU15E	17- 18	IGLD	BH+RC2244	16.0	30.34	70	0.40- 0.65mbgl RTD (slightly gravelly SILT) 0.65- 1.20mbgl RTD (slightly gravelly SAND) 1.20- 2.00mbgl RTD (gravelly SAND) 2.00- 3.00mbgl RTD (slightly clayey gravelly SAND) 3.00- 4.05mbgl RTD (clayey very sandy GRAVEL)	N/A	None recorded	Borehole backfilled on completion	A provisional assessment based on log description indicates potentially good drainage conditions between 0.65- 3.00mbgl in RTD.	No GI at the location of the pond. Estimated permeability rates indicate potentially poor to good drainage conditions in the RTD, although groundwater levels are high and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. BH+RC2244 - no soil data exceedances. Non-hazardous waste soil classification. BH2609- no soil data exceedances. Non-hazardous waste soil classification. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			BH2609	16.55		110	0.40- 0.70mbgl RTD (silty CLAY) 0.70- 1.40mbgl RTD (slightly gravely sandy silty CLAY) 1.40- 2.80mbgl RTD (slightly silty very sandy GRAVEL)	N/A	3.90, no rise after 20min	Only 1 set of results were available dated Nov 2020. 1.00m to 10.0m response zone:	A provisional assessment based on log description indicates poor to practically impervious drainage conditions	

DF2 balancing pond number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory hole	Exploratory hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							2.80- 3.50mbgl RTD (fine and medium SAND with some gravel) 3.50- 7.80mbgl RTD (slightly silty slightly gravelly fine and medium SAND)			2.87 (13.68mAOD) 11.50m to 20.45m response zone: 2.62 (13.93mAOD)	between 0.40-1.40mbgl, potentially poor to good drainage conditions >1.40mbgl.	
S2-OU15G	21- 22	HEAD	BH+RC2266	24.50	40.95	70	0.60- 1.20mbgl HEAD (slightly sandy slightly gravelly SILT) 1.20- 1.85mbgl RTD (clayey gravelly SAND) 1.85- 4.55mbgl RTD (slightly silty gravelly SAND)	N/A	None recorded	1.0m to 6.0m response zone: 4.94 (19.56mAOD) 7.0m to 37.0m response zone: 2.35 (22.15mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions in deposits ≤1.85mbgl. Potentially good drainage conditions between 1.85-4.55mbgl.	No GI at the location of the pond. Estimated permeability rates indicate variable soils with potentially good to practically impervious drainage conditions, and groundwater levels are high and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. TP2569 - no soil data exceedances. Non-hazardous waste soil classification. BH+RC2266 - non-hazardous waste soil classification. Soil leachate exceedance (copper). This is not anticipated to have any significant impact as not located directly on the pond and soakaway drainage is unlikely to be adopted Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP2569	23.30	4.00	75	0.40- 0.80mbgl HEAD (silty very sandy fine to coarse GRAVEL) 0.80- 2.90mbgl HEAD (slightly gravelly slightly sandy SILT) 2.90- 4.00mbgl RTD (clayey very sandy fine and medium GRAVEL)	N/A	Dry	N/A	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	
S2-OU15H	25.5- 26.5	LOFT	BH2056	26.65	10.45	88	0.40- 1.20mbgl LOFT (slightly sandy slightly gravelly CLAY) 1.20- 2.00mbgl LOFT (slightly gravelly slightly sandy CLAY with bands of gravelly sand and silt) 2.00- 2.45mbgl GFD (slightly gravelly clayey fine to coarse SAND) 2.45- 2.70mbgl GLLMP (slightly sandy clayey SILT) 2.70- 3.00mbgl LOFT (slightly gravelly sandy CLAY) 3.00- 3.45mbgl GLLMP (slightly sandy clayey SILT) 3.45- 6.00mbgl LOFT (slightly sandy slightly gravelly CLAY)	N/A	None recorded	Response Zone 1.00m to 6.50mbgl: 1.57 (25.08mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions, and groundwater levels are high and therefore soakaway drainage is unlikely to be feasible. No significant potential source of land contamination identified on the pond location. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.

DF2 balancing pond number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory hole	Exploratory hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S2-OU18	27.5- 28.5	RTD	BH+RC2271	26.0		49	0.65- 1.20mbgl RTD (gravelly SAND) 1.20- 4.05mbgl RTD (slightly clayey SAND with rare gravel) 4.05- 12.90mbgl LOFT (slightly gravelly silty CLAY)	N/A	Not recorded	1.0m to 5.0m response zone: Dry 10.0m to 21.0m response zone: 3.95 (22.05mAOD)	A provisional assessment based on log description indicates potentially good to poor drainage conditions between 0.65- 4.05mbgl.	No GI at the location of the pond. Estimated permeability rates indicate potentially good to poor drainage conditions, although groundwater levels are high and therefore soakaway drainage is unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. BH+RC2271 - no soil data exceedances. Non-hazardous waste soil classification. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
S2-OU19	20- 21	HEAD	BH+RC2272	21.10	15.50	73	0.50- 1.50mbgl HEAD (slightly gravelly sandy SILT) 1.50- 2.00mbgl RTD (very sandy GRAVEL) 2.00- 4.00mbgl RTD (very gravelly SAND) 4.00- 6.30mbgl RTD (very sandy GRAVEL)	N/A	15.30, rose to 11.70 after 20min	Installation in adjacent BH+RC2272A: 1.9m to 4.0m response zone: 2.18 (18.92mAOD) 4.9m to 6.6m response zone: 2.30 (18.80mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions in deposits ≤1.5mbgl. Potentially good drainage conditions between 1.50- 6.30mbgl.	No GI at the location of the pond. Estimated permeability rates indicate potentially good drainage conditions although groundwater levels are high and therefore soakaway drainage is unlikely to feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. BH+RC2272 - no soil data exceedances. Non-hazardous waste soil classification. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
S2-OU24A	23	HEAD	BH+RC2267	23.70		29	0.40- 1.00mbgl HEAD (slightly gravelly sandy clayey SILT) 1.00- 1.70mbgl HEAD (slightly gravelly slightly sandy silty CLAY) 1.70- 2.30mbgl HEAD (slightly gravelly sandy silty CLAY) 2.30- 2.50mbgl HEAD (sandy silty CLAY) 2.50- 3.15mbgl HEAD (slightly gravelly sandy silty CLAY) 3.15- 4.20mbgl ISC (clayey SILT with black organic traces)	N/A	None recorded	1.0m to 16.0m response zone: 2.66 (21.04mAOD) 18m to 24.0m response zone: 2.59 (21.11mAOD)	A provisional assessment based on log description indicates poor to practically impervious drainage conditions.	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Groundwater levels are indicated to be high and therefore soakaway drainage is unlikely to be feasible. BH+RC2267 - no soil data exceedances. Non-hazardous waste classification. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Where dewatering is required to construct a lined solution, further GI is required, and a Detailed Quantitative Risk Assessment (DQRA) may be required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.

DF2 balancing pond number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory hole	Exploratory hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]

Notes

MBRO- Made Ground- Road Embankment, MG- Made Ground, ALV- Alluvium, BRK- Brickearth, HEAD- Head Deposits, RTD- River Terrace Deposits, ISC- Interglacial Silt and Clay, GFD- Glaciofluvial Deposits, GLLMP- Glaciolacustrine Deposits, LOFT- Lowestoft Formation, LC- London Clay Formation.

Groundwater and soil leachate exceedances – groundwater and soil leachate analysis results have been compared against Environmental Quality Standards (EQS, annual average) to assess the potential risks to controlled water receptors in close proximity to the scheme. Screening against the Drinking Water Standards (DWS) has also been undertaken in locations that are located within or close to a source protection zone.

Soil data exceedances –soil chemical analysis results have been screened against the Category 4 Screening Levels (C4SLs) and Suitable for Use Levels (S4Uls) generic assessment criteria for assessing potential risks to human health from exposure to contaminants in soil (in a commercial/industrial use scenario).

Soil waste classification - preliminary waste characterisation has been undertaken to classify soils tested as either hazardous or non-hazardous.

Uncontrolled discharge of groundwater to surrounding areas should be avoided if dewatering is required during construction.

[1] Approximate levels determined from EA Opensource LiDAR DTM level contours.

[2] Groundwater level data based on AGS data received August 2021.

[3] A preliminary assessment of groundwater levels and the risk of inundation / uplift has been provided. However, levels may vary, particularly where GI data is limited, and all attenuation ponds are to consider during detailed design the risk of inundation and or uplift pressures, and the requirement for discharge consents where groundwater lowering is required.

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S3-OU1	21.0/22.0	RTD	TP2585	22.25	3.6	80	0.30 – 3.60mbgl RTD (slightly clayey very sandy fine to coarse GRAVEL)	N/A	Not encountered	N/A	A provisional assessment based on log description indicates potentially good drainage conditions.	No GI at the location of the pond. Estimated permeability rates indicate material varying from good to poor / practically impervious drainage conditions. No groundwater data locally. Risk of inundation / uplift if levels are found to be high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No significant potential source of land contamination identified within the pond location. The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
			WS2465B	21.45	10.45	93	0.50 – 3.80mbgl MBRO. 3.80 – 5.20mbgl ISC (Silty CLAY, containing rootlets)	N/A	8.45, rose to 5.22 after 20 mins	Response zone 2.00 to 4.50mbgl and 6.00 to 10.45mbgl No results available.	A provisional assessment of the ISC deposits based on log description indicates potentially poor to practically impervious drainage conditions.	
S3-OU2	22.0 / 23.0	RTD	WS3402G	21.95	5.90	On	0.30- 1.20mbgl LOFT (slightly gravelly sandy CLAY) 1.20 – 1.60mbgl GFD (slightly silty gravelly fine to coarse SAND) 1.60mbgl – 5.90mbgl LOFT (slightly gravelly silty CLAY)	N/A	1.65 rose to 1.20 after 20 mins	Response zone 1.00 to 5.90: 1.2 (20.75 mAOD)	A provisional assessment based on log description indicates generally poor to practically impervious drainage conditions. A relatively thin layer of GFD may have good drainage conditions.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. WS3402 - soil leachate (lead) and groundwater (total cyanide, sulphate, manganese and electrical conductivity) exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3503	22.41	2.20	30	0.30- 0.80mbgl LOFT (slightly gravelly sandy CLAY) 0.80- 1.20mbgl LOFT (gravelly sandy CLAY) 1.20- 2.20mbgl LOFT (gravelly CLAY)	No test possible- trial pit collapsed prior to filling with water	Recorded as 'Damp'	N/A	Provisional assessment based on log descriptions indicates generally poor to practically impervious drainage conditions.	
			TP3503A	22.1	1.60	44	0.30- 1.00mbgl LOFT (slightly sandy gravelly CLAY) 1.00- 1.60mbgl LOFT (gravelly CLAY)	No test possible- trial pit collapsed prior to filling with water	Slight groundwater seepages throughout.			
			TP3503B	21.75	3.00	45	0.30- 0.50mbgl RTD (slightly gravelly sandy CLAY) 0.50- 0.70mbgl RTD (clayey GRAVEL) 0.70- 3.00mbgl LOFT (slightly gravelly CLAY)	No test possible- trial pit collapsed prior to filling with water	None recorded			

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
			TP3503C	21.75	3.00	45	0.50- 1.20mbgl RTD (clayey sandy GRAVEL) 1.20- 3.00mbgl LOFT (slightly sandy slightly gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded		1 test undertaken indicating practically impervious drainage conditions.	
			TP3504	22.05	0.40	On	Too shallow	No test possible- land drain encountered at shallow depth	None recorded		N/A	
			TP3504A	22.05	3.20	On	0.30- 0.80mbgl LOFT (slightly gravelly sandy CLAY) 0.80- 3.20mbgl LOFT (gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	3.20mbgl with no rise after 20mins		1 test undertaken indicating practically impervious drainage conditions.	
S3-OU3	21.0 / 21.5	RTD	No GI at the location of the pond. BGS map indicates RTD, so drainage conditions could vary from Good to Practically Impervious.									Risk of inundation as groundwater levels may be high. Supplementary GI required to confirm the ground / groundwater conditions and infiltration characteristics. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No significant potential source of land contamination identified within the pond location The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable.
S3-OU4	26.5	RTD	BH3001	26.60	15.37	57	0.35 – 1.20mbgl RTD (slightly silty sandy GRAVEL to slightly clayey sandy GRAVEL 1.20 – 3.10mbgl RTD (sandy GRAVEL) 3.10 – 4.60mbgl RTD (Slightly gravelly sandy CLAY)	N/A	14.80 No rise in level after 20 mins	N/A	Log descriptions indicate the RTD may have good drainage conditions to 3.10mbgl, becoming poor to practically impervious with depth.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No soil data exceedances (WS3403, TP3501). No soil leachate exceedances (WS3403) No groundwater chemical analysis was undertaken. Where dewatering is required to construct a lined solution, a permit for discharge may be required.
			WS3403	25.35	5.45	65	0.30 – 1.60mbgl HEAD (CLAY and slightly sandy slightly gravelly CLAY) 1.60 – 5.45mbgl LC (CLAY)	N/A	No water encountered	Response zone 0.80 to 3.00: 1.28 (24.07 mAOD)	Provisional assessment based on log descriptions indicates practically impervious drainage conditions.	
			TP3501D	24.65	3.00	39	0.50- 1.10mbgl RTD (clayey sandy GRAVEL)		None recorded	N/A	Test 1 only.	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							1.10- 3.00mbgl LOFT (slightly sandy slightly gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates			Practically impervious drainage conditions.	Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3502B	24.35	3.00	45	0.50- 1.10mbgl RTD (clayey sandy GRAVEL) 1.10- 3.00mbgl LOFT (slightly sandy slightly gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
S3-OU5	21.0	RTD	No GI at the location of the pond. BGS map indicates RTD, so drainage conditions could vary from Good to Practically Impervious.									Risk of inundation as groundwater levels may be high. Supplementary GI required to confirm the ground / groundwater conditions and infiltration characteristics. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU8	24.5 / 25.5	LOFT	TP3510	26.20	3.00	20	0.30- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are unknown. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No soil data exceedances in TP3510. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU8A+OU7	24.0 / 25.0	RTD and LOFT	No GI at the location of the pond. BGS map indicates RTD and LOFT, so drainage conditions could vary from Good to Practically Impervious.									Groundwater levels may be high. No GI has been undertaken in this location The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift This pond is located directly on a historical sewage works. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
												If possible, this pond should be relocated away from the historical sewage works.
OU08B Ponds 1 and 2, and OU08E	36.5 / 38.0	LOFT	BH2068	37.50	10.10	20 to 65	0.20- 7.00mbgl LOFT (slightly sandy slightly gravelly to gravelly CLAY)	N/A	None encountered	Response zone 1.00 to 10.10: 0.91 (36.59 mAOD)	Provisional assessment based on log descriptions indicates generally poor to practically impervious drainage conditions.	Estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No significant potential source of land contamination was identified directly on the ponds. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP1872	40.05	4.00	90 to 167	0.30- 4.00mbgl LOFT (slightly gravelly sandy CLAY and slightly sandy slightly gravelly CLAY)	N/A	None encountered	N/A		
			TP1854	37.95	4.00	20 to 95	0.30- 4.00mbgl LOFT (slightly sandy slightly gravelly CLAY and slightly sandy slightly gravelly CLAY)	N/A	None encountered	N/A		
S3-OU9	26.0	LOFT	No GI at the location of the pond. BGS map indicates LOFT, so drainage conditions are likely to be Practically Impervious.									No GI at the location of the pond. BGS map indicates LOFT, so drainage conditions are likely to be Practically Impervious and soakaway drainage is unlikely to be feasible. Groundwater levels are unknown. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. This pond is located directly on a historical infilled land. If possible, this pond should be relocated away from the historical infilled land. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU10	26.0 / 27.0	HEAD	WS3409	24.20	5.45	38	0.30- 5.45mbgl LOFT (slightly gravelly sandy silty CLAY to slightly gravelly silty CLAY)	N/A	3.2 rose to 2.2 in 20 mins	Response zone 1.00 to 5.45: 0.9 (23.30 mAOD)	BGS map indicates Head. Description indicates LOFT. Provisional assessment based on log descriptions indicates generally poor to practically impervious drainage conditions.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No soil leachate data exceedances in WS3409. Groundwater exceedance in WS3409 (manganese, nitrite).
			TP3511	25.70	1.00	10	0.30- 1.00mbgl RTD (slightly gravelly sandy CLAY)	No test possible- trial pit collapsed	Water strike at 1.0mbgl, rising	N/A	Provisional assessment based on log descriptions indicates generally poor to	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							prior to filling with water	to 0.4mbgl after 20min		practically impervious drainage conditions.	The RTD located close to the pond is classified as Secondary A aquifer. Due to the presence of contamination, where groundwater lowering is required to enable construction of the pond, a Detailed Quantitative Risk Assessment (DQRA) is required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.	
			TP3511A	25.60	3.00	10	0.20- 1.00mbgl HEAD (slightly sandy CLAY) 1.00- 2.20mbgl LOFT (silty CLAY) 2.20- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3512A	26.00	3.00	On	0.20- 1.20mbgl HEAD (slightly sandy CLAY) 1.20- 2.60mbgl LOFT (silty CLAY) 2.60- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
S3-OU13	28.5 / 29.0	LOFT	WS3404A	30.2	5.00	64	0.50- 1.00mbgl MG (slightly sandy slightly gravelly silty CLAY) 1.00- 1.20mbgl LOFT (slightly sandy silty gravelly CLAY) 1.20- 5.00mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	N/A	Not encountered	N/A	Provisional assessment based on log descriptions indicates poor to practically impervious drainage conditions.	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are unknown. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. A historical infilled pond is located close to the attenuation pond. Closest GI to the location – WS3404A, no soil and soil leachate exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU14	36.0	RTD	TP1847	35.90	4.00	75	0.40- 1.00mbgl LOFT (slightly gravelly sandy silty CLAY) 1.00- 4.00mbgl LOFT (sandy gravelly silty CLAY)	N/A	Not encountered	N/A	Log descriptions indicate poor to practically impervious drainage conditions.	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Closest GI location – BH+RC3202, no soil data exceedances. Groundwater exceedances (copper, manganese, nickel, nitrite and nitrate).
			TP1848	37.60	4.00	61	0.20- 2.00mbgl RTD (slightly clayey slightly gravelly SAND to clayey gravelly SAND) 2.00 – 2.80mbgl RTD (slightly clayey slightly gravelly SAND to clayey gravelly SAND)	N/A	Not encountered	N/A		

