A47 North Tuddenham to Easton Dualling

Scheme Number: TR010038

Volume 6
6.3 Environmental Statement Appendices
Appendix 13.2 - Drainage Strategy Report, Part 1 of 2

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

March 2021

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A47 North Tuddenham to Easton Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES

Appendix 13.2 - Drainage Strategy Report, Part 1 of 2

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Rev 0	March 2021	Application Issue

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1. Scheme Introduction

1.1. Purpose of this report

1.1.1. This drainage strategy report documents the drainage strategy and selection process, demonstrating compliance with technical standards under the prescribed headings as set out in Appendix B of CG 502.

1.1.2. This report has been prepared by Highways England (the Applicant) to support an Environmental Statement (ES) (**TR010038/APP/6.1**) and Development Consent Order (DCO) application for the North Tuddenham to Easton dualling scheme (the Proposed Scheme).

1.2. Proposed Scheme Overview

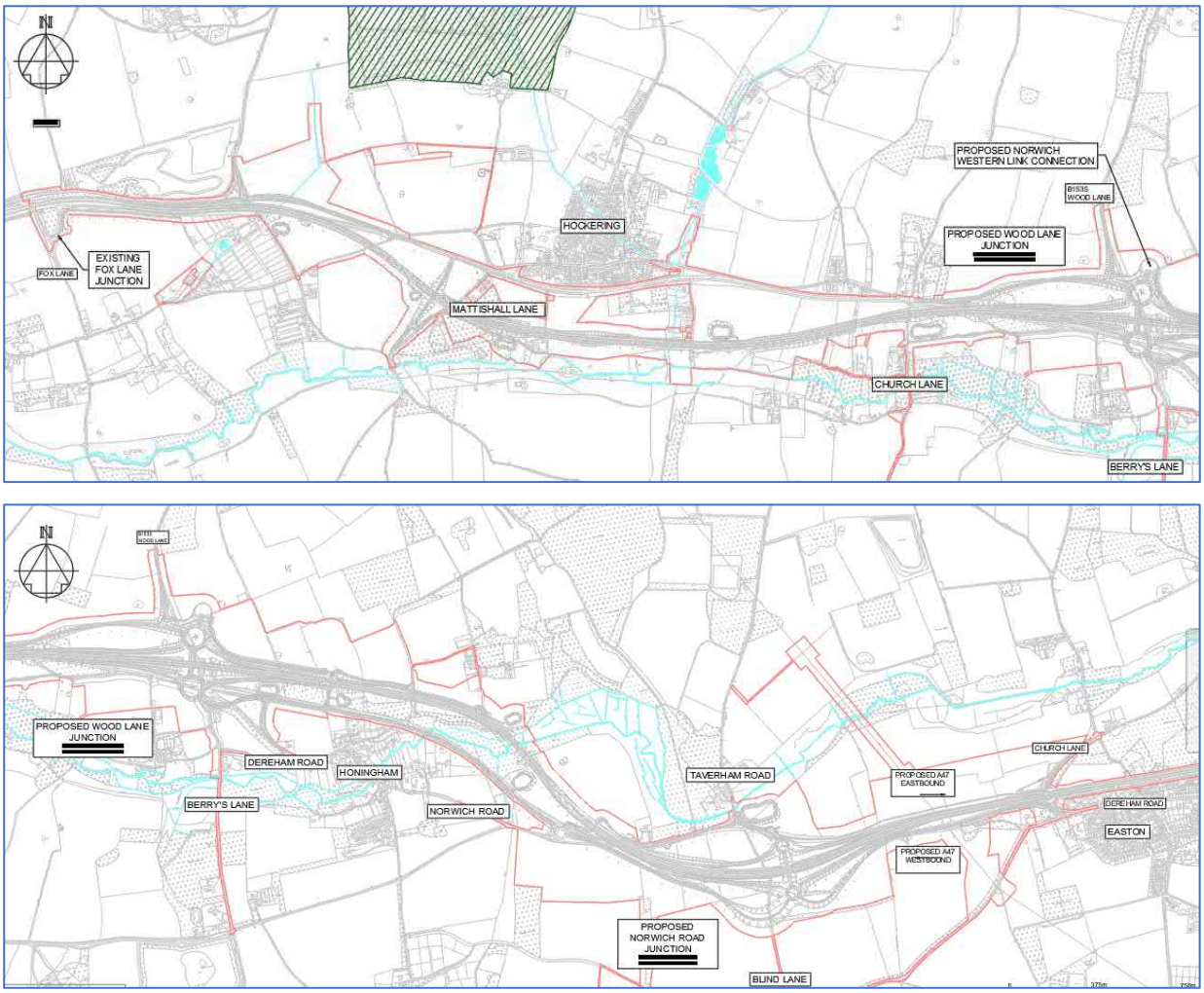
1.2.1. In December 2014, the Government launched the Roads Investment Strategy (RIS) aiming to increase the capacity and improve the condition of the strategic road network to support economic growth and resilience, improve safety performance and accessibility while enhancing sustainability by minimizing the impact on the surrounding landscapes, natural environment and existing ecosystems.

1.2.2. A feasibility study undertaken in October 2014 by the Department of Transport identified the A47 as an integral part of the Strategic Road Network. The RIS proposed improvement works on six schemes across the region of the A47 between the A1 near Peterborough at its western extent, and Great Yarmouth and on the northern section of the A12 between its junction with the A47 at Great Yarmouth and Lowestoft.

1.2.3. The Proposed Scheme replaces the existing single carriageways between North Tuddenham and Easton with a dual carriageway, linking existing dual carriageway at North Tuddenham to the Southern Norwich Bypass at Easton. The proposed route is offline and crosses the existing A47 at three different locations, as shown in Figure 1-1.

1.2.4. The Proposed Scheme is located in Norfolk County Council (NCC) and sits within the local districts of Breckland District, Broadland District and South Norfolk Council (SNC).

Figure 1-1 : Proposed Scheme extents



2. Data Sources

2.1. Existing drainage records

2.1.1. The following is a list of surveys that have been provided, examined and used where applicable, as part of the assessment and design process.

Highways Agency Drainage Data Management System HADDMS - Drainage assets

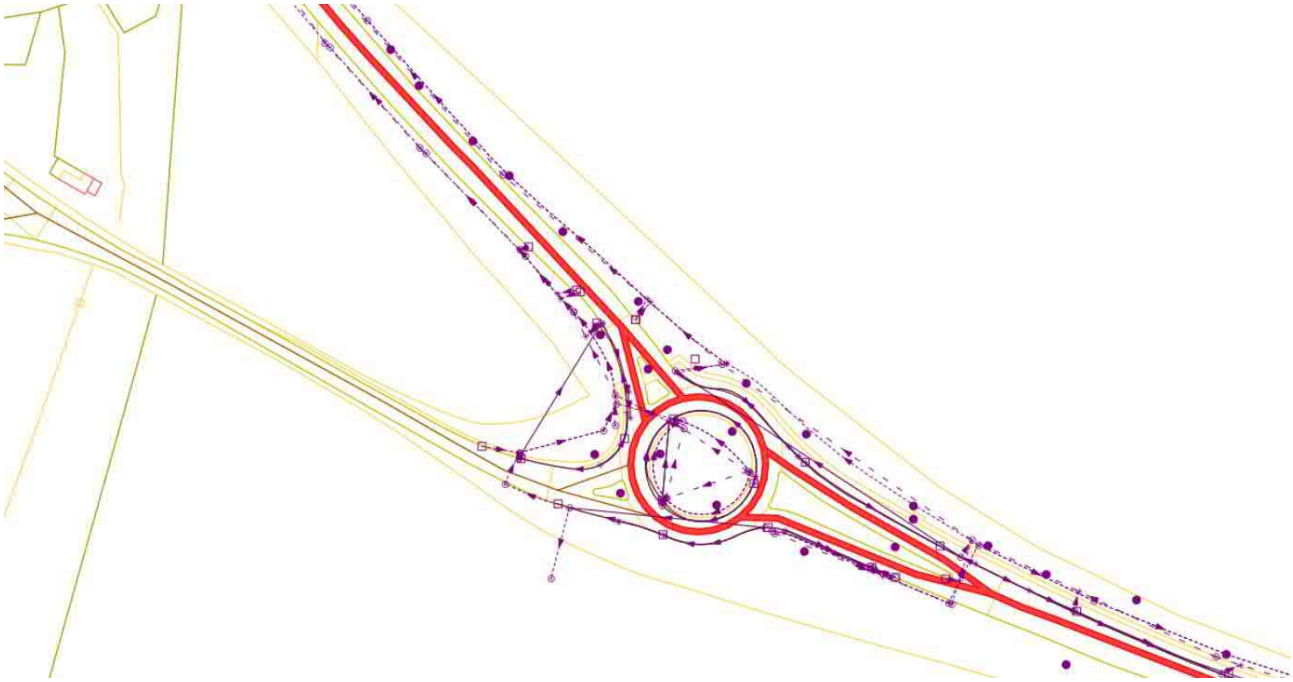
2.1.2. From a review of the HADDMS database there is limited information available regarding existing drainage along the existing A47.

2.1.3. The extracts shown below from HADDMS highlight the information available at selected locations along the existing A47 route. Namely the end tie-in points and a strategic roundabout that connects a realigned local road with a proposed grade-separated junction.

Figure 2-1 : HADDMS extract 1 – Tie-in east of North Tuddenham

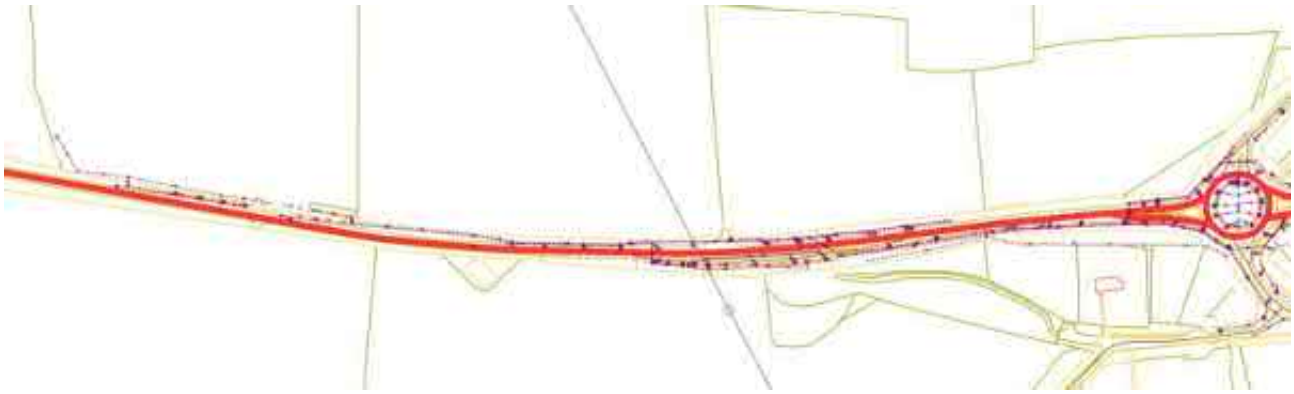
2.1.4. Figure 2-1 shows the tie in at western tie close to North Tuddenham. No formal pipework identified with limited gulley and chamber locations shown.

Figure 2-2: HADDMS extract 2 – Side road tie-in east of Honingham



2.1.5. Figure 2-2 shows the roundabout east of Honingham. The plan indicates a piped network system with no supporting information attached on the data base.

Figure 2-3 : HADDMS extract 3 – Tie-in to Norwich Southern Bypass



2.1.6. Figure 2-3 shows the existing single carriageway A47 connection to the roundabout just west of Easton that connects to the Norwich Southern Bypass. Plans indicate a piped network to an outfall, again with no supporting information in the data base.

Drainage asset survey

2.1.7. A drainage survey specification has been developed outlining further surveys to be undertaken to fully understand the existing drainage provision and inform the design of the proposed drainage outfall routes required. At the time of writing this report the drainage survey has been undertaken with the report yet to be provided such that the preliminary design assumptions can be confirmed. The

findings from this survey will be fully reviewed at the commencement of the detailed design stage to verify assumptions made during the development of the design for the DCO application, and inform where amendments in the design approach or solution need to be made.

2.2. Survey records

Geodetic (topographical) surveys

2.2.1. The topographical survey used during the options studies was in basic 3D ACAD file format. There was no indication as to when it was carried out, also the accuracy of this survey has not been proven as no survey report was provided. Further, there is also a lack of permanent ground markers to determine any onsite accuracies.

2.2.2. The extents of the survey received is a corridor of varying widths along the existing A47 route. It covers a corridor from the existing Fox Lane overbridge in the west, to the town of Easton at the eastern tie-in. The full route is approximately 9.5km in length and covers an area of around 3.4km^2.

2.2.3. A further topographical survey for the Proposed Scheme shall be undertaken prior to the detailed design stage. The findings from this survey will be fully reviewed at the commencement of the detailed design stage to verify assumptions made during the DCO application design stage, and inform where amendments in the design approach or solution need to be made.

2.3. Existing surface water features and flood risk

2.3.1. The Environment Agency Flood Map for Planning (Environment Agency, 2020a) indicates the majority of the Proposed Scheme is located within Flood Zone 1. Flood Zone 1 is associated with a low risk of flooding (an annual probability of less than 1 in 1,000 (0.1%) of river flooding). There are localised areas within Flood Zones 2 and Flood Zone 3 which area associated with the River Tud and its tributaries. The Proposed Scheme crosses two sections of Flood Zone 2 and 3 east of Honingham where it crosses the River Tud and south east of Hockering where it crosses a tributary of the River Tud.

- Flood Zone 2 is associated with a medium risk of flooding (land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of flooding (1%-0.1%) in anyone year).
- Flood Zone 3 is associated with high risk of flooding (land assessed as having a 1 in 100 year or greater annual probability of river flooding (>1%) in any year).

2.3.2. Flood Zone 3 is split into two separate zones; 3a and 3b. The Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (JBA, 2017) identifies the

crossing at the River Tud east of Honingham to be Flood Zone 3b. Flood Zone 3b comprises as land where water has to flow or be stored in times of flood. Breckland Council SFRA (Aecom, 2017) identifies the crossing at a tributary of the River Tud, south east of Hockering, to be Flood Zone 3a. Flood Zone 3a comprises of land assessed as having a 1 in 100 or greater annual probability of river flooding.

2.3.3. Fluvial flood risk modelling has been undertaken as part of the flood risk assessment. Further details can be found in the Flood Risk Assessment (ES Appendix 13.1 (**TR010038/APP/6.3)**).

Figure 2-4 : Extract from flood map for planning (Environment Agency ~ Fluvial) – Ch.2+950 south east of Hockering

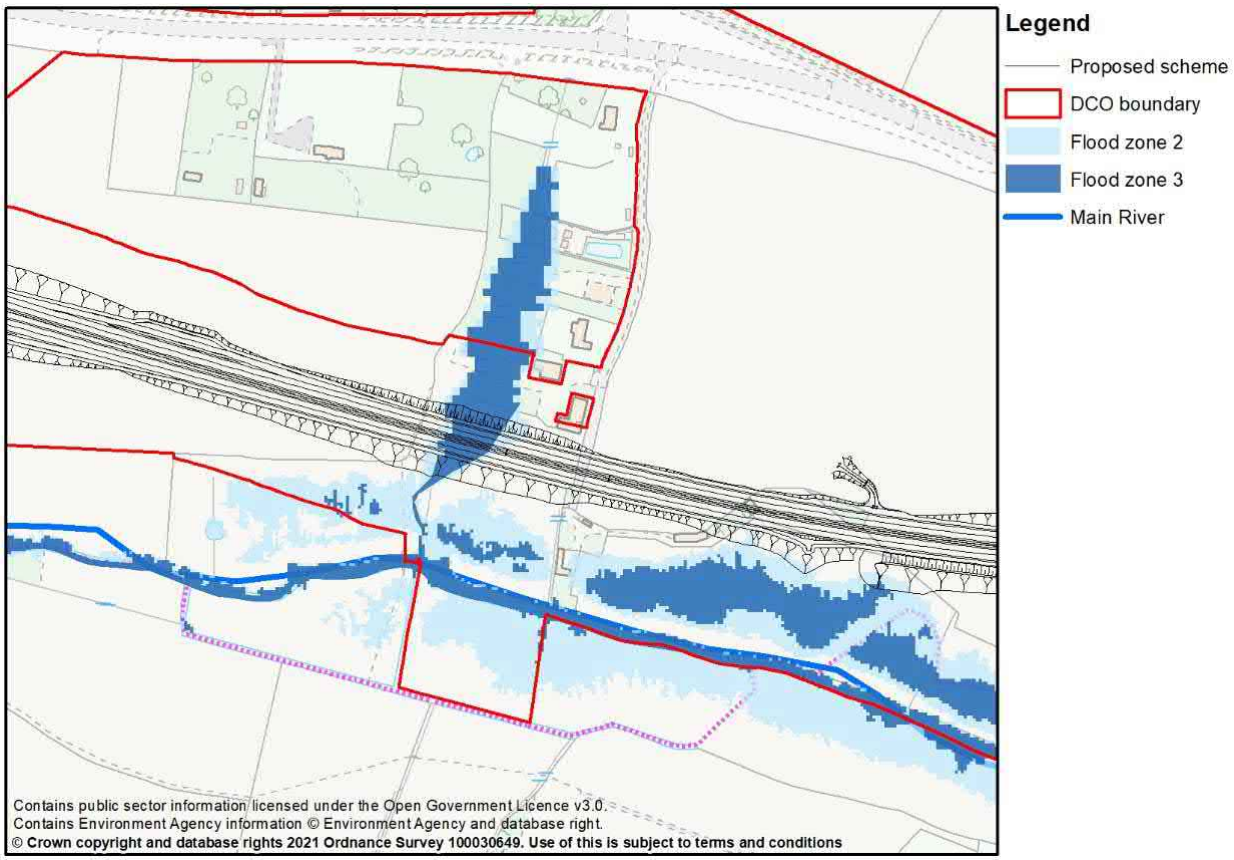
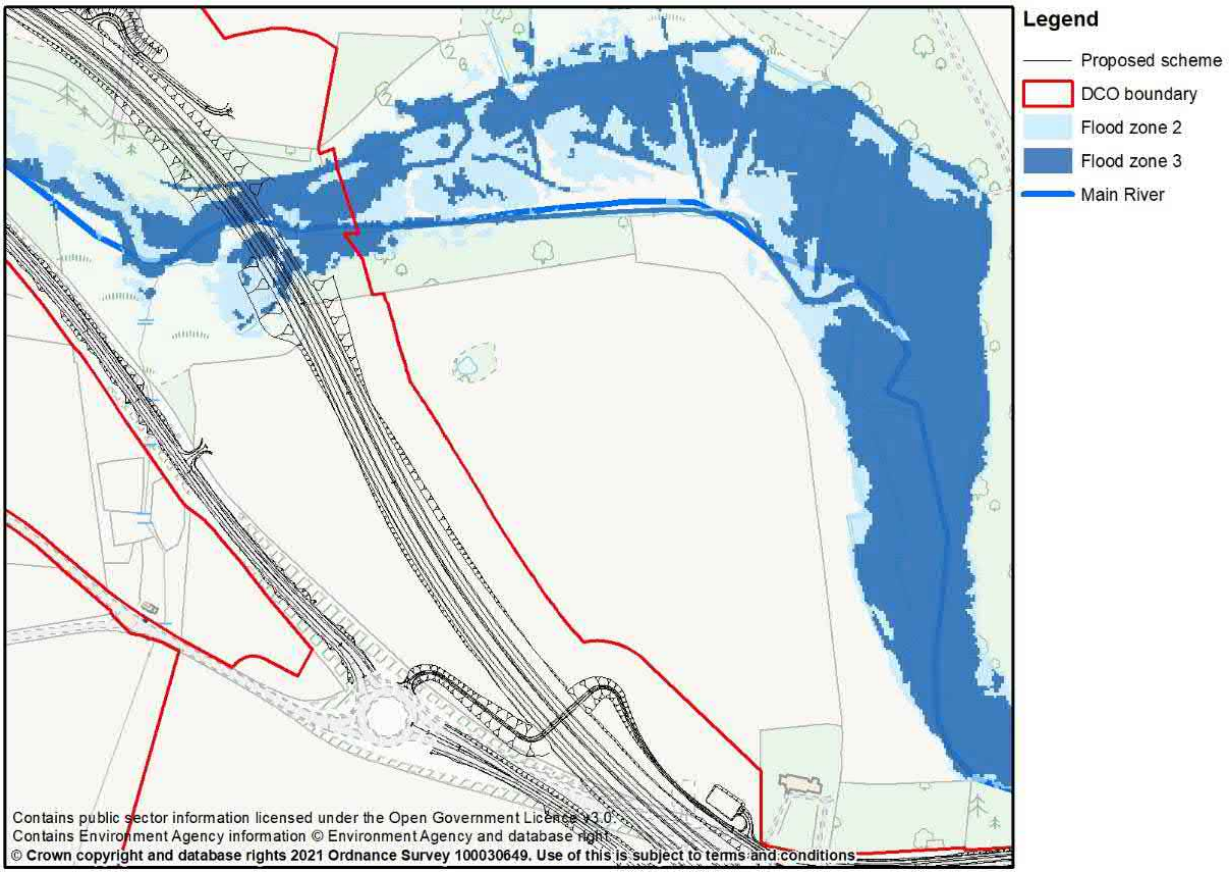


