A47/A11 Thickthorn Junction

Scheme Number: TR010037

Volume 6
6.3 Environmental Statement Appendices
Appendix 13.2 – Drainage Strategy Report

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

The A47/A11 Thickthorn Junction Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 13.2 – Drainage Strategy Report

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010037
Application Document Reference	TR010037/APP/6.3
BIM Document Reference	HE551492-GTY-HDG-000-RP-CD-30003
Author:	A47/A11 Thickthorn Junction Project Team, Highways England

Version	Date	Status of Version
Rev 0	March 2021	Application Issue

Table of contents

Appendices

Figures

Tables

1. Scheme introduction

1.1. Purpose of this report

1.1.1. The purpose of this report is to define the strategy for delivering the drainage assessments, surveys and designs for the A47/A11 Thickthorn Junction improvement scheme. This includes: design criteria, pre-development and post-development catchment areas, collection and conveyance systems, water quality and quantity controls.

1.1.2. This drainage strategy report has been produced by Sweco on behalf of Galliford Try to demonstrate technical compliance as set out in CG 502, certification of drainage design. This 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.

1.1.3. This report has been prepared to support the A47/A11Thickthorn Junction Environmental Statement **(TR010037/APP/6.1)**. The report is supported by the ES Appendix 13.1 of Chapter 13 Road Drainage and Water Environment (**TR010037/APP/6.3**) and the findings of a 2018 ground investigation study.

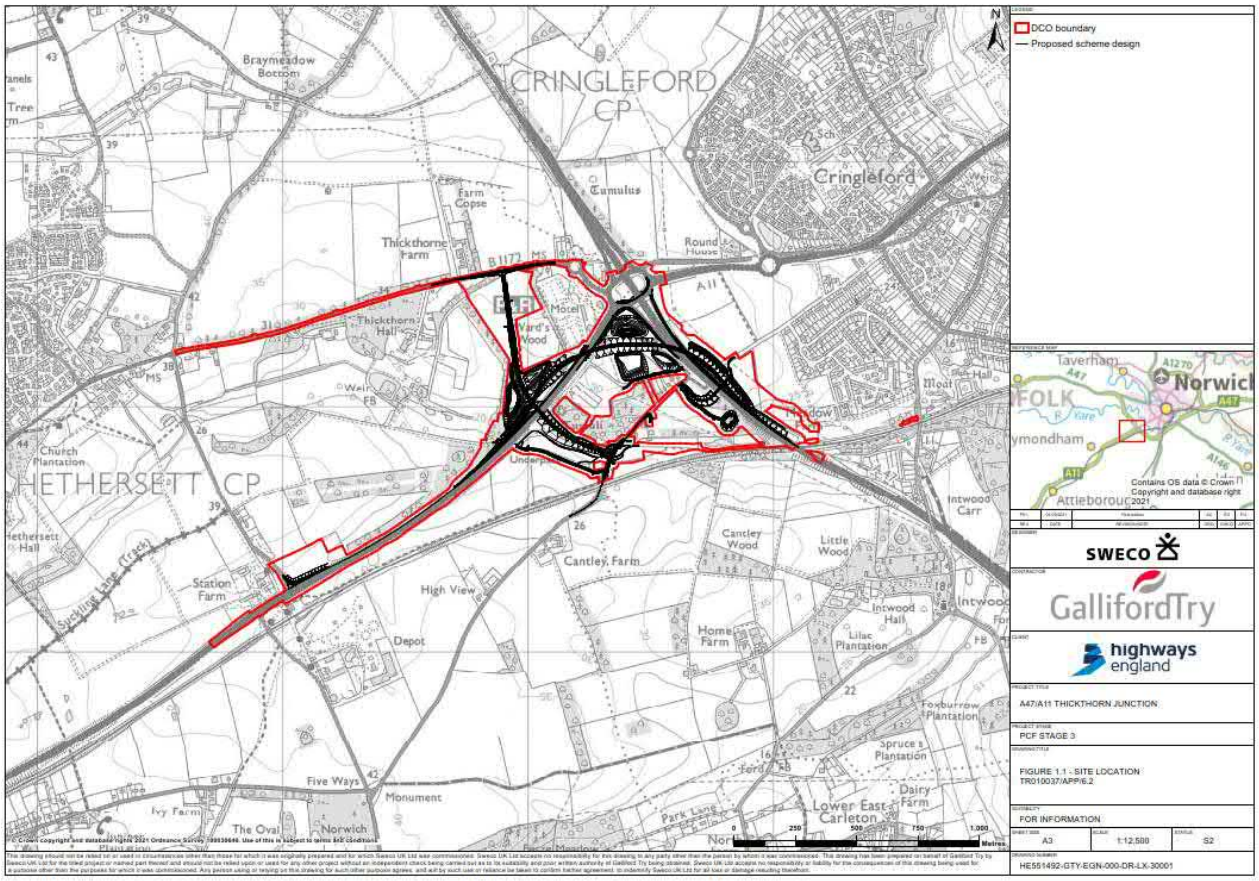
1.2. Scheme overview

1.2.1. In April 2020, the Department of Transport (DfT) published the Road Investment Strategy 2 (RIS2) for 2020-2025. The RIS2 sets out the list of schemes that are to be developed by Highways England over the period covered by the RIS.

1.2.2. The A47 trunk road forms part of the strategic road network and provides for a variety of local, medium and long distance trips between the A1 and the east coast of England. The corridor connects the cities of Norwich and Peterborough, the towns of Wisbech, King's Lynn, Dereham, Great Yarmouth and Lowestoft, and a succession of smaller towns and villages in what is largely a rural area. Over half of the A47 trunk road is single carriageway.

1.2.3. The scheme is located within the Norfolk County Council (NCC) administrative area at the junction of the A47 Norwich Southern Bypass with the A11 Hethersett Bypass. The local authority within this area is South Norfolk District Council (SNDC).

Figure 1-1 : 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 as part of the assessment and design process.

Drainage asset survey

2.1.2. In September 2018, Carnell/Keir services undertook an asset and detailed defect survey of the drainage on the A11, A47 and Thickthorn Junction. This survey was mainly limited to the highway verge and did not extend fully to final outfall positions, but to the chambers at the base of highway slopes.

2.1.3. The information provided included:

- Assets report with plan.
- Defects report with plan.
- Wincan report (CCTV).