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							2.80- 4.00mbgl LOFT (very gravelly silty CLAY)					Due to the presence of contamination, where groundwater lowering is required to enable construction of the pond, a Detailed Quantitative Risk Assessment (DQRA) is required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			BH+RC3202	36.30	40.0	30	0.30- 0.80mbgl LOFT (slightly gravelly slightly sandy CLAY) 0.80- 1.40mbgl LOFT (gravelly sandy CLAY) 1.40- 6.40mbgl LOFT (gravelly CLAY)	N/A	Not encountered	Response zone 5.40 to 19:00: 11.68 (24.62 mAOD)		
S3-OU15A	16.5 / 18.0	RTD and HEAD	WS3434A	39.85	5.45	50	0.30- 3.10mbgl LOFT (slightly gravelly sandy silty CLAY to grey slightly gravelly slightly sandy silty CLAY) 3.10- 5.00mbgl GFD (gravelly slightly silty slightly clayey SAND)	N/A	1.65 no rise in 20 mins 4.00 rose to 2.30 in 20 mins.	N/A	Provisional assessment based on log descriptions indicates generally poor to practically impervious drainage conditions to 3.10mbgl and potentially good conditions in GFD.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Historical nursery is located close to this pond. WS3046 (at 55m), soil leachate exceedance (manganese). Due to the presence of contamination, where groundwater lowering is required to enable construction of the pond, a Detailed Quantitative Risk Assessment (DQRA) is required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			TP3543	40.55	3.00	On	0.35- 0.60mbgl LOFT (slightly sandy CLAY) 0.60- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient drop in level to calculate infiltration rate.	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3544	40.35	3.00	On	0.40- 0.60mbgl LOFT (slightly sandy CLAY) 0.60- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient drop in level to calculate infiltration rate.	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
S3-OU15B and S3-OU15C	41	LOFT	BH3043	40.40	10.0	50 and 57	0.30- 5.20mbgl LOFT (generally slightly gravelly slightly sandy silty CLAY)	N/A	Dry	Response zone 5.00 to 10.00: 9.88 (30.52 mAOD)	Provisional assessment based on log descriptions indicates generally poor to practically impervious drainage conditions	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI location BH3043 recorded soil leachate exceedance (manganese). Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			WS3432	40.70	10.0	57	0.30- 5.20mbgl LOFT (generally gravelly silty CLAY)	N/A	1.20 rose to 1.00 after 20 mins	Response zone 1.00 to 5.45: 1.12 (39.58 mAOD))		
			TP3541	41.15	3.0	78 and 64	0.35- 1.50mbgl LOFT (slightly sandy CLAY) 1.50- 2.80mbgl LOFT (silty CLAY) 2.80- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3542	40.55	3.0	25	0.40- 1.60mbgl LOFT (slightly sandy CLAY) 1.60- 2.60mbgl LOFT (silty CLAY)	Insufficient fall in water level to	None recorded	N/A		

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							2.60- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	calculate infiltration rates				
S3-OU16	39.5 / 40.0	LOFT	WS3435	39.75	5.45	On	0.50- 1.90mbgl LOFT (slightly sandy gravelly silty CLAY) 1.90- 2.60mbgl GFD (clayey fine and medium SAND) 2.60- 5.45mbgl LOFT (slightly sandy gravelly silty CLAY)	N/A	Dry	Response zone 1.50 to 2.60: Dry	Provisional assessment based on log descriptions indicates poor to practically impervious drainage conditions.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. No scheduled land quality testing for this location. Significant land contamination is not anticipated as no potential source have been identified within the attenuation pond.
			TP3545	40.50	3.00	17	GL- 1.15 MGR 1.15- 3.00mbgl LOFT (gravelly CLAY with cobbles)	Insufficient fall in water level to calculate infiltration rates	Dry	N/A		
			TP3546	40.20	3.00	21	GL- 0.60 MGR 0.60- 3.00mbgl LOFT (slightly gravelly slightly sandy silty CLAY with cobbles)	Insufficient fall in water level to calculate infiltration rates	Dry	N/A		
S3-OU17	30.0 / 32.0	MG / LOFT / RTD	WS3436	31.67	5.55	On	0.50- 1.00mbgl LOFT (slightly sandy gravelly silty CLAY) 1.00- 5.55mbgl GFD (gravelly silty fine to coarse SAND)	N/A	3.81 rose to 3.61 after 20 mins	Response zone 0.80 to 5.00: 3.20 (28.47 mAOD)	Provisional assessment based on log descriptions indicates potentially good to poor from 1.00mbgl in GFD.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. Location of the pit partially in a historic landfill is likely to preclude soakaway drainage. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift Groundwater exceedances recorded in boreholes close to the pond (BH3053 and BH3051). Where dewatering is required to construct a lined solution, a Detailed Quantitative Risk Assessment (DQRA) is required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			TP3547	31.45	3.00	7	MGR	N/A	Dry	N/A	TP located in historic landfill.	
			TP3548	31.95	3.00	10	0.20- 0.65mbgl LOFT (slightly gravelly sandy silty CLAY) 0.65- 1.60mbgl LOFT (slightly gravelly slightly sandy CLAY) 1.60- 2.40 GFD (slightly gravelly slightly sandy CLAY with medium interbeds of medium spaced slightly gravelly SAND) 2.40- 3.00mbgl GFD (slightly gravelly clayey SAND)	3.7×10^{-6}	3.0mbgl, no rise in 20 mins	N/A	Test 1 only Calculated by extrapolating timeline. Poor drainage conditions.	
S3-OU19	31.0- 32.0	RTD	BH3015	30.9	10.05	75	0.50 – 1.05mbgl HEAD (Slightly gravelly sandy clayey SILT) 1.05 – 2.70mbgl ISC (slightly sandy silty CLAY and slightly sandy CLAY)	N/A	3.20m No rise recorded.	Response zone 2.50 to 8.50: 4.26 (26.64 mAOD)	Provisional assessment based on log descriptions indicates potentially good	No GI at the location of the pond. Estimated permeability rates indicate material varying from good to poor / practically impervious drainage conditions.

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							2.70 – 6.40mbgl RTD (slightly gravelly medium and coarse SAND to slightly clayey slightly gravelly medium and coarse SAND)				drainage conditions from 2.70mbgl	Limited groundwater data locally, but levels are potentially high. Risk of inundation if levels are found to be high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest borehole – BH3015, groundwater exceedances (chromium III, nitrate). The RTD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable. Due to the presence of contamination, where groundwater lowering is required to enable construction of a pond, a Detailed Quantitative Risk Assessment (DQRA) is required for the management of any dewatering and to support a permit for discharge. Treatment or disposal of groundwater may be necessary.
			BH3016	29.6	15.15	84	0.40- 0.90mbgl RTD (slightly gravelly slightly silty SAND with occasional silty CLAY pockets) 0.90- 2.20mbgl RTD (slightly gravelly to gravelly SAND) 2.20-3.40mbgl GLLMP (interlaminated slightly sandy clayey SILT) 3.40- 6.00mbgl LOFT (slightly sandy slightly gravelly silty CLAY)	N/A	Not encountered	N/A	Provisional assessment based on log descriptions indicates potentially good drainage conditions between 0.90- 2.20mbgl	
S3-OU20 Swales	32.0 / 33.0	LOFT	BH3018	32.55	10.45	63	0.30 – 4.40mbgl LOFT (slightly sandy gravelly CLAY)	N/A	1.10 No rise recorded	N/A	Provisional assessment based on log descriptions indicates poor / practically impervious drainage conditions	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest borehole – BH3017, no soil data exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			BH3017	34.40	10.45	70	0.45- 0.90mbgl HEAD (slightly gravelly slightly sandy silty CLAY) 0.90- 1.80mbgl RTD (slightly gravelly clayey SAND) 1.80- 2.20mbgl RTD (slightly gravelly slightly sandy silty CLAY) 2.20- 5.65mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	N/A	Not encountered	Response zone 1.50 to 10.45: 2.26 (32.14 mAOD))		
S3-OU21	29.0- 30.0	LOFT	BH3022	28.2	15.45	40	0.30- 1.20mbgl LOFT (slightly gravelly sandy CLAY) 1.20- 4.40mbgl LOFT (gravelly CLAY)	N/A	Not encountered	Response zone 2.00 to 14.00: 1.21 (26.99 mAOD)	Provisional assessment based on log description indicates poor / practically impervious drainage conditions	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures
			BH+RC3210	30.3	40.40	25	0.30- 0.85mbgl LOFT (gravelly CLAY with pockets of fine to coarse sand and silt)		0.85mbgl and 6.90mbgl (rose	Response zone 6.40 to 12.80:		

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
							0.85- 1.30mbgl GFD (sandy clayey GRAVEL with pockets of clay) 1.30- 4.00mbgl LOFT (gravelly CLAY with pockets of coarse sand and silt) 4.00- 6.90mbgl LOFT (gravelly CLAY with rare cobbles)		to 3.20mbgl after 20min)	2.93 (27.37 mAOD)		(e.g., clay and or concrete) to reduce the effects of potential uplift. Closest borehole – BH+RC3210 no soil and soil leachate data exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU22	27.5	LOFT	WS3416	27.50	5.45	32	0.30- 5.45mbgl LOFT (gravelly slightly sandy silty CLAY to slightly gravelly slightly sandy silty CLAY)	N/A	Dry	Response zone 1.00 to 5.00: 0.85 (26.65 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	In-situ tests and estimated values indicate soakaway drainage is unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI - WS3416, no soil and soil leachate data exceedances. No soil data exceedance in TP3515. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3515	28.15	1.70	18	0.30- 0.80mbgl LOFT (slightly gravelly sandy CLAY) 0.80- 1.70mbgl GFD (silty SAND)	No test possible- trial pit collapsed prior to filling with water	GW at 1.20mbgl, no rise after 20min)	N/A	Provisional assessment based on log descriptions indicates generally poor drainage conditions.	
			TP3515D	28.15	3.00	18	0.20- 0.40mbgl LOFT (slightly sandy slightly gravelly CLAY) 0.40- 3.00mbgl GFD (SAND)	Insufficient fall in water level to calculate infiltration rates	Dry	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3516A	28.05	3.00	39	0.30- 3.00mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	Insufficient fall in water level to calculate infiltration rates	Dry	N/A	Test 1 only. Practically impervious drainage conditions.	
S3-0U23	32.0	LOFT	BH3019	30.5	30.50	58	0.40- 1.20mbgl HEAD (slightly gravelly sandy CLAY) 1.20- 4.00mbgl LOFT (generally slightly gravelly very sandy silty CLAY)	N/A	3.40, rose to 2.20 after 20min	N/A	Provisional assessment based on log descriptions indicates poor to practically impervious drainage conditions.	No GI at the location of the pond. Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
												(e.g., clay and or concrete) to reduce the effects of potential uplift. This pond is located directly on a historical nursery. Closest GI – BH3019, no soil and soil leachate data exceedances. If feasible, this pond should be relocated away from the historical nursery. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU24	32.0- 33.0	LOFT	WS3413	31.15	5.45	15	0.30- 5.45mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	N/A	0.80, rose to 0.70 in 20 mins	Response zone 1.00 to 5.45: 1.12 (30.03 mAOD)	Provisional assessment based on log descriptions indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. This pond is located directly on a historical nursery. Closest GI – WS3413, no soil and soil leachate data exceedances. Additional GI located directly on the pond required. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3514	31.50	3.80	25	0.30- 0.50mbgl LOFT (slightly sandy CLAY) 0.50- 3.80mbgl LOFT (slightly sandy gravelly CLAY)		Not encountered	N/A		
			TP3513	31.90	3.70	On	0.35- 3.70mbgl LOFT (slightly sandy gravelly CLAY)					
S3-OU26	38.0 / 39.0	LOFT	WS3418	32.10	4.00	80	0.40- 1.60mbgl LOFT (slightly gravelly to gravelly, sandy to slightly sandy silty CLAY) 1.60- 4.00mbgl GFD (slightly clayey gravelly SAND, to gravelly SAND from 3.85m).	N/A	None recorded	Response zone 1.00 to 4.00: Dry	Provisional assessment based on log description indicates generally good drainage conditions below 1.60mbgl.	GI close to but not directly on the proposed pond. The estimates from log descriptions and results of in-situ testing are variable from good to poor / practically impervious conditions. Soakaway drainage potentially feasible subject to confirmatory GI including groundwater monitoring. A petrol station is located upstream. Closest GI - TP3519, no soil data exceedances. WS3418 (approx. 70m) recorded soil leachate exceedance (manganese). There is a risk of soakaway drainage mobilising contamination into the underlying groundwater. Possible mitigation measures include removal and replacement of the contaminated materials, or adopting a lined pond solution.
			TP3519	33.05	3.00	On	0.30-2.10mbgl LOFT (slightly sandy slightly gravelly CLAY and slightly sandy slightly gravelly CLAY with low cobble content) 2.10-3.00mbgl GFD (very gravelly SAND)	2.80×10^{-5}	None recorded	N/A	Test 1 only Calculated by extrapolating timeline. Good drainage conditions.	
			TP3519A	32.70	3.00	25	0.40- 3.00 LOFT (slightly sandy gravelly CLAY / silty CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Provisional assessment based on log description indicates generally poor to	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
			TP3520	32.80	1.00	20	0.30-1.00mbgl LOFT (slightly sandy to sandy, slightly gravelly silty CLAY)	No test possible-tractor/bowser could not reach position	None recorded	N/A	practically impervious drainage conditions.	The GFD underlying the pond is classified as Secondary A aquifer, run-off may have to be treated prior to entry to the pond to ensure contamination does not impact the aquifer. Feasibility of discharge via soakaway will be considered for approval by regulatory authorities. A lined solution may be required if treatment is not practicable
			TP3520A	32.75	3.00	25	0.40- 1.80mbgl LOFT (slightly sandy gravelly CLAY) 1.80- 3.00mbgl LOFT (slightly gravelly sandy CLAY)	5.90×10^{-5}	None recorded	N/A	Test 1 only. Calculated over depth range achieved for test. Results should be treated with caution. Good drainage conditions.	
			TP3520B	32.65	3.00	29	0.40- 3.00mbgl LOFT (slightly sandy to sandy, slightly gravelly to gravelly CLAY)	2.40×10^{-5}	None recorded	N/A	Test 1 only. Infiltration rate extrapolated. Treat with caution - collapsing strata. Good drainage conditions.	
S3-OU26A	35.0- 36.0	LOFT	BH3029	35.9	10.45	10	0.30- 0.70mbgl LOFT (slightly sandy slightly gravelly CLAY) 0.70- 1.20mbgl LOFT (slightly gravelly slightly sandy CLAY with medium cobble content) 1.20- 4.70mbgl LOFT (sandy gravelly silty CLAY)	N/A	8.0mbgl, no rise after 20min	N/A	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Closest GI – BH3029, no soil and soil leachate data exceedances.
S3-OU26B	34.0	LOFT	BH3033	35.35	20.00	20	0.40- 1.00mbgl MG/RW (silty sandy CLAY) 1.00- 8.80mbgl LOFT (slightly sandy slightly gravelly silty CLAY)	N/A	8.80mbgl, rose to 0.35mbgl after 55min	Response zone 8.50 to 13.00: 1.24 (34.11 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No significant land contamination source identified directly on this pond location. No scheduled LQ testing. Closest GI – BH3034 (at 70m) recorded soil leachate exceedance (manganese). Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S3-OU27	39.0	LOFT	WS3421	38.75	5.00	20	0.40- 5.00mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	N/A	4.90 rose to 3.54 in 20 mins.	N/A		Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Groundwater levels are potentially high. Soakaway drainage unlikely to be feasible. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI – WS3421, no soil data exceedance. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3527A	39.25	3.00	45	0.35- 3.00mbgl LOFT (slightly sandy slightly gravelly CLAY and silty CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3528	39.00	3.00	57	0.25- 0.60mbgl LOFT (slightly sandy CLAY) 0.60- 3.00mbgl LOFT (slightly sandy slightly gravelly silty CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A		
S3-OU27A Swale	41.0	LOFT	BH3031	40.8	10.00	0	0.40- 5.40mbgl LOFT (slightly sandy slightly gravelly silty CLAY with rare pockets silt and fine sand)	N/A	8.00mbgl, rose to 5.90mbgl after 20min	Response zone 8.00 to 10.00: 6.05 (34.75 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. WS3031, no soil data exceedance.
S3-OU28	39.0	LOFT	WS3424	39.2	5.45	27	0.30-5.45mbgl LOFT (generally slightly gravelly slightly sandy silty CLAY)	N/A	2.00, no rise after 20 mins	Response zone 1.00 to 5.45: 3.92 (35.28 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. No significant land contamination source identified directly on this pond location. No scheduled LQ testing Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			WS3423	39.1	4.00	30	0.50- 0.90mbgl MG (gravelly silty CLAY) 0.90- 4.00mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	N/A	Not encountered	N/A		
S3-OU29	41.0 / 42.0	LOFT	WS3425	40.65	5.45	37	0.40- 5.45mbgl LOFT (slightly gravelly slightly sandy silty CLAY)	N/A	Water entered overnight to 0.55m bgl	Response zone 1.00 to 5.45: 0.89 (39.76 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high.
			TP3529A	40.70	3.00	48	0.30- 0.60mbgl LOFT (slightly sandy CLAY)		None recorded	N/A	Test 1 only.	