Figure 2-5 : Extract from flood map for planning (Environment Agency~ Fluvial) - Ch.6+320 River Tud crossing east of Honingham



2.3.4. The Environment Agency's indicative long-term flood risk map (Environment Agency, 2020b) indicates the majority of the Proposed Scheme is at very low risk of surface water flooding (less than 1 in 1000 (0.1%) chance of flooding in any given year). However, the map identifies areas of the Proposed Scheme are at low to high risk of surface water flooding.

2.3.5. The Proposed Scheme crosses isolated areas of low (between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of pluvial flooding in any given year) and medium (between 1 in 100 (1%) and 1 in 30 (3.3%) chance of pluvial flooding in any given year) flood risk. This is associated with flood flow pathways which run in a southerly direction. There are eight locations where the Proposed Scheme cross these pathways.

2.3.6. The Proposed Scheme crosses three areas of high surface water flood risk (greater than 1 in 30 (3.3%) chance of surface water flooding in any given year); south east of Hockering originating from a drain running adjacent to the River Tud, east of Hockering (near the Sandy Lane Junction) due to a depression in the land which would collect overland flow and, north and east of Honingham originating from the cluster of drains and the River Tud.

2.3.7. A pre-application surface water assessment was supplied by Norfolk County Council (received 15th September 2020). This gives an overview of known incidences of surface water flooding within the vicinity of three points taken at Honingham, Hockering and Oak Farm, which is in agreement with the locations and levels identified above. There was no information provided by Norfolk County Council Highways team regarding flooding to the existing road.

Figure 2-6: Extract from long-term flood risk map (Environment Agency) – Ch.1+150 east of Poppy's Wood

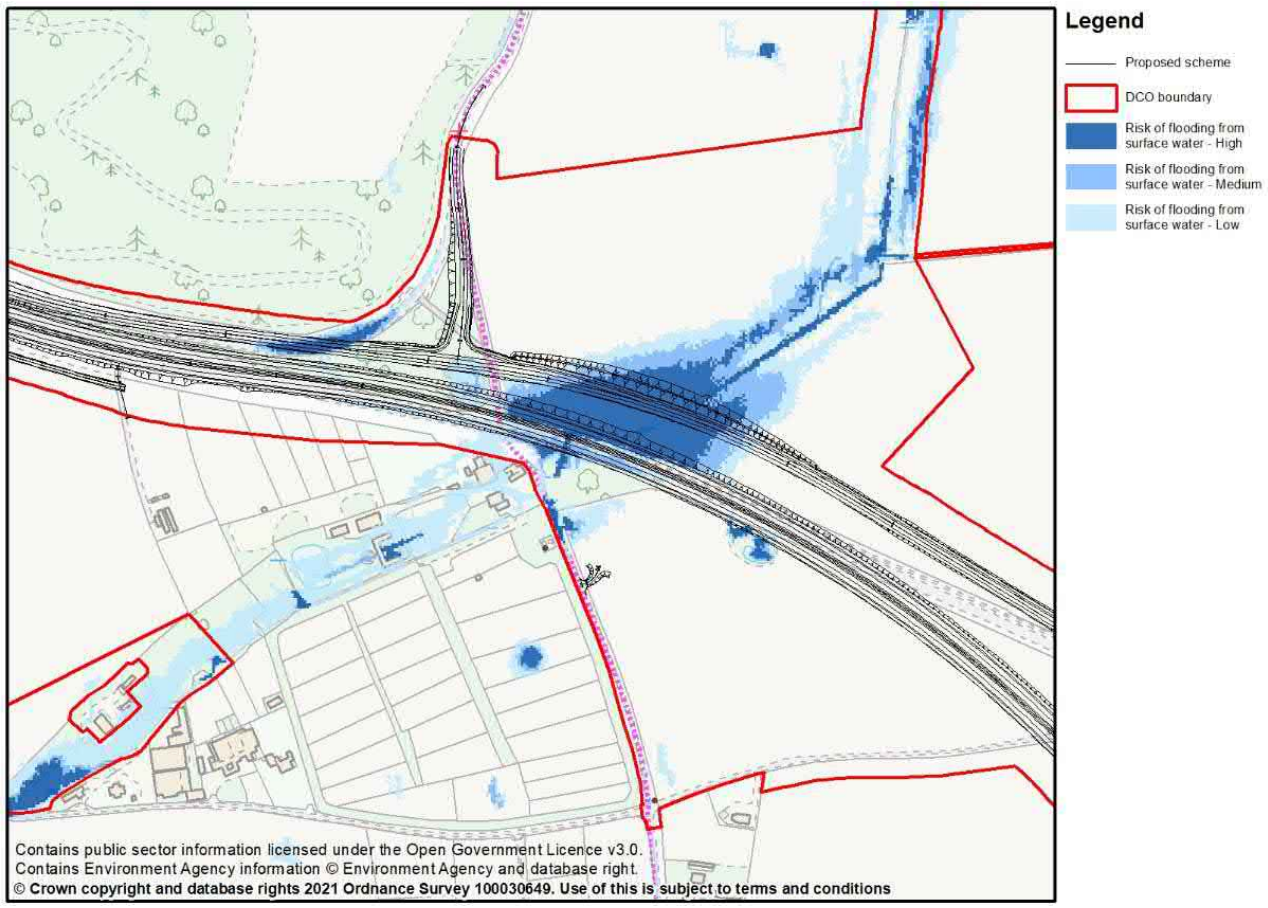


Figure 2-7 : Extract from long-term flood risk map (Environment Agency) – Ch.2+950 & Ch.3=250 south east of Hockering

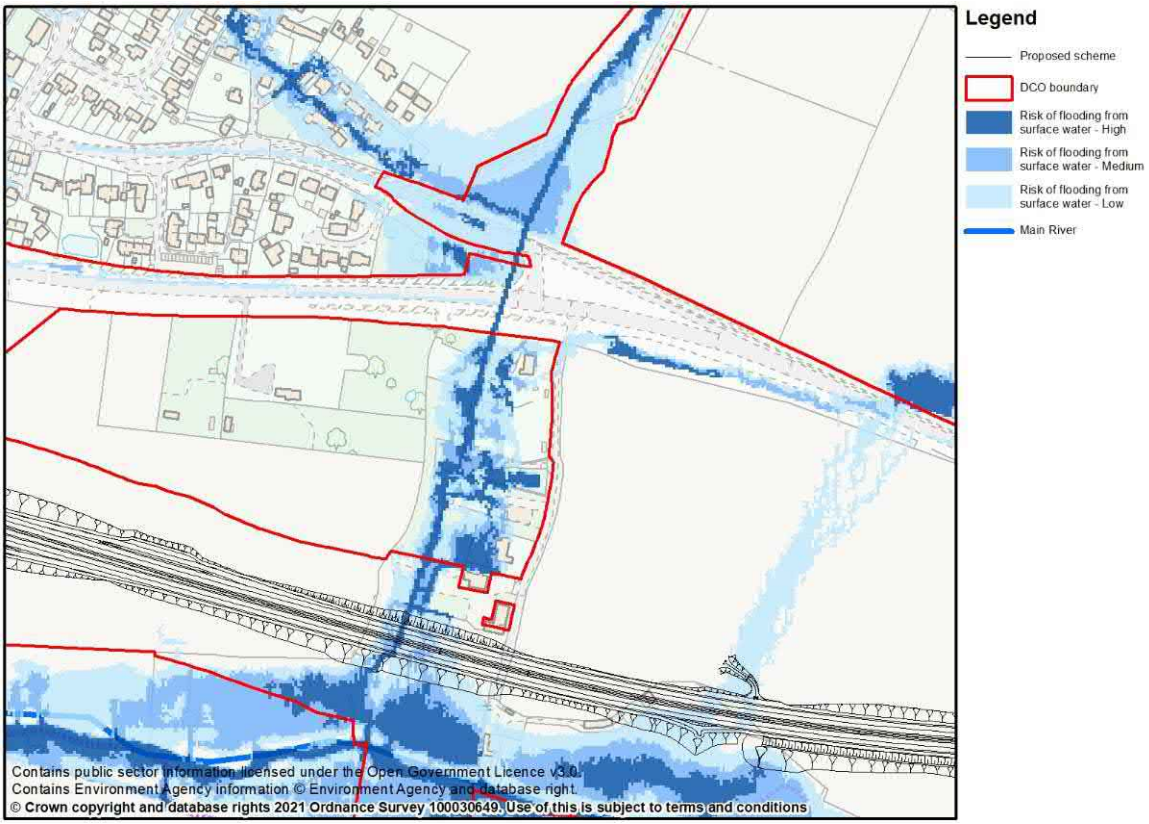


Figure 2-8: Extract from long-term flood risk map (Environment Agency) – Ch.3+970 Sandy Lane & Ch.4+260

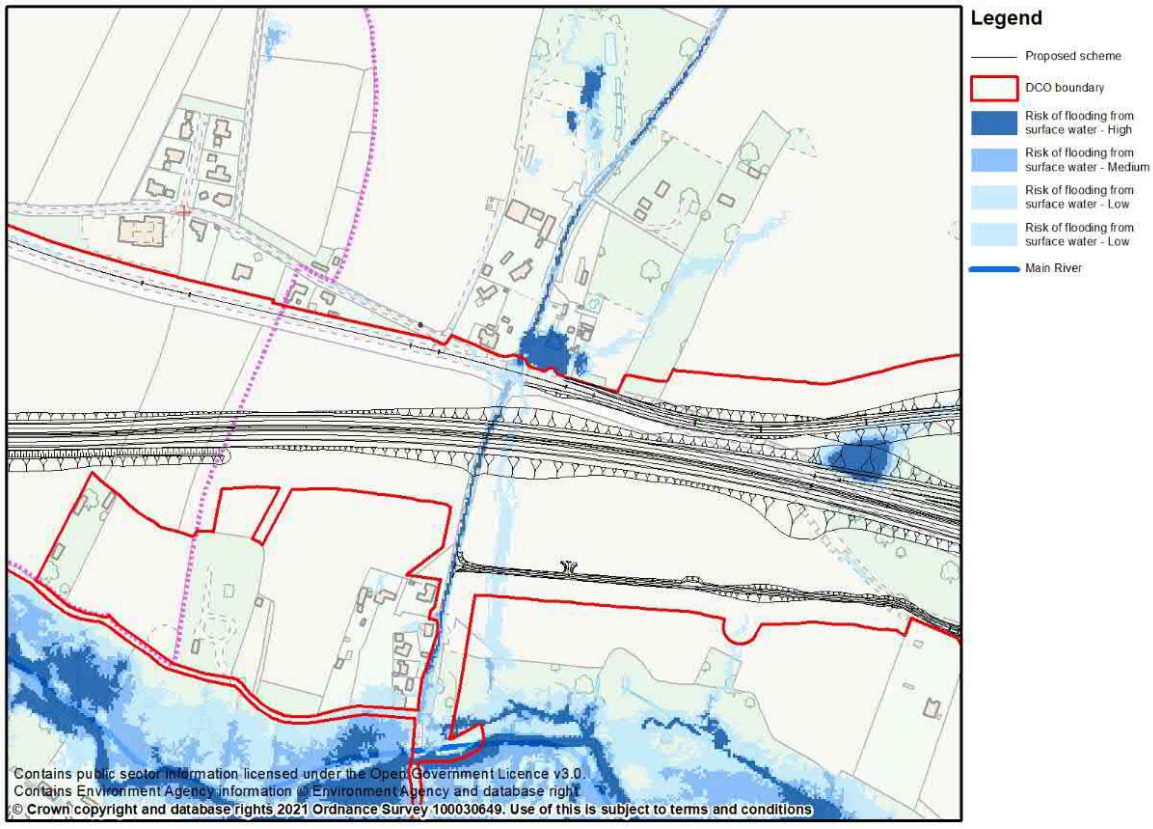


Figure 2-9: Extract from long-term flood risk map (Environment Agency) – Ch.5+000 Wood Lane & Ch.5+550