2.1.4. There was an inconsistency within the drainage survey report where the drainage crossing from the central island of the Thickthorn Junction to the central reserve of the A11 to the west of the junction was not shown as being connected, this did not appear to be correct which was supported by pipe sizes and flow direction. Chamber CRA71 is shown as having a 150mm incoming gully pipe only and therefore does not justify the 600mm outgoing pipe. The 525mm cross-carriageway drain connecting into this chamber would justify the 600mm outgoing pipe.

2.1.5. The two inconsistent extracts from the survey are shown below:

Figure 2-1 : Plan of chamber CRA71, extracted from Carnell drainage survey drawing 11813a_AI_001

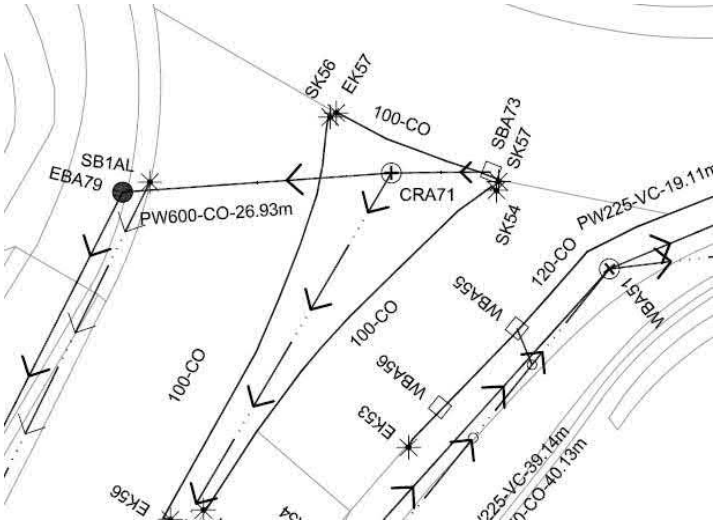
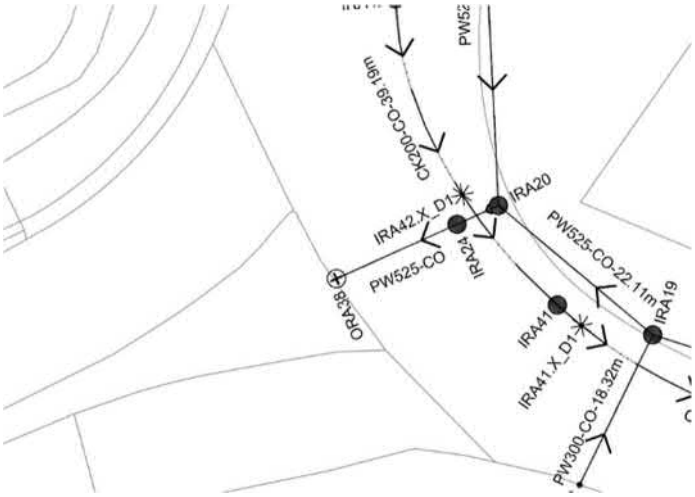


Figure 2-2 : Plan of chamber ORA38, extracted from Carnell drainage survey drawing 11681_DE_001



2.1.6. As shown within Figure 2-1, the drainage survey denotes the head of the drainage run as having a 600mm diameter pipe from chamber CRA71. The asset summary (Figure 2-3) did not detail any other incoming pipe details other than a gulley connection from asset SBA73.

2.1.7. As shown within Figure 2-2, the drainage survey shows the drainage network terminating with a 525mm diameter pipe to chamber reference ORA38. No information on the pipe or chamber assets is available to confirm that this connects to chamber CRA71. The position of CRA71 and ORA38 would appear to correlate. It is noted that when the cross-carriageway pipe was surveyed, the downstream chamber within the A11 was not surveyed as traffic management was not available.

2.1.8. The survey information above was populated within Highways Agency Drainage Data Management System (HADDMS) and therefore shows the same anomaly.

Figure 2-3 : Asset report for chamber CRA71

Incoming Pipes Table

	Pipe Ref	Pipe Size (mm)	Pipe Material	Depth to Invert (m)	Invert Level (m AOD)	Length (m)	Item Type	Stuctural Grade	Service Grade	Constraint
A	SBA73.X	150	Polyvinyl chloride	1.19	27.34	9.96	PW	1	1	
B										
C										
D										
E										

Outgoing Pipes Table

	Pipe Ref	Pipe Size (mm)	Pipe Material	Depth to Invert (m)	Invert Level (m AOD)	Length (m)	Item Type	Stuctural Grade	Service Grade	Constraint
X	CRA71.X	600	Concrete	5.8	22.73	26.93	PW	1	1	
Y	CRA71.Y	150	Polyvinyl chloride	1.63	26.9	91.67	CF	4	1	
Z										

2.1.9. Based on the above, this anomaly is considered to be survey error only, attributed to survey phasing and will be required to be confirmed during detailed design. This survey anomaly is unlikely to affect the design.

Highways Agency Drainage Data Management System (HADDMS) - Drainage assets

2.1.10. The information within HADDMS is considered to be superseded by the intrusive Full Asset Detailed Defect Surveys (FADDS), which provides appropriate information for carrying out design work.

2.2. Survey records

Geodetic (topographical) surveys

2.2.1. The topographical survey for the site was received from Highways England on the 3rd of April 2018 and was prepared by Kier. The survey covers:

- Thickthorn Junction
- Approximately 2km section of the A11 west of Thickthorn Junction
- Approximately 1.2 km section of the A11 east of Thickthorn Junction
- Approximately 0.4km section of the A47 west of Thickthorn Junction
- Approximately 1.7km section of the A47 east of Thickthorn Junction
- Approximately 1.0km section of the B1172 west of Thickthorn Junction
- Areas of open ground between the road sections are also covered.

2.2.2. The topographical survey has been used to produce accurate information on the locations of drainage chambers and features where available.

2.3. Record drawings

2.3.1. A plan was provided by Norfolk County Council that outlined the as-built drainage layout at the Thickthorn Park and Ride. This indicated that a soakaway was provided as the discharge method for the drainage system. This plan has been included in Appendix C.