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
S3-OU30	35.0 / 36.0	LOFT					0.60- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates			Practically impervious drainage conditions.	The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI – WS3425, no soil and soil leachate data exceedances. TP3529A (at 50m) recorded soil leachate exceedance (manganese). Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3530A	40.70	3.00	37	0.45- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	1.00 / 1.00	N/A		
			BH3035	33.30	20.00	75	0.25- 2.00mbgl ALV (generally slightly sandy to sandy, slightly gravelly silty CLAY and sandy clayey SILT) 2.00- 9.60mbgl LOFT (slightly sandy gravelly silty CLAY)	N/A	Strike at 10.20mbgl, rose to 4.30mbgl after 20 mins	Response zone 9.00 to 13.00: 0.37 (32.93 mAOD) Response zone 16.50 to 20.00: 0.35 (32.95 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI – TP3532, no soil and soil leachate data exceedances. Domsey Brook is located to the south. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3532	36.85	3.00	25	0.40- 1.60mbgl LOFT (slightly sandy gravelly CLAY) 1.60- 3.00mbgl LOFT (slightly gravelly sandy CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3533	36.60	3.00	107	0.40- 2.40mbgl LOFT (slightly sandy slightly gravelly CLAY / silty CLAY) 2.40- 3.00mbgl GFD (SAND)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	TP3532 likely to be more representative of conditions at the pit location.	
S3-OU30A	36.0 / 37.0	LOFT	BH3038	37.95	10.00	114	0.30- 8.50mbgl LOFT (slightly sandy gravelly / slightly gravelly CLAY / silty CLAY)	N/A	8.00mbgl, rose to 3.20mbgl after 20min	Response zone 4.0 to 10 - 3.41 (34.54 mAOD) Response zone 1.4 to 3.40 - 1.11 (36.84 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. WS3038 (at 100m), no soil or soil leachate data exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required.

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
												Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
S3-OU31	37.5	LOFT	WS3428	37.45	5.00	50	0.30- 4.00mbgl LOFT (slightly sandy to sandy, slightly gravelly to gravelly silty CLAY) 4.00- 5.00mbgl GFD (slightly silty gravelly SAND)	N/A	4.20 rose to 2.60 after 20 mins	Response zone 4.00 to 5.00: 2.98 (34.47 mAOD)	Provisional assessment based on log description indicates poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI –WS3428, no soil and soil leachate data exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3535	37.65	3.00	19	0.40- 1.10mbgl LOFT (slightly sandy CLAY) 1.10- 2.20mbgl LOFT (silty slightly sandy CLAY) 2.20- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
			TP3536	37.50	3.00	32	0.35- 1.40mbgl LOFT (slightly sandy silty CLAY) 1.40- 3.00mbgl LOFT (slightly sandy slightly gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded. Water pipe breached and repaired.	N/A		
S3-OU32	39.5	LOFT	WS3431	39.75	5.45	35	0.30- 5.45mbgl LOFT (generally: slightly sandy gravelly silty CLAY)	N/A	Strike at 1.65mbgl, rose to 1.20mbgl after 20 mins	N/A	Log descriptions indicate poor to practically impervious drainage conditions.	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. Soakaway drainage unlikely to be feasible. Groundwater levels are potentially high. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. Closest GI –WS3431, soil leachate data exceedance (manganese). Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).
			TP3539	39.80	3.00	20	0.40- 0.60mbgl LOFT (slightly sandy CLAY) 0.60- 3.00mbgl LOFT (slightly sandy gravelly CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	
S3-OU33	37.0	LOFT	WS3429	38.50	5.45	75	0.30- 5.45mbgl LOFT (sandy to slightly sandy, slightly gravelly silty CLAY)	N/A	None recorded	N/A	Log descriptions indicate poor to practically impervious drainage conditions.	Estimated permeability rates and in-situ tests indicate generally poor / practically impervious drainage conditions.

DF2 Balancing Pond Number	Pond Elevation from LiDAR [1] (mAOD)	Geology at Pond Location in Accordance to BGS GeoIndex Map	Exploratory Hole	Exploratory Hole Elevation (mAOD)	Exploratory Hole Depth (mbgl)	Exploratory Hole Distance from the Pond (m)	Geology of Exploratory Hole Within Anticipated Pond Depth	Soil Infiltration Rate from Soakaway Test (ms-1)	Groundwater Strike / Level (mbgl)	Highest Recorded GW Monitoring Level (mbgl) [2]	Comments and Provisional Assessment of Drainage Conditions	Engineering Assessment of Infiltration Drainage Feasibility [3]
			TP3537	38.65	3.00	120	0.35- 0.80mbgl LOFT (slightly sandy CLAY) 0.80- 3.00mbgl LOFT (slightly sandy slightly gravelly silty CLAY)	Insufficient fall in water level to calculate infiltration rates	None recorded	N/A	Test 1 only. Practically impervious drainage conditions.	Soakaway drainage unlikely to be feasible. No groundwater data. The design of a lined pond solution must consider mitigation measures (e.g., clay and or concrete) to reduce the effects of potential uplift. TP3537 and WS3429, no soil and soil leachate exceedances. Where dewatering is required to construct a lined solution, a permit for discharge may be required. Treatment and/or disposal of groundwater may still be necessary (for example management of sediments).

Notes

MBRO- Made Ground- Road Embankment, MG- Made Ground, ALV- Alluvium, BRK- Brickearth, HEAD- Head Deposits, RTD- River Terrace Deposits, ISC- Interglacial Silt and Clay, GFD- Glaciofluvial Deposits, GLLMP- Glaciolacustrine Deposits, LOFT- Lowestoft Formation, LC- London Clay Formation.

Groundwater and soil leachate exceedances – groundwater and soil leachate analysis results have been compared against Environmental Quality Standards (EQS, annual average) to assess the potential risks to controlled water receptors in close proximity to the scheme. Screening against the Drinking Water Standards (DWS) has also been undertaken in locations that are located within or close to a source protection zone.

Soil data exceedances –soil chemical analysis results have been screened against the Category 4 Screening Levels (C4SLs) and Suitable for Use Levels (S4Uls) generic assessment criteria for assessing potential risks to human health from exposure to contaminants in soil (in a commercial/industrial use scenario).

Soil waste classification - preliminary waste characterisation has been undertaken to classify soils tested as either hazardous or non-hazardous.

Uncontrolled discharge of groundwater to surrounding areas should be avoided if dewatering is required during construction.

[1] Approximate levels determined from EA Opensource LiDAR DTM level contours.

[2] Groundwater level data based on AGS data received September 2021. For the Phase 3 GI this data set does not include results over a winter period and therefore higher seasonal levels are anticipated.

[3] A preliminary assessment of groundwater levels and the risk of inundation / uplift has been provided. However, levels may vary, particularly where GI data is limited, and all attenuation ponds are to consider during detailed design the risk of inundation and or uplift pressures, and the requirement for discharge consents where groundwater lowering is required.

Annex E. Infiltration Assessment Summary Tables

Table E.1 Groundwater level, infiltration and contaminated land assessment at proposed attenuation ponds (Drainage Section 1)

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S1-OU1	Four off pond (25 – 90)	2.3×10^{-6} to 9.3×10^{-6}	Yes	No	Likely	Yes	Infiltration rates indicate borderline good to poor drainage conditions. No local groundwater data at present. Risk of inundation or uplift if levels found to be high. **Sensitive Secondary A aquifer** associated with the River Terrace Deposits identified in GI positions located 25m from the pond location. An existing industrial estate (potential source of land contamination) is located within 50m of the pond location on the western side of A12. Groundwater chemical testing data not available currently. New groundwater monitoring installation is proposed as part of the ongoing GI gap analysis to aid the attenuation pond design and groundwater sampling to assess the water chemical quality, should dewatering be required during construction.

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Provisionally, an impermeable liner is recommended.
S1-OU7A	One on pond, three off pond (71 - 148)	N/A to 6.3×10^{-6}	No	Yes	Likely	Yes	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is not feasible.** Groundwater monitoring indicates **shallow groundwater. No sensitive aquifer** underlying the pond location. An existing industrial estate (potential source of land contamination) is located on the western side of A12. No local soil chemical testing data (within 25m) currently available but **no exceedances have been recorded in GI positions** located 70m from the pond location. **No groundwater chemical testing data (within 25m) is currently available**. Monitoring of existing groundwater installation proposed as part of the ongoing GI gap analysis to aid the attenuation pond design and groundwater sampling to assess water chemical quality should dewatering be required during construction.

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Provisionally, an impermeable liner is recommended.
S1-OU11	Four off pond (25 - 75)	Insufficient drop in water level to calculate infiltration rate	No	Likely	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is not feasible.** Groundwater monitoring in nearby boreholes indicates **shallow groundwater**. No groundwater monitoring hole directly on the pond location. New GI location proposed directly on the pond location to aid design and assess water chemical quality should dewatering be required. **No sensitive aquifer identified** locally but Boreham Brook is located close to the pond location. Chemical testing undertaken in nearby boreholes. **Groundwater screening criteria exceedances (cadmium, lead, nickel, sulphate, zinc) in borehole located 55m from the pond location. Therefore, an impermeable liner may be required that would need**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							to be confirmed through supplementary GI at detailed design stage.
S1-OU12	One on pond, two off pond (71 - 148)	Insufficient drop in water level to calculate infiltration rate	Yes	No	Unlikely	No	Potentially good ground drainage conditions in deposits ≤1.9m bgl. **Infiltration is likely feasible**. This is subject to further supplementary GI survey on pond location. **No shallow groundwater** encountered in nearby boreholes. No groundwater monitoring hole directly on the pond location. New GI location proposed directly on pond location to aid design and assess water chemical quality should dewatering be required. Chemical testing undertaken. **No screening criteria exceedances.** **Sensitive Secondary A aquifer** associated with Glaciofluvial Deposits has been identified in GI positions located 15m from the pond location. Boreham Brook is also located close by. **Therefore an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S1-OU13	One on pond, two off pond (15 - 20)	Insufficient drop in water level to calculate infiltration rate	No	Yes	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is likely not feasible.** Chemical testing undertaken. **No screening criteria exceedances.** No groundwater chemical testing data. Groundwater monitoring indicates **shallow groundwater. Sensitive Secondary A aquifer** associated with Glaciofluvial Deposits and Alluvium underlies the pond location. The River Ter is located close by. **Therefore, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S1-OU18	Three off pond (5 - 32)	Insufficient drop in water level to calculate infiltration rate	No	Yes	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is likely not feasible.** Groundwater monitoring in nearby boreholes indicates **shallow ground water.** Chemical testing undertaken. **No screening criteria exceedances.** No groundwater chemical testing data. **Sensitive Secondary A aquifer** associated with Alluvium underlies the pond location. **Therefore**, **an impermeable liner may be required that would need to be**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							confirmed through supplementary GI at detailed design stage.
S1-OU19	Two off pond (49 - 135)	Insufficient drop in water level to calculate infiltration rate	No	Likely	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is likely not feasible.** **Slight groundwater seepage** recorded at 3.95m depth in nearby boreholes. **No significant potential source of land contamination** identified within the proposed attenuation pond footprint. **Provisionally, an impermeable liner is not recommended.**
S1-OU19C	Two off pond (16 - 22)	N/A to 3.0×10^{-6}	No	Yes	Likely	Yes	Infiltration rates and estimates from log descriptions indicate generally poor ground drainage conditions. **Infiltration is likely not feasible.** Groundwater monitoring in nearby boreholes indicates **shallow groundwater.**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							No groundwater chemical analysis data available currently. Proposed attenuation pond is **located close to an infilled historical gravel pit.** **Provisionally an impermeable liner is recommended.**
S1-OU19C1	One off pond (51)	N/A	No	Likely	Yes	Yes	Limited GI but infiltration estimates from local log descriptions indicate poor to practically impervious drainage conditions. **Infiltration is likely not feasible.** **Groundwater seepage** recorded at depth in borehole. Proposed attenuation pond **located on a historical infilled gravel pit.** Hydrocarbon was recorded in one GI position located at 5m above the generic screening criteria for soils. The **soil was also assessed as hazardous**. Relocation of the proposed attenuation pond is required if practicable. Otherwise, the **contaminated Made Ground should be excavated for offsite disposal** prior to pond construction. Groundwater chemical analysis has not been undertaken. **Provisionally an impermeable liner is recommended.**
S1-OU23	Two on pond	N/A to 1.4×10^{-6}	Unlikely	Yes	Unlikely	No	Infiltration rates and estimates from log descriptions indicate good to poor ground drainage conditions. **Infiltration is unlikely to be feasible.**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Groundwater monitoring indicates **shallow groundwater.** Chemical testing undertaken**. No screening criteria exceedances.** No groundwater chemical testing data. **Groundwater chemical analysis required if dewatering will be undertaken.** **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. **Therefore**, **an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S1-OU23C	One off pond (18)	N/A	No	Unlikely	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is likely not feasible.** Groundwater monitoring in a nearby borehole indicates **shallow groundwater is unlikely.** Chemical testing undertaken. **No screening criteria exceedances.** **Provisionally, an impermeable liner is not recommended.**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S1-OU23D	One off pond (57)	N/A	No	Unlikely	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor to practically impervious ground drainage conditions. **Infiltration is likely not feasible.** Groundwater monitoring in a nearby borehole indicates **shallow groundwater is unlikely.** No scheduled environmental testing. **Provisionally, an impermeable liner is not recommended.**
S1-OU24A	One off pond (24)	N/A	No	Yes	Unlikely	No	Infiltration rates and estimates from log descriptions indicate generally poor ground drainage conditions. **Infiltration is likely not feasible.** Groundwater monitoring in a nearby borehole indicates **shallow groundwater.** No scheduled environmental testing. Groundwater chemical analysis required if dewatering will be undertaken. **An impermeable liner requirement would need to be confirmed through supplementary GI at detailed design stage.**