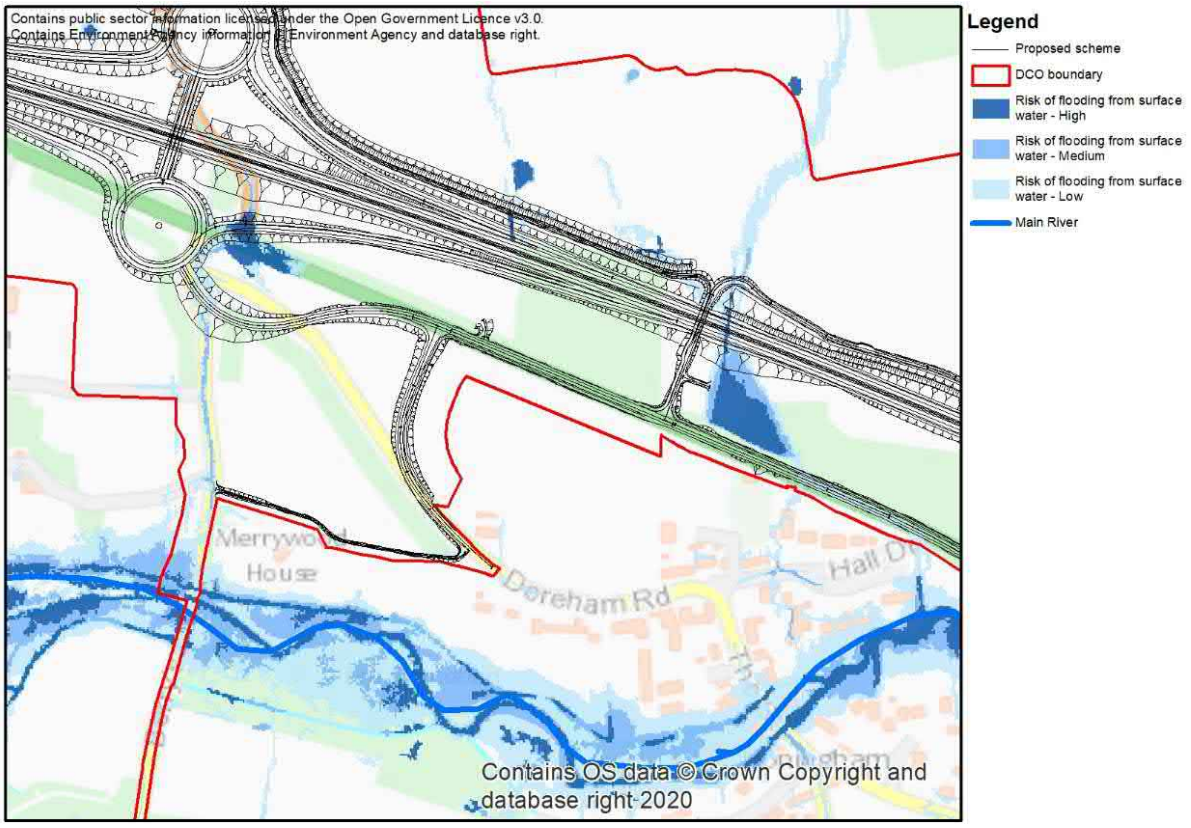
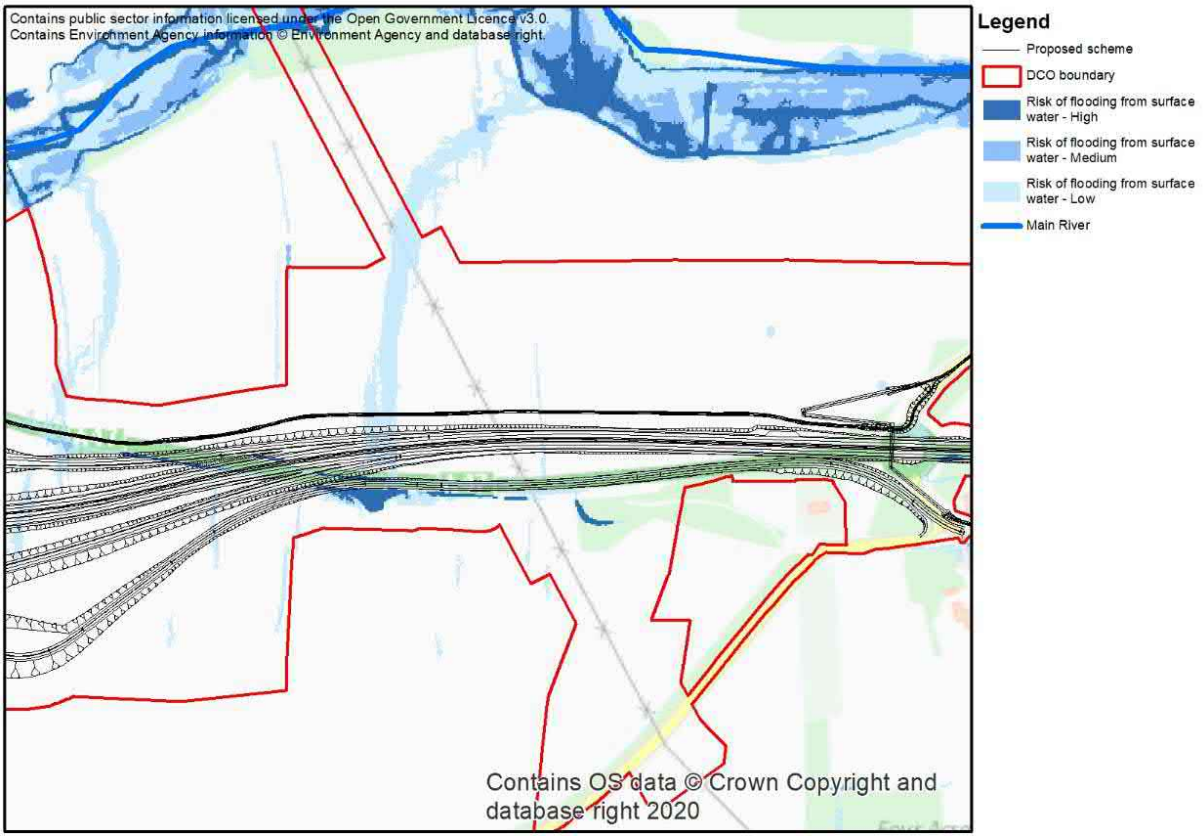
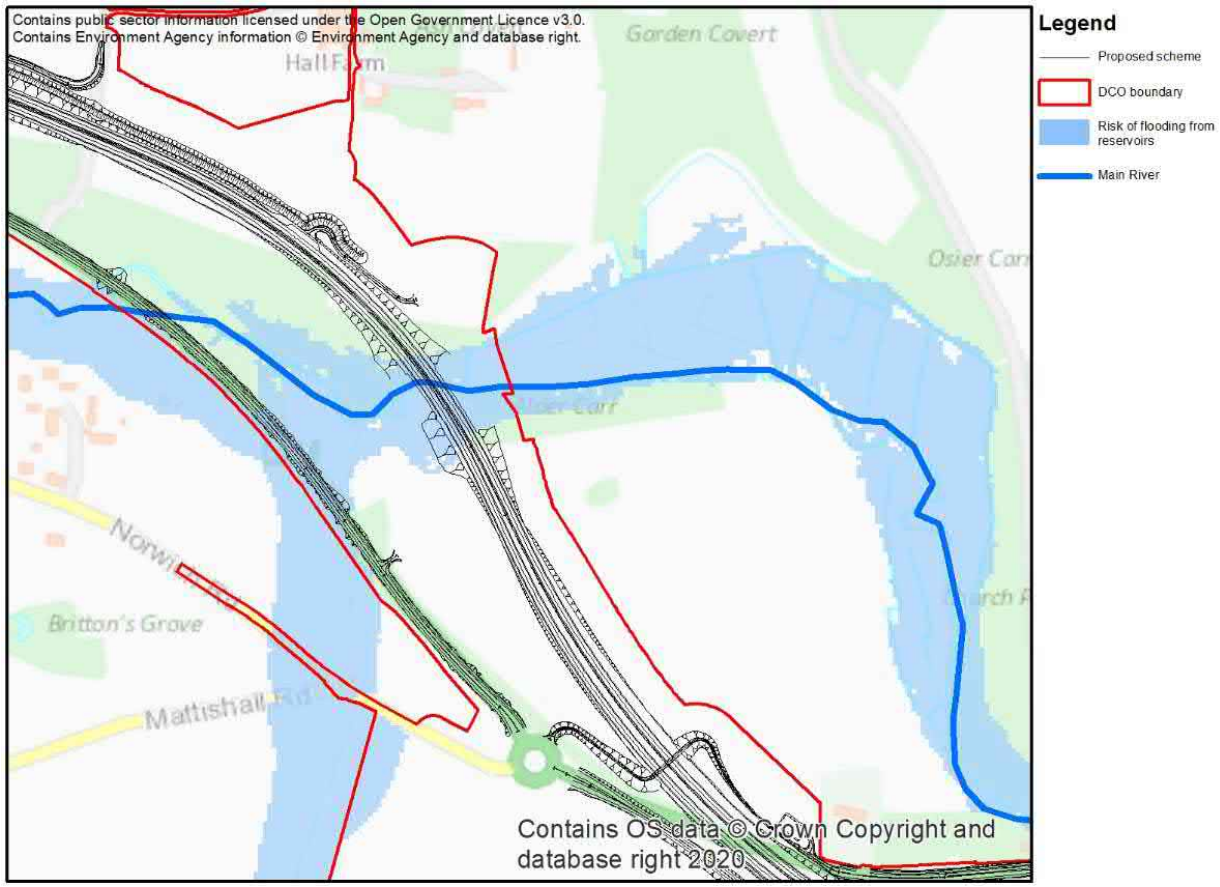


Figure 2-10: Extract from long-term flood risk map (Environment Agency) – Ch.7+850 & Ch.8+240 west of Easton



2.3.8. The Environment Agency's indicative flood risk map (Environment Agency, 2020b) also shows that there is risk of flooding from reservoir failure where the Proposed Scheme crosses the River Tud. The area where the Proposed Scheme crosses the River Tud, east of Honingham is predicted to be affected by floodwater in the event of a failure of Colton Reservoir.

Figure 2-11: Extract from long-term flood risk map for reservoir flooding (Environment Agency) – Ch.7+850 & Ch.8+240 west of Easton



2.3.9. Historic highway flooding events as noted in HADDMS are summarised in Table 2-1 below, these highlight the number of flooding events along the existing A47 route, ranging in severity and whether the problem was addressed, requires further attention or no attention.

Table 2-1: Flooding assets and status

Road	Flood events, severity				
	0-2	3-4	5-6	7-8	9-10
A47	6	10	3	0	0

2.3.10. These flooding events are grouped at certain location along the route, these are likely due to being highlighted as the only areas where drainage systems are

present, where the majority of the route is suspected not to have any formal drainage system present.

2.3.11. Figure 2-12 shows 5 flooding events on or near the junction of the A47 with Sandy Lane and Church Lane, with a maximum severity rating of 3-4 (out of 10) with all being noted as historic or closed and none requiring any action.

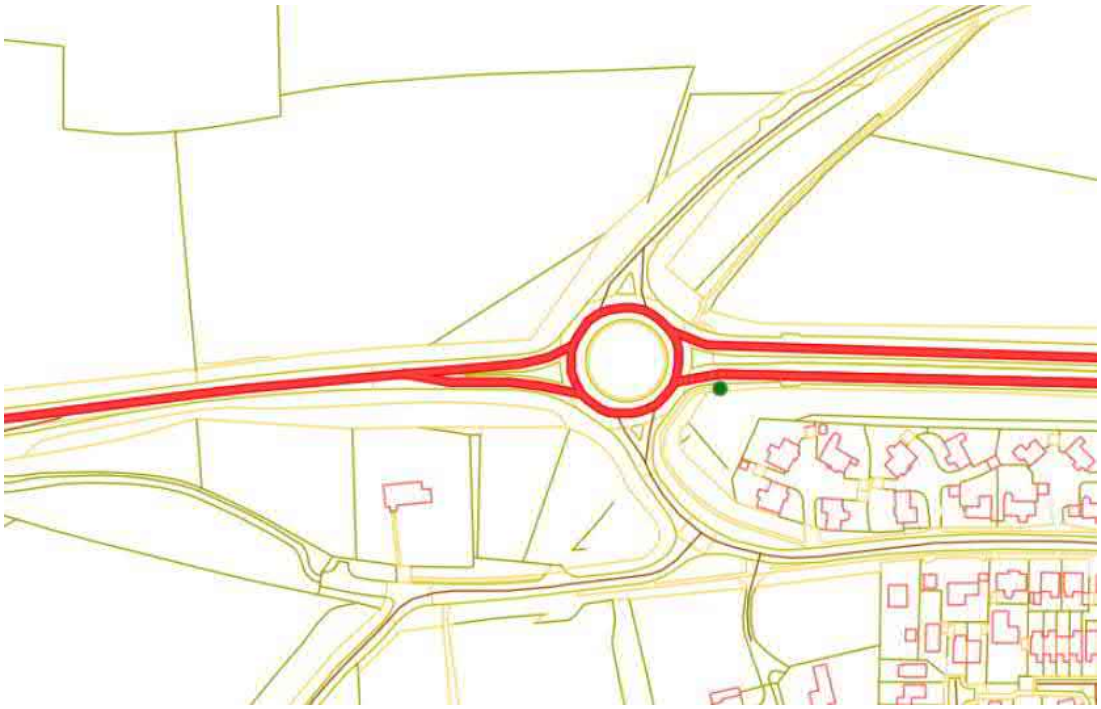
Figure 2-12: HADDMS flooding Sandy Lane Road.

2.3.12. The junction of Wood lane and Berrys Lane further historic flooding has been noted on Figure 2-13 with maximum severity rating of 3-4 and noted as historic and no actions required.

Figure 2-13: HADDMS flooding Wood Lane Road.

2.3.13. At the eastern tie in at Easton shown on Figure 2-14, a single flood event has been highlighted with a low 0-2 rating and the status being closed.

Figure 2-14: HADDMS flooding Easton.



2.3.14. Most of the Proposed Scheme lies within areas that has limited potential for groundwater flooding to occur. However, there is potential for groundwater flooding to below ground structures to the south and east of Hockering and

north-east of Honingham. Where the Proposed Scheme crosses the River Tud there is also potential for groundwater flooding to above ground structures.

2.3.15. Table 2-2 below summarises the flood risk assessment and potential mitigation measures. Further details can be found in the Flood Risk Assessment (Volume 3, Appendix 13.1 (**TR010038/APP/6.3)**).

Table 2-2: Summary of flood risk

Risk	Potential for flood risk to highway or 3rd party land as result of the Proposed Scheme	Mitigation
Flooding from rivers (fluvial)	Yes	Where the Proposed Scheme crosses the River Tud and associated tributaries all proposed bridges and culverts will be designed accordingly (to a 1 in 100 year storm event including 65% climate change) to mitigate against flood risk impacts to others. Flood compensatory storage is provided for the River Tud Crossing.
Flooding from sea (tidal)	N/A	N/A
Flooding from reservoirs, canals, or other artificial drainage systems	Yes	No reservoirs or canals in the vicinity of the Proposed Scheme. The area where the Proposed Scheme crosses the River Tud, east of Honingham is predicted to be affected by floodwater in the event of a failure of Colton Reservoir. Given the inspection regimes in place for reservoirs the risk of failure is very low. Existing field drainage will be intercepted where required.
Flooding from highway surface run-off	Yes	The proposed drainage system is to be designed to accommodate storms outlined in Table 3-1. No carriageway flooding will occur during a 1 in 5 year storm, with no flooding of third party land during a 1 in 100 year storm event including 40% climate change. All proposed impermeable areas will be attenuated to greenfield runoff rates up to and including the 1 in 100 year storm event including a 40% climate change allowance.
Flooding from groundwater	Yes	Sub-surface drainage to be proposed where required. Further ground investigation data will be assessed when available and drainage designed accordingly.
Flooding from overland flow	Yes	Cut-off drainage to be proposed where required to intercept overland flow, with cross drains and culverts provided at road crossing designed accordingly. These will be designed to accommodate 1 in 100 year storm event including 65% climate change to mitigate impacts to the Proposed Scheme and to others.

2.4. Spill register

2.4.1. There is no evidence of spillages occurring along the A47 route, or within 1km of the tie-ins.

2.5. Priority register

2.5.1. Using HADDMS, Table 2-3 below details the priority outfalls, soakaways and culverts that have been identified within along and serving the existing A47 carriageway.

Table 2-3: Priority assets and status

Road	Outfalls	Soakaways			Culverts
		Chamber	Multiple chamber	Trench	
A47	6 (risk addressed) 2 (medium risk)	9 (risk addressed) 1 (low risk)	0	0	0
The Street	1 (risk addressed)	0	0	0	0

2.5.2. The pollution risk from the existing soakaways identified within the Proposed Scheme boundary on the existing A47 is reported as “risk addressed” or “low risk” indicating the risk to groundwater is low.

2.5.3. The pollution risk from the majority of the existing outfalls identified within the Proposed Scheme boundary is reported as “risk addressed”, indicating the risk to surface water is low. Two outfalls, located to the west of the Proposed Scheme outside of the DCO boundary, are identified as “medium risk” due to an acute copper failure. This outfall discharges to a tributary of the River Tud. All other outfalls discharges run-off from the A47 or the Street to the River Tud and its tributaries.

2.5.4. There are no other priority outfalls, soakaways or culverts identified within the Proposed Scheme area.

2.6. Ground Investigation

2.6.1. A ground investigation (GI) was undertaken between 2 March 2020 and 28 August 2020 with the overall objective of providing a robust data set to inform and characterise the geotechnical (underlying soils, rock and groundwater regime) and geo-environmental (nature and extent of any potential sources of contamination) conditions and to facilitate design development of the Proposed Scheme.

2.6.2. As part of the ground investigation works, activities specifically relating to the investigating of the groundwater regime and infiltration potential of the lithologies encountered included:

- 46No. groundwater monitoring wells installed into selected boreholes to monitor the groundwater regime over a 12 month period.
- Ten variable head permeability tests.
- Four infiltration tests (BRE 365 method) to determine the soil infiltration characteristics at known drainage basin locations.

2.6.3. It should be noted that at the time of the main GI, the drainage strategy was in early development stages and basin locations were subject to change to suit the evolving scheme design.

2.6.4. Ground investigation to confirm / verify ground conditions and derive permeability and infiltration characteristics at the locations of the drainage basins is a key objective of the supplementary GI, proposed for the first quarter of 2021.

3. Field Studies

3.1.1. Due to the ongoing Covid-19 pandemic there has been limited opportunity for the designers to gain access for further onsite investigation works or site walkovers to obtain information to inform the development of the preliminary drainage design.

3.1.2. A site walkover was carried out in November 2019 to:

- To confirm any surface water features identified within the study area from Ordnance Survey mapping which are to be included in the hydraulic model.
- To understand the hydraulic connectivity across the Proposed Scheme.

4. Site Description

4.1. Overview

4.1.1. The A47 North Tuddenham to Easton corridor scheme lies approximately 15km west from the centre of Norwich and runs in an east west direction connecting Dereham to Norwich. The ground is undulating, predominantly rural and mainly comprises agricultural land. There are three villages that are adjacent to the existing A47, the villages of Hockering within the western half of the scheme, Honingham within the eastern half of the scheme and Easton at the eastern end of the scheme extents.

4.1.2. There are several minor roads that run north south through the scheme. Fox Lane at the west of the scheme connects with the existing dual carriageway in the form of a compact grade separated junction. Low Road and Mattishall Lane connect to and cross the existing A47 to the west of Hockering. Sandy Lane and Church lane connect to and cross the existing A47 east of Hockering. The B1535 Wood Lane and Berrys Lane connect to and cross the existing A47 to the west of Honingham. Taverham Road and Blind Lane lie in the middle of Honingham and Easton. There are also several small settlements and numerous properties with direct access onto the existing route.

4.1.3. The River Tud meanders in a west east direction south of the existing A47 alignment and crosses to the north of the A47 at Honingham. The River Tud is the major watercourse in the study area. There are no other named watercourses that discharge to the River Tud. There are, however, several drains marked on the OS mapping that discharge to the River Tud. The scheme falls wholly within the River Tud catchment which is designated as a Main River and as such, consent for any works associated with the River Tud would be required from the Environment Agency. The ordinary watercourses fall under the consenting authority of Norfolk County Council who are the Lead Local Flood Authority in this area. Furthermore, parts of the Proposed Scheme will contribute flow to the hydrological catchment of the Norfolk Rivers Internal Drainage Board (NRIDB). The NRIDB have been consulted and details of this consultation have been outlined in Section 6.10 below.

4.2. Existing drainage

Surface runoff drainage

4.2.1. The existing A47 drainage is predominately informal over-the-edge drainage where the road is at-grade or on low embankment. It is unclear if combined drains or ditches are used to collect carriageway run-off because of the poor quality of information from HADDMS. Only small sections of combined drain are evidenced using Google Street view and are mainly situated in cutting. There are

two larger embankments that are kerbed / channelled and are positively drained by gullies. The numerous at-grade junctions are generally kerbed with gullies to drain the carriageway, but not in all cases. The roundabout and approaches east of Honingham have formal hardstrips that are kerbed and include positive drainage using gullies and combined drainage kerbs. On the approach to the terminal roundabout that connects to Norwich Southern Bypass, conventional carriageway section and drainage is apparent. The road is an S2 carriageway with hardstrips and kerbed edges, and with filter drains in cut settings. The available drainage information in this area is not well-defined.

4.2.2. The eastern tie-in with the existing A47 dual carriageway the road at this point is on embankment and on side-long ground. The eastbound verge is on low embankment / at-grade and does not appear to have any drainage when in superelevation. Where the carriageway is balanced, using Google Streetview, over-the-edge drainage with unknown collection system is noted, likely a ditch / swale system. HADDMS shows no linear drainage in this area. The central reserve is soft with a steel safety barrier and accepts run-off from the west bound carriageway with a combined drain. The westbound verge is on embankment and is kerbed with gullies where the carriageway is not superelevated.

4.2.3. The western tie-in to the existing A47 occurs over through a straight section of carriageway in shallow cutting. The surface runoff collection for the carriageway and earth slopes is with a non-standard concrete surface water channel in each verge. The central reserve is standard width and has a soft surface.

4.2.4. Apart from the B1174 at the eastern tie-in and Dereham Road at Easton, all other local roads that the Proposed Scheme interfaces with have minimal associated formal drainage. The B1174 and Dereham Road are drained by kerb and gullies.

4.2.5. There are several existing static water bodies / ponds within the study area. Notably there are two ponds either side of the A47 at the western tie-in and another two in the same formation close to the western tie-in. It is possible that these may be flood attenuation or / and pollution facilities. The HADDMS information shows that the water body in the eastbound verge near the eastern tie-in is part of the Norwich Southern Bypass drainage. The function of the other ponds is currently unknown and whether or not they form part of the existing carriageway drainage system. Further investigation is required to ascertain if the ponds can be made available for attenuating surface runoff from the Proposed Scheme.