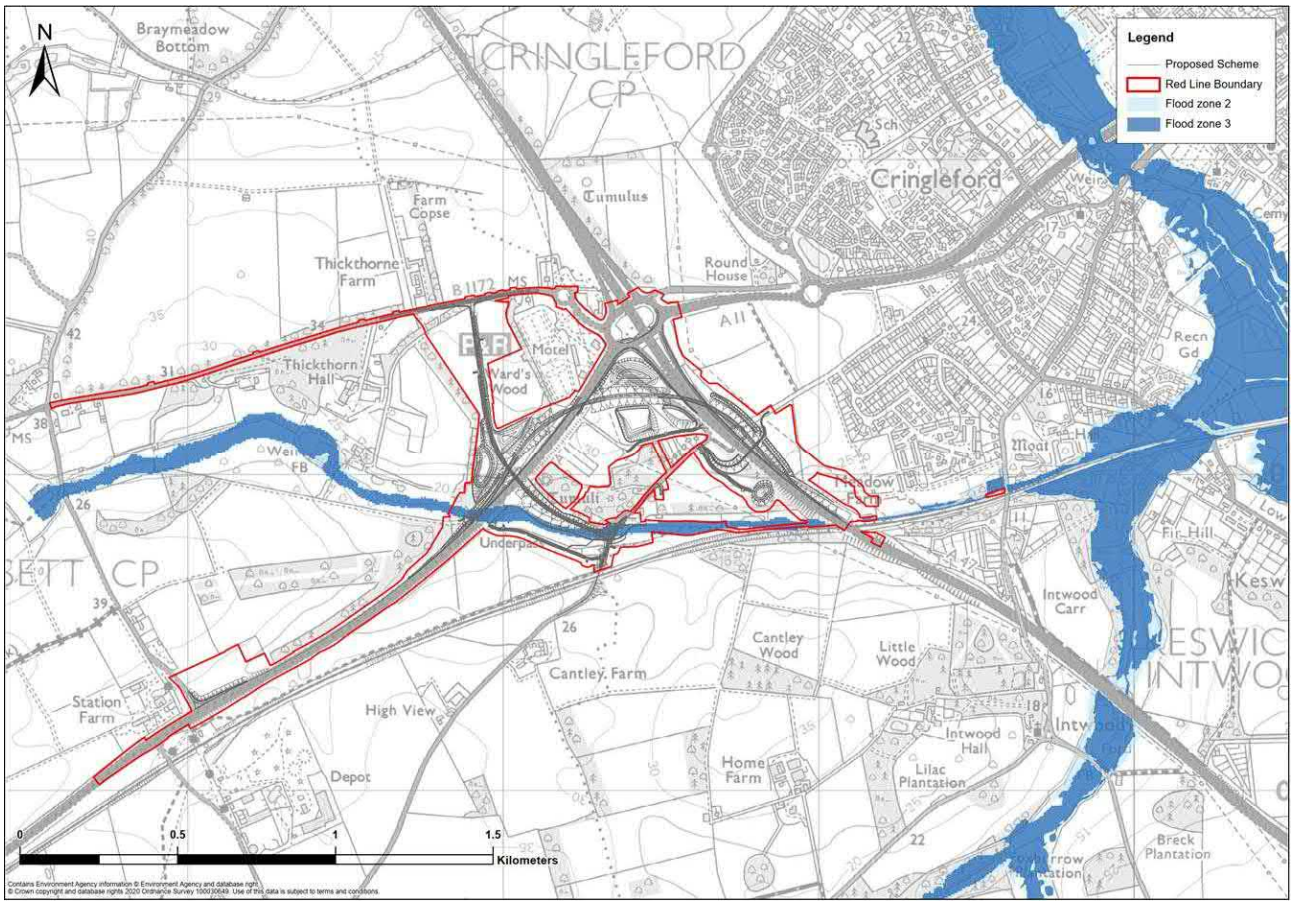
2.3.2. A plan was provided by Norfolk County Council that outlined the as-built drainage layout on Cantley Lane South under the existing railway bridge. This indicated that a gully and carrier drain system is present and outfalls to Cantley Stream at the existing culvert. This plan has been included within Appendix C.

2.4. Existing surface water features and flood risk

2.4.1. The Environment Agency Surface (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 3 which are associated with Cantley Stream. The Proposed Scheme crosses three sections of Flood Zones 2 and 3 at the A11, at Cantley Lane South and between these two roads.

- 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 any 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).

Figure 2-4: Flood Zone Map (Environment Agency)



2.4.2. The Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (JBA Consulting, 2017) identifies areas of Flood Zone 3 as being Flood Zone 3a and

indicative 3b. Flood Zone 3a comprises of land assessed as having a 1 in 100 or greater annual probability of river flooding and Flood Zone 3b comprises as land where water has to flow or be stored in times of flood.

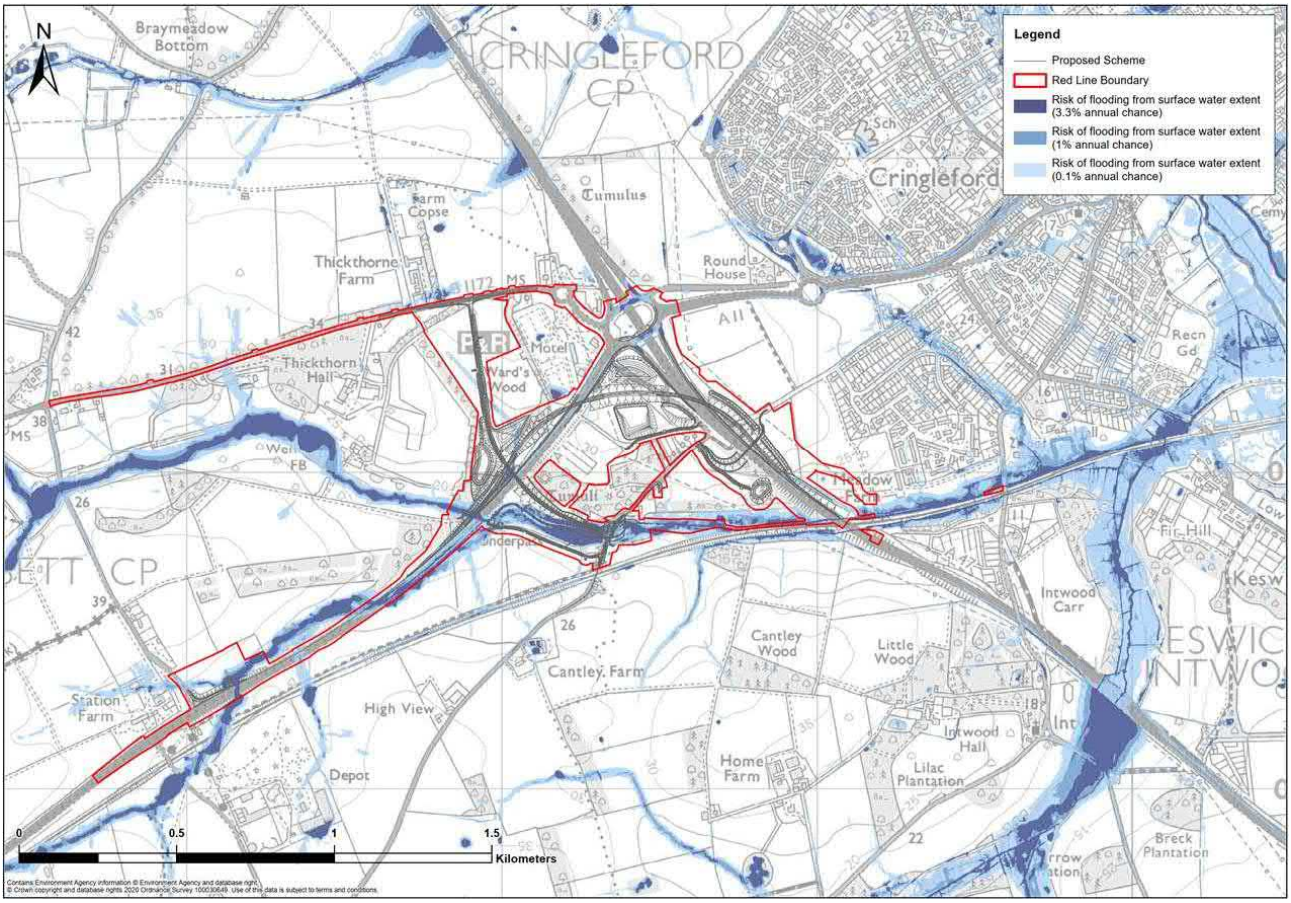
2.4.3. The Environment Agency's indicative long-term flood risk map (Environment Agency, 2020b) indicates a large area of the Proposed Scheme is at very low risk of surface water flooding (less than 1 in 1000 (0.1%) chance of flooding in any given year). However, the map identifies areas of the Proposed Scheme are at low to high risk of surface water flooding, which are predominantly associated with the Cantley Stream. Thickthorn Junction and the A11 within the vicinity of, and south west of Cantley Stream is identified as being at high risk (greater than 1 in 30 (3.3%) chance) of surface water flooding in any given year).