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S1-OU24B	One off pond (45)	N/A	No	Yes	No	No	Infiltration rates and estimates from log descriptions indicate generally poor ground drainage conditions. **Infiltration is likely not feasible.** Groundwater monitoring in a nearby borehole indicates **shallow groundwater.** No scheduled environmental testing. Groundwater chemical analysis required if dewatering will be undertaken. **An impermeable liner requirement would need to be confirmed through supplementary GI at detailed design stage.**

Notes:

1. Exploratory hole distance from proposed attenuation storage location is represented by the numbers in brackets within the table second column.
2. Where no infiltration rates are currently available at some exploratory holes for the Drainage Section 1 proposed attenuation storage locations, the infiltration potential is inferred from a preliminary assessment based on log descriptions.

Attenuation pond reference	Number of exploratory holes (m)[1]	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
3. For the proposed attenuation storage locations where there is currently no *in situ* GI data within the attenuation storage footprint, supplementary GI within the attenuation storage footprint will be required to inform the detailed design stage. This includes long-term groundwater monitoring (i.e. shallow groundwater confirmation), infiltration rates and contaminated land identification. 4. It should be noted that an additional water depth of 0.3m is to be designed at the bottom of the proposed attenuation ponds (i.e. below the proposed attenuation pond outlet pipe invert level) to create a wetland feature to achieve further water quality treatment and biodiversity benefits. Consequently, this will potentially preclude the use of infiltration for these proposed attenuation pond locations. This is subject to confirmation at the detailed design stage.							

Table E.2 Groundwater level, infiltration and contaminated land assessment at proposed attenuation ponds (Drainage Section 2)

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S2-OU4	Three off pond (56 – 90)	N/A	Yes	Likely	Yes	Yes	No *in situ* GI data currently on the proposed attenuation pond location. A preliminary assessment based on log descriptions with estimated permeability rates indicates material varying from good to poor drainage conditions. **Infiltration is potentially feasible.** **Groundwater seepage recorded** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. The proposed attenuation pond is located approximately 50m south-east of a large historical landfill (Whetmead LNR Witham landfill). Groundwater chemical analysis required if dewatering will be undertaken. **Provisionally, an impermeable liner is recommended.**
S2-OU9	One off pond (90)	N/A	Unlikely	Likely	Likely	Yes	No *in situ* GI data currently on the proposed attenuation pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely.** **Groundwater recorded** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Groundwater chemical analysis required if dewatering will be undertaken. Witham industrial estate located approximately 150m west of the pond location. **Provisionally, an impermeable liner is recommended.**
S2-OU10	One off pond (150)	N/A	Unlikely	Likely	Likely	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely.** **No groundwater recorded** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. No soil or groundwater chemical testing on or within 25m of the pond location. Groundwater chemical analysis required if dewatering will be undertaken. Witham industrial estate located approximately 150m west of the pond location. **Provisionally, an impermeable liner is recommended.**
S2-OU11	One on pond	N/A	Likely	Yes	Likely	Yes	Limited *in situ* GI at the pond location. A preliminary assessment based on log descriptions indicates good to poor drainage conditions. **Infiltration is likely.** **Groundwater seepage recorded** in a nearby borehole. **Sensitive Secondary A aquifer** associated

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							with River Terrace Deposits underlies the pond location. Chemical testing undertaken. **No screening criteria exceedances.** Witham industrial estate located approximately 50m west of the pond location. **Provisionally, an impermeable liner is recommended.**
S2-OU14	One off pond (68)	N/A	Yes	No	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates potentially good drainage conditions below 2m bgl. **Infiltration is potentially feasible.** Note this attenuation pond is located on a quarry site. **Groundwater recorded at significant depth** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond. No soil screening criteria exceedances from GI position off the pond location. No groundwater chemical analysis data within 25m of the pond location. **An impermeable liner may be required that would need to be confirmed through specification of quarry backfill material at detailed design stage.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S2-OU15A	One off pond (23)	N/A	Yes	No	Unlikely	No	No current *in situ* GI data on the pond location. A preliminary assessment based on log descriptions indicates potentially good drainage conditions below 2m bgl. **Infiltration is potentially feasible.** Note this attenuation pond is located on a quarry site. **Groundwater recorded at significant depth** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. No soil screening criteria exceedances from GI position off the proposed attenuation pond. No groundwater chemical analysis data within 25m of the pond location. **An impermeable liner may be required that would need to be confirmed considering the specification of quarry backfill material at detailed design stage.**
S2-OU15C	One off pond (138)	N/A	Yes	No	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates potentially good drainage conditions. **Infiltration is potentially feasible.** Note this attenuation pond is located on a quarry site. **No groundwater recorded** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							No soil data exceedances from GI position off the pond location. No groundwater chemical analysis data within 25m of the pond location. **An impermeable liner may be required that would need to be confirmed considering the specification of quarry backfill material at detailed design stage.**
S2-OU15C1	One off pond (86)	N/A	Yes	No	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates potentially good drainage conditions below 2.20m bgl. **Infiltration is potentially feasible.** **No groundwater recorded** in a nearby borehole. No soil screening criteria exceedances from GI position off the pond location. No groundwater chemical analysis data within 25m of the pond location. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. **Therefore**, **an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S2-OU15D	No GI within >250m of pond	None	Yes	No	Unlikely	No	No *in situ* GI data (soil and groundwater) currently on or within 250m of the pond location.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Sensitive Secondary A aquifer associated with River Terrace Deposits underlies the pond location. **Therefore, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S2-OU15E	Two off pond (70 – 110)	N/A	Unlikely	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely.** Note this attenuation pond is located on a quarry site. **Groundwater recorded** in a nearby borehole. No soil screening criteria exceedances from GI position off the pond location. **An impermeable liner may be required that would need to be confirmed considering the specification of quarry backfill material at detailed design stage**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S2-OU15G	Two off pond (70 – 75)	N/A	Unlikely	Yes	Likely	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely.** **Groundwater recorded** in a nearby borehole. **Soil leachate screening criteria exceedance (copper)** recorded GI location off the proposed attenuation pond**.** Groundwater chemical analysis required to support any dewatering requirement. Rivenhall Brook is located to the south of the attenuation pond. **Provisionally, an impermeable liner is recommended.**
S2-OU15H	One off pond (88)	N/A	Unlikely	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely.** **Groundwater recorded** in a nearby borehole. **No significant** potential source of land contamination identified.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Provisionally, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.
S2-OU18	One off pond (49)	N/A	Unlikely	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates good to poor drainage conditions. **Infiltration is unlikely.** **Groundwater recorded** in a nearby borehole. No soil chemical screening criteria exceedances in GI off the pond location. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. **Therefore**, **an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage**
S2-OU19	One off pond (73)	N/A	Yes	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates potentially good drainage conditions below 1.50mbgl. **Infiltration is potentially feasible**. **Groundwater recorded** in a nearby borehole. No soil screening criteria exceedances in GI locations off the pond location. Groundwater chemical analysis

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							required to support any dewatering requirements. River Blackwater located within 50m east of the attenuation pond. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S2-OU24A	One off pond (29)	N/A	No	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded** in a nearby borehole. Chemical testing undertaken. **Non-hazardous waste soil classification.** No soil screening criteria exceedances. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage**

Notes:

1. Exploratory hole distance from the proposed attenuation storage location is represented by the numbers in brackets within the table second column.
2. No infiltration rates currently available at any of the exploratory holes for the Drainage Section 2 proposed attenuation storage device locations. Hence, infiltration potential is inferred from a preliminary assessment based on log descriptions.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration[2] rate range (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
3. For the proposed attenuation storage locations where there is currently no *in situ* GI data within the attenuation storage footprint, supplementary GI within the attenuation storage footprint will be required to inform the detailed design stage. This includes long-term groundwater monitoring (i.e. shallow groundwater confirmation), infiltration rates and contaminated land identification. 4. It should be noted that an additional water depth of 0.3m is to be designed at the bottom of the proposed attenuation ponds (i.e. below the proposed attenuation pond outlet pipe invert level) to create a wetland feature to achieve further water quality treatment and biodiversity benefits. Consequently, this will potentially preclude the use of infiltration for these proposed attenuation pond locations. This is subject to confirmation at the detailed design stage.							

Table E.3 Groundwater level, infiltration and contaminated land assessment at proposed attenuation ponds (Drainage Section 3)

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU1	Two off pond (80 – 93)	N/A	Unlikely	Unlikely	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates good to poor / practically impervious drainage conditions. **Infiltration is unlikely.** **Groundwater recorded at significant depth** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. **No significant** potential source of **land contamination** identified. **Provisionally, an impermeable liner is recommended.**
S3-OU2	Three on pond, four off pond (30 – 45)	Three times, no test possible as trial pits collapsed. Twice, insufficient fall in water level to calculate infiltration rates	No	Yes	Likely	Yes	*In situ* GI tests and estimated values indicate that **infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. Chemical testing undertaken. **Soil leachate screening criteria exceedance (lead) and groundwater screening criteria exceedances (total cyanide,**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							sulphate, manganese and electrical conductivity) in GI position off pond location (30m). **Provisionally, an impermeable liner is recommended.**
S3-OU3	No GI Data	N/A	Likely	Likely	Unlikely	No	No *in situ* GI data currently on the pond location. BGS map indicates River Terrace Deposits and so drainage conditions could vary from good to practically impervious. **Infiltration is likely.** Groundwater levels **may be high.** **No significant** potential source of **land contamination** identified within the pond location. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. **Therefore, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU4	Four off pond (39 – 65)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Unlikely	No	Nearby *in situ* GI tests and estimated values indicate that **infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby borehole.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							No groundwater chemical analysis was undertaken. **No soil or soil leachate screening criteria exceedances.** **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond. **Therefore, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU5	No GI Data	N/A	Likely	Likely	Likely	Yes	No *in situ* GI data currently on the pond location. BGS map indicates River Terrace Deposits and so drainage conditions could vary from good to practically impervious. **Infiltration is likely.** Groundwater levels **may be high.** A small portion of infilled land is located close to the pond location. Groundwater chemical testing is required to support any dewatering. **Provisionally, an impermeable liner is recommended.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU8	One off pond (20)	Insufficient fall in water level to calculate infiltration rates	No	Unknown	Unlikely	No	No *in situ* GI data currently on the pond location. Nearby *in situ* GI tests and estimated values indicate practically impervious drainage conditions. Hence, **infiltration is not feasible.** Groundwater levels are **unknown.** River Blackwater is located to the north of the pond location. No groundwater chemical analysis undertaken. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU8A	No GI data	N/A	Likely	Likely	Yes	Yes	No *in situ* GI data currently on the pond location. BGS map indicates River Terrace Deposits and Lowestoft Formation and so drainage conditions could vary from good to practically impervious. **Infiltration is likely.** Groundwater levels **may be high. Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. The attenuation pond is also located within a Source Protection Zone (SPZ3). River Blackwater is located to the north of the pond. No groundwater chemical analysis undertaken. Groundwater chemical testing required to support any dewatering. The attenuation pond is **located directly on a historical sewage works site** and should be relocated if possible. **Provisionally, an impermeable liner is recommended.**
OU8B, OU8D and OU8E	Three off pond (20 – 167)	N/A	No	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** Groundwater levels are **potentially high.** **No significant** potential source of **land contamination** identified in the vicinity of the pond location.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.
S3-OU9	No GI data	N/A	Unlikely	Unknown	Yes	Yes	No *in situ* GI data currently on the pond location. BGS map indicates Lowestoft Formation and so drainage conditions are likely to be practically impervious. **Infiltration is unlikely to be feasible.** Groundwater levels are unknown. Attenuation pond is l**ocated on historical infilled brickwork**. Attenuation pond to be relocated if possible. **No soil or groundwater chemical analysis data available**. Groundwater chemical testing required to support any dewatering. **Provisionally, an impermeable liner is recommended.**
S3-OU10	One on pond, three off pond (10 – 38)	One test was impossible as trial pits collapsed. Twice there was	No	Yes	Likely	Yes	*In situ* GI tests and estimated values indicate practically impervious drainage conditions. **Infiltration is unlikely to be feasible.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
		insufficient fall in water level to calculate infiltration rates					**Groundwater recorded (potentially high)** in a nearby borehole. No soil or groundwater chemical analysis undertaken. **Provisionally, an impermeable liner is recommended.**
S3-OU13	One off pond (64)	N/A	Unlikely	Unlikely	Likely	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **No soil data exceedances or soil leachate exceedances** in GI position off the pond location**. Groundwater levels are unknown.** **A small and infilled pond is located within 50m** to the north of the pond location. No groundwater chemical analysis was undertaken. This is required to support dewatering if groundwater levels are high. **Provisionally, an impermeable liner is recommended.**
S3-OU14	Three off pond (30 – 75)	N/A	Unlikely	Unlikely	Likely	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Groundwater recorded at significant depth below ground in a nearby borehole. **Sensitive Secondary A aquifer** associated with River Terrace Deposits underlies the pond location. The attenuation pond is also located within a Source Protection Zone (SPZ3). Chemical testing undertaken. **No soil screening criteria exceedances. Groundwater exceedances (copper, manganese, nickel, nitrite and nitrate)** in borehole located within 50m of the pond location. **Provisionally, an impermeable liner is recommended.**
S3-OU15A	Two on pond, one off pond (50)	Insufficient drop in level to calculate infiltration rate	No	Yes	Likely	Yes	*In situ* GI tests and estimated values indicate practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby borehole. The attenuation pond is located near a historical nursery. **Soil leachate exceedance (manganese)** in GI position off the pond location. Groundwater chemical testing is required to support dewatering. **Provisionally, an impermeable liner is recommended.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU15B and S3-OU15C	Four off pond (25 – 78)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Likely	Yes	Nearby *in situ* GI tests and estimated values indicate practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby borehole. The attenuation ponds are located near an industrial area. **Soil leachate exceedance (manganese**) in GI position off the pond location. Groundwater chemical testing is required to support dewatering. **Provisionally, an impermeable liner is recommended.**
S3-OU16	One on pond, two off Pond (17 – 21)	Insufficient fall in water level to calculate infiltration rates	No	Unknown	Likely	Yes	*In situ* GI tests and estimated values indicate practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** Groundwater levels **are unknown.** The pond is located near a historical nursery. **Soil leachate exceedance (benzo[a]pyrene)** in GI position off pond location. Groundwater chemical testing is required to support dewatering if levels are high. **Provisionally, an impermeable liner is recommended.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU17	One on pond, two off pond (7 – 10)	N/A to 3.7×10^{-6}	No	Yes	Yes	Yes	*In situ* GI tests and estimated values indicate poor drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby borehole. Attenuation pond is **located directly on the historical London Road Landfill** near junction 25. This is likely to preclude infiltration. **The Environment Agency should be consulted** prior to placing this pond on a landfill. No soil screening criteria exceedances recorded directly on the pond location. However, **construction of the attenuation pond may require the removal and disposal of landfill materials**. **Groundwater and soil leachate exceedances were recorded** in this location and other nearby boreholes within the historic landfill. **Provisionally, an impermeable liner is recommended.**
S3-OU19	Two off pond (75 – 84)	N/A	Likely	Likely	Likely	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates potentially good drainage conditions. **Infiltration is likely to be feasible.** Limited **groundwater data** locally, but levels are **potentially high.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							A potential infilled pit is located close to the pond location. **Groundwater chemical exceedances (chromium(III) nitrate)** recorded in an exploratory hole off the pond location. **Provisionally an impermeable liner is recommended.**
S3-OU20	Two off swale (62 – 70)	N/A	No	Yes	Unlikely	No	The S3-OU20 attenuation storage is a proposed swale. No current *in situ* GI data on the proposed swale location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby boreholes. **No soil screening criteria exceedances in** GI positions off the pond location. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU21	Two off pond (25 – 40)	N/A	No	Yes	Likely	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby exploratory hole. The attenuation pond is **located close to a historical nursery.** **Groundwater exceedances (chromium(III) and manganese**) in a nearby exploratory hole. **Provisionally an impermeable liner is recommended.**
S3-OU22	Four off pond (18 – 39)	One test was impossible as trial pits collapsed. Twice, there was insufficient fall in water level to calculate infiltration rates	No	Yes	Unlikely	No	Nearby *in situ* GI tests and estimated values indicate poor drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes. Chemical testing undertaken. **No soil or soil leachate screening criteria exceedances.** **Provisionally, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU23	One off pond (58)	N/A	No	Yes	Yes	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes. The attenuation pond is **located on a historical nursery.** Chemical testing undertaken. **No soil or soil leachate screening criteria exceedances** in off pond exploratory hole. **Provisionally, an impermeable liner is recommended.**
S3-OU24	One on pond, two off pond (15 – 25)	N/A	No	Yes	Yes	Yes	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes. The attenuation pond is **located on a historical nursery.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Chemical testing undertaken. **Soil screesning criteria exceedances (naphthalene – PAH)** recorded in nearby exploratory hole. **Provisionally, an impermeable liner is recommended.**
S3-OU26	One on pond, five off pond (20 – 80)	2.4×10^{-5} to 5.9×10^{-5} One instance of insufficient fall in water level to calculate infiltration rates	Yes	No	Unlikely	No	*In situ* GI tests and estimated values are variable and indicate good to poor / practically impervious drainage conditions**. Infiltration is potentially feasible.** **No shallow groundwater** issues. Chemical testing undertaken. **No soil or soil leachate screening criteria exceedances.** **Provisionally, an impermeable liner is not recommended.**
S3-OU26A	One off pond (10)	N/A	No	No	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							No shallow groundwater issues. Chemical testing undertaken. **No soil or soil leachate data exceedances.** **Provisionally, an impermeable liner is not recommended**.
S3-OU26B	One off pond (20)	N/A	No	Yes	Unlikely	No	No *in situ* GI data currently on the pond location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby exploratory hole. **No significant land contamination** source identified directly on the pond location. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU27	Three off pond (20 – 57)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Unlikely	No	A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes. Chemical testing undertaken. **No soil screening criteria exceedances.** **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU27A	One on swale	N/A	No	No	Unlikely	No	The S3-OU27A attenuation storage is a proposed swale. No *in situ* GI data currently on the swale location. A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **No shallow groundwater** issues. Chemical testing undertaken. **No soil screening criteria exceedances.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Provisionally, an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.
S3-OU28	Two off pond (27 -30)	N/A	No	Yes	Unlikely	No	A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes. **No significant land contamination** source identified directly on the pond location. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU29	Three off pond (37 -48)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Unlikely	No	Estimated permeability rates indicate generally poor / practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Soil leachate screening criteria exceedances in nearby exploratory holes (manganese).Therefore, **an impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU30	Three off pond (25 -107)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Unlikely	No	A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in nearby exploratory holes Chemical testing undertaken. **No soil or soil leachate screening criteria exceedances.** **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**
S3-OU30A	One off pond (114)	N/A	No	Yes	Likely	Yes	A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							Groundwater recorded (potentially high) in nearby exploratory holes**.** Chemical testing undertaken. **No soil or soil leachate data exceedances.** **Groundwater chemical exceedance (manganese) and soil leachate exceedance (chromium (III))** in a nearby exploratory hole. **Provisionally, an impermeable liner is recommended.**
S3-OU31	Three off pond (19 -50)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Unlikely	No	A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby exploratory holes. Chemical testing undertaken. **No soil or soil leachate screening criteria exceedances** in a nearby exploratory hole. **An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.**