Natural catchment drainage

4.2.6. The Proposed Scheme route traverses the River Tud valley. Naturally, where the route is to the north of the river then the land falls to the eastbound verge of the proposed route or the local redirected roads associated with the Proposed Scheme. And, where the route is to the south of the river then the land naturally falls to westbound verges.

4.2.7. Existing overland flow pathways have been identified and presented on the drainage layout drawings presented in Appendix B.

4.2.8. A detailed topographical survey is scheduled to be undertaken and will be available for Stage 5 detail design and shall confirm the correct locations of the pathway routes.

4.2.9. The site is largely greenfield, and the surrounding land is predominantly agricultural fields. No information regarding field drainage systems is currently available.

4.2.10. The figures presented in the table on drawing HE551489-GTY-HDG-000-DR-CD-30005 in appendix C, the reduction in catchments represent where the new alignment intersects these areas, these areas are captured within the new drainage systems for the scheme and are proposed to outfall at greenfield runoff rates, this shall ensure that there is no detrimental impact from flooding from the Proposed Scheme to the surrounding land or properties. The remaining areas shall be conveyed below the new alignment via a ditch and pipe system as detailed on the plans in Appendix B of this report.

4.3. Groundwater

4.3.1. Groundwater was encountered during the ground investigation across the Proposed Scheme, and specifically within alluvium, river terrace deposits, Lowestoft Formation, Sheringham Cliffs Formation (eastern extents only) and Chalk.

4.3.2. Groundwater levels within the superficial deposits range between 48 and 21.8mAOD (-0.2 – 12.5mbGL) and in the underlying Chalk range between 40.5mAOD and 20.5mAOD (-1.32 – 11.65mbGL).

4.3.3. The Chalk is semi-confined by overlying deposits of cohesive Lowestoft Formation away from the river, where groundwater levels within the Chalk are sub-artesian (i.e. above the top of the Chalk). Closer to the River Tud, Chalk groundwater levels are artesian (i.e. above ground level) and is semi-confined by cohesive layers of Alluvium and peat.

4.3.4. Infiltration testing was undertaken during the GI in accordance with BRE 365 at a limited number of locations where drainage basins were initially anticipated. The results are summarised in Table 4-1.

Table 4-1: Summary of infiltration testing undertaken during Stage 3 GI

Location ID (cycle)	Date of test	Infiltration (m/sec)	Test zone			Targeted strata	Notes
			Length (m)	Width (m)	Base depth (m)		
S1 (1)	26/05/2020	$1.81x10^{-4}$	2.00	0.60	1.30	Sheringham Cliffs Formation (SMCL)	-
S1 (2)	26/05/2020	$7.08x10^{-5}$	2.00	1.10	1.50	SMCL	-
S1(3)	26/05/2020	$6.63x10^{-5}$	2.00	1.10	1.57	SMCL	-
S2	18/05/2020	-	2.00	0.45	2.00	Lowestoft Formation (LOFT)	Insufficient infiltration to calculate soil infiltration rate
S3	14/05/2020	-	2.00	0.50	2.10	LOFT	
S3A	15/05/2020	-	2.00	0.45	2.50	LOFT	

4.3.5. The results of the infiltration tests have been calculated for Trial Pit S1 only, located within the Sheringham Cliffs Formation (SMCL) which had an infiltration rate range between $7x10^{-5}$m/s and $1.81x10^{-4}$m/s. All other locations were within cohesive layers of the Lowestoft Formation and had insufficient infiltration to complete the test, due to high clay content within the test lithology suggesting low permeability characteristics.

4.3.6. Permeability tests were also undertaken in exploratory boreholes. The test results range between $7.33x10^{-6}$ m/s and $1.21x10^{-4}$ m/s within the cohesive Lowestoft Formation and $2.61x10^{-5}$m/s and $1.48x10^{-4}$m/s within the granular Lowestoft Formation.

4.4. Source protection zones

4.4.1. There is an Anglian Water Services licensed groundwater abstraction for public water supply situated to the south of the Proposed Scheme at East Tuddenham. The abstraction is newly licensed, and a source protection zone (SPZ) is not yet available. The Environment Agency highlighted in their scoping response that a 1km wide section of the Proposed Scheme to the north of the abstraction, between chainage 3050 and 4050, should be taken as the SPZ1 (inner zone).

4.4.2. The Proposed Scheme is also within a SPZ3 (Total Catchment) between Honingham and Easton for public water supply abstractions to the southeast of the Proposed Scheme.

4.5. Sensitive receptors

4.5.1. There are no Ramsar sites, Special Areas of Conservation (SAC), Local Nature Reserves (LNR), Sites of Special Scientific Interest (SSSI) or National Nature Reserves (NNR) within the DCO boundary. However, Priority Habitats (Coastal and Floodplain Grazing Marsh, Lowland Fen, Lowland Meadow and Good Quality Semi-Improved Grassland) have been identified within the DCO boundary.

4.5.2. The existing priority habitats of intact hedgerows, deciduous woodland and coastal and floodplain grazing marsh will be directly impacted as a result of the Proposed Scheme. Additional indirect impacts will occur on lowland fens, traditional orchards, coastal and floodplain grazing marsh, ponds, rivers, deciduous woodland and hedgerows. It will take several years for deciduous woodland and hedgerows to reach their full former maturity, as shown in the Environmental Masterplan. Grassland habitats and ponds mature quickly and pond habitat will gain more species, but the floodplain grazing marsh wetland replacement will take longer to mature. The long time lag until maturity has been assessed as a significant moderate adverse residual effect for woodland, hedgerows and grazing marsh. Grasslands and ponds will have a slight beneficial effect.

4.6. Constraints

4.6.1. There is a high-pressure gas main to the west of Honingham that crosses the Proposed Scheme alignment in a north south direction. The position and proposed diversion of the gas main does affect the alignment and location of some of the elements to the Wood Lane grade separated junction and drainage structures.

4.6.2. There is an overhead power line that runs north south across the A47 toward the eastern end of the Proposed Scheme just west of Easton. Proposed Scheme geometry is affected by the proximity of the electricity pylons and wires.

4.6.3. Following a review of the unexploded ordnance (UXO) risk assessment it was determined the overall level site risk for the Proposed Scheme is classified as Medium Risk. At this stage specific locations of potential UXO are unknown but this could have an impact on design and construction methodologies. This shall be explored further at the detailed design stage and appropriate mitigation and/or alternative solutions implemented where necessary.

5. Design Options

5.1. Principles

5.1.1. The proposed integrated drainage design includes:

- surface water collection systems and,
- carrier / conveyance systems, to remove water efficiently and safely from the carriageway and;
- pavement sub-surface drainage where new pavement is proposed, to maximise pavement life and earthworks and;
- attenuation requirements and,
- spillage control measures that minimises the impact of the increased development runoff on the receiving environment.

5.1.2. The proposed drainage design also:

- maintains existing local outfalls,
- introduces new outfalls to watercourse, and
- incorporates new drainage connections to existing highway surface water sewers,

5.1.3. The highway drainage should discharge, in order of preference, to the following locations.

- Ground,
- Surface water course,
- Surface water sewer.

5.1.4. For the ongoing design, full 3D models will form the main drainage features and be provided with supporting asset information that will establish a high degree of certainty for construction.

5.2. Design parameters

5.2.1. Table 6-1 below sets out the parameters used for the design in accordance with DMRB CG 501 and Norfolk County Council's *Highway Guidance for Development.*

Table 5-1: Design criteria for storm return periods

Storm return period	Item	Design parameters
1 in 1 year	Drainage network	No surcharging of the pipe.
1 in 5 year	Drainage network	No surcharging pavement layers or carriageway.
1 in 30 year	Drainage network	No flooding of carriageway at underpass low points.
1 in 50 year	Drainage network	No flooding at sags or road crossings
1 in 100 year	Drainage network	No flooding of third-party land.

5.2.1. A 40% climate change allowance is considered within the above design storm events as per Norfolk County Council's *Highway Guidance for Development.*

5.2.2. Additional design parameters are given below:

Minimum Pipe Velocity*:	Self-cleansing	0.75m/s
Maximum Pipe Velocity:	within network	3.20m/s
	at open outfalls	2.50m/s
Pipe Roughness coeff.** (k_s value):	Carrier pipe:	0.6mm
	Filter pipe:	1.5mm
Conduit*** roughness coeff.:	Mannings n	0.011
Conduit*** velocity:	minimum	0.75m/s
Conduit*** velocity:	maximum	3.20m/s
Time of Entry:		5 minutes
Rainfall:	M5-60:	20 mm
	Ratio R:	0.408
	M5-2min:	5mm
Ditch roughness coeff.:	mannings n	0.050
Minimum ditch gradient		1 in 500

* Assumed in-service deteriorated condition.

** For use with new and existing pipes

*** Propriety combined drainage system, manufacturers advised values based on moderate maintenance regimes.

Pipe Sizing

5.2.3. XP MICRODRAINAGE Version 2019.1 is utilised for hydraulic design of pipework, applying the Modified Rational Method in accordance with the Wallingford Procedure using FSR rainfall maps.

5.2.4. The minimum pipe size used shall be 150mm diameter on Highways England adopted roads and 225mm diameter on Norfolk County Council adopted roads in accordance with Norfolk County Council's *Highway Guidance for Development.*

Pipe length

5.2.5. Maximum 150 metres centres between drainage chambers where no lateral connections are made to the pipe, otherwise a maximum spacing of 90m is to be provided.

5.2.6. Maximum connection length between gully / combined drainage kerb outlet to pipe connection to be 12.5 metres.

5.3. Surface run-off collection and conveyance

5.3.1. The collection and conveyance of surface water will be achieved using the methods outlined below. The flow will be conveyed, attenuated where required, and discharged back to the hydrological environment by various methods, including:

Kerb and gully

5.3.2. On embankments, kerb and gully drainage is the principal surface runoff collection option. Kerb and gullies are also present in some cutting settings, usually at junctions and lay-bys.

Combined drains

5.3.3. The combined sewer collects carriageway run-off through a filter drain and negates the use of separate drainage to drain the pavement foundation. The combined sewer system is used extensively in cutting situations.

5.3.4. Combined drains may be required to form part of the pollution treatment process for surface run-off. Discussions with the water environment team are to take place as the design progresses.

5.3.5. The diameter of combined or filter drain shall not exceed 300mm diameter as directed in CD 524. A departure from standard would be required and sought for diameters larger than 300mm.

5.3.6. When the diameter through the design process exceeds the 300mm requirement, unless a departure from standard has been obtained as noted above, an additional carrier pipe shall require to be introduced to the system in order to continue the combined drain at a dimeter less than 300mm.

Combined drainage kerb system

5.3.7. Combined kerb drainage is mainly used on bridge decks. The layout of combined drainage kerb system and outfall points are shown on the drainage layout drawings. The final combined drainage kerb selection is to be designed in accordance with the parameters above and the manufacturers requirements and recommendations.

5.3.8. Where the longitudinal channel gradient is less than 0.5% then the combined drainage kerb shall incorporate an integral drainage channel providing minimum 0.5% gradient where possible. All outlets that discharge to the pipe network are to be fitted with silt traps.

5.3.9. Where a kerb and gully system cannot be accommodated, a suitable linear drainage system shall be used. Areas of shallow longitudinal gradient and at junctions are locations that typically benefit from linear drainage systems.

Sub-surface drainage

- ### Sub-formation drainage

5.3.10. Narrow filter drains (NFD) / fin drains (FD) in accordance with MCHW are specified to provide sub-formation drainage as part of the Proposed Scheme. These drains are located at the low side of the carriageway where no alternative solution is provided.

5.3.11. Bridge sub-surface drainage is to be provided and shall be passed over the structure or shall be tied into any back of wall drainage or kerb drainage system to ensure drainage of the road pavement layers. Where the sub-formation drainage is directed to the back of wall drainage, this in turn shall be conveyed via a pipe to an adjacent road network drainage system or suitable infiltration soakaway as this does not take road surface drainage and is therefore suitable to filter to ground.

5.3.12. Sub-surface drains will be proposed in accordance with DMRB and MCHW Highway Construction Details, providing drainage to the road construction layers and control of ground water levels where required.

- **Conveyance**

5.3.13. Carrier drains and combined drains are proposed in accordance with the MCHW Highway Construction Details, collecting surface runoff from gullies, surface water channels and combined drainage kerb outlets. Sub surface pipes that drain road construction layers connect to downstream chambers.

Ditches

5.3.14. Ditches are likely to be adopted throughout the Proposed Scheme to capture run-off from surrounding land that falls towards the works as well as from new earthwork slopes. Runoff would then be conveyed to a suitable outfall, either directly to a watercourse or via an attenuation basin.

5.3.15. Ditches may also be used to convey carriageway run-off when forming part of the highway drainage network. Ditches can be used where additional pollution control and / or attenuation is required before discharging to a river or watercourse.

5.3.16. Ditches can be used to catch the runoff from the proposed new embankments and direct then to the new attenuation system where levels allow, where it is unable to be attenuated these shall be directed to a suitable outfall as a PED system.

5.3.17. Runoff from new embankments will generally reach ditches quicker than the assessed runoff from the surrounding natural catchments. As a result, the peak flows from the embankments are likely to have been captured and passed prior to any natural peak flows entering the ditches, this combined with the reduced catchment areas as shown on drawing HE551489-GTY-HDG-000-DR-CD-30005 in Appendix C will mean it is less likely there will be additional or worse flood risk to downstream catchments than the pre-development scenario.

5.3.18. Where ditches are used for attenuation purposes, these ditches shall have baffles installed to allow for retention of the runoff. Local widening of the ditch bases will also be adopted to accommodate larger storage volume requirements.

5.3.19. Attenuation of runoff from embankments within the ditches using flow control devices will not generally be practical due to the relatively small catchment areas.

5.3.20. Where existing ditches are to be utilised, they shall be cleared and regraded to suit, where required.

5.4. Natural catchment drainage

5.4.1. There are several natural surface water flow pathways that are intercepted by the new works as shown on drawing HE551489-GTY-HDG-000-DR-CD-30005 in Appendix C. It is proposed to provide drainage in the form of pre-earthworks ditches or filter drains to convey this runoff to a suitable outfall that is separate from the main highway drainage system where possible as detailed on the proposed catchment plan HE551489-GTY-HDG-000-DR-CH-30016 in Appendix C.

5.4.2. Where field drainage is severed by the works it is the intention to keep this drainage independent of the highway drainage system. All overland runoff from natural catchments should freely discharge to nearby watercourses without restriction.

5.5. Catchment run-off factors

5.5.1. Only two catchment types are identified for both the existing and proposed drainage layouts. Carriageway including other hard impermeable surfaces, verges (nominally flat) and gentle grassed slopes. The permeability factors of each surface are indicated in Table 6.2 these are in line with DMRB CD 521 Table 5.6.2.

Table 5-2: Catchment permeability factors

Surface	Impermeable factor (%)
Hard	100
Soft	26

5.5.2. In addition to the factors set out above the drainage at the bottom of the newly constructed embankments will be designed to accommodate a 100% impermeable factor run-off as required by Norfolk County Council.

5.6. Guidance and policy

Design codes and standards used

5.6.1. The design codes used in the drainage design are in accordance with the Design Manual for Roads and Bridges (DMRB), specifically:

- CD 109 Highway link design
- CD 521 Hydraulic design of road edge surface water channels and outlets

- CD 522 Drainage of runoff from natural catchments
- CD 523 Determination of pipe roughness and assessment of sediment deposition to aid pipeline design
- CD 524 Edge of pavement details
- CD 525 Design of combined surface and sub-surface drains and management of stone scatter
- CD 526 Spacing of road gullies
- CD 527 Sumpless gullies
- CD 528 Vortex separators for use with road drainage systems
- CD 529 Design of outfall and culvert details
- CD 530 Design of soakaways
- CD 532 Vegetated drainage systems for highway runoff
- CD 533 Determination of pipe and bedding combinations for drainage works
- CD 534 Chamber tops and gully tops for road drainage and services
- CD 535 Drainage asset data and risk management
- CG 501 Design of highway drainage systems
- CG 502 The certification of drainage design
- National Planning Policy Framework
- Sustainable Drainage Systems Non -statutory technical standards for sustainable drainage systems, DEFRA, March 2015.
- Flood risk and coastal change, Ministry of Housing, Communities & Local Government, March 2014.
- Sewers for Adoption (8th Edition).
- CIRIA: The SuDS manual (C753).
- Highways England Manual of Contract Documents for Highway Works (MCHW) Volume 1 (Series 500) and Volume 3, Section 1, Highway Construction Details (HCD) B & F Series. Specific list of HCD's to be referred to:
  - Section F – Drainage
  - Surface Water Drains – Trench and Bedding Details F1
  - Type 2 Chamber – (Precast Concrete Manhole) F4
  - Type 3 Chamber – (Precast Concrete Manhole) F5
  - Type 4 Chamber – (Precast Concrete Manhole) F6
  - Type 7 Chamber – (1050 Catchpit) F11
  - Precast and In Situ Cast Gullies F13
  - Edge of Pavement Drains – Fin Drains & Narrow Filter Drains F18

- Edge of Pavement Drains – Installation of Fin Drains F19
- Edge of Pavement Drains – Installation of Narrow Filter Drains F20
- Edge of Pavement Drains – Under Channel Drainage Layers F21
- Gully Frame - BSEN124, Group3, D400, Ductile Iron.
- Manhole cover - BSEN124, D400, 600x600, Ductile Iron.
- Filter drains - HCD F2, Type H, K or I, minimum 225mm dia. Minimum depth to pipe crown 900mm in verge, 600mm in fields.