2.4.4. The map also shows areas between the A11 and Cantley Lane South which are at high risk of surface water flooding. Areas of the A11 between Thickthorn Junction and Cantley Stream are indicated to be at medium risk (between 1 in 100 (1%) and 1 in 30 (3.3%) in any given year) of surface water flooding. As are parts of Cantley Lane South and parts of the agricultural land to the west of the Thickthorn Park and Ride.

2.4.5. The available records within HADDMS (Highways England, 2020) indicates a number of instances of historic carriageway flooding. Norfolk County Council Highways team confirmed by email on the 16th of September 2020 that there has been no flooding on county road approaches to the roundabout. However, there has been flooding on the Thickthorn Junction carriageway itself.

2.4.6. There is potential for groundwater flooding to occur in the south-west and south-east of the study area generally along the line of Cantley Stream. Chalk is found close to the surface in this area and it is thought to outcrop in the riverbed of Cantley Stream. Sub-artesian groundwater conditions have been noted in the boreholes closest to Cantley Stream, namely BH1, BH2, BH31 and BH33. The locations are provided in ES Figure 13.8 Ground investigation boreholes (**TR010037/APP/6.2**) and further details can be found in the Groundwater assessment (ES Appendix 13.3) (**TR010037/APP/6.3**).

Figure 2-5 : Surface water flooding risk (Environment Agency website)



2.5. Spill register

2.5.1. There is no evidence of spillages occurring at the Thickthorn Junction or nearby (within 1km).

2.6. Priority register

2.6.1. Table 2-1 below details the priority outfalls and soakaways that have been identified within the Proposed Scheme DCO boundary using HADDMS (Highways England, 2020). The location of these are given in ES Figure 13.5 (Groundwater abstractions, discharges and source protection zones) **(TR010037/APP/6.2)** and in ES Figure 13.6 (Surface water flood risk) **(TR010037/APP/6.2)**. The existing outfalls lie in clusters in the area where the existing A11 and A47 cross Cantley Stream, and this is likely that this discharges to the stream. Additional drainage survey is being undertaken prior to detailed design. The soakaways lie along the existing A47 at various locations primarily between Thickthorn Junction and Cantley Stream. The information on HADDMS is unverified, so this information may not be accurate and a recent drainage survey was undertaken but couldn't identify the locations of the outfalls and soakaways.

Table 2-1 : Priority outfalls and status

Road	Outfalls	Soakaways			Culverts
		Chamber	Multiple chamber	Trench	
A47 east of Thickthorn Junction	13 (risk addressed) 2 (low priority)	13 (risk addressed)	0	0	0
A47 west of Thickthorn Junction	0	1 (risk addressed) 2 (low)	0	0	0
A11	12 (risk addressed)	0	0	0	0

2.6.2. The pollution risk from the existing outfalls and soakaways identified within the Proposed Scheme DCO boundary is reported as “risk addressed” indicating there is no existing pollution risk (this assumes road run-off from the total existing drainage area to a single cumulative outfall to Cantley Stream at the A11 and A47 crossing).

2.6.3. Further drainage surveys are planned to confirm the location of the outfalls. Subject to further drainage surveys, it is considered that the majority of outfalls and all of the soakaways would not be retained as part of the proposed drainage system.

2.6.4. There are no other priority outfalls, soakaways or culvert identified within the Proposed Scheme area. Further drainage surveys are proposed to further detail the outfalls noted in Table 2-1.

3. Field studies

3.1.1. Due to the Covid-19 pandemic, there has been limited opportunity for the designers to gain further access for on-site investigation works or site walkovers to obtain further information for the drainage design. Where a drainage survey was not available, further surveys have been requested as described within Section 2 of this report.

3.1.2. A site visit was carried out in December 2019 that noted the following drainage outfall, shown in figure 3-1 on the west side of the A11 immediately southwest of Cantley Stream. This confirmed one of the outfalls to Cantley Stream included within HADDMS. This is likely to be the outfall noted in the Carnell/Kier drainage survey report reference WBA69.