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
S3-OU32	Two off pond (20 -35)	Insufficient fall in water level to calculate infiltration rates	No	Yes	Likely	Yes	A preliminary assessment based on log descriptions indicates poor to practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** **Groundwater recorded (potentially high)** in a nearby exploratory holes. Chemical testing undertaken. **Soil leachate screening criteria exceedance (manganese)** in a nearby exploratory hole. **Provisionally, an impermeable liner is recommended.**
S3-OU33	Two off pond (75 -120)	Insufficient fall in water level to calculate infiltration rates	No	Unknown	Unlikely	No	Estimated permeability rates and *in situ* tests indicate generally poor / practically impervious drainage conditions. **Infiltration is unlikely to be feasible.** Groundwater levels are **unknown.** Chemical testing undertaken. **No soil or soil leachate screening criteria exceedances** in a nearby exploratory hole.

Attenuation pond reference	Number of exploratory holes[1] (m)	Infiltration rate range[2] (m/s)	Feasibility of infiltration[4]	Potential shallow groundwater	Contaminated land issue	Provisional Impermeable liner recommendation	Site-specific comments[3]
							An impermeable liner may be required that would need to be confirmed through supplementary GI at detailed design stage.

Notes:

1. Exploratory hole distance from proposed attenuation storage location is represented by the numbers in brackets within the table second column.
2. Where no infiltration rates are currently available at some exploratory holes for the Drainage Section 3 proposed attenuation storage locations, the infiltration potential is inferred from a preliminary assessment based on log descriptions.
3. For the proposed attenuation storage device locations where there is currently no *in situ* GI data within the attenuation storage footprint, supplementary GI within the attenuation storage footprint will be required to inform the detailed design stage. This includes long-term groundwater monitoring (i.e. shallow groundwater confirmation), infiltration rates and contaminated land identification.
4. It should be noted that an additional water depth of 0.3m is to be designed at the bottom of the proposed attenuation ponds (i.e. below the proposed attenuation pond outlet pipe invert level) to create a wetland feature to achieve further water quality treatment and biodiversity benefits. Consequently, this will potentially preclude the use of infiltration for these proposed attenuation pond locations. This is subject to confirmation in the detailed design stage.

Annex F. Lead Local Flood Authority Meeting Minutes

A12 Chelmsford to A120 widening scheme

Meeting Minutes

LLFA SW DRAINAGE STRATEGY DISCUSSION MEETING MINUTES

HE551497-JAC-HDG-SCHW-MI-D-0004 | P01

09/11/2021

HE551497

A12 Chelmsford to A120 widening scheme

Project No:	HE551497
Document Title:	LLFA SW DRAINAGE STRATEGY DISCUSSION MEETING MINUTES
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
P01	09/11/2021	MEETING MINUTES	JC	AM	JT	RC

Subject	LLFA SW DRAINAGE STRATEGY DISCUSSION MEETING MINUTES		
Project	A12 Chelmsford to A120 widening scheme Stage 3		
Project No.	HE551497	File	HE551497-JAC-HDG-SCHW-MI-D-0004
Prepared by	James Cullinane/Asit Modi	Phone No.	0118 946 8389
Location	Microsoft Teams	Date/Time	9th November 2021 at 14:00
Participants	Asit Modi (AM) – Jacobs (Drainage Task Lead) Jose Tavares (JT) – Jacobs (Drainage Team Lead) James Cullinane (JC) – Jacobs (Senior Drainage Engineer) Caroline Frost (CF) – Jacobs (Water Quality Lead) Tim Simpson (TS) – Essex County Council (LLFA) Zahida Yousuf (ZY) - Essex County Council (LLFA)		
Copies to	All listed – All participants	Apologies	None

Notes		Action
1	Introductions Introductions of all the attendees were made. AM went through the agenda and the meeting objectives. AM stated that this meeting was a follow on from the previous meetings where the drainage design and flood risk design criteria for the A12 Scheme had been presented and discussed. AM stated that the A12 Surface Water Drainage Strategy report (referred to as the Drainage Strategy hereafter) is currently being drafted. AM stated that the general purpose of this meeting is to present drainage design information (including catchment specific discussions and a typical Drainage Layout Drawing) that would be included in the Drainage Strategy, to obtain the LLFA's early feedback/inputs to the presented information and the Drainage Strategy.	
2	Safety Moment None. Proceeded directly with the meeting.	
3	Project Update AM provided a brief project update about the recent design freeze history for the A12 project. AM stated that the Design Fix 2 (DF2) design freeze was to inform the Statutory Consultation. The Statutory Consultation was held between June and August 2021. AM stated that the DF3 design freeze incorporated the feedback from the Statutory Consultation phase. The DF3 design freeze will inform the A12 Environmental Statement (ES) document including the Drainage Strategy. Targeted	

	supplementary consultation has also been undertaken post the DF3 design freeze at a small number of specific locations on the proposed Scheme and constitutes the DF4 design fix. This additional targeted consultation will also be included in the ES and Drainage Strategy, but the bulk of the design pertains to DF3. The scheme DCO submission is planned for March 2022.	
	AM stated that there are a number of internal dates for completing the Drainage Strategy and external dates relating to issuing the Drainage Strategy. Post Meeting Note – Drainage Strategy will be issued in Feb'22 as per current programme. There is a possibility that draft version of Drainage Strategy could be provided in advance.	AM to confirm the correct external dates relating to issuing the Drainage Strategy
4	Overview of Proposed Highway Drainage Strategy Proposed Scheme Sections - AM gave an overview of the proposed highway drainage strategy stating that the proposed Scheme (between Chelmsford and Marks Tey) is split into three sections for ease of engineering assessment and information presentation on the project. Broadly these sections are Section1, Section 2 and Section 3 respectively. Section1 is Junction 19 to Junction 21, Section 2 is Junction 21 to existing Junction 23 and Section 3 is Junction 23 to Junction 25. Each section includes A12 mainline, junctions and side roads / local roads. Catchment Number - AM stated there are approximately 85 drainage catchments in total. These cover online sections of the proposed Scheme (i.e. online widening works) and offline sections (i.e. new paved areas on greenfield sites) Proposed Outfalls - In terms of proposed outfalls AM stated that these discharge to main rivers (approx. 22 outfalls), ordinary watercourses (approx. 45 outfalls) and existing highway drainage systems (approx. 18 outfalls) Attenuation Storage Provision - AM stated that attenuation ponds are proposed as the primary means of attenuation storage where feasible and cover approx. 60 to 65 outfall locations. TS queried the attenuation storage types used for the remainder outfall locations. AM stated that the remaining outfall locations are covered by either underground geocellular attenuation storage units, swales or oversized pipes if there are spatial constraints instead of attenuation ponds. LLFA Meeting Schedule - JT suggested that perhaps 4 additional meetings could be held to discuss the A12 Drainage Strategy given that it's such a large scheme	AM to understand the availability of TS and ZY and book in a series of meetings in

	and cannot be covered in one meeting. JT suggested that case study examples could be discussed for an online catchment example, an offline catchment example, a side road catchment example, etc. as opposed to trying to discuss all 85 outfall locations specifically. TS agreed with this proposal.	the coming weeks. AM to send Outlook calendar invites
5	Highway Drainage Assessment Approach AM briefly described the highway drainage assessment approach. This involved: • Review of existing drainage information/understand existing drainage catchments, outfalls arrangements and to inform allowable discharge rates. • Development of proposed drainage catchments/outfalls arrangement from review of proposed highway geometry (high point / low point), proposed topography and maintenance liabilities (National Highways / Essex Highways). • Allowable discharge estimation for online and offline highway proposals. Online sections (Hydraulic modelling used to determine existing peak discharge rates). Offline section (Spreadsheet based calculations used to estimate greenfield runoff rates). • Preliminary assessment for edge collection systems. • Proposed case drainage network modelling (sizing for attenuation storage • Exceedance flow assessment. AM asked TS and ZY if they had any questions on the highway drainage assessment approach. TS and ZY had no questions.	
6	Section 3 Drainage Catchment Example Discussion (S3-OU1 and S3-OU2 Outfalls – Online Widening A12 Mainline Catchments) Flood Risk - TS questioned AM whether we are increasing flood risk with the provision of new outfall locations. AM stated that for the proposed online widening catchments the existing case has been modelled to determine the allowable discharge rates for the 1yr, 2yr, 5yr and 100yr return period events and that these have been applied to the proposed case outfalls to ensure the proposed discharge rates do not exceed the existing case. AM stated that the proposed attenuation storage is sized for the 100yr return period event plus 20% climate change allowance. TS questioned whether the 40% climate change allowance scenario has been modelled to assess exceedance flows. AM confirmed that the 100yr return period event plus 40% climate change allowance has been assessed for exceedance flows. Exceedance Flows - Regarding the exceedance flow map examples presented, TS asked about the extent of	

	flooding outside the proposed highway boundary. JT subsequently queried TS if the flooding in the proposed case can be outside the proposed highway boundary if it is shown to be less than the existing case flooding. TS stated that this is potentially acceptable if there are site constraints that limit the amount of attenuation storage provision that can be provided. TS then stated that as a minimum Jacobs should reduce the flood extents / depths / hazards relative to the existing case and provide flow exceedance mapping to demonstrate this. Review of Ground Investigation (GI) Data – AM stated that the Drainage Strategy will have summary tables documenting each proposed catchment / outfall location presenting the ground conditions, infiltration rates, contaminated land presence, etc. to demonstrate if infiltration is likely / possible for a given catchment. TS stated that the LLFA would not look at detailed GI factual reports, soakage test results, etc. TS would expect to see concise summary text, perhaps supported by summary tables as AM mentioned, to present infiltration rates, ground conditions, etc. to understand if infiltration techniques can be incorporated to the proposed highway drainage design.	
7	Section 3 Drainage Catchment Example Discussion (S3-OU3, S3-OU4 and S3-OU5 Outfalls – Side Road Catchments) Paved Area & Discharge Rates Data Provision - AM explained these catchments are potential redundant pavements (existing paved area would be removed) and the proposed discharge rate of 5l/s is considered in absence of drainage surveys. AM mentioned existing site allowable discharge would not be presented in such cases as this would clearly offer a betterment over the existing case. TS stated that the LLFA would need to see full tables of existing and proposed case paved areas in addition to full tables of existing and proposed case discharge rates to demonstrate that the proposed Scheme is not increasing flood risk. Exceedance Flow Maps – AM stated that exceedance flood maps would not include volume of flooding < $0.5m^3$ as it is considered to be negligible. TS generally was in agreement with this approach. TS further stated that with regards to exceedance flow mapping, if the volume of flooding is $1m^3$ or greater it would need to be shown on the flood maps and an explanation given on the mitigation measures where applicable if there is sizeable flooding.	AM and Jacobs Drainage team to consider providing information on existing paved area and existing site discharge rates
8	Drainage Layout Plans Drainage Networks & Edge Collection Features - JT stated that Jacobs would want LLFA inputs on the Drainage Layout Plans to ensure that sufficient	