Planning policy

Joint Core Strategy for Broadland, Norwich and South Norfolk

5.6.2. The relevant policies within the strategy (Greater Norwich Development Partnership, 2014) in relation to the water environment are summarised below:

- Policy 1: addressing climate change and protecting environmental assets. Development should be located to minimise flood risk and mitigate any such risk through design and the implementation of sustainable drainage. Development should minimise water use and protect groundwater sources
- Policy 3: energy and water. This policy ensures that, amongst other things, water quality is protected and improved with no significant detriment to areas of environmental performance

The Broadland District Council Development Management Development Planning Document (DPD)

5.6.3. The relevant policies within the DPD (Broadland District Council, 2015) in relation to the water environment are summarised below:

- Policy EN4 – Pollution. Development must include an assessment of potential pollution and provide mitigation, where required. Development will only be permitted where there will be no significant impact upon amenity, human health or the natural environment.
- Policy CSU5 – Surface water drainage. Development should not increase flood risk elsewhere. Developments should not:
  - increase the vulnerability of the site, or wider catchment, to flooding from surface water runoff
  - Wherever practicable, development should have a positive impact on surface water flooding in the wider area

Breckland Council Local Plan

5.6.4. The relevant policies within the local plan adopted on November 28th, 2019 (Adoption Draft) (Breckland District Council, 2019) in relation to the water environment are summarised below:

- Policy ENV 09 - Flood Risk & Surface Water Drainage. All new development will:
    - be located to minimise the risk of flooding, mitigating any such risk through design and implementing sustainable drainage (SuDS) principles.
    - incorporate appropriate surface water drainage mitigation measures to minimise its own risk of flooding and should not materially increase the flood risk to other areas. Particular care will be required in relation to habitats designated as being of international importance in the area and beyond which are water sensitive, as well as habitats designated of regional or local importance.
- Developers will be required to show that the proposed development would:
    - not increase green field run off rates and vulnerability of the site, or the wider catchment, to flooding from surface water runoff from existing or predicted water flows;
    - wherever practicable, have a positive impact on the risk of surface water flooding in the surrounding area adjacent to the development; and
    - address potential impact of infiltration upon groundwater Source Protection Zones and/or Critical Drainage Catchments.

5.6.5. Norfolk County Council also provide guidance to developers on their role as Lead Local Flood Authority (Norfolk County Council, 2019).

5.7. Design options considered

5.7.1. Specific considerations and options considered through the design phase for each drainage network are discussed within section 6 of this report alongside the proposed design narrative where applicable.

Mainline

5.7.2. The mainline carriageway is an all-purpose rural dual carriageway and does not have a footway within the highway verge. In accordance with DMRB CG 501, the recommended verge side drainage on embankment in order of preference is;

- surface water channel (and piped system),
- informal over-the-edge drainage on low embankments (of granular material),

- grassed surface water channel on low embankments (of granular material) and in the unpaved central reserve,
- surface water channel (and piped system),
- combined surface and sub-surface drain.

5.7.3. Surface water channels are also recommended in cuttings with no groundwater problems.

5.7.4. It was considered impractical to install surface water channels because the geometric alignment has numerous sections of carriageway with gradients in excess of 2.0%, which requires the installation of weir type outlets. The larger outlets necessitate additional barrier introducing new hazards to verges, and wider verges and central reserves, so also increasing land take.

5.7.5. The design solutions selected for the collection of carriageway runoff for the mainline and slip roads are;

- kerb and gullies on embankments and in central reserves,
- informal over-the-edge drainage on low embankments (of granular material),
- combined surface and sub-surface drain in cutting and soft central reserve.

Proposed new local roads

5.7.6. For proposed carriageways, junctions etc., the selection of drainage collection systems considered for the surface water removal from carriageways on embankments includes, kerb and gullies with hardstrip, kerb and gullies and combined drainage and kerb systems. The drainage collection systems considered for carriageways in cuttings or low embankments include those systems used on embankments plus combined drainage with permeable top. These systems are typical solutions and align with DMRB recommendations.

5.7.7. Ditches will be used to collect natural run-off and slope run-off from earthworks. Where space is limited filter drains will be used.

5.7.8. The drainage types selected are well established systems familiar to maintenance providers.

Mattishall Lane Link Road Underbridge

5.7.9. The inclusion of the Mattishall Lane Link Road alignment and underbridge necessitated several drainage solutions to be assessed. This alignment has a low point located within a deep cutting that has no nearby natural outfall available. This proposed underbridge also impacts on approximately 200m of mainline drainage system which is severed by the cutting. Three drainage solutions were considered;

- Option 1: pumping station. This was ultimately rejected due to additional cutting requirements to provide a suitable location for the pumping chamber, as well as capital expenditure and future maintenance costs, for a such a small section of road.

- Option 2: a gravity drain outfall to the south west. This was rejected on the basis that this was not a proven outfall and required a significant run of deep drainage trenches and chambers, this option may be revisited at the detailed design stage following review of the drainage survey report. This option would also require an additional attenuation basin to be provided for the severed mainline carriageway runoff.

- Option 3: a gravity drain outfall to an adjacent mainline network. This option was taken forward for the DCO application on the basis of it being a more economical outfall route and reduced the need for an additional basin. This solution does however would require the installation of a pipe run at significant depth over a length of approximately 140m.

Conveyance systems

5.7.10. Typically, on embankments a sealed carrier system with narrow filter drains (NFD) are considered the favoured option. Sealed drains are used extensively in the existing trunk roads.

5.7.11. In cuttings combined sub-surface / carriageway drainage is considered necessary based on the likelihood of encountering groundwater, especially in deeper cuttings. The solution is also favoured because it simplifies construction and these drains can be maintained throughout their life. Sealed carrier systems will be required for carriageway drainage within SPZ1 areas, however, where carriageway drainage to groundwater is to be avoided.

5.7.12. Ditches will be used to convey natural run-off and slope run-off from earthworks. Where space is limited filter drains will be used.

Outfalls

5.7.13. The proposed drainage design has considered outfalls in the order of preference set out within CG 501. The order of preference is:

- Ground via infiltration,
- Surface watercourse,
- Surface water sewer.

5.7.14. Infiltration to ground was considered at several locations, and tests were carried out during ground investigation works. Results were poor so this approach has

not been considered at this time but shall be assessed further at Stage 5, see Section 5.12.

5.7.15. A section of the Proposed Scheme has been identified as a source protection zone 1, within which discharge to ground is to be avoided.

5.7.16. The highway runoff does not discharge directly to natural ponds, lakes, canals, reservoirs.

5.8. Flood risk management

5.8.1. As part of a SuDS system, the discharge solution is to collect all run-off from the new development and return it to the natural environment at the greenfield discharge rate. This will ensure any flood risk is not increased post-development. Where overall catchments connecting to existing systems are reduced by the Works the flood risk is also reduced and the intention would then be to match the existing discharge rate into that system as a worst case to ensure there is no increase in downstream flood risk.

5.8.2. All new design outfalls require flow control management. Where space permits, attenuation basins are provided. Infiltration basins were discounted because of poor ground conditions and other constraints on discharging to ground. Where space is restricted and on smaller catchments, attenuation is provided by oversized pipes or ditches.

5.9. Pollution management

5.9.1. Highways England Water Risk Assessment Tool (HEWRAT), used to quantify the impacts of routine run-off and accidental spillage on the water receptors will influence the need for specific additional pollution management infrastructure.

5.9.2. Gate valves were considered as a possible shut off facility for the containment of spillages, but penstocks are considered a more reliable solution over a longer term.

5.10. Pollution control

5.10.1. Water quality and flood control can be improved using sediment traps, filter drains, wetlands and other vegetated systems. The three main processes applicable to the treatment of highway runoff are;

- Sedimentation. The removal of suspended solids,
- Separation. The removal of all solids and non-aqueous liquids,

- Vegetated treatment processes including filtration, settlement, adsorption, biodegradation and plant up take depending on the type and combination of systems.

5.10.2. Where practically possible the techniques outlined above will be utilised.

5.10.3. Pollution control devices such as penstocks shall be provided to the inlets and the outlets of the basins/wetlands and any online pipe/ditch attenuation features, in order to reduce any pollution that may occur in the event of a spillage.

5.11. Sustainable Urban Drainage Systems (SuDS)

5.11.1. As per CIRIA C753 The SuDS Manual, SuDS designs should benefit the four main pillars, these include quantity, quality, biodiversity and amenity.

5.11.2. The proposed SuDS features included within the proposed design include; detention basins or wetlands, filter drains, and grassed ditches.

5.11.3. The detention basins and wetlands promote the 4 pillars of SuDS by providing storage to restrict discharge rates to greenfield run-off rates, providing vegetated surface for water to flow over to settle, filtrate and biodegrade hydrocarbons and pollutants (including sediment and dissolved sediment-bound heavy metals) . The detentions basins also promote biodiversity as these will include a diverse range of local plants which will provide habitat and food for invertebrates and birds. Perimeter fencing around the basins will be provided but will not be designed to restrict wildlife access. The proposed basins are irregular shaped and are designed to be sympathetic with the surrounding landscape which will be further enhanced by the proposed planting. The additional benefits of the wetlands will depend on the level of contamination anticipated of the inflows.

5.11.4. The amenity potential of the detention basins is limited given their function, setting and close proximity to the proposed new dual carriageway. However, the detention basins and their surroundings have all been developed to try and sympathetically sit in the existing landscape using native species of grass, shrubs, hedgerows and trees.

5.11.5. Grassed ditches provide a vegetated surface for water to flow over to settle and filtrate hydrocarbons and pollutants. Grassed ditches also promote biodiversity as these include a diverse range of local plants which will provide habitat and food for invertebrates and birds. The proposed ditches will be natural in form and will be designed to be sympathetic to their setting.

5.11.6. Filter drains provided at the edge of road carriageways provide a degree of filtration and contributes to slowing down carriageway run-off. Gravel media can also host microorganisms and provide a breeding ground for insects.

5.12. Infiltration Potential

5.12.1. The infiltration testing undertaken during the 2020 GI (see Section 4.3) generally indicated variable permeabilities reflecting the highly varied ground conditions. It is likely that the cohesive glacial deposits (Lowestoft & Happisburgh Formation) is of low permeability however the lithological units vary over short distances and depths. Where lithologies with a higher proportion of granular particles are encountered, infiltration rates are likely to be acceptable.

5.12.2. Due to the evolving scheme design, there is limited information on the infiltration potential at the drainage basin locations. Further investigation of the ground conditions and associated infiltration characteristics at proposed drainage basin will be undertaken during the supplementary GI, which is proposed for the first quarter of 2021.

6. Proposed Design

6.1.1. This section describes the proposed drainage design adopted for the DCO application preliminary design.

6.1.2. The preliminary drainage design layout drawings are contained within Appendix B of this report.

6.1.3. The proposed drainage catchment plan is contained within Appendix F of this report.

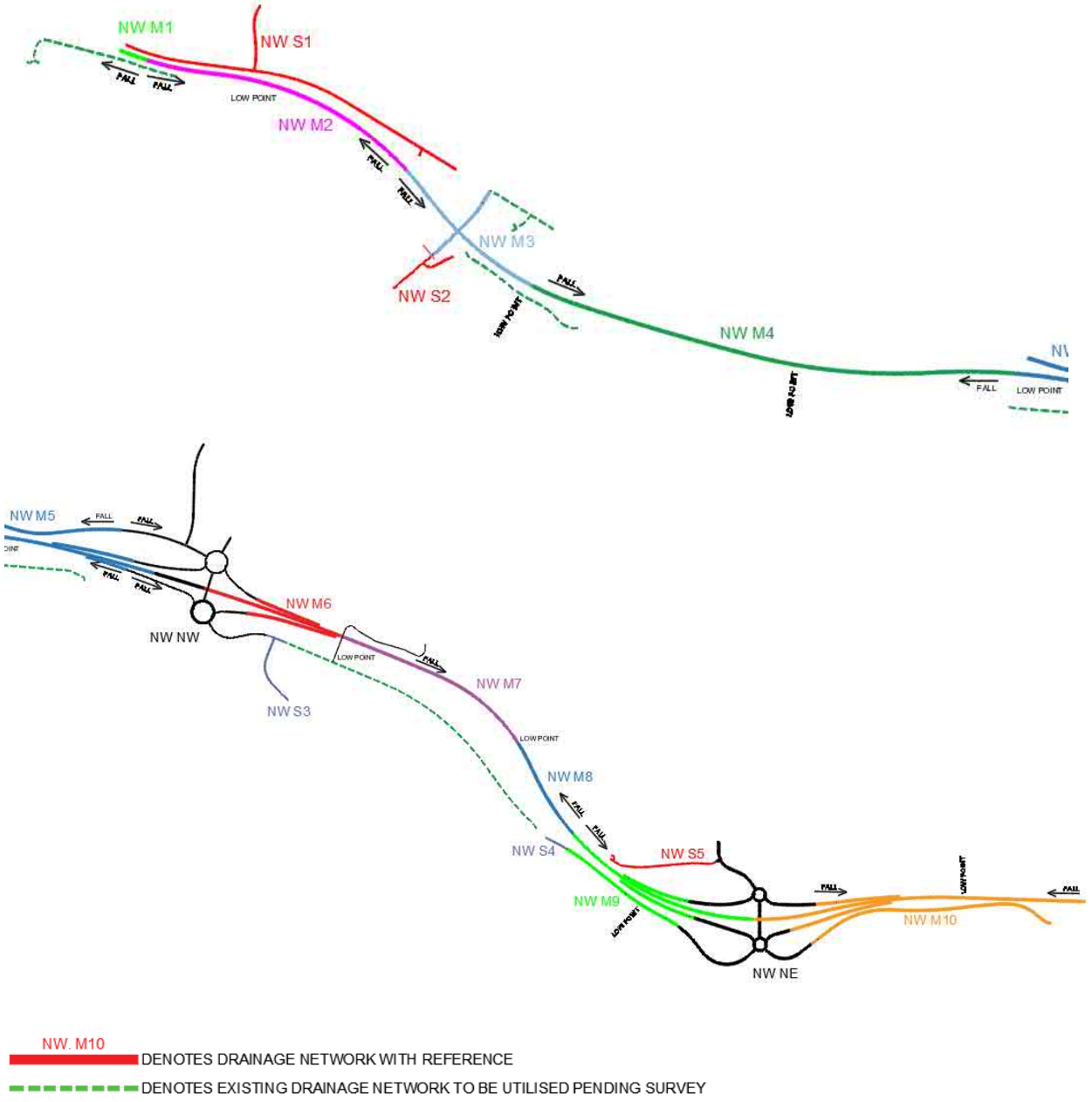
6.1.4. The proposed road surface water collection system is detailed with Table 6-1.

6.2. Proposed network catchment and design

6.2.1. The Proposed Scheme catchments shown in Figure 6-1 relate to the drainage networks presented in Appendix B utilising the drainage systems described below. Each catchment has been designed using the methodologies outlined in section 5 of this report.

6.2.2. Individual network catchment descriptions of the proposed drainage networks are outlined below. Refer also to Table 6-1 for the proposed drainage and SuDS systems to be utilised for each network catchment.

Figure 6-1: Proposed Network Catchments



6.3. Network catchments

6.3.1. Network M1 - Approximate length of 250m of the new dual carriageway that falls back to tie-in with the existing drainage system. The drainage at the new head of run to the existing system has been calculated as a like for like catchment area with no attenuation proposed.

6.3.2. Network M2 - Approximate length of 990m of the new dual carriageway that is at existing ground level or on slight embankment. This network will outfall to an existing watercourse downstream of the culverted section below the new

alignment. The design currently specifies a detention basin as the attenuation system but the design will be amended to a wetland or similar treatment solution at Detailed Design in order to remove copper as per the HEWRAT assessment.

6.3.3. Network M3 - Approximate length of 580m of the new dual carriageway and the new Mattishall Lane Link Road. This network will outfall to the River Tud.

6.3.4. Network M4 - Approximate length of 1.7km of the new dual carriageway. This network will outfall to the River Tud.

6.3.5. Network M5 - Approximate length of 750m of the new dual carriageway and 500m section of the new link to the existing de-trunked A47. This network will outfall to the River Tud.

6.3.6. Network M6 - Approximate length of 800m of the new dual carriageway. This network will outfall to the River Tud.

6.3.7. Network M7 - Approximate length of 860m of the new dual carriageway that will outfall to the River Tud on the northern side of the new bridge location.

6.3.8. Network M8 - Approximate length of 440m of the new dual carriageway that will outfall to the River Tud on the southern side of the new bridge location.

6.3.9. Network M9 - Approximate length of 840m of the new dual carriageway. This network will outfall to the River Tud.

6.3.10. Network M10 - Approximate length of 1.35km of the new dual carriageway that will outfall to the River Tud, this will also convey approximately 600m of the existing dual carriageway and approximately 1km of the new sideroad to the new outfall.

6.3.11. Network S1/S1a - this network encompasses a 1.2km section of the link to the existing de-trunked A47 west of Hockering and the link to Lyng Road. This network will outfall to an existing watercourse downstream of the culverted section below the new alignment.

6.3.12. Network S2 – this network encompasses a small section of the new Mattishall Lane Link Road. Pending the results of the drainage survey, this network will outfall to the River Tud via a short carrier system.

6.3.13. Network S3 - this network encompasses the new link road to Dereham Road (Honingham) and will outfall to the existing road drainage system pending the results of the drainage survey.

6.3.14. Network S4 - this network encompasses a short 75m section of the link to Norwich Road from the existing Honingham roundabout and will outfall to the existing road drainage system pending the results of the drainage survey.

6.3.15. Network S5 – this network encompasses the realignment/overlay of the existing A47 between Taverham Road and St. Andrew's Church, including a new turning area in front of the church. This network will outfall to network M9 which ultimately outfalls to the River Tud east of Taverham Road.

6.3.16. Network NW – this network encompasses the Wood Lane junction, incorporating the slip roads, roundabouts and connector road, sections of the links to existing de-trunked A47 as well as the B1535 Wood Lane, This network shall outfall to the River Tud via a detention basin.

6.3.17. Network NE - this network encompasses the Norwich Road junction, incorporating the slip roads, roundabouts and connector road, sections of the links to the existing de-trunked A47 as well as Taverham Road. This network shall outfall to the River Tud via a detention basin, this basin also receives outfalls from networks M9 and M10.

6.3.18. Summary table:

Table 6-1: Proposed drainage solutions for each network

Catchment Reference	Drainage system options					SuDS		
	Combined Drain	Kerb and Gulley	Carrier Pipe	Over the edge with ditch	Combined drainage Kerb system	Detention Basin	Ditch or Swale	Wetland
Area M1	X	X						
Area M2	X	X	X			X		X1
Area M3	X	X			X	X		
Area M4	X	X	X			X		
Area M5	X	X	X			X		X1
Area M6	X	X				X		
Area M7	X	X				X		
Area M8	X	X	X			X		X1
Area M9	X	X	X			X		
Area M10	X	X	X	X		X		
NW (Wood Lane junction)	X	X	X			X		
NE (Norwich Rd junction)	X	X	X			X		
S1	X	X	X	X			X	
S2	X	X	X					
S3	X	X	X					
S4	X	X	X					
S5	X	X	X					
W1	X	X	X			X		

X denotes use X1 Denotes potential use, requires further investigation or information for selection

6.4. Natural Catchment Drainage

6.4.1. An assessment of the natural catchment and overland flow pathways have been carried out based on the SENSAT topographical survey. A further assessment will be undertaken at Stage 5 when the updated topographical survey is available. This will be used to verify the Stage 3 assessments and ensure the overland flows and outfall paths are modelled appropriately.

6.4.2. Outfalls for the pre-earthworks drainage and intercepted overland flows have been indicatively provided to nearby watercourse or drainage ditches. These can be seen on the drainage design layout drawings in Appendix B. The proposed routes will be verified at the detailed design stage following review of the drainage survey and updated topographical survey.