Figure 3-1 : Outfall

Sweco image captured December 2019

4. Site description

4.1. Overview

4.1.1. The A47/A11 Thickthorn Junction is located on the south-western edge of Norwich and provides access to the A47, A11 and B1172 Norwich Road for Eaton, Cringleford, Hethersett and Wymondham. Refer to Section 1, Figure 1-1, for the scheme location plan. The highways network associated with the Proposed Scheme is as follows:

- The A47 Norwich Bypass runs in a north-westerly / south-easterly direction over Thickthorn Junction.
- The A11 runs in a north-easterly / south-westerly direction and connects onto the Thickthorn Junction. A11 Hethersett Bypass is to the west of Thickthorn Junction and A11 Newmarket Road is to the east of Thickthorn Junction.
- The B1172 Norwich Road connects to the west of Thickthorn Junction.
- Old Newmarket Road connects to the north-east of Thickthorn Junction.
- Other notable local roads include Cantley Lane South that interfaces with the A47 westbound diverge and the A11 Hethersett Bypass roundabout exit, and the stopped-up Station Lane on the A11 Hethersett Bypass.

4.1.2. Additional prominent features and constraints within the vicinity of the Proposed Scheme include:

- Thickthorn Park and Ride is located to the west of Thickthorn Junction.
- There are two overhead power lines that generally run parallel to each side of the A47 Norwich Southern Bypass.
- The adjacent lands are agricultural in nature and include areas of woodland. Cantley Wood is situated to the south west of the scheme extents bounded by Cantley Stream, the A11 Hethersett Bypass and Cantley Lane South.
- There is a small number of domestic properties situated nearby on Cantley Lane South adjacent to the A47 Norwich Bypass. A footbridge crosses the A47 to connect these properties with Cringleford.
- Breckland railway runs to the south of the A11 and passes over Cantley Lane South and under the A47.
- Cantley Stream runs west to east and passes through an open culvert below the A11, a piped culvert under Cantley Lane South and a piped culvert under the A47 adjacent to Breckland Railway underpass. Cantley Stream connects into Intwood Stream to the east of the A47 before ultimately connecting into the River Yare approximately 1.6km downstream of the Proposed Scheme. The River Yare is the main watercourse in the area.

4.2. Existing drainage catchments

4.2.1. The existing drainage catchments are shown on drawing HE551492-GTY-HDG-000-SK-CD-30010 contained within Appendix D.

4.2.2. The existing carriageway surface water collection systems are noted in Table 4-1.

4.2.3. The scheme falls wholly within the Cantley Stream catchment. Cantley Stream discharges into the Intwood Stream which is under the management of the Norfolk Rivers Internal Drainage Board (NRIDB). The Intwood Stream in turn discharges to the River Yare further to the east which is also under management of the NRIDB.

4.2.4. There are no other water features within the extents or adjacent to the site except for commercial fishponds that are located to the immediate west of the A47 and immediately north of the Breckland Railway. These ponds are assumed to be groundwater and rainwater fed.

4.2.5. A brief description of each existing catchment associated with this scheme is provided below.

Catchment A, (A11 Hethersett Bypass)

4.2.6. This catchment includes the A11 carriageway to the south-west of Cantley Stream as it passes through the A11 open culvert and the junction of Station Lane. The catchment extends circa 1.2km to the south-west of Cantley Stream.

4.2.7. Based on HADDMS information, cut-off drainage is provided along the eastbound carriageway which is on embankment resulting in this catchment consisting of carriageway and verge run-off only.

Catchment E, (Cantley Lane South).

4.2.8. There is no formal drainage infrastructure along the majority of Cantley Lane South. Cantley Lane South is constructed within a cutting from 450m south of the railway bridge to approximately 75m past where the road rises to meet surrounding ground levels, the verges are heavily vegetated with large mature trees. There are several property entrances along Cantley Lane South with no notable drainage features present. A small section of positive drainage is present from 50m prior to the railway bridge heading north, with gullies located in the road channel is un-kerbed. This drainage network leads north where it is suggested that it discharges to a culverted section of Cantley Stream.

Catchment F2, (A47 Norwich Southern Bypass)

4.2.9. This catchment includes the A47 between Thickthorn Junction and the Breckland Railway bridge with some natural run-off collection on both sides of the A47. The carriageway run-off and pre-earthworks drainage is collected and directed to an outfall with a pipe network via a carrier drain network to Cantley Stream adjacent to the Breckland railway bridge.

Catchment J, (A47 Thickthorn Junction, part of the A47 Norwich Southern Bypass, A11 Hethersett Bypass, A11 Newmarket Road and part of the B1172 Norwich Road)

4.2.10. This catchment includes:

- Thickthorn Junction and associated slip roads.
- The B1172 Norwich Road junction area with Thickthorn Junction.
- The A11 Newmarket Road for circa 0.2km east of Thickthorn Junction.
- The A11 from Thickthorn Junction to the A11 Cantley Stream open culvert.
- The A47 over Thickthorn Junction.
- Cantley Lane South road connections with the A11 and A47.
- Some natural catchments either side of the above roads also fall within this catchment.

4.2.11. The A47 Norwich Southern Bypass passes over Thickthorn Junction and is generally at original ground level with the high point near the centre of the roundabout. To the north, run-off drainage is directed to the slip roads.

4.2.12. The Thickthorn Junction circulatory carriageway and slip roads are generally in cut and are below natural ground level, as is the A11 Newmarket Road from a high point circa 170m east of the roundabout and the short length of dual B1172 Norwich Road. The A11 Hethersett Bypass falls from Thickthorn Junction through a cutting and then onto embankment to a low point at the Cantley Stream crossing where drainage discharges through a single outfall.

Natural Catchment A, (B1172 Norwich Road and natural catchment to the south)

4.2.13. This catchment includes the B1172 Norwich Road and the natural catchment to the south up to the A11. The B1172 Norwich Road eastbound verge is kerbed with an adjacent footpath, no drainage provision is observed along this verge. The westbound verge is un-kerbed and has no notable drainage features. The verge is heavily vegetated with large trees. It is noted that sections of the verge are at a lower level than the road, and some form of informal ditch/grip appears

to be present. In the absence of positive drainage, it is assumed that the B1172 Norwich Road drains south over the natural catchment described above.

Natural Catchment B (Natural Catchment and Cantley Lane South)

4.2.14. This catchment is a fully natural catchment and falls south towards Cantley Stream.

Natural Catchment C (Natural Catchment and Cantley Lane South)

4.2.15. This catchment is predominantly natural catchment including a section of Cantley Lane South which has no notable positive drainage features. This catchment falls towards Cantley Stream.

Drainage networks

4.2.16. The following existing information has been collated from HADDMS and the CCTV surveys detailed under section 2 above.