	information is provided. For example, would it be acceptable that the proposed highway drainage networks are omitted due to data clarity presentation issues?	
	AM stated that it is not Jacobs intention to show the proposed highway drainage networks or edge collections features on the Drainage Layout Plans as these drawings are already too busy with information at the proposed scale. Indicative inlets and outlets from attenuation ponds, attenuation storage features, proposed and existing catchments, outfalls, etc. will be included on the Drainage Layout Plans.	
	ZY responded and stated that if the proposed highway drainage networks and edge collection features are not shown on the Drainage Layout Plans with only text descriptions in the main report, then it is harder for the LLFA to assess the drainage proposals. TS suggested that if it is not practicable to provide the drainage networks and edge collection features on the drawings then providing summary tables of the edge collection features on the layout plans would be an acceptable alternative.	AM and the Jacobs drainage team to provide drainage edge collection feature summary tables on the Drainage Layout Plans
	DCO Planning Lead Query on DCO Process – ZY stated that it may be worth querying with the DCO planning lead if the DCO process for such a large scheme requires the highway drainage networks and edge collection features on the Drainage Layout Plans. Or can it be agreed as part of the conditions that the highway drainage networks and edge collection features be presented on subsequent iterations of the proposed Scheme drainage layout drawings.	AM to follow up on this enquiry with the DCO planning lead and to provide an update on next meeting
	Example Drainage Layout Drawings – AM suggested that perhaps examples of drainage layout plans could be sent to the LLFA for their initial comment. TS and ZY were open to this.	AM to forward example drainage layout plans to TS and ZY for their initial comment
9	Attenuation Storage Half-Drain Times	
	ZY asked if the half drain times have been determined for the proposed attenuation storage devices and if they will be reported in the Drainage Strategy. AM stated that the half drain time have not been assessed and do not form part of the current drainage design assessment. This is also in line with the drainage design principles/criteria previously discussed and agreed. AM suggested that perhaps it is better to send across previous meeting minutes to ZY for clarity.	AM to forward the previous meeting minutes and the previously discussed drainage design criteria
10	Next Meeting(s)	
	In this meeting on the 09/11/2021 examples of the proposed online mainline catchments and the proposed side road catchments were discussed. AM stated that in the next meeting a proposed offline mainline catchment example (i.e. greenfield discharge rates) and a	TS and ZY to respond to AM with their availability for future meetings. AM to subsequently arrange the meetings

catchment example discharging to an existing highway drainage systems can be discussed.

A12 Chelmsford to A120 widening scheme

Meeting Minutes

SURFACE WATER DRAINAGE STRATEGY MEETING NO 2

HE551497-JAC-HDG-SCHW-MI-D-0006 | P01

30/11/2021

HE551497

A12 Chelmsford to A120 widening scheme

Project No:	HE551497
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
P01	30/11/2021	MEETING MINUTES	AM	JT	JT	RC

Subject	SURFACE WATER DRAINAGE STRATEGY MEETING NO 2		
Project	A12 Chelmsford to A120 widening scheme Stage 3		
Project No.	HE551497	File	HE551497-JAC-HDG-SCHW-MI-D-0006
Prepared by	Asit Modi/Jose Tavares	Phone No.	0118 946 8389
Location	Microsoft Teams	Date/Time	30th November 2021 at 10:00
Participants	Asit Modi (AM) – Jacobs (Drainage Task Lead) Jose Tavares (JT) – Jacobs (Drainage Team Lead) Miguel Machado (MM) – Costain (Construction Manager) Tim Simpson (TS) – Essex County Council (LLFA) Zahida Yousuf (ZY) - Essex County Council (LLFA)		
Copies to	All listed – All participants	Apologies	Caroline Frost (CF) – Jacobs (Water Quality Lead)

Notes		Action
1	Introductions Introductions were briefly made for MM. AM went through the agenda and stated that this meeting was a follow on from the previous meetings where the drainage design principles and catchment specific discussions for the A12 Scheme had been presented and discussed. AM re-iterated the purpose of this meeting was to present drainage design information that would be included in the Drainage Strategy, and to obtain the LLFA's early feedback/inputs to the presented information and the Drainage Strategy. AM stated that this meeting would also provide an update to some of the actions agreed from the previous meeting.	
2	Safety Moment None. Proceeded directly with the meeting.	
3	Summary – Discussions from Previous Meeting/Call Project Update AM provided a brief project update and clarified that the Drainage Strategy would be issued in Feb'22 as part of the Environmental Statement (ES). This aligns with the current DCO submission that is planned for March 2022. AM stated there is a possibility that a draft version of the Drainage Strategy could be provided in advance in Jan'22. Summary of Catchments discussed in previous meeting AM reminded everyone that the overall drainage design has been divided up into three sections for the drainage design assessment. AM stated that the catchments previously discussed were from Section 3 (Catchments	

	S3-OU1 to S3-OU5) that potentially included brownfield sites i.e. A12 mainline catchments (widening of existing A12) and catchments requiring highway improvement works at local roads (realignment to existing roads). AM stated that this meeting would follow a similar approach on the catchment specific drainage design discussions focussing on examples of other drainage catchments for the proposed A12 scheme i.e. discussions on potential catchments with spatial constraints and other site specific constraints, catchments with developments on greenfield sites and typical drainage requirements for Junctions. Typical Drainage Layout Plan (Update) AM presented the previously discussed sample layout plan updated with additional information incorporated as requested by TS and ZY with regards to catchment specific edge collection systems in a tabular form. AM asked TS and ZY if they had any questions on the presented information. ZY indicated she would prefer to see catchment specific SuDS methods to be included as part of the table as well. AM and JT stated that the drainage strategy would cover the further relevant details and it may not be practicable to cover additional information on plans. JT further mentioned the drainage layout plans currently prepared have similarities with other recent DCO schemes. AM and JT took an action to review potential additional information regarding SuDS methods that could be included on layout plans.	AM and Jacobs Drainage team to review provision of information on proposed SuDS methods on layout drawings
4	Section 2 Drainage Catchments Example Discussion (S2-OU3, OU4, OU5 & OU8 Outfalls – Online Widening A12 Mainline Catchments) Catchment Descriptions - AM explained these catchments have potential spatial constraints and other site specific constraints where the attenuation storage has been mainly provided by oversized pipes (except for catchment S2-OU4). AM presented each of these catchments including a summary table with a comparison on paved areas and existing and proposed discharge rates for the design events. AM clarified the increased discharge rates for catchment S2-OU5 have been compensated by additional restrictions on discharge rates and provision of mitigation storage on adjacent catchment S2-OU4 on the basis that both outfalls have a common receptor the River Brain. ZY questioned about catchment S2-OU5 discharge whether there will be any treatment at this outfall location. AM responded that the attenuated flows from catchment S2-OU5 will be received by the proposed toe ditch prior to discharging to River Brain. AM further stated that the water quality assessment undertaken and had not highlighted any water quality	AM and JT to arrange for a separate call for discussions on Water Quality Assessment

concerns for this outfall location. JT mentioned a separate call will be arranged in near future to discuss water quality aspects. AM stated that potential constraints for catchments S2-OU5 and S2-OU8 included the potential presence of nature reserve and potential flood plain. TS was generally in agreement with such potential site constraints and relevant decisions.	
Exceedance Flows - Regarding the exceedance flood maps presented for these catchments, TS asked about the extent of flooding outside the proposed highway boundary for catchment S2-OU8 for a design event of 100yr plus 40%CC and raised concerns about exceeding flows reaching an ordinary watercourse. A review of the flood maps for this catchment for 100yr plus 20%CC event showed that the flood extent was localised and around $5m^3$. AM and JT stated that this is not significant for a watercourse situated in a flood plain and there are no other immediate critical receptors that could potentially be impacted from such minor exceedance flows. TS stated Jacobs should reduce the flood extents/depths/hazards relative to the existing case and that it would need to be demonstrated. JT agreed to review and compare in more detail the existing case flood extents/flood volume against the proposed case for this specific catchment S2-OU8.	AM and JT to review flood exceedance events for Catchment S2-OU8
TS mentioned there could be potentially more detailed information required about the flow directions and ground levels. AM and JT stated that it would not be possible to provide this level of detail for the extent of A12 scheme. However, some further information like flood volume could be added on the exceedance plans for the critical locations like S2-OU8 outfall to inform a meaningful review. JT further stated that the current level of information for exceedance flood maps is generated using the MicroDrainage FloodFlow analysis tool which uses a ground surface to determine flood flow paths and extents and considered to be adequate to inform the potential impact assessment without providing further information. JT suggested that if level information is required a contour file could be provided separately.	Drainage Strategy to include additional supporting flood volume information
Review of Ground Investigation (GI) Data – AM presented summary tables documenting each proposed catchment/outfall location presenting the ground conditions, infiltration rates, contaminated land presence, etc. to demonstrate if infiltration is likely/possible for a given catchment. AM also presented additional GI information that wasn't included in the previous discussion showing the general geology along the A12 mainline and how that has informed potential assessment on the feasibility of infiltration techniques along the mainline alignment. TS	Drainage strategy to include this additional supporting GI information

	suggested that such information would be useful and requested that it included in the Drainage Strategy.	
5	Section 1 Drainage Catchments Example Discussion (Junction 21 Catchments : S1- OU19, S1-OU19C, S1-OU19C1, S1-OU23C, S1-OU24A, S1-OU23D) Catchment Descriptions - AM explained the proposed works at Junction 21 includes widening of A12 mainline, a new elevated junction 21 (include new overbridge and slip roads), plus local road connections from a new junction. The proposed highway drainage catchments follow the highway geometry, existing outfall arrangements and proposed maintenance liabilities. AM presented the summary tables for the paved areas and discharge rates. AM clarified that catchments S1-OU23C and S1-OU24A are sub-catchments to proposed catchment S1-OU23 and offers interim attenuation storage hence the discharge rates are not related to the ultimate outfalls. TS appeared to be satisfied to see these interim attenuation measures. AM stated catchments S1-OU19C and S1-OU19C1 are new local roads on greenfield sites and outfall to Watercourse 7 which also accepts the highway runoff from mainline catchment S1-OU19. The proposed discharge rates from catchments OU19C and OU19C1 will be limited to a minimum practicable discharge rate of 5 l/s although the allowable greenfield runoff discharge rate is lower than the proposed 5 l/s. This increase in discharge rate has been mitigated with catchment S1-OU19 proposed discharge rates ensuring the total combined discharge rates from these three catchments are less than the existing case catchment S1-OU19 discharge rates. There were no concerns raised by TS and ZY on this proposal.	
	AM mentioned that catchment S1-OU24B is for a proposed local road where the calculated greenfield runoff rate is 1.95 l/s however the proposed minimum practicable discharge rate of 5 l/s will be applied. TS raised point from previous discussion where the greenfield runoff rates up to 1 l/s should be considered. AM and JT stated that minimum practicable discharge rate of 5 l/s in line with previous discussions (based on a minimum orifice diameter of 100 mm to prevent blockages) however any increase in outfall discharge rates will be assessed for potential flood risk impact and will be documented within Drainage Strategy.	AM and JT to ensure the Drainage Strategy includes flood risk impact assessment for outfalls with adopted minimum practicable discharge rates of 5 l/s against actual greenfield runoff rates less than 5 l/s
	Exceedance Flows – AM presented the flood exceedance maps for all catchments at Junction 21. TS raised concerns for exceedance flood extent for catchment S1-OU19 for 100yr plus 40%CC event in a very similar way that has been explained above for Section 2 catchment S2-OU8. JT explained 100yr plus 20% CC event flood	AM and JT to review flood exceedance events for Catchment S1-OU19

	exceedance results are not available at this stage to compare the potential impact between the design event and exceedance event. AM and JT took an action to investigate the exceedance flow assessment undertaken for catchment S1-OU19 including any additional mitigation required as necessary. Review of Ground Investigation (GI) Data – AM presented the summary tables and other GI information in a similar way that has been explained above for Section 2 catchments concluding the infiltration techniques are unlikely to be feasible. TS and ZY raised no concerns about the GI findings.	
6	Section 3 Drainage Catchment Example Discussion (Catchments : S3- OU26, S3-OU26A, S3-OU27, S3-OU27A, S3-OU28) Catchment Descriptions - AM explained these catchments are mainly offline sections (development on greenfield sites) that include A12 mainline and local roads. AM presented the summary tables for the paved areas and discharge rates. AM clarified that catchment S3-OU26 is for the A12 mainline and all other catchments are relatively small size catchments where the calculated greenfield runoff rates are well below the proposed minimum practicable discharge rate of 5 l/s. AM and JT stated as explained above flood risk assessment will be undertaken and potential impact of the minimum practicable discharge rates over greenfield runoff rates will be reported in the Drainage Strategy. TS asked if there is a possibility to combine some of the minor catchments to achieve higher greenfield runoff rates. JT responded the catchments currently follow the proposed highway geometry/alignment and any such opportunities would need to be investigated further in subsequent design stages. AM mentioned that catchments S3-OU27A and S3-OU28 use swale as attenuation storage features. Exceedance Flows – AM presented the flood exceedance maps for all catchments discussed above. There were no specific concerns raised by TS and ZH. Review of Ground Investigation (GI) Data – AM presented the summary tables and other GI information in a similar way that has been explained above for Section 2 catchments concluding the infiltration techniques are unlikely to be feasible. TS and ZY raised no concerns about the GI findings.	
7	Next Meeting(s) AM stated that in the next meeting which is now scheduled for 17.12.2021, remaining catchments can be discussed including any updated information on the catchments already discussed.	AM to send meeting invites to TS and ZY

A12 Chelmsford to A120 widening scheme

Meeting Minutes

SURFACE WATER DRAINAGE STRATEGY MEETING NO. 3

HE551497-JAC-HDG-SCHW-MI-D-0007 | P01

17/12/2021

HE551497

A12 Chelmsford to A120 widening scheme

Project No:	HE551497
Document Title:	SURFACE WATER DRAINAGE STRATEGY MEETING NO. 3
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
P01	17/12/2021	MEETING MINUTES	AM	JT	JT	DT

Subject	SURFACE WATER DRAINAGE STRATEGY MEETING NO. 3		
Project	A12 Chelmsford to A120 widening scheme Stage 3		
Project No.	HE551497	File	HE551497-JAC-HDG-SCHW-MI-D-0007
Prepared by	James Cullinane/Asit Modi	Phone No.	0118 946 8389
Location	Microsoft Teams	Date/Time	17th December 2021 at 14:15
Participants	Asit Modi (AM) – Jacobs (Drainage Task Lead) Jose Tavares (JT) – Jacobs (Drainage Team Lead) James Cullinane (JC) – Jacobs (Senior Drainage Engineer) Dan Smee (DS) – Jacobs (Flood Risk Lead) Miguel Machado (MM) – Costain (Construction Manager) Tim Simpson (TS) – Essex County Council (LLFA) Zahida Yousuf (ZY) - Essex County Council (LLFA)		
Copies to	All listed – All participants	Apologies	Caroline Frost (CF) – Jacobs (Water Quality Lead)

Notes		Action
1	Introductions Introductions were briefly made for the benefit of the call participants. AM went through the agenda and stated that this meeting was a follow on from the previous meetings where the drainage design principles and catchment specific discussions for the A12 Scheme had been presented and discussed. AM re-iterated the purpose of this meeting was to present drainage design information that would be included in the Drainage Strategy, and to obtain the LLFA's early feedback/inputs to the presented information and the Drainage Strategy. AM stated that this meeting would also provide an update to some of the actions agreed from the previous meeting.	
2	Safety Moment None. Proceeded directly with the meeting.	
3	Summary – Discussions from Previous Meeting/Call AM reminded everyone that the overall drainage design has been divided up into three sections for the drainage design assessment. AM stated that this meeting would follow a similar approach on the catchment specific drainage design discussions focusing on examples of drainage catchments for the proposed A12 scheme (i.e. discussions on potential catchments with spatial constraints and other site specific constraints, catchments with developments on greenfield sites, etc.)	