6.4.3. New culverts are proposed as part of the works to convey existing watercourses below the new roads and are shown on the drainage design layout drawings in Appendix B.

6.4.4. Two culverts are located towards the western tie-in of the scheme north of Oak Farm on an unnamed watercourse. The culvert below the mainline is an extension to an existing culvert (West Culvert) that runs below the existing A47. Additionally, there is also a new culvert (New West Culvert) proposed below the new realigned A47 west of Hockering.

6.4.5. A culvert is also proposed below the mainline to the south of Newgate House. This culvert shall convey the water from an unnamed watercourse south where it outfalls to the River Tud.

6.5. Infiltration/Soakaways

6.5.1. Following assessment of the infiltration potential and noting the results of tests carried out during ground investigation works in Section 4.3, at this stage of the design development it is not anticipated that infiltration to ground at the final outfall point would be a feasible approach. However, supplementary ground investigation shall be carried out prior to the detailed design stage and the potential for infiltration to ground shall be further considered during the development of the detailed design.

6.6. Attenuation

6.6.1. An assessment has been undertaken to ascertain the approximate volume of storage attenuation required for each catchment. The allowable greenfield runoff discharge rates have been calculated using the IH124 calculation in line with the DMRB for catchments less than 25ha, with the catchments noted in Table 6-3. Following consultation with Norfolk County Council, and direction to their design

guidance for developers, it is noted the preferred rainfall analysis should use the FEH 2013 online rainfall / catchment characteristics, it is noted however that the FEH 2013 is for use with catchments above 0.5km2 (50ha). In addition, it is noted that the allowable greenfield runoff discharge rates should be calculated using the ReFH2 method.

6.6.2. Following the above noted consultation, checks were carried out on two networks in the current design using the FEH 2013 data and ReFH2 methods for the greenfield runoff flows, volumes and simulated rainfall events within the ICM drainage modelling program, to determine whether the current attenuation system designs could accommodate reverting to the above noted methods. Both checks yielded similar results in attenuation volume when compared to the IH124 greenfield and FSR rainfall. It is therefore proposed that the detailed drainage design at the detailed design stage shall use the FEH 2013 rainfall data along with the ReFH2 suite of calculations.

6.6.3. The networks noted in Table 6-2 below are proposed at this stage to tie into existing systems. Pending final design and calculations these networks are to be a like for like or provide betterment i.e. a reduction of flows to the existing system, as shown in Table 6-2 below and the drainage catchment plans in Appendix C, where any increase of flow are found to be excessive, these shall be attenuated to the existing greenfield flows for the same event via flow controls and the use of either oversized pipes in the verges or ditches.

Table 6-2: Existing vs proposed catchment area comparison

Catchment Reference	Existing Catchment Area (from 0S/survey) m^2	Proposed Catchment Area (from Design) m^2	Catchment Area Difference (from Design to existing) m^2	% increase/decrease
Area M1	12384	12470	86	0.7
S1	17737	9164	-8573	-48.0
S2	5080	2244	-2836	-55.0
S3	3835	4267	432	11.0
S4	1066	891	-175	-16.0

6.6.4. Catchment M1 is considered to be ‘brownfield’ as it’s a realignment of the existing carriageway. A new positive drainage system is proposed in the verge and shall be connected to the existing drainage network. This is a head of a run and the overall catchment change is negligible as shown on Table 6-2, the existing network is therefore considered unaffected.

6.6.5. Where the sideroads routes have been altered by the Proposed Scheme, it is proposed to return the existing roads that are no longer in use to greenfield, by

removing the road pavement and associated drainage to below the formation level and soiling over the former road surface area.

6.6.6. Table 6-3 outlines the network catchment details including an estimated required storage volume. The catchment areas shown are for the carriageway and embankment runoff only as it is assumed at this stage that any natural runoff will be collected via the earthworks drainage systems and discharged separately.

6.6.7. The storage volume has initially been estimated for a 100-year return period plus 40% uplift for climate change using Micro Drainage 'Quick Storage Estimate' hydraulic software. The software provides a lower and higher volume with the mid-range value being shown in Table 6-3 below.

6.6.8. The volumes of storage required shall be contained in suitably sized attenuation basins or wetlands. this shall be confirmed pending consultation with the Environment Agency and Norfolk County Council.

6.6.9. Flow control device such as hydrobrakes and orifice plates will be used in conjunction with the attenuation provision to reduce the peak flows to the outfall locations as indicated on Table 6-3.

6.6.10. Inlets and outlets to the basins / wetland features shall be located as far apart as possible in order for a longer water route through the basin this provides a more effective treatment. Where the inlets and outlets are unable to be located in this manner, a small berm or baffle shall be provided to the basin floor between the inlet and outlet structures in order to direct any initial surface water around the base for more effective treatment.

Table 6-3: Catchment areas, Proposed Discharge Rates and Storage Volume

Catchment Reference	Chainage Start	Chainage End	Catchment Area (m2)	Greenfield Runoff (l/s)	Storage Volume (m3)
Area M1	Tie-in	677	0.3657	n/a	N/A
Area M2	677	1644	2.584	7.7	1507
Area M3	1644	2250	3.082	7.7	1226
Area M4	1644	2250	5.612	13.0	2950
Area M5	2250	3911	3.956	7.5	1749
Area M6	3911	1693	2.827	5.7	1301
Area M7	4693	5499	3.098	7.0	1546
Area M8	5499	6400	1.525	3.4	734
Area M9	6400	6885	3.751	0.0	0
Area M10	6885	7541	8.743	0.0	0
NW (West Interchange)	7541	Tie-in	7.179	18.0	N/A
NE (Norwich Rd Interchange)	N/A	N/A	20.892	50.0	8015
S1	N/A	N/A	1.877	0.0	N/A

Catchment Reference	Chainage Start	Chainage End	Catchment Area (m2)	Greenfield Runoff (l/s)	Storage Volume (m3)
S2	N/A	N/A	0.589	0.0	N/A
S3	N/A	N/A	0.298	0.0	N/A
S4	N/A	N/A	0.135	0.0	N/A
S5	N/A	N/A	0.698	0.0	N/A
W1	N/A	N/A	0.384	0.0	N/A

1. Areas S1 to S5 are local side roads with W1 being the NMU underpass alignment.
2. Networks W1, S5, M9, M10 and NE are to be routed to a single attenuation basin with totals added in the NE row.
3, The Greenfield runoff flows are based on the IH124 peak flow calculation and are subject to change.

6.6.11. The drainage catchments shown in Figure 6-1 and the plans in Appendix C have been determined from the proposed alignment design. The catchment areas generally lie between two high points along the proposed alignment with the outfall being in the vicinity of a low point of the alignment.

6.6.12. Detention basins are proposed as the initial solution for attenuation pending consultations and will be positioned in the vicinity of low points of the proposed alignment. Basin sizes are dependent on the allowable discharge rate to existing watercourses. These basins shall have a suitable liner system in place to prevent any infiltration to the ground unless designed to do so, theses shall be in the form of a natural puddle clay layer if site won, or a bentomat self-healing system or similar, these systems shall ensure a low to zero infiltration rate to mitigate any risk to groundwater via infiltration.

6.6.13. Wetlands are also being considered for use at a number of locations as a potential alternative to basins, this will help raise biodiversity for the Proposed Scheme, these will have a larger footprint and be shallower in nature to the basins, with the inclusion of small micro-pools, these are shallow permanent areas of water in the base of the wetland, with suitable planting to the base of the wetland being provided.

6.7. Flood risk and mitigation

6.7.1. The increase in impermeable area resulting from the Proposed Scheme would, without mitigation, result in an increase in the surface water run-off rate and volume discharging to the proposed outfalls. This has the potential to increase flood risk downstream of the outfalls.

6.7.2. The proposed drainage system is designed to attenuate storms outlined in Table 6-1 above. There would be no (or negligible) increase in runoff rates from the site up to the 1 in 100-year storm event including a 40% climate change allowance. No carriageway flooding will occur during a 1 in 30-year storm with

no flooding of third-party land during a 1 in 100-year storm event including a 40% allowance for climate change.

6.7.3. Flow paths of surface water runoff from the highway drainage arising from storm events more than the design standards would flow along the alignment within the carriageway extents towards the lower elevations. Once an extreme storm event has passed, surcharging within the network would reduce, thus allowing any residual runoff back into the network away from the surface and towards the attenuation provisions and final discharge at greenfield runoff rates.

6.7.4. When the alignment is in cutting any exceedance volumes shall remain in the highway network, when on embankment any flooding volume that potentially could overtop the verge shall be collected by the extensive bottom of embankment drainage provision which is either routed to the available detention basins or a natural pre earthworks outfall.

6.7.5. Cut-off drainage is proposed where required to intercept overland flow, with cross drains and 'dry' culverts provided at road crossing designed accordingly. These will be designed to accommodate a 1 in 100-year storm event including 65% climate change to mitigate impacts to the Proposed Scheme and to others.

6.7.6. No further mitigation is required to address other sources of flood risk posed to or arising from the Proposed Scheme; this includes tidal, fluvial, groundwater, reservoir failure or water or sewerage infrastructure failure. Further details can be found in the Flood Risk Assessment (ES Appendix 13.1 (**TR010038/APP/6.3**)).

6.8. Pollution control

6.8.1. The routine runoff assessment for outfalls was undertaken using HEWRAT. The full results can be found in document in ES Appendix 13.3 Water quality assessment (**TR010038/APP/6.3)**. The assessment indicates that there is a negligible impact following dilution in the channel for both soluble and sediment-bound pollutants all of outfalls except for catchment M1. A wetland and swale have been included at catchment M2 and S1 respectively to mitigate against copper pollution impacts. In addition to this, there is an intention to provide filter drains and a wetland or similar treatment prior to discharging via the outfall, the locations can be found in Table 6-4. Due to the outcome of the HEWRAT assessment (see Table 6-4), for these outfalls, there is no requirement for additional mitigation measures beyond those stipulated in the drainage design.

6.8.2. The outfall M1 which discharges runoff from the existing drainage catchment to the west of the DCO boundary and proposed catchment M1 failed for acute copper. It is noted the existing outfall and the majority of the contributing

catchment lie outside of the DCO boundary. The Proposed Scheme incorporates filter drains on the M1 catchment to provide treatment. This results in a reduction in pollutant load from the proposed M1 catchment compared to the baseline scenario and thus provides a minor benefit.

6.8.3. The accidental spillages assessment was undertaken using the HEWRAT spillage assessment. The assessment indicates that the risk of serious pollution incident is considerably less than the annual acceptable threshold of 0.5% for discharge to a sensitive designated site (see Table 6-4).

Table 6-4: Routine runoff and accidental spillages assessment summary

Drainage Catchment	Required water quality mitigation	Mitigation proposed in drainage design	Soluble				Sediment	Spillage assessment
			EQS annual average concentration		Acute impact			
			Copper (µg/l)	Zinc (µg/l)	Copper	Zinc		
M1 (including existing catchment)	Filter drains (M1)	N/A	Pass (0.96)	Pass (2.26)	Fail	Pass	Pass	Pass
M2 & S1	Wetland (M2), swale (S1)	Filter drain, wetland (M2), swale (S1)	Pass (0.77)	Pass (2.42)	Pass	Pass	Pass	Pass
S2 and S3A	Not required	Filter drain and vegetated detention basin	Pass (0.17)	Pass (0.03)	Pass	Pass	Pass	Pass
M3	Not required	Filter drain and vegetated detention basin	Pass (0.18)	Pass (0.07)	Pass	Pass	Pass	Pass
M4	Not required	Filter drain and vegetated detention basin	Pass (0.21)	Pass (0.14)	Pass	Pass	Pass	Pass
M5	Not required	Filter drain and wetland	Pass (0.20)	Pass (0.11)	Pass	Pass	Pass	Pass
M6 & NW	Not required	Filter drain and vegetated detention basin	Pass (0.22)	Pass (0.17)	Pass	Pass	Pass	Pass
M7	Not required	Filter drain and vegetated detention basin	Pass (0.18)	Pass (0.05)	Pass	Pass	Pass	Pass
M8	Not required	Filter drain and wetland	Pass (0.17)	Pass (0.02)	Pass	Pass	Pass	Pass
M9, M10, NE, S5 & W1	Not required	Filter drains and vegetated detention basin	Pass (0.33)	Pass (0.71)	Pass	Pass	Pass	Pass
S3	Not required	Filter drains	Pass (0.16)	Pass (0.00)	Pass	Pass	Pass	Pass
S4	Not required	N/A	Pass (0.28)	Pass (0.36)	Pass	Pass	Pass	Pass
M7 and M8 (cumulative)	Not required	Filter drain and vegetated detention basin (M7) and wetland (M8)	Pass (0.19)	Pass (0.07)	Pass	Pass	Pass	N/A

6.8.4. Pollution control devices, such as penstocks, shall be provided at the inlets and outlets to the basins / wetlands, in order to mitigate the effects that may occur in the event of a spillage.

6.8.5. Routine runoff assessments have also been undertaken for discharges to ground, where permeable filter drains are used or outfalls discharge to watercourses with low flows. These have been undertaken using HEWRAT. The full results can be found in ES Appendix 13.4 Groundwater assessment (**TR010038/APP/6.3)**. The assessment highlights that there is negligible impact to groundwater receptors following dilution within the aquifer for soluble pollutants. The filter drains are primarily included in the design for filtration and attenuation of flows, however. Filter drains intercept a combination of granular and cohesive deposits, and therefore infiltration to groundwater may be limited.

Enhancement measures

6.8.6. Two of the detention basins are to be developed as a wetland feature as part of enhancement measures. They shall be planted with suitable local species to provide additional pollution treatment and biodiversity enhancement at the following locations:

- catchment M5 (Church Lane, south east of Hockering)
- catchment M8 (south of the River Tud crossing)

6.8.7. The remaining detention basins will be vegetated with suitable local species to provide biodiversity and further water quality enhancements.

6.8.8. The provision of wetland features would improve finer sediment removal, improve heavy metal removal and reduce phosphate concentrations through biological uptake (Woods Ballard *et al.*, 2015). Vegetated detention basins would also reduce phosphate concentrations through biological uptake (although less effectively than a wetland). Phosphate and nitrogen are not typically associated with road runoff but are may enter the watercourse directly as the result of agricultural runoff local to the Proposed Scheme.

6.9. Design assumptions

6.9.1. Where existing drainage is to be used in the proposed design it is assumed that life expiry is 60 plus years.

6.9.2. Existing direct discharges to watercourses will remain where no increase in impermeable area is introduced or the impermeable and catchment area is reduced.

6.9.3. Where mainline drainage positively discharges to the River Tud. The proposed discharge rate into the river shall match greenfield runoff rates from the new and any existing development catchment discharge rate.

6.9.4. Pipe roughness and minimum pipe velocities are based on an effective regular maintenance of all drainage and the application of combined drainage kerbs trapped gullies to reduce the transportation silt through the network.

6.10. Consultation

6.10.1. Consultation has been undertaken with the following organisations:

- The Environment Agency (Oct 2020)
- Norfolk County Council (Aug, Oct 2020) – from other closely related A47 schemes with feedback pertinent to this scheme
- Norfolk County Council as Lead Local Flood Authority (Jan 2021)
- Norfolk Rivers Internal Drainage Board (NRIDB) (Jan 2021)

6.10.2. In October 2020, the Environment Agency discussed the following via email and is extracted form said email below:

- “As I understand it, you propose a road drainage scheme that will take drainage from the widened A47 along with a new access road; you propose to use the existing outfall to the Oak Stream to the Tud, after the water has been through mitigation measures to remove elevated Cu (filter drains, swales, possibly wetlands) but have found that low flows will preclude this option. You therefore need to look at drainage to ground in an area where the groundwater level is within 5 m of the ground surface within the Principal chalk aquifer which is used for drinking water supply; you would like to know the detail required for the groundwater assessment. You already have water quality investigations going to assess surface water and groundwater quality in the area of the Oak Stream, and no doubt have detailed information geology and soakage times. It’s not clear to me whether you are proposing a scheme that discharges to surface water in high flows and groundwater at other times, or purely a groundwater scheme.”
- “I have consulted my team and am pleased to confirm that you do not need an Environmental Permit for the discharge; you need to follow the SUDS train, using the guidance at: https://www.susdrain.org”

6.10.3. In August 2020, consulation with Norfolk County Council took place

- Consultation was centred around other A47 Projects, the Blofield and Thickthorn schemes, with Tuddenham to Easton requiring further consultations

6.10.4. Exert from the letter of 7 October 2020 (FW2020_0786) following previous discussions on embankment drainage at the meeting of 24 September. From

this consultation, although not directly aimed at this scheme, it was intimated that this approach should be taken forward to the relevant A47 schemes.

- Norfolk County Council requested that the embankment runoff should be attenuated. The DMRB CG501 Rev 2, paragraph 2.1, 4) requires that the drainage design manages water flows from earthworks and structures associated with the roads.

6.10.5. In January 2021 Norfolk County Council commented on the draft drainage strategy report with alteration made to the report as per their comments and suggestions.

6.10.6. In January 2021 the Norfolk Rivers Internal Drainage Board were consulted. The NRIDB raised comments with regards to the use of infiltration features but noted the potential issues and difficulties with this. Further comments were made with regards to outfalling into NRIDB adopted watercourses and specifically the consents required for this or for works within 9m of any adopted watercourse. At this stage no discharge into an NRIDB adopted watercourse is anticipated but this will be confirmed following review of the drainage survey and the updated topographical survey. Any necessary consents will be applied for at Stage 5.

6.11. Departures from DMRB standards

6.11.1. The Proposed Scheme requires an extension of an existing culvert adjacent to Oak Farm below the proposed A47 mainline at approximate Ch. 1+150. A new culvert will also be required below the proposed new sideroad that will tie into the de-trunked A47 west of Hockering. In addition, the existing watercourse will be diverted into a ditch between the sideroad and mainline.

6.11.2. The existing culvert has an internal diameter of 750mm as confirmed to the design team from a site survey undertaken.

6.11.3. In accordance with Clauses 3.4 and 3.5 of CD 529 Design of outfall and culvert details, the extended and new culverts would need to have a diameter of at least 1.2m to allow for maintenance access as both would be in excess of 12m in length.

6.11.4. In order to accommodate a 1.2m diameter culvert the level of the proposed sideroad above the culvert would need to be raised by circa 800mm to 1000mm in order to provide the necessary clearance to accommodate the new road pavement. This will result in a substantial length of new sideroad needing to be lifted onto embankment and will have further repercussions to the proposed new junction to the west as well as visual impact, and additional mitigation for headlight glare along the A47 mainline.