Table 4-1 : Existing surface water collection

Carriageway	Edge drainage
A47 Thickthorn Junction	Combined drainage kerb systems at central island. Combination of kerb and gully and combined drainage kerbs at road entry and exit flares. Kerb and gully including hard strip at slip roads except on the eastbound diverge where a surface water channel is present.
A47 Norwich Southern Bypass	Concrete surface water channel in the central reserve for the west bound carriageway. Concrete surface water channel in the verge for the east bound carriageway.
A11 Hethersett Bypass	Combined drains in cutting (in verge and central reserve) Kerb and gully including hard strip on embankments (in verge and central reserve).
A11 Newmarket Road	Combined drains in cutting (in verge and central reserve)
B1172 Norwich Road dual carriageway	Kerb and gully including bus lane. Kerb and gully in the central reserve.
B1172 Norwich Road	Over the edge (west bound verge only).
Cantley Lane South	Kerb and gully at connection with A47 / A11 otherwise no formal drainage except single gully at low point.

Sub-surface drainage

4.2.17. The A47 carriageway and A11 carriageway incorporate combined drains to drain the pavement foundation within cuttings.

4.2.18. It is assumed that the A11 Newmarket Road also utilises combined drains to drain the pavement foundation.

4.2.19. It is unclear from the survey and historic HADDMS information if sub-surface drainage is present on the A11 carriageway and A47 carriageway at the low side of carriageway on embankments to drain the pavement foundation.

4.2.20. In cuttings, including the Thickthorn Junction circulatory carriageway, filter drains are used to collect seepage from slopes and soft verges.

4.2.21. From the survey information, gullies would appear to be collected by carrier drains but in some instances are collected by combined drains.

Toe / cut-off drainage

4.2.22. Cut-off filter drains are provided at the top of the cut along the eastbound merge slip road at the Thickthorn Junction.

4.2.23. A cut-off drainage ditch has been identified at the toe of the embankment on the south-bound side of the A11. The ditch discharges towards the southern bank of Cantley Stream. This is shown as a watercourse on OS mapping.

4.2.24. There is no other information available to determine if toe or cut-off drainage is present elsewhere. Additional drainage survey is being undertaken to identify further drainage assets.

Natural catchment drainage

4.2.25. An overland flood flow pathway has been identified using the topographical contours and this is also identified on ES Figure 2-5 (Surface water flooding risk - Environment Agency website). The pathway falls in a north-west to south-easterly direction from south of the B1172 Norwich Road through wooded and agricultural land towards the northbound verge of the A11 Hethersett Bypass, where it changes direction to fall into the Cantley Stream.

Soakaways

4.2.26. The information available on existing soakaways (see section 2.6) are not sufficiently detailed in order to determine their attributes and asses their suitability. Additional survey is being undertaken to identify drainage assets where applicable.

4.3. Sensitive receptors

4.3.1. 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 area of the Proposed Scheme. However, Priority Habitats (Coastal and Floodplain Grazing Marsh, Lowland Fen, Lowland Meadow and Good Quality Semi-Improved Grassland) have been identified within the area of the Proposed Scheme.

4.3.2. Appendix G contains a figure detailing the Environmental Constraints.

4.4. Constraints

4.4.1. Overhead power lines run parallel to the east and west of the A47 Norwich Southern Bypass. The land to the east of the A47 is currently being developed into a residential area which includes a proposed infiltration basin.

4.4.2. An existing foul sewer crosses below the A47 Norwich Southern Bypass in a west to east direction approximately 40m north of the Breckland Railway bridge.

4.4.3. There are a number of commercial fishponds located adjacent to Cantley Stream which are in close proximity the Breckland Railway bridge wing walls which may hamper construction of a new drainage outfall. Additional survey is proposed in this area to establish constraints and boundaries.

5. Design options

5.1. Principles

5.1.1. The proposed integrated drainage design includes:

- Surface water collection systems.
- Carrier / conveyance systems, to remove water efficiently and safely from the carriageway.
- Pavement sub-surface drainage where new pavement is proposed, to maximise pavement life and earthworks.
- Attenuation requirements.
- Spillage control measures that minimises the impact of the increased development run-off on the receiving environment.
- Sustainable Urban Drainage Systems (SUDS).

5.1.2. The proposed drainage design also:

- Maintains existing outfalls to watercourse
- Introduces new outfalls to watercourse
- Incorporates new drainage connections to existing highway surface water sewers
- Introduces a surface water pumping system

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

- Ground
- Surface watercourse
- 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 which will establish a high degree of certainty for construction.

5.2. Design parameters

5.2.1. Table 5-1 below sets out the parameters used for the design in accordance with DMRB CG 501.

Table 5-1 : Design criteria for storm return periods

Storm return period	Item	Design parameters
1 in 1 year	Drainage network	No surcharging of pipe soffit.
1 in 5 year	Drainage network	No surcharging pavement layers or carriageway.
1 in 30 year	Drainage network	No flooding of carriageway.
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.

5.2.2. A 40% climate change allowance is considered within the above design storm events as per the Lead Local Flood Authority requirements.

5.2.3. 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
Surface water channel (concrete)	roughness coef.	tbc
Time of Entry:		5 minutes
Rainfall:	M5-60:	20 mm
	Ratio R:	0.408
	M5-2min:	5mm
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

5.2.4. XP MicroDrainage Version 2019.1 is utilised for hydraulic design of pipework, applying the Modified Rational Method in accordance with the Wallingford Procedure using Flood Studies Report (FSR) rainfall maps.

Pipe length

5.2.5. Maximum 150m centres between carrier drain and combined drain chambers are proposed where no lateral pipe connections are made into the pipe, otherwise a maximum spacing of 90m.

5.2.6. The maximum connection length between gully outlets or combined drainage kerb outlets to carrier drain connection is to be 12.5m.

Surface water channel (concrete)

5.2.7. The sectional profile of the existing concrete surface water channel does not correspond with the typical sections within the DMRB. The design proposals are to replace and maintain existing flows where the existing channels are severed by the works on the A47 mainline carriageways. Where the proposed A11/A47 connector road connects to the A47 mainline, then a new surface water channel will be designed at detailed design stage.

Conduit (combined drainage kerb) system

5.2.8. The layout of combined drainage kerb systems and outfall points are shown on the drainage layout drawings provided in Appendix B. The final combined drainage kerb selection is to be designed in accordance with the parameters above and the manufacturers requirements and recommendations. All outlets that discharge to the pipe network shall include silt traps.

Kerb and gully

5.2.9. On embankments, kerb and gully drainage is the principal surface run-off collection option. Kerb and gully drainage is also present in some cutting settings, usually at junctions and lay-bys.