	TS raised an initial query on whether or not AM had clarified the DCO process and the level of detail required for the Drainage Layout Plans with the Jacobs Planning Team. AM stated that we would ideally present all the information required but some conditions may be required if the level of detail cannot be developed within the project programme timeframe. AM to discuss and confirm the level of detail required with the Jacobs Planning team.	AM to discuss and confirm the DCO process and level of detail required on the Drainage Layout Plans with the Jacobs Planning team
4	Section 1 Drainage Catchments Example Discussion (S1-OU13, S1-OU13A, S1-OU14, S1-OU15, S1-OU17 and S1-OU18 Outfalls – Online Widening A12 Mainline Catchments) Proposed Catchment Descriptions – AM explained that these proposed catchments involve online highway widening works and so are subject to brownfield discharge rates (i.e. brownfield discharge rates informed by existing case hydraulic modelling). AM explained that these proposed catchments have potential spatial constraints and other site specific constraints such that the re-distribution of the existing case catchment area is required to proposed catchments where attenuation storage in the form of attenuation ponds can be provided spatially. An example is the re-distribution of a large portion of the existing S1-OU15 catchment to the proposed S1-OU13 catchment.	
	TS made a comment on the paved area summary table for the proposed S1-OU13, S1-OU13A, S1-OU14, S1-OU15, S1-OU17 and S1-OU18 catchments. TS suggested that an additional column be provided which presents the additional new paved area over and above the existing paved area (to be retained) as opposed to just presenting the total proposed paved area. A column is to also be provided for any existing catchment area to be re-distributed to other proposed catchments due to site specific spatial constraints for clarity (e.g. existing S1-OU15 catchment portion to the proposed S1-OU13 catchment). Proposed Catchments S1-OU17 and S1-OU18 - AM presented each of these proposed catchments including a summary table with a comparison on paved areas and the existing and proposed discharge rates for the design events. AM clarified that the proposed S1-OU17 catchment is unattenuated due to spatial constraints that prevent the provision of an attenuation storage pond locally. The adjacent proposed S1-OU18 catchment is attenuated such that the combined proposed S1-OU17 and S1-OU18 discharge rates are less than the existing case S1-OU17 discharge rates. AM clarified that the existing case S1-OU17 allowable discharge rates for the 1 in 1 year, 1 in 5 year, 1 in 100 year return period design events are not exceeded by the combined proposed case S1-OU17 and S1-OU18	AM to take TS suggestion on board and provide additional paved area data within the paved area summary tables for clarity

catchments. TS suggested that ideally the LLFA would like to see proposed discharge rates with 50% betterment. JT responded to TS stating that the proposed highway drainage is being designed to the DMRB design guidance and that the proposed case discharge rates are not exceeding the existing case allowable discharge rates for catchments subject to online widening works which is in accordance with DMRB. Potential rainfall intensity increases due to climate changes are mitigated for in the proposed case by restricting to the proposed discharge rates to the existing case allowable discharge rates as stated previously. TS suggested that for proposed highway catchments subject to online widening works, the greenfield runoff rates should be estimated for the additional highway widening portions with this provided as an entry in the discharge rate summary tables. This would be further to the existing case allowable discharge rates already estimated for the existing highway. This would then clearly present the allowable discharge rates as a combination of the existing case brownfield rates and the additional highway widening works portion greenfield rates. AM stated that we are currently designing to the existing case brownfield discharge rates which is a more conservative design approach at this early design stage. Exceedance Flows - Regarding the exceedance flood maps presented for the proposed S1-OU17 and S1-OU18 catchments, a small extent of proposed case flooding extends just outside the proposed highway boundary around the existing Junction 20a. TS was accepting of this as the proposed flooding extent is less than the existing case flood extent and volume so full mitigation measures are not required.	
Regarding the proposed flood extent from the proposed S1-OU18 catchment immediately adjacent to the River Ter, TS suggested that where this occurs the flood volume should be documented on the exceedance flow maps in addition to the flow rate in the nearby watercourse. This is to enable a comparison and establish if the proposed case flooding is significant or not. TS suggested that where there is proposed case flood volumes of $2m^3$ and above then this needs documenting on the exceedance flow maps and the proposed mitigation measures stated if required. DS stated that these proposed case flooding instances will be covered in the FRA but the Drainage Strategy can provide a suitable reference to the FRA report. With regards to the proposed case flooding shown on the S1-OU17 and S1-OU18 exceedance flow maps (on the mainline carriageway), TS queried if flood mitigation	AM to take TS suggestion on board and document the proposed case flood volumes where proposed case flood extents are adjacent to a nearby watercourse (in addition to the nearby watercourse flow rates)

	measures or traffic control / speed restrictions would be applicable / needed for the flood depths 10 – 100mm on the A12 mainline carriageway. DS stated that this flooding of 10 – 100mm depth does not need to be fully mitigated as it's a shallow flood depth (low hazard) and it's not practicable, from a highway design and overall scheme cost perspective, to fully mitigate the minor flooding for such a large event as the 1 in 100 year plus 20% CC. Road users can take due care when driving through such shallow flood depths and may likely not even be driving during such a significant storm event as the 1 in 100 year plus 20 % CC. TS agreed with this reasoning from DS.	
	Regarding the S1-OU13, S1-OU13A, S1-OU14 and S1-OU15 flow exceedance maps, TS stated that the existing case flooding outside the proposed works boundary appears to be red (i.e. higher) in terms of depth. AM clarified that these higher flood depths occur in the verges and not within the live running lanes. TS suggested that more detail be provided on the flow exceedance maps where flood depths of 300 – 600mm occur as it is a sizable depth of floodwater. DS stated that locations where these greater depths of flooding occur will be assessed in more detail to confirm that they do occur in the verges and not in the running lanes.	Where locations of greater flood depths occur (300 – 600mm), DS to assess in further detail to ensure it is not occurring in the running lanes.
	Review of Ground Investigation (GI) Data – AM presented GI summary tables documenting each proposed catchment/outfall location presenting the ground conditions, infiltration rates, contaminated land presence, etc. to demonstrate if infiltration is likely/possible for a given catchment. It is generally found that the ground drainage conditions are poor to practically impervious with shallow groundwater also present. Therefore, infiltration is unlikely to be feasible. This information will be presented in the Drainage Strategy report for clarity. AM also presented additional GI information showing the general geology along the A12 mainline and stated how it has informed the assessment of the feasibility of infiltration techniques along the A12 mainline alignment.	
5	Section 3 Drainage Catchments Example Discussion (S3-OU19, S3-OU20, S3-OU21, S3-OU22, S3-OU23 and S3-OU24 – Offline A12 Mainline Catchments) Catchment Descriptions - AM explained that these catchments are mainly offline highway sections (development on currently greenfield sites) that cover the A12 mainline and proposed local roads (namely the Prested Hall – Threshelfords offline highway connections). AM presented summary tables for the proposed paved areas and discharge rates. AM clarified that the proposed S3-OU19, S3-OU20, S3-OU21,	

S3-OU22, S3-OU23 and S3-OU24 catchments are relatively small in size where the calculated greenfield runoff rates are generally below the proposed minimum practicable discharge rate of 5 l/s (with the exception of the proposed S3-OU19 catchment). AM and JT stated, as explained in previous meetings, that a flood risk assessment will be undertaken and the potential impact of the minimum practicable discharge rates over greenfield runoff rates will be reported in the Flood Risk Assessment report. TS still had concerns regarding the use of a minimum practicable discharge rate of 5 l/s for proposed catchments subject to greenfield runoff estimates. TS stated that the cumulative proposed discharge rates for these proposed catchments and from other proposed developments discharging at 5 l/s could increase the flood risk locally and for the watercourse. TS suggested potentially using an orifice size less than 100mm and potentially as small as 50mm to achieve the greenfield discharge rates. JT clarified that in discussions with the authorities likely to adopt the proposed drainage they were against orifice sizes less than 100mm in diameter due to the increased blockage risk (and associated upstream flood risk) and increased maintenance requirements.	
DS stated that the FRA team have undertaken a flood risk assessment of the proposed outfalls subject to the 5l/s minimum practicable discharge rate criteria and that these are in locations with no major receptors and therefore not likely to be an issue. TS stated that the LLFA would prefer to see reduced discharge rates to minimise the flood risk to any receptors and would accept the increased blockage / flood risk associated with a smaller orifice size below 100mm diameter.	AM and JT to ensure the FRA includes flood risk impact assessment for outfalls with adopted minimum practicable discharge rates of 5 l/s against actual greenfield runoff rates less than 5 l/s.
TS suggested that in the cases where the proposed outfall hydrobrake diameters are slightly greater than 100mm (e.g. 107mm, 109mm, etc.) can the orifice size be reduced to 100mm? AM stated that Jacobs will look into the practicalities of doing this. AM stated that reducing the hydrobrake diameters to 100mm could result in surcharging of the upstream highway drainage systems which could compromise the integrity of the highway pavement build-up.	
AM stated that the proposed S1-OU19 catchment is located on the footprint of the existing A12 highway. Therefore, there is the potential to remove some existing redundant pavement and reduce the overall proposed discharge rates to the S1-OU19 outfall location.	
Exceedance Flows – AM presented the flow exceedance maps for the S3-OU19, S3-OU20, S3-OU21, S3-OU22, S3-OU23 and S3-OU24 catchments. There is no flooding for the 1 in 100 year plus 20% CC design event. Flooding is present for the proposed S3-OU21 offline	

	A12 mainline catchment in the 1 in 100 year plus 40% CC design event, but it is confined to the proposed highway boundary. TS queried if the proposed flood extents could be managed by re-profiling the proposed highway geometry. AM stated that the proposed flooding depths are less than 100mm and are low risk such that further mitigation measures are not justified. TS agreed with the clarification from AM. Review of Ground Investigation (GI) Data – AM presented GI information showing the general geology for the above catchments and stated how it has informed that infiltration is unlikely to be feasible.	
6	Review of Exceedance Flood Maps (Specific Catchments) AM presented some selected catchments showing exceedance flood maps noting that these catchments are in addition to the catchments presented so far and the primary objective is to obtain some early feedback from LLFA with regards to the exceedance assessment only. The catchments presented included S1-OU1, S2-OU8, S2-OU24, S3-OU8A and S3-OU18. TS replied that in general the majority of the plans presented including the relevant information were found to be acceptable. TS advised and reminded AM that flood maps should include information such as flood volume and flood depths so as to facilitate the review of any impact as a result of exceedance flows.	
7	Summary AM highlighted that it would be a good opportunity to summarise the discussions over the last few meetings /calls as this was the last meeting to present catchment specific information. AM stated that the discussions have covered how the drainage strategy for the proposed scheme has been developed in 3 sections and the drainage design criteria/principles followed in the development of drainage design solutions for these 3 sections. AM stated around 35 catchments have been presented that included online and offline sections plus junctions covering the mainline highways and local roads, key information has been presented regarding the proposed scheme (i.e. paved area summary, modelled discharge rates, attenuation storage and exceedance flow assessment including examples of typical drainage layout plans and supportive GI that has been used to inform the feasibility of infiltration techniques). AM stated that the information that has been presented has largely covered the major drainage elements of the proposed drainage solutions for the proposed scheme which should facilitate the LLFA review of the Drainage Strategy report. JT requested TS's and ZY's overall feedback on the information presented over the last few calls. TS replied	

with concerns around the proposed design criteria that currently do not align with the LLFA/ECC SuDS Design requirements and stated that this would potentially lead to the LLFA placing a holding objection to the A12 DCO submission.

Meeting Minutes

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Subject	**Drainage and Flood Risk Meeting Minutes**		
Project	A12 Chelmsford to A120 Widening		
Project No.	B229H130	**File**	
Prepared by	Steve Mills		
Location	Chelmsford: EA Office	**Date/Time**	17 October 2019
Participants	Martin Barrell (MB), Environment Agency Sustainable Places Sarah Palmer (SP), Environment Agency Flood Risk Management Lee Sencier (LS), Essex County Council (ECC) Surface Water Planning Jo Baxter (JB), Highways England Project Manager Santi Santhalingam (SS), Highways England Head of Drainage and Water Jose Garvi Serrano (JGS), Highways England Senior Environmental Advisor Steve Mills (SM), Jacobs Environmental Lead Jose Tavares (JT), Jacobs Drainage Lead (by Skype) Asit Modi (AM), Jacobs Drainage Design Mike Symons (MS), Jacobs Water lead		
Copies to	All participants	**Apologies**	Nutcha Sritong (EIA Coordinator)

Notes		Action
1	**Safety Moment** The Extinction Rebellion planned disruption to the London tube had resulted in changed travel plans with SM and AM deciding to drive instead of taking the train. SM noted that Jacobs policy was not to drive unless absolutely necessary. Highways England has also set challenging targets for carbon savings on the A12 project including reductions in personal travel. It was agreed that opportunities would be explored to hold some future meetings by Skype.	
2	**Meeting Objectives** SM presented the following meeting objectives: • Update on project status • Agree highway drainage design criteria/principles • Agree flood risk design criteria/principles • Establish status of hydraulic models No additional objectives were forthcoming from attendees.	

3 Project Status

SM provided a scheme update dating back to the last Drainage/Flood Risk meeting in 2017, at the time of the non-statutory consultation on the short-listed options. It was explained that the project had effectively gone on hold due to the emergence of the Colchester Braintree Borders Garden Community proposal between Junctions 24-25.

SM advised that in four days' time, on 21 October 2019, the following would be announced by Highways England:

1. Start of a 6-week non-statutory consultation on four route options between Junctions 24-25 to avoid the core development area of the Garden Community.
2. Preferred Route Announcement for Junctions 19-23.

SM presented slides illustrating extracts from the brochures for the above, all of which will be available on the project website from 21 Oct:

[redacted]

For J24-25, the consultation includes four options A-D. It was noted that if the Local Plan Inquiry does not provide approval for the Garden Community then the A12 project will probably revert to one of the 2017 options.

It was noted that the PRA for J19-23 comprises Option 2 from the 2017 consultation, but with a route revision just to the east of Rivenhall to move further away from the Rivenhall Scheduled Monument. This revision takes the route back onto the existing road alignment prior to the River Blackwater crossing and therefore has the added advantage of reducing impacts on the Blackwater floodplain.

4 Project Programme

SM outlined the project programme going forward to DCO submission, noting the following key activities and dates:

- Non-stat consultation J24-25	Autumn 2019
- PRA J19-23	Autumn 2019
- PRA J23-25	Summer 2020
- Scoping Report	Summer 2020
- Design Freeze for consultation	Autumn 2020
- PEIR	Autumn 2020
- Statutory consultation	Autumn 2020
- Design Freeze for EIA	Early 2021
- EIA/ES	Spring/summer 2021
- DCO application submission	Summer 2021
- DCO award	Late 2022
- Start of Works	2023

MB queried whether the DCO application would include both J19-23 and J23-25. SM confirmed it would.

MB queried whether the scheme would include A120 improvements. SM advised that passive provision for a 4th lane is being considered between J23-24 to address potential need in the event that an A120 scheme is brought forward to route the A120 into J23. JB advised that a RIS-2 (Road Investment Strategy) announcement may be forthcoming in this respect.

5 Drainage

JT presented the proposed approach to the drainage design, including criteria for climate change allowance, flood return periods for design, allowable discharge rates, sizing of attenuation storage, and determination of pollution control requirements.

JT advised that the approach would be in line with DMRB/HEWRAT, noting that DMRB HD45/09 has recently been updated to DMRB LA 113.

LS advised that for the recent Harlow & Gilston Garden Community application, ECC had commented that the CIRIA SuDS Manual approach should be considered as it provides a more conservative approach than HEWRAT. However, there was general acknowledgment in the meeting that the CIRIA guidance is more applicable to residential development and that DMRB is more applicable for highways schemes. JT noted that the CIRIA guidance itself refers to HEWRAT as being the appropriate tool for highways schemes.

JT queried whether the ECC/EA had any comments on the proposed approach/criteria to the drainage design.