6.11.5. The loss of floodplain volume resulting from the widened dual carriageway and the local access road was estimated to be 2785m^3. This also includes the area between the widened dual carriageway and the new access road and was based on the 100-year (plus 35% climate change) baseline peak flood level of 44.4m AOD (as previously agreed with the Environment Agency). The proposed bund displaces water upstream such that the provision of level for level compensatory flood storage is not feasible and would require extensive landscaping of the arable land upstream. Given that there are no sensitive receptors impacted by the Proposed Scheme, as well as the essential need to maintain the existing throttle downstream and protect the new local access road, it is proposed that no flood compensatory storage is provided. This has been agreed, in principle, with Norfolk County Council and the Environment Agency to be appropriate. However, the need for floodplain compensation will need to be confirmed at the detailed design stage, so an area of land has been identified in the DCO application in the event that floodplain compensation is later required. Further details can be found in the Flood Risk Assessment (ES Appendix 13.1).

6.11.6. Given the requirement to throttle the flow through the culverts to protect downstream infrastructure as well as not increase flood risk downstream, a 1.2m diameter would in effect provide substantial over capacity downstream. Further, given the existing section of 750mm diameter culvert will be retained there would be a 450mm step change between the existing and new sections.

6.11.7. The flood modelling and proposals have been discussed and agreed in principle with the Lead Local Flood Authority (LLFA) and the Environment Agency.

6.11.8. This Departure has been formally submitted on Highways England's Departure Approval System and has now been approved with conditions. In approval the specialist reviewer made the following comments, *'Conditional approval is given, but subject to the project manager securing the necessary consents to divert the watercourse and acceptance of the stated approach for maintenance and mitigation measures.'* These conditions will all be met during development of the detailed design.

6.11.9. No further departures for drainage have been identified or are required at this stage.

7. Residual Risks

7.1.1. In determining an appropriate drainage system for the new A47, options were progressed with input from the highways, structures, environment and geotechnical teams. A number of items and issues remain outstanding, or unknown elements that have not been able to be confirmed pre the detailed design stage, that that may impact the Proposed Scheme in subsequent stages. Details of these are outlined below.

7.1.2. Supplementary ground investigation works are to be carried out ahead of the detailed design stage. From this the geotechnical team will be able confirm gradients for the earthwork cuttings and attenuation pond side slopes; contaminated land and any expected ground water levels. This will inform the inclusion and design of any works required to mitigate seepages in the cuttings and the use of filter drains in areas of shallow groundwater.

7.1.3. Consultation with Anglian Water and the Environment Agency has been undertaken with regards to the licensed groundwater abstraction to the south of the Proposed Scheme source protection zone for this is not yet available. This means there could be further implications on the drainage design at the detailed design stage to the drainage layout, where this may impact on the design options for the drainage within these areas.

7.1.4. Further and final consultations with the Local Authority, Norfolk County Council and the Environment Agency will be required in order to determine drainage outfall parameters and standards during the detailed design stage.

7.1.5. Drainage network designs have been checked for exceedance events of 1 in 100 year with 40% rainfall climate change allowance. Any additional discharge is shown to be volumetrically minimal and should be retained within the highway boundaries, and eventually routed back into the drainage networks once the extreme event has receded. Therefore, the residual flood risk to others is considered to be low and is reduced compared to the existing drainage systems

7.1.6. Outfall of the M2 drainage network and the associated new and extended drains at this location is critical. The attenuation system is sited in Flood Zone 1 above design flood levels. If updated topographical and drainage survey levels indicate a higher outfall level is necessary, then this will have an adverse effect on the adjacent highway alignment.

7.1.7. The Mattishall Lane Link Road drainage is located in an area where the ground water levels may encroach within 1m of the base of the drainage system, supplementary ground investigations are being carried out to further investigate

the ground water levels, as such the drainage system is in abeyance pending results of these investigations.

7.1.8. Deep drainage runs are proposed south of the mainline and east of Mattishall Lane Link Road over a length of approximately 140m. Thrust boring techniques are being considered to construct the pipes. These present a residual risk during both construction and operation of the Proposed Scheme and appropriate mitigation measures will be detailed in subsequent stages.

7.1.9. The drainage located at around ch5+800 on the mainline shall be monitored as there is a dynamic sampling hole, DS231, which records ground water above the depth of the proposed cutting, it is unclear at this stage whether this is perched groundwater or not. The drainage at this location shall be amended at the detailed design stage for a suitable system pending final monitoring results of the ground water.

7.1.10. The drainage for the mainline between chainages 3+050 and 4+050 is currently proposed to be a combined / filter drainage system as the alignment is predominately in cutting, this section of highway is located within a potential SPZ1, as such no infiltration from highways road surface runoff is allowed, this section of drainage will be amended at the detailed design stage to a system suited for this zone, it is also noted that the SPZ1 location is yet to be fully scoped by the Environment Agency but indications that this information is unlikely to be confirmed prior to the detailed design stage, as such the design should follow current information for this potential SPZ1.

7.1.11. Uncharted existing drainage systems (including hidden field drainage and SuDS systems) encountered during construction of the works are to be investigated in order to determine if any diversions are required or if connection to the new system is to be considered. This in turn may impact on the pipe sizes and attenuation volumes.

7.1.12. The provision of one replacement pond is required for each pond lost in the location of the Proposed Scheme (seven ponds lost). The replacement ponds shall be constructed prior to the existing ponds being lost. This shall mitigate the potential negative impact on biodiversity and aquatic ecology caused by the loss of these water features. The location of the replacement ponds within the DCO boundary is shown on the Environmental Masterplan (**TR010038/APP/6.8**). This has been discussed, along with detailed mitigation requirements of the replacement ponds in Chapter 8 Biodiversity in volume 1 of the Environmental Statement (**TR010038/APP/6.1**).

7.1.13. There is a risk of a third party reservoir failing at Colton which could result in flooding to the Proposed Scheme. The reservoir should be subject to regular

safety inspections and as such the likelihood of a failure event is considered very low.

7.1.14. Outcome from the topographical survey results, the natural catchment land flows may require new or alterations to outfall positions as well as any culverts and pipe crossing levels that may require alteration to the alignment to achieve suitable cover for protection.

7.1.15. Changes made to future developments could have an impact on the traffic movements and highway capacity and this could ultimately require a further upgrade of the Proposed Scheme and associated drainage design.

7.1.16. Removal of earthworks to facilitate drainage could contain invasive species. The removal of any earthworks containing invasive species will be carefully managed.

7.1.17. We are not aware of any existing drainage issues that third parties are experiencing on their properties downstream of proposed outfalls on the scheme, however all surface water runoff from road runoff will be conveyed via a robust and suitably designed drainage network then attenuated to greenfield rates using SuDS systems like detention basins therefore the risk of increasing any existing drainage issues is considered to be low.

7.1.18. Uncharted connections into the existing network drainage system that were not picked up by HADDMS or in any drainage survey may require a modification to the drainage design at construction stage.

7.1.19. A re-work of drainage designs would be required if assumed levels at outfalls do not meet the levels determined from the drainage and updated topographical surveys.

7.1.20. The method used in the calculation of the greenfield flow / volume and simulated rainfall is to be updated using the latest ReFH2 calculation, this could potentially impact on the required attenuation volumes at the detailed design stage.

7.2. Residual risk from utility diversions

7.2.1. Utility providers have been consulted and they are in the process of providing suitable diversions for their services to avoid any proposed new drainage assets where possible. There is some detail to be worked up on this between the drainage design and the proposed diversions, however it is not expected that the refining of the design will contribute to any increased risk to the protection of the receiving environment.

7.2.2. Unforeseen utilities will always present a residual risk on any scheme and this residual risk has been noted on the design drawings for this scheme.

7.3. Residual risk from unexploded ordnance

7.3.1. Removal of earthworks to facilitate drainage infiltration facilities could contain unexploded ordnance. The removal of any earthworks will be carefully managed.

7.4. Erosion

7.4.1. The design has been delivered using water velocities fast enough to maintain self-cleansing and restricted to ensure at least design life of the materials will be achieved.

7.4.2. Flow velocities at outfalls are kept to a minimum and not greater than existing flows.

8. Maintenance

8.1. Standards and Policy

8.1.1. Maintenance of the proposed new mainline all-purpose trunk road shall be carried out in accordance with DMRB GM 701 Asset delivery maintenance requirements.

8.2. Responsibility

8.2.1. The proposed responsibility of the drainage assets will be that of the Applicant and Norfolk County Council. Allocation of assets between the two bodies is subject to agreement at this time.

8.2.2. It is proposed that the Applicant would take responsibility of any assets located along or within the proposed mainline A47 highway, whilst Norfolk County Council would adopt assets located within the proposed junctions and local highways, in addition to any de-trunked sections of the A47 that will be retained.

8.3. Provision

8.3.1. The carriageway drainage assets are conventional in nature and would fit seamlessly into road drainage maintenance regimes.

8.3.2. The sustainable drainage systems should be assessed and integrated into the incumbents' maintenance regimes.

8.3.3. Access tracks are provided to and around the SuDS basins and wetlands, providing access to the inlet and outlet chambers.

8.4. Sustainable Drainage Systems

8.4.1. The proposed maintenance regime, in accordance with the CIRIA SuDS Manual 2015, is depicted below. The regime for the basin, filter drains and ditches are set out respectively in Table 8-1 to 8-3

Table 8-1: Required maintenance for basins

Required action	Typical frequency
Remove litter and debris	Monthly (or as required)
Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
Inspect inlets, banksides, structures, pipework etc for evidence of blockage and / or physical damage	Monthly

Required action	Typical frequency
Inspect water bodies downstream for signs of poor water quality	Monthly (May – October)
Inspect silt accumulation rates at the inlet and in main body of the basin and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
Check any mechanical devices, for example penstocks	Half yearly
Mow grasses covering base of basin	Monthly during the growing season (or as required)
Hand cut denser growth/shrubs at inlet to basin	Monthly during the growing season (or as required)
Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
Remove sediment accumulation at inlet	Every 1–5 years, or as required

Table 8-2: Required maintenance for filter drains

Required action	Typical frequency
Remove litter (including leaf litter) and debris from filter drain surface and access chambers	Monthly (or as required)
Inspect filter drain surface, inlet / outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
Inspect inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	6 monthly
Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (for example NJUG, 2007 or BS3998:2010)	As required
At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	5 yearly (or as required)
Clear perforated pipework of blockages	As required

Table 8-3: Required maintenance for ditches

Required action	Typical frequency
Remove litter and debris	Monthly, or as required
Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
Manage other vegetation and remove nuisance plants	Monthly at start, then as required
Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then

Required action	Typical frequency
Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Repair erosion or other damage by re-turfing or reseeding	As required
Relevel uneven surfaces and reinstate design levels	As required
Inspect overflows and outlets from existing drains connecting to the new ditches	Monthly, or as required

9. References

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South Norfolk Council Planning Policy https://www.south-norfolk.gov.uk/residents/planning-and-building/planning-policy

South Norfolk Council Infrastructure and delivery https://www.south-norfolk.gov.uk/residents/planning/planning-policy/infrastructure-and-delivery

NORFOLK COUNTY COUNCIL Planning obligations https://www.norfolk.gov.uk/rubbish-recycling-and-planning/planning-applications/planning-obligations

NORFOLK COUNTY COUNCIL Local Transport Plan (2011-2016) https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/roads-and-travel-policies/local-transport-plan

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Woods Ballard, B., Wilson, S., Udale-Clarke, H., Illman, S., Scott, T., Ashley, R. and Kellagher, R. (2015). The SuDs Manual. CIRIA C753.

UXO Risk Assessment Report (Doc. ref, P6124 V 3.0, Detailed Unexploded Ordnance (UXO) Threat and Risk Assessment Report, 6APLHA Associates, December 2019

APPENDIX A - Drainage design certificate

A1 North Tuddenham to Easton Dualling - Drainage design certificate

"We certify that the documents listed below have been prepared by us with reasonable professional skill, care and diligence, and that in our opinion:

a) accurately represent the work required by the Overseeing Organisation;

b) with exception of any departure from standards given at A3 below, have been prepared in compliance with LA 113 [Ref 6.N] and CG 501 [Ref 1.N];

c) constitute an appropriate drainage design for the scheme; and d) enable an appropriate drainage system to be constructed and managed in accordance with the Manual of Contract Documents for Highway Works".

A2 List of documents

Document Reference	Title
HE551489-GTY-HDG-000-RP-CD-30001	Drainage Strategy Report
HE551489-GTY-HDG-000-DR-CD-30001	Drainage Layout Sheet 1 of 14
HE551489-GTY-HDG-000-DR-CD-30002	Drainage Layout Sheet 2 of 14
HE551489-GTY-HDG-000-DR-CD-30003	Drainage Layout Sheet 3 of 14
HE551489-GTY-HDG-000-DR-CD-30004	Drainage Layout Sheet 4 of 14
HE551489-GTY-HDG-000-DR-CD-30005	Drainage Layout Sheet 5 of 14
HE551489-GTY-HDG-000-DR-CD-30006	Drainage Layout Sheet 6 of 14
HE551489-GTY-HDG-000-DR-CD-30007	Drainage Layout Sheet 7 of 14
HE551489-GTY-HDG-000-DR-CD-30008	Drainage Layout Sheet 8 of 14
HE551489-GTY-HDG-000-DR-CD-30009	Drainage Layout Sheet 9 of 14
HE551489-GTY-HDG-000-DR-CD-30010	Drainage Layout Sheet 10 of 14
HE551489-GTY-HDG-000-DR-CD-30011	Drainage Layout Sheet 11 of 14
HE551489-GTY-HDG-000-DR-CD-30012	Drainage Layout Sheet 12 of 14
HE551489-GTY-HDG-000-DR-CD-30013	Drainage Layout Sheet 13 of 14
HE551489-GTY-HDG-000-DR-CD-30014	Drainage Layout Sheet 14 of 14
HE551489-GTY-HDG-000-DR-CD-30005	Existing Catchment Plan
HE551489-GTY-HDG-000-DR-CD-30016	Proposed Drainage Catchment Plan

A3 Departures from standard (where applicable)

A departure from standard from Clauses 3.4 and 3.5 of CD 529 Rev 1 Design of outfall and culvert details (formerly HA 107/04) has been submitted on Highways England's Departure Approval System imminently, reference 102104 **and is currently progressing through the necessary review and approval process**

A4 Report on the drainage design

Drainage Strategy report - HE551489-GTY-HDG-000-RP-CD-30001

On behalf of **SWECO**, I hereby certify the drainage design has been undertaken in accordance with items A1 and A3 above and accurately translated into the requirements for development in to detailed design prior to construction given at item A2 above.

Signed [redacted] Name: [redacted]

Position: **Senior Engineer** Qualification(s): **Chartered Engineer** Date: **22/02/2021**

On behalf of **SWECO**, I hereby certify that the above signatory has the necessary knowledge and competence to undertake the drainage design covered by this certificate.

Signed: [redacted] Name: [redacted]

Position: **Operations Director** Qualification(s): **Chartered Engineer** Date: **22/12/2021**

APPENDIX B - Drawings

Layout plans

HE551489-GTY-HDG-000-DR-CH-30001-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30002-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30003-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30004-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30005-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30006-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30007-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30008-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30009-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30010-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30011-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30012-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30013-C01.pdf

HE551489-GTY-HDG-000-DR-CH-30014-C01.pdf

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER
DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

⚠		HAZARD IDENTIFICATION AND ASSESSMENT SHALL BE UPDATED THROUGHOUT DESIGN PHASES AND COMMUNICATED AS NECESSARY ON DESIGN DOCUMENTS.

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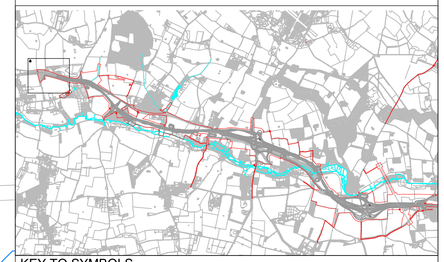

KEY TO SYMBOLS

- Combined Drain
- Carrier Drain
- Filter & Lower Carrier Drains
- Narrow Filter/Fin Drain
- Oversized Pipes for Attenuation
- Drainage Ditch for over the edge provision
- PED Ditches (natural catchment)
- PED Filter drains
- Combined Kerb Drain
- Deck Drainage
- Kerb & Gully
- Manhole/Catchpit
- Headwall
- PED Cross Drain
- DCO Boundary
- Existing Surface water bodies
- Existing Overland Flow Pathways
- Culverts
- Chamber Reference (NE-1)
- Pipe Reference (NE-1.000)
- Network Marker Point (NE)

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	14/11/19	DESIGN FIX A	BR	BR	BR
P02	19/11/19	DESIGN FIX A UPDATE	BR	BR	BR
P03	29/04/20	DESIGN UPDATED FOR DESIGN FIX B	SG	JM	JM
P04	18/09/20	INTERIM DFC ISSUE	SG	JM	BA
P05	30/11/20	DESIGN FIX C	SG	JMcC	BArt
P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 1 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30001

HALL LANE

S09
FOX LANE
OVERBRIDGE

EXISTING A47 EASTBOUND

EXISTING A47 WESTBOUND

EXISTING FOX LANE JUNCTION

FOX LANE

FOX LANE

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

CONNECTION TO EXISTING TO BE CONFIRMED BY SURVEY

S1

M1

M2

M1-3
M1-6
M1-8
M1-1.001
M1-2.001
M1-3.000
M1-2
M1-5
M1-2.000
M1-1.000
M1-7
M1-4
S1-12
S1-4.001
S1-15
M1-1
M2-22
M2-20
S1-4.002
M2-12.000
M2-11.000
M2-23

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30002

Hawthorn Cottage
Pomonous Cottage
Ponderosa
Pond
Pond
Track
MS
46.0m

SCALE 1 : 1250
50m 0 50m

LYNG ROAD

DRAINAGE TIE IN TO BE CONFIRMED BY SURVEY

EXISTING POND REMOVED CATCHMENT AND OUTFALL TO BE CONFIRMED BY SURVEY

DRAINAGE OUTFALLS TO BE CONFIRMED BY SURVEY

S08A
NEW WEST CULVERT

RE-ALIGNED A47 WEST OF HOCKERING

RE-ALIGNED A47 WEST OF HOCKERING

PROPOSED A47 WESTBOUND

PROPOSED A47 EASTBOUND

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

S08
EXISTING WEST CULVERT

Basin M2

EXISTING POND TO BE REMOVED, CATCHMENT AND OUTFALL TO BE CONFIRMED BY SURVEY

Low Road

CONTINUED ON DRAWING HE551489-GTY-HDG-000-CH-30001

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30003

SCALE 1 : 1250
50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-	
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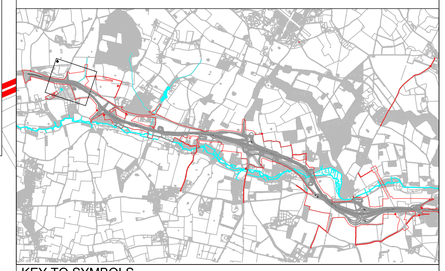