Combined drain

5.2.10. 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.

Combined drainage kerbs

5.2.11. Combined kerb drainage is mainly used on bridge decks except at the A47 Norwich Southern Bypass where surface water channels are to be maintained for continuity.

5.2.12. 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.

Permeable surfaces

5.2.13. Soft verges are designed to fall away from the road on embankment situations and towards the road where in cutting.

5.2.14. In cutting, combined drains offer drainage to excess water that discharges from earthworks slopes.

5.2.15. Ditches are proposed extensively to collect and transport natural run-off and collect any overland flow pathways.

Sub-surface drainage

5.2.16. Narrow filter drains (NFD) / fin drains (FD) in accordance with the Manual of Contract Documents for Highway Works (MCHW) are specified to provide sub-formation drainage as part of the scheme. These drains are located at the low side of the carriageway where no alternative solution is provided.

5.2.17. Pavement sub-surface drainage will be provided on the proposed bridges.

Conveyance

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

Ditches

5.2.19. Ditches are used extensively to capture run-off from natural catchments and earthwork slopes and to convey these flows and managed attenuation flows to outfalls.

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

Natural catchment drainage

5.2.21. There are several natural landforms that are intercepted by the new works, it is proposed to provide drainage in the form of pre-earthworks ditches or filter drains to convey this run-off to a suitable outfall that is separate from the main highway drainage system where possible.

Catchment run-off factors

5.2.22. Only two catchment types are identified for both the existing and proposed drainage layouts. Carriageway including other hard impermeable surfaces and verges (nominally flat) including gentle grassed slopes. The permeability factors of each surface are indicated in Table 5.2 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

5.2.23. In addition to the above factors, pre-earthworks drainage at the bottom of embankments will be designed to accommodate a 100% impermeable factor run-off from compacted embankment fill as required by Norfolk County Council.

5.3. Guidance and policy

Design codes and standards used

5.3.1. 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 run-off 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 run-off
- 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
- 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

5.3.2. The following planning policies were examined in the context of the water environment.

5.3.3. Joint Core Strategy for Broadland, Norwich and South Norfolk:

- 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

5.3.4. The South Norfolk Development Management Policies document:

- Policy DM 4.2 – Sustainable drainage and water management.
  - Sustainable drainage measures must be fully integrated within design to manage any surface water arising from development proposals, and to minimise the risk of flooding on the development site and in the surrounding area.
  - Must not cause any deterioration in water quality and measures to treat surface water run-off must be included within the design of the drainage system.
- In addition to NPPF (2019) requirements, developments must include a drainage strategy to demonstrate:
  - Suitable consideration given to surface water drainage
  - Appropriate arrangements for attenuating surface water run-off using SUDS
  - That issues of ownership and maintenance are addressed

5.3.5. Norfolk County Council also provide guidance to developers on their role as Lead Local Flood Authority (Norfolk County Council, 2020).

5.4. Design considerations

5.4.1. 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.

Outfalls

5.4.2. Proposed and retained existing drainage outfalls are discussed within Section 6 of this report based on a drainage network basis.

5.4.3. The proposed drainage design has considered outfalls in the order of preference set out within CG501. The order of preference is:

- Discharge to ground

- Discharge to watercourse
- Discharge to sewer

5.4.4. The Proposed Scheme has not identified any locations where discharge into ground via infiltration is possible. Soakaway testing has been undertaken at the proposed westernmost detention basin location as explained within Section 5.9. This soakaway testing was unsuccessful.

5.4.5. As part of the design proposal, there are a number of new outfalls to Cantley Stream, however, the water table in the areas is close to existing ground level and therefore, infiltration is not considered possible.

5.4.6. The proposed western detention basin design includes a positive outfall to Cantley Stream, however, whilst ground water is expected to be high, additional soakaway testing is being undertaken in this area to determine infiltration viability.

5.4.7. All existing and proposed outfalls discharge to watercourse.

5.5. Flood risk management

5.5.1. As part of a SUDS system, the discharge solution is to collect all run-off from the original and new development and return it to the environment at the same discharge rate as the original development discharge rate as a minimum. This should be an acceptable solution and is still to be agreed with the Environment Agency. Depending on an individual catchment's condition, discharge rates can be as low as natural greenfield run-off rates.

5.5.2. There are five outfalls that require flow control management. Two of these outfalls incorporate basins with appropriate flow controls. These outfalls collect most of the drainage catchment from the proposed roads but also a substantial amount can be collected from existing road catchments.

5.5.3. Single oversized pipes with flow restrictions are used to attenuate flows at the remaining three outfalls. In comparison, these networks discharge a small amount of drainage from the proposed road catchment, but they may also include an amount from existing road catchments.

5.6. Pollution management

5.6.1. 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.

5.6.2. 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. Where existing drainage or pre-earthworks ditches are to be utilised, they shall be cleared and regraded to suit, where required.

5.7. Sustainable urban Drainage Systems (SuDS)

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

5.7.2. The proposed SuDS features included within the proposed design include, detention basins, filter drains, attenuation pipes and grassed ditches.

5.7.3. The detention basins promote the four 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.

5.7.4. 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.

5.7.5. 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.

5.7.6. Attenuation pipes are provided to hold back water to slow the rate of discharge to green field run-off. Attenuation pipes will include catch pits to settle and capture sediment within the surface water run-off.

5.8. Pumping station

5.8.1. Where there is no solution to outfall the drainage to the ground or a positive outfall then pumping the surface water to a suitable outfall will be required. Typically, this type of system is a final option for highways schemes due to the associated costs and maintenance liability.

5.8.2. On the A11/A47 connector road, a pump solution is necessary as a gravity outfall cannot be achieved.

5.8.3. A preliminary design proposal has been prepared to set out the proposed requirements for the pump solution. This is subject to further discussions, risk assessments and agreement with Highways England and Highways England Operations prior to detailed design.

5.9. Infiltration potential and source protection zone

5.9.1. It is noted that the scheme is fully contained within a source protection zone III (total catchment). Whilst there are no restrictions to infiltrate to ground in these areas, it is noted that there is a number of non-licensed abstractions in the local area. Where there are deep cuttings within the design which encroach on the chalk aquifer, infiltration must be avoided to avoid direct discharge due to environmental sensitivity. Where the proposed drainage design is in close proximity to the chalk aquifer, separate sealed carrier drain systems with road gully collection may be required. In some locations, impermeable wrapping to the filter drains may be possible, however, this will be subject to discussions with the Environment Agency.