LS advised that for some brownfield development sites a 50% betterment is sometimes sought; however, it was acknowledged that this is more applicable to residential development and that highway schemes should be treated differently. It was also noted that the scheme viability has been in the balance and a 50% betterment would result in very large drainage and storage requirements.

In relation to any proposals for infiltration, MB commented that assessment would be needed to establish the groundwater unsaturated zone and any potential constraints on infiltration. MB noted that problems had been encountered with some other schemes in relation to tight red line boundaries constraining infiltration methods.

SS noted the impending change to the Reservoir Act which might reduce the volume threshold to 10,000m^3. JT advised that all attenuation ponds have been designed to be below this volume to avoid the potential risks of being captured by the Act.

MB queried whether attenuation ponds have been designed as two stage. JT confirmed that this has been included where considered necessary (i.e. with a sediment forebay).

SS noted that the DMRB documents are currently being updated and will continue until March 2020.

6 Flood Risk

MS presented the proposed approach to flood risk assessment noting that the approach would be in line with the policy requirements of the National Policy Statement for National Networks and the assessment criteria would be in line with DMRB LA113.

MS described the Main River crossings. For J19-23 these comprise:

- Boreham Brook: potential widening of existing bridge although this is still under review and dependent on final proposals for J19 improvements
- River Ter: the current proposals are for no changes to the existing bridge because widening work is proposed to be confined within the extent of the existing structure

- River Brain: existing bridge to be widened
- Rivenhall Brook: new bridge needed
- River Blackwater: widening of existing bridge or provision of new bridge adjacent to the existing crossing – the latter has safety advantages in avoiding construction work near to live traffic. MB advised that a potential disadvantage of an adjacent bridge is that it might create more shading than a widened bridge.

For J23-25 the Main River crossings comprise:

- Domsey Brook: two new crossings for each of Options A-D, one of which is common to all options (at Easthorpe Road). In response to a query from SP it was advised that bridges as opposed to culverts were being proposed.
- Roman River: only affected by two of options A-D and for these it might require realignment of a section of the river which has already been realigned adjacent to the A12 – it was noted that there could be potential opportunity for enhancement if this new realignment is needed.

MS queried whether there had been any update since 2017 to the Environment Agency model for the Brain and Blackwater. SP advised probably not but would check. MS advised that topographic surveys were about to commence to support hydraulic model builds for the remaining Main Rivers. — SP

LS advised that modelling of the upper Braintree and Witham catchment has been undertaken for the Surface Water Management Plan (SWMP), and that there may also be useful data in the Chelmsford SWMP. MS to liaise with LS regarding this data. — MS

MS advised that it is proposed to only undertake hydraulic modelling of Main Rivers and would not be undertaken for Ordinary Watercourses.

MS queried whether there were any records of significant groundwater flooding in the project area. LS advised nothing significant.

MS queried whether there are any flood defences or storage areas which need to be taken into consideration in the flood risk assessment. SP advised nothing significant.

SP advised that the Evidence and Risk Team would need to review FRA outputs if a significant number of sensitive receptors could be affected. This would involve a 4-6 week turnaround. The review time would be shorter if undertaken locally in-house.

MS noted the two EA schemes previously advised (2017 meeting) at Coggeshall and Domsey Brook and queried if there were any additional ones that could impact on the A12 project. SP advised not.

SP queried whether the FRA would include modelling of floodplain compensation areas. MS confirmed it would, if included as mitigation.

SS advised that a comprehensive revamp of C689 Culvert Design and Operation Guide is being undertaken and will be issued by Dec-19. HA107 will align with this.

SP advised that securing agreements with land owners for increased flood risk (of agricultural land) would benefit the approvals process.

7	**Actions and Next Steps**	
	SM advised that Jacobs would circulate the Proposed Drainage and Flood Risk Assessment Criteria for agreement with the Environment Agency and Essex County Council.	MS/JT
	It was agreed that timing for the next meeting would depend on the progress with model build and flood modelling but is likely to be in the Spring. This will be important in order to inform the Scoping Report. In the interim it was agreed that regular consultation via Skype meetings would be useful to track progress and agree approach.	
	JT and MS to advise SM as work progresses.	JT/MS
8	**AOB**	
	SS advised that he will be retiring in ~9 months' time and Claire Corbett would be taking over his role on the project.	
	{Post Meeting Note: The Proposed Drainage and Flood Risk Assessment Criteria discussed in the meeting and circulated with the Meeting Minutes are based (where applicable) on the DMRB documents published at the time of the meeting}	

Meeting Minutes

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Subject	RDWE WQ DRAINAGE LLFA MTG 151120		
Project	A12 Chelmsford to A120 widening scheme Stage 3		
Project No.	HE551497	File	HE551497-JAC-EWE-SCHW-MI-LE-0006
Prepared by	Charlie Wheatley	Phone No.	
Location	Microsoft Teams	Date/Time	4/11/2020
Participants	Charlie Wheatley (Jacobs – Flood Risk Team) Caroline Frost (Jacobs – Water Quality Lead) Asit Modi (Jacobs – Drainage Team) Michael Symons (Jacobs – Water Environment Lead) Jose Tavares (Jacobs – Drainage Lead) Andy Bailey (Highways England - Safety Engineering and Standards) Sam Patel (Costain – Design Manager) Tim Simpson (Essex County Council – Development and Flood Risk Manager) Lee Sencier (Essex County Council – Surface Water Engineer)		
Copies to		Apologies	Lee Lyons Steve Mills (Jacobs)

Notes		Action
1	JT – Safety Moment: Vehicle Breakdown Advice	
2	MS – Project Update	
3	MS – Programme key dates	
4	JT – Drainage update	
5	JT – Update to Drainage Design Criteria TS noted that they would expect consideration of the Essex SuDS guidance to be included in part of any documentation and assessment. Not solely based on DMRB. JT – Some of the Essex SuDs guidance requirements are more onerous than DMRB, e.g. no flooding at 1 in 30yr and requirement for designing to a +40% rainfall allowance – which are not being adopted for the scheme (adopting DMRB instead as national standard for HE schemes).	TS to provide contact for Essex Highways

Notes		Action
	TS – ECC will have some flexibility, we may be able to reflect the Essex guidance in our water quality assessments. The flood risk design criteria is +20% in rainfall intensity and a test is run for +40%, The 1 in 30yr criteria is quite specific to housing. JT – Noting that we are proposing to apply DMRB to sideroads – some of those sideroads may be managed by Essex Highways. TS – HE will need to discuss that with Essex Highways because they will review and accept the proposed criteria. Principles are the same in that no flooding should occur outside the highway boundary for the 1 in 100 event. In most cases that would likely be an improvement to those sideroads. AB – HE is not aware of any significant off-network flooding in this location. TS – Essex do not experience highway flooding on a regular basis in this area. But would recommend having conversation with Essex Highways on that point (TS to provide a contact). TS – Regarding the assumption that no infiltration will be possible. Along length of A12 there have been significant gravel extraction sites – likely there will be areas suitable for infiltration. TS appreciates that a conservative approach is adopted at this stage but would want to ensure that infiltration features are incorporated where practicable. JT – As soon as the information becomes available incorporation of SuDS measures will be considered. LS – Worth noting part of the route runs through the Braintree & Witham SWMP area – so if there is any implication of discharges/watercourses that might interact with CDAs etc that would need to be considered. MS – This will be considered as part of the FRA.	
6	Water Quality Assessment CF provided presentation on approach, methodology and asked whether there were any opportunities for enhancement and collaboration. <u>Discussion:</u> Concerns raised by ECC in using DMRB for assessing water quality. Specifically the following was identified: 1. Cumulative impacts with other developments - taking the potential for future development into account (Essex has a lot of proposed development so it is likely that receptor points	

Notes	Action
will see other flows and if all use a concentration approach then there is a cumulative impact that is not accounted for. 2. Receptor value criteria. A number of receptors in the area are small unnamed watercourses so if they are all considered as 'low' value then the impact of the scheme could be misrepresented as the scheme has the potential to impact a large number of these. 3. ECC would prefer to see methods employed to stop the pollution reaching those watercourses. Treatment of water to remove pollutants before it reaches those watercourses (SuDS and engineered solutions). Preferable to reduce runoff in total from the highway rather than saying that this particular receiving watercourse has increased ability to accept those pollution levels and provide level of dilution. Responses to concerns discussed as follows: 1. Jacobs/HE – HEWRAT would undertake a cumulative assessment of the HE outfalls into the same stretch of receiving watercourses. It is not within the remit of the scheme to consider other developments quantitatively, however as part of the EIA process other developments will be assessed qualitatively. 2. Jacobs – The value of the receptors does not influence the outcome from the HEWRAT assessment, it solely influences the significance of the effect in terms of EIA. So if a failure were identified we would seek to include mitigation to address those failures. Our focus would be on achieving the EQS because that is the legal standard that the EA would expect us to achieve as a minimum. Ideally we would seek to achieve the DMRB standards as well. 3. HE/Jacobs – In the principal drainage document we have a drainage hierarchy which the design team follow. That considers infiltration and discharge to watercourses – has to be pragmatic to the situation. The HEWRAT assessment is based upon work with the EA. Jacobs have been looking at ponds initially. If it is identified that mitigation is required then efforts will be made to include this.	Initial HEWRAT results to be discussed as part of consultation process based on the PEIR to inform the ES. Meeting to be arranged post-PEIR.

Notes		Action
	• Query over whether on site flow monitoring and sampling would be undertaken. Jacobs - Data from site visits to be used to feed into the assessment of sediment pollution. • Query over assumptions made in other assessments. Would like to see confirmation that these values are correct to confirm the dilution and level of contamination in the receiving watercourses Jacobs – HEWRAT provides default values. We do not intend to use these in our assessments. Sensitivity analysis is proposed as part of the assessments. • Jacobs questioned if any concerns about a particular watercourse (i.e.. Existing issues in relation to water quality). None identified.	
7	MS – Update to Minor Watercourse/Culvert Assessment JT – Where existing culverts don't meet the +65% climate change requirements, is there any relaxation on the cc requirements for these? TS – Existing culverts, we would need to look at existing downstream flood risk – so wouldn't necessarily want to widen a culvert which might be protecting downstream networks. Will probably be down to individual assessment of those features MS – The culvert design will need to be pragmatic to ensure no increase in flood risk up and downstream	
8	AOB LS – Has the safeguarding zone been confirmed yet? Will that include the spatial requirements for SuDS features? MS – To take away but the design is still being progressed. TS – Has the RLB been made public? MS – To check with our EIA coordinator. TS – Important because becomes harder to change RLB once it has been made public. We would want to ensure that there had been allowance made for storage and treatment features. MS – PEIR will be completed in Spring 2021 for statutory consultation We understand the difficulties associated with changing RLBs later in the design process so that is something we all want to avoid.	MS to confirm whether the safeguarding zone has been confirmed yet MS to confirm whether RLB has been made public

Notes	Action
TS – Who is the main contact for the EA? We would like to touch base with them. MS – We are talking to Martin Barrell (coordinating all EA inputs). LS – The Braintree and Witham SWMP is now complete so modelling information and action plans are available if required.	

A12 Chelmsford to A120 widening scheme

Meeting Minutes

DRAINAGE DESIGN UPDATE WITH LLFA MEETING MINUTES

HE551497-JAC-HDG-SCHW-MI-D-0003 | P01

23/08/21

HE551497

A12 Chelmsford to A120 widening scheme

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
P01	23/08/21	MEETING MINUTES	AM	JT	JT	SG

Subject	DRAINAGE DESIGN UPDATE WITH LLFA MEETING MINUTES		
Project	A12 Chelmsford to A120 widening scheme stage 3		
Project No.	HE551497	File	HE551497-JAC-HDG-SCHW-MI-D-0003
Prepared by	Asit Modi/Jose Tavares	Phone No.	0118 946 8389
Location	Microsoft Teams	Date/Time	8th July 2021 at 15:30
Participants	Asit Modi (AM) (Jacobs) Jose Tavares (JT) (Jacobs) Michael Symons (MS) Caroline Frost (CF) (Jacobs) Tim Simpson (TS) (LLFA) Quentin Dawson (QD) (HE)		
Copies to	All listed – all participants	Apologies	Andy Bailey (HE) Zahida Yousuf (LLFA) Miguel Machado (Costain)

Notes		Action
1	Introductions Introductions of all attendees were made. JT went through the agenda and the meeting objectives. JT stated that this meeting was a follow on from the previous meetings where the drainage and flood risk design criteria for the A12 scheme had been presented and discussed. JT/QD provided a brief overview of the roles and responsibilities for Jacobs as the designer for Highways England as the Highways Authority for the A12 scheme. QD stated that the drainage design will be certified for compliance with Design Manual for Roads and Bridges (DMRB) documents LA 113 and CG 501.	
2	Safety Moment AM provided a safety moment based on a few recent incidents of swollen laptop batteries. Some of the common findings indicated the overcharging of laptops and keeping the laptop connected to the charger all the time as the main cause. This was a good reminder that while we are still working from home to disconnect/switching off our laptops when not in use.	
3	Project Update JT/AM provided a brief project update about the recent design freeze that has formed the basis for statutory consultation. JT also mentioned the statutory consultation period (between June to August'21) and the scheme DCO submission (March'22). JT informed	

	that this meeting was in line with the above-mentioned programme to consult with the LLFA during the statutory consultation period. JT provided an update on the drainage surveys and GI investigations that have been undertaken at preliminary design stage. It was noted that gaps in the drainage surveys were mainly due to limited information on local roads and assumptions have been made in the design.	
4	Update on Drainage Design Criteria JT presented the drainage design principles covering the various highway drainage elements including type of edge collection and conveyance system, attenuation storage ponds, climate change, allowable discharge rates, culvert sizing and the design criteria followed for the drainage network modelling. JT emphasised the previous discussions held with LLFA and that the design criteria adopted in the design are in line with the previous discussions (with the exception of any changes to DMRB). It was noted that the drainage design has followed the DMRB requirements. The design principles/criteria presented and discussed have not been repeated here, however, a copy of presentation slides will be provided along with this meeting minutes. There were few concerns raised on the call that have been noted below for consideration in the design. JT mentioned the design currently excludes the A12 de-trunking sections. QD raised a query about the DCO boundary with regards to the de-trunking sections for which AM clarified that the DCO boundary includes the de-trunking section. TS raised a query about the scope for the de-trunking sections. JT/AM explained that discussions are currently ongoing between HE and ECC about the de-trunking sections and further updates will be provided in due course. QD and TS raised the concerns about any surface water drainage discharge to the public sewer for which JT/AM confirmed there are no drainage discharge to the public sewers. JT mentioned the minimum practicable discharge rates of 5 l/s has been adopted. JT further clarified that this is equivalent to the smallest size orifice control (100mm) to avoid the potential risk of blockage and associated flooding. TS indicated that the LLFA would require minimum discharge rates of less than 5l/s. QD stated that the risk of blockage and flooding would need to be considered in the design.	The presentation slides are to be issued to all attendees along with this meeting minutes

	CF mentioned that the water quality assessment would be based on DMRB. TS raised CIRIA and its requirements compared to DMRB. Designated funds maybe a potential future funding source for water quality enhancements.	
5	Drainage strategy overview JT mentioned that the drainage strategy document is being prepared and will be made available in due course. JT /AM provided a brief overview of the drainage strategy covering the scheme wide drainage catchments/outfalls and the proposal for attenuation ponds and their discharge arrangements. TS raised concerns about the extent of scheme and the time for review process allowed in the programme. TS also requested for interim discussions to ensure there are no delays from the design review process. It was agreed that additional meetings will be arranged where JT/AM would present the catchment specific drainage strategy/proposals to expedite the review process. JT further summarised various meetings and consultations undertaken to date with EA/LLFA and maintenance authorities as part of design update.	JT/AM to arrange for meeting with TS to discuss catchment specific drainage proposals.
6	Next steps Additional meetings are to be arranged to continue discussions around the drainage elements specific to the proposed drainage design and water quality assessment.	