KEY TO SYMBOLS

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- Culverts
- Chamber Reference NE-1
- Pipe Reference NE-1.000
- Network Marker Point ▶NE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	14/11/19	DESIGN FIX A	BR	BR	BR
P02	19/11/19	DESIGN FIX A UPDATE	BR	BR	BR
P03	29/04/20	DESIGN UPDATED FOR DESIGN FIX B	SG	JM	JM
P04	18/09/20	INTERIM DFC ISSUE	SG	JM	BA
P05	30/11/20	DESIGN FIX C	SG	JMcC	BArt
P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 2 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30002

IMPORTANT

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HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

E03	PROPOSED DEEP CUTTINGS.
E13	PROPOSED DEEP DRAINAGE

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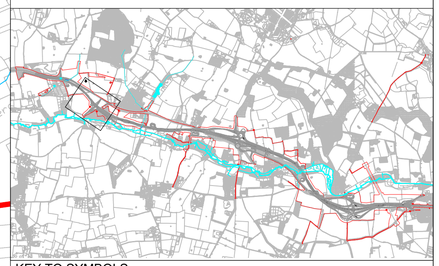

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DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS SHEET 3 OF 14

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER: HE551489-GTY-HDG-000-DR-CH-30003

RE-ALIGNED A47 WEST OF HOCKERING

EXISTING A47 TO BE DETRUNKED

EXISTING DRAINAGE TO REMAIN IN PLACE ADDTIONAL GULLEYS PROVISION TO BE ASSESSED AND CONFIRMED BY SURVEY

DRAINAGE TIE IN TO BE CONFIRMED BY SURVEY

PROPOSED A47 EASTBOUND

PROPOSED A47 WESTBOUND

S16 MATTISHALL LANE UNDERBRIDGE

EXISTING MATTISHALL LANE

Basin S3

MATTISHALL LANE LINK ROAD

MATTISHALL LANE

PED OUTFALL TO BE ASSESSED

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

E03

E13

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30002

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30004

SCALE 1 : 1250

50m 0 50m

IMPORTANT

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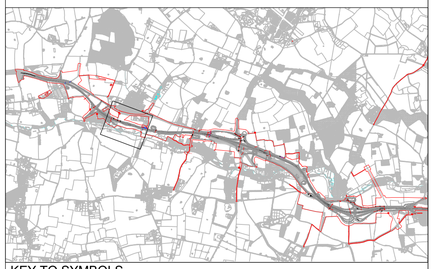

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DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 4 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30004

HOCKERING

EXISTING A47

PROPOSED EB LAY-BY

PROPOSED WB LAY-BY

PROPOSED A47

S01
EAST CULVERT

Basin M3

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30003

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30005

SCALE 1 : 1250

50m 0 50m

IMPORTANT

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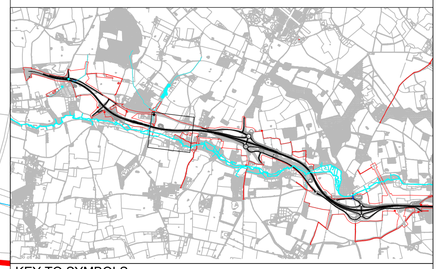

KEY TO SYMBOLS

- Combined Drain
- Carrier Drain
- Filter & Lower Carrier Drains
- Narrow Filter/Fin Drain
- Oversized Pipes for Attenuation
- Drainage Ditch for over the edge provision
- PED Ditches (natural catchment)
- PED Filter drains
- Combined Kerb Drain
- Deck Drainage
- Kerb & Gully
- Manhole/Catchpit
- Headwall
- PED Cross Drain
- DCO Boundary
- Existing Surface water bodies
- Existing Overland Flow Pathways
- Culverts
- Chamber Reference NE-1
- Pipe Reference NE-1.000
- Network Marker Point NE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	14/11/19	DESIGN FIX A	BR	BR	BR
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P03	29/04/20	DESIGN UPDATED FOR DESIGN FIX B	SG	JM	JM
P04	18/09/20	INTERIM DFC ISSUE	SG	JM	BA
P05	30/11/20	DESIGN FIX C	SG	JMcC	BArt
P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 5 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30005

SCALE 1 : 1250

50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

⚠		HAZARD IDENTIFICATION AND ASSESSMENT SHALL BE UPDATED THROUGHOUT DESIGN PHASES AND COMMUNICATED AS NECESSARY ON DESIGN DOCUMENTS.

NOTES

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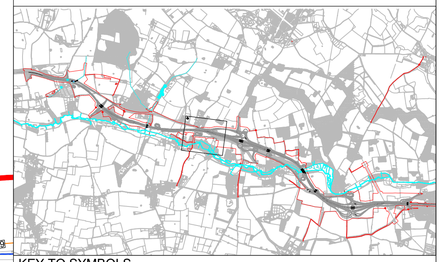

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P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 6 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30006

EXISTING A47

DRAINAGE TIE IN TO BE CONFIRMED BY SURVEY

PROPOSED A47 EASTBOUND

LINK TO EXISTING A47 (HOCKERING)

WOOD LANE JCT, EB DIVERGE

Basin M5

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

HILLCREST COTTAGE ACCESS TRACK

CHURCH LANE

S11 BLOIS BRIDGE

ROTTEN ROW JUNCTION WIDENING

DRAINAGE TO CONNECT TO EXISTING CROSS CARRIAGEWAY DRAIN. EXISTING TO TO BE CONFIRMED THROUGH SURVEY.

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30005

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30007

SCALE 1 : 1250

50m 0 50m

WOOD LANE

DRAINAGE TIE IN TO BE CONFIRMED BY SURVEY

LINK TO B1535 WOOD LANE

LINK TO EXISTING A47 (HOCKERING)

WOOD LANE JUNCTION

WOOD LANE JCT, NORTH RBT

50m CONNECTION STUB FOR NORWICH WESTERN LINK SCHEME

WOOD LANE JCT, EB DIVERGE

S03
WOOD LANE JUNCTION UNDERBRIDGE

OBSERVATION PLATFORM

WOOD LANE JCT, EB MERGE

WOOD LANE JCT, WB MERGE

PROPOSED A47

PROPOSED A47

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30008

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30006

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30009

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-		
⚠	J13	HIGH PRESSURE GAS MAIN.

SCALE 1 : 1250

50m 0 50m

NOTES

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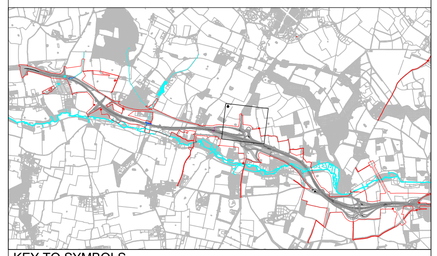

KEY TO SYMBOLS

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- Existing Surface water bodies
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- Culverts
- Chamber Reference NE-1
- Pipe Reference NE-1.000
- Network Marker Point NE

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P05	30/11/20	DESIGN FIX C	SG	JMcC	BArt
P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 7 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30007

S03
WOOD LANE JUNCTION
UNDERBRIDGE

CONTINUED ON DRAWING
HE551489-GTY-HDG-000-DR-CH-30007

OBSERVATION PLATFORM

WOOD LANE JCT, EB MERGE

PROPOSED A47

WOOD LANE JCT, WB MERGE

WOOD LANE JCT, WB DIVERGE

WOOD LANE JCT, SOUTH RBT

WOOD LANE JUNCTION

Basin NW

S3
EX

LINK TO EXISTING A47

LINK TO DEREHAM ROAD
(HONINGHAM)

DRAINAGE OUTFALL TO BE
CONFIRMED BY SURVEY

J13

S12
BERRY'S BRIDGE

BERRY'S
LANE

CONTINUED ON DRAWING
HE551489-GTY-HDG-000-DR-CH-30006

CONTINUED ON DRAWING
HE551489-GTY-HDG-000-DR-CH-30009

Berry Hall Cottages
Tennis Court
Wisteria Cottage
Rosemary Cottage
TheButtery
Berry Hall
TheHayloft
Tanglewood Barn
Merrywood House
Alder Carr
Pond
Drain
Track
Path (um)
River Tud
Fen Plantation
FB
LV o/h
HV o/h

SCALE 1 : 1250
0
50m
50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER
DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

⚠	J13	HIGH PRESSURE GAS MAIN.

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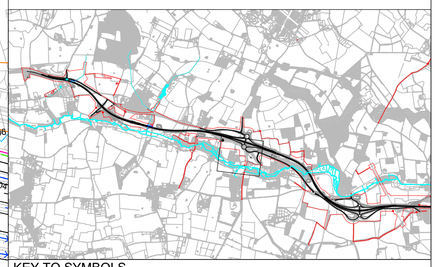

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C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER
SWECO

CONTRACTOR
GallifordTry

CLIENT
highways england

PROJECT TITLE
A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
DRAINAGE LAYOUT PLANS
SHEET 8 OF 14

SUITABILITY
AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER
HE551489-GTY-HDG-000-DR-CH-30008

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

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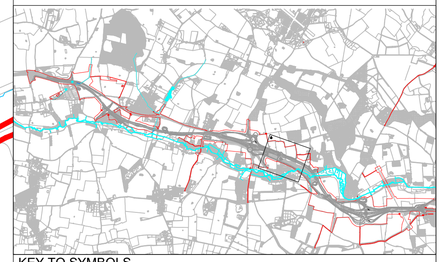

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- Kerb & Gully
- Manhole/Catchpit
- Headwall
- PED Cross Drain
- DCO Boundary
- Existing Surface water bodies
- Existing Overland Flow Pathways
- Culverts
- Chamber Reference (NE-1)
- Pipe Reference (NE-1.000)
- Network Marker Point (NE)

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	14/11/19	DESIGN FIX A	BR	BR	BR
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P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS SHEET 9 OF 14

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER: HE551489-GTY-HDG-000-DR-CH-30009

SCALE 1 : 1250 (50m 0 50m)

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30007

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30008

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30010

WOOD LANE JCT, EB MERGE

M6 ◀ ▶ M7

S04 HALL FARM ACCESS UNDERPASS

PASSING PLACE

HALL FARM ACCESS

PROPOSED A47

EXISTING A47

Basin NW

Basin M6

PASSING PLACE

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

EXISTING DRAINAGE TO REMAIN IN PLACE ADDTIONAL GULLEYS PROVISION TO BE ASSESSED. AND CONFIRMED BY SURVEY

EXISTING A47

HALL DRIVE

S13 EXISTING RIVER TUD BRIDGE

LINK TO DEREHAM ROAD (HONINGHAM)

DRAINAGE CONNECTION TO EXISTING TO BE CONFIRMED BY SURVEY

DEREHAM ROAD

HONINGHAM

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

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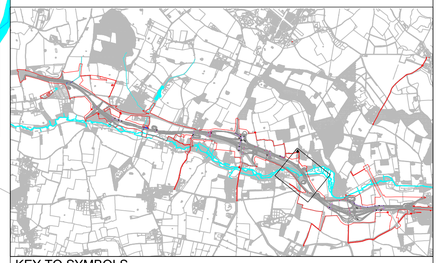

KEY TO SYMBOLS

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C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 10 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30010

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

Basin M7

M7 M8

S05
NEW RIVER TUD BRIDGE

PROPOSED A47 EASTBOUND

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

Basin M8

PROPOSED A47 WESTBOUND

EXISTING A47

EXISTING DRAINAGE TO REMAIN IN PLACE ADDTIONAL GULLEYS PROVISION TO BE ASSESSED. AND CONFIRMED BY SURVEY

S13
EXISTING RIVER TUD BRIDGE

EXISTING DRAINAGE TO REMAIN IN PLACE ADDTIONAL GULLEYS PROVISION TO BE ASSESSED. AND CONFIRMED BY SURVEY

CONNECTION TO EXISTING TO BE CONFIRMED BY SURVEY

HONINGHAM

NORWICH ROAD

MATTISHALL ROAD

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30009

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30011

SCALE 1 : 1250
50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

E03	PROPOSED DEEP CUTTINGS,

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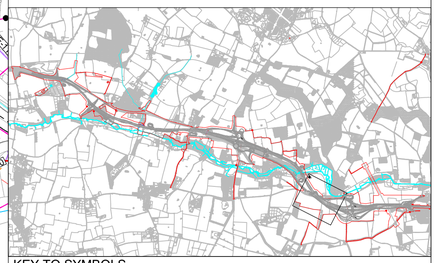

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DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 11 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30011

SCALE 1 : 1250

50m 0 50m

TAVERHAM ROAD

DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

Basin NE

ACCESS TO ST ANDEW'S CHURCH

LINK TO TAVERHAM ROAD

EXISTING DRAINAGE TO BE RETAINED AND BE CONFIRMED BY SURVEY

PED OUTFALL TO BE ASSESSED.

PED OUTFALL TO BE ASSESSED.

NORWICH ROAD JCT, NORTH RBT

NORWICH ROAD JCT, EB DIVERGE

NORWICH ROAD JCT, EB MERGE

NORWICH ROAD JCT, EB MERGE

S07
NORWICH ROAD JUNCTION UNDERBRIDGE

PROPOSED A47

NORWICH ROAD JCT, WB MERGE

LINK TO NORWICH ROAD (HONINGHAM)

NORWICH ROAD JCT, WB DIVERGE

NORWICH ROAD JCT, WB DIVERGE

LINK TO DEREHAM ROAD (EASTON)

NORWICH ROAD JCT, SOUTH RBT

BLIND LANE

E03

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30011

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30013

SCALE 1 : 1250

50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF	AND BRIEF DESCRIPTION OF HAZARD:-
E03	PROPOSED DEEP CUTTINGS.

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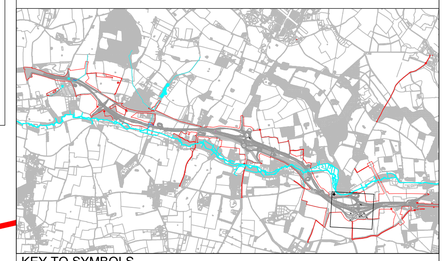

KEY TO SYMBOLS

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- Combined Kerb Drain
- Deck Drainage
- Kerb & Gully
- Manhole/Catchpit
- Headwall
- PED Cross Drain
- DCO Boundary
- Existing Surface water bodies
- Existing Overland Flow Pathways
- Culverts
- Chamber Reference NE-1
- Pipe Reference NE-1.000
- Network Marker Point NE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	14/11/19	DESIGN FIX A	BR	BR	BR
P02	19/11/19	DESIGN FIX A UPDATE	BR	BR	BR
P03	29/04/20	DESIGN UPDATED FOR DESIGN FIX B	SG	JM	JM
P04	18/09/20	INTERIM DFC ISSUE	SG	JM	BA
P05	30/11/20	DESIGN FIX C	SG	JMcC	BArt
P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 12 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30012

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER
DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF	AND BRIEF DESCRIPTION OF HAZARD:-
J14	HIGH VOLTAGE O/H CABLE.

J14

NORTH

NORWICH ROAD JCT, EB MERGE

NORWICH ROAD JCT, WB DIVERGE

LINK TO DEREHAM ROAD (EASTON)

PROPOSED A47 EASTBOUND

PROPOSED A47 WESTBOUND

OVER THE EDGE DITCH

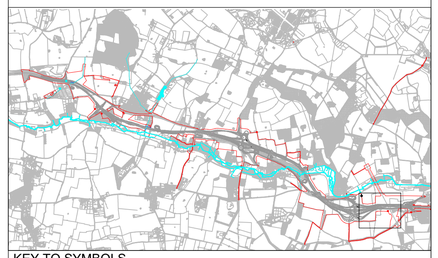
DRAINAGE OUTFALL TO BE CONFIRMED BY SURVEY

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30012

CONTINUED ON DRAWING HE551489-GTY-HDG-000-DR-CH-30014

NOTES

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
3. DRAWINGS ARE TO BE READ IN COLOUR.



KEY TO SYMBOLS

- Combined Drain
- Carrier Drain
- Filter & Lower Carrier Drains
- Narrow Filter/Fin Drain
- Oversized Pipes for Attenuation
- Drainage Ditch for over the edge provision
- PED Ditches (natural catchment)
- PED Filter drains
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- Deck Drainage
- Kerb & Gully
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- Network Marker Point ▶NE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
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P06	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur
C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE
A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
DRAINAGE LAYOUT PLANS
SHEET 13 OF 14

SUITABILITY
AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER
HE551489-GTY-HDG-000-DR-CH-30013

SCALE 1 : 1250
50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551489-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

HAZARD IDENTIFICATION AND ASSESSMENT SHALL BE UPDATED THROUGHOUT DESIGN PHASES AND COMMUNICATED AS NECESSARY ON DESIGN DOCUMENTS.

NOTES

1. ALL DIMENSIONS ARE IN METRES (m) UNLESS OTHERWISE STATED.
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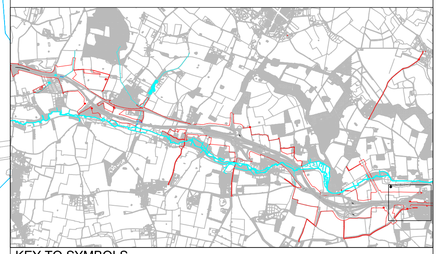
3. DRAWINGS ARE TO BE READ IN COLOUR.



KEY TO SYMBOLS

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- Culverts
- Chamber Reference NE-1
- Pipe Reference NE-1.000
- Network Marker Point NE

EXISTING DRAINAGE TO REMAIN IN PLACE ADDTIONAL GULLEYS PROVISION TO BE ASSESSED. AND CONFIRMED BY SURVEY

CHURCH LANE

DOG LANE

S17 EASTON WCHR OVERRBRIDGE

PROPOSED A47 EASTBOUND

OVER THE EDGE DRAINAGE DITCH

PROPOSED A47 WESTBOUND

EXISTING A47

DRAINAGE TIE IN TO BE CONFIRMED BY SURVEY

M10

LINK TO DEREHAM ROAD (EASTON)

DRAINAGE TIE IN TO BE CONFIRMED BY SURVEY

EASTON

HE551489-GTY-HDG-000-DR-CH-30013 CONTINUED ON DRAWING

SCALE 1 : 1250

50m 0 50m

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	14/11/19	DESIGN FIX A	BR	BR	BR
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C01	01/02/21	UPDATED FOR SGAR 3	KMcC	JMcC	MMur

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 NORTH TUDDENHAM TO EASTON DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
SHEET 14 OF 14

SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	A3	C01

DRAWING NUMBER

HE551489-GTY-HDG-000-DR-CH-30014