5.9.2. The highway run-off does not discharge directly to natural ponds, lakes, canals, reservoirs or a groundwater source protection zone I.

5.9.3. Appendix F contains aquifer designations and source protection zone figures.

5.9.4. Two soakaway tests were undertaken during the 2018 ground investigation. These were undertaken at the approximate location of the westernmost drainage basin (TP12) within the Sheringham Cliffs Formation at a depth of 2.5mbGL, and also to the south of the Wards Wood underpass (TP04) within the Lowestoft formation, also at a depth of 2.5mbGL. No infiltration rate was calculated for either test as a result of slow water dissipation rate, which suggest poor infiltration in these locations.

5.10. Groundwater

5.10.1. The groundwater levels across the site is within the range of 12 to 16maOD (19.74 to 14.11mbGL) at the Thickthorn Junction and the A11 approach. This reduces to approximately 11maOD (0.05mbGL) in the Chalk at the Breckland Railway bridge, with groundwater flowing towards the south and southeast, and towards the Cantley Stream. The Sheringham Cliffs Formation is generally dry in the study area but is saturated in the vicinity of Cantley Stream. In this area, Chalk groundwater levels are sub-artesian and the maximum recorded groundwater levels (11maOD; 0.05mbGL) are higher than those in the Sheringham Cliffs Formation (0.7mbGL). This suggests an upwards hydraulic

gradient between the two aquifer units. It is likely, therefore, that groundwater from the Chalk supplies baseflow to Cantley Stream.

5.10.2. Chalk groundwater levels beneath the proposed drainage basins are likely to be relatively shallow (less than 5m below ground level) due to the location in relation to the Cantley Stream.

6. Proposed design

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

6.1.2. The preliminary drainage design is contained within Appendix B of this report with proposed drainage catchment plan being contained within Appendix E of this report. The proposed road surface water collection system is detailed with Table 6-1.

6.2. Proposed network catchments

Catchment A

Existing A11 eastbound towards Thickthorn Junction.

6.2.1. The proposed design associated with this catchment involves road widening to accommodate the proposed diverge for the A11-A47 connector road. The existing verge drainage along the extent of widening is affected and will be removed as part of the Proposed Scheme. It is proposed to construct new edge of carriageway drainage through this section. New edge of carriageway drainage is proposed to maintain the existing drainage network which becomes severed and it will also collect the A11 and the proposed A11-A47 connector road diverge surface run-off.

6.2.2. Due to proposed widened embankment, new pre-earthworks drainage is proposed along the bottom of the embankment to mitigate erosion to the embankment and trapped water.

6.2.3. Due to the proposed road widening, the impermeable road surface area is being increased, therefore, an attenuation system is proposed in the form of oversized pipes prior to outfall to ensure there is no increase in discharge rates to the outfall at Cantley Stream. At this stage, the outfall arrangement is expected to be in the form of a concrete headwall.

6.2.4. Other design considerations given to the design in this location include:

- At the next design stage, consideration will be given to providing an open ditch solution to provide the required attenuation in favour of an underground pipe solution.
- A basin option was considered for this drainage network on the A11 eastbound section in place of the proposed oversized pipe. This option was discounted due to the land take required and significant tree removal. The proposed oversized pipe is considered to be a more appropriate solution in this instance.

Proposed A11/A47 connector road to A47 Underpass

6.2.5. The majority of the A11-A47 connector road is in deep cutting and is required to pass through the new structure below the existing A11. The road alignment falls to a low point at ch.450 and rises again to ch.850. This section of the A11/A47 connector road has no positive outfall due to the significant cutting and associated low levels. This area requires a pumping solution in order to convey the surface water to a suitable outfall location.

6.2.6. The rising main associated with the pumped solution is located in the west verge and outfalls to the proposed attenuation basin provided to the west of the proposed Cantley Lane link road which ultimately outfalls to the Cantley Stream watercourse.

6.2.7. At this design stage, the inlets and outlets to the detention basin and the outfall arrangement to Cantley Stream are expected to be in the form of headwalls.

Cantley Lane Link, North of the A11

6.2.8. This section of proposed Cantley Lane link road runs from the junction with the B1172 Norwich Road to the proposed bridge over the A11-A47 connector road. This drainage network outfalls to the proposed attenuation basin provided to the west of the proposed Cantley Lane link road which outfalls to the Cantley Stream watercourse.

6.2.9. At this design stage, the inlets and outlets to the detention basin and the outfall arrangement to Cantley Stream are expected to be in the form of headwalls.

Existing A11

6.2.10. The existing drainage network on the A11 becomes severed by the introduction of the proposed A11 underpass structure. The contributing area that passes through this network is significant and includes Thickthorn Junction and associated slip roads.

6.2.11. At the point at which the existing drainage networks is severed, a new drainage system is proposed which will route along the top of the west side of the proposed A47-A11 connector road cutting. This drainage network outfalls to the new attenuation basin provided to the west of the proposed Cantley Lane link road which outfalls to the Cantley Stream watercourse. As the existing drainage network currently outfalls directly to the water course, the proposed system is considered to provide both water quality and quantity benefits.

6.2.12. At this design stage, the inlets and outlets to the detention basin and the outfall arrangement to Cantley Stream are expected to be in the form of headwalls.

6.2.13. Other design considerations given to the design in this location include:

- The A11 drainage network is severed due to the proposed A11 underpass. The design originally considered connecting the severed catchment down to the A11/A47 connector road. This would result in this catchment conveying through the connector road drainage and the proposed pump installation being significantly larger. Furthermore, this would increase carriageway flood risk to the A11/A47 connector road during pump failure. For this reason, the proposed drainage network runs along the top of cutting and outfalls to the new detention basin via gravity.

Catchment E
Cantley Lane South, South of the A11, North of the proposed Cantley Lane culvert.

6.2.14. This drainage network commences at the proposed bridge on the Cantley Lane link road over the A11 and continues to the junction with Cantley Lane South. This drainage network also includes an area of Cantley Lane South which is being realigned as part of this scheme. This drainage network is being attenuated by providing oversized pipes within the road verge (due to limited space). Once attenuated, it is proposed that the water will discharge to Cantley Stream via proposed ditches via headwalls. The proposed vegetated ditches will provide some benefit in terms of water quality prior to discharging into Cantley Stream.

6.2.15. Other design considerations given to the design in this location include:

- This area of proposed carriageway is on embankment with kerbs which limits surface water collection options. The catchment is divided into two sections due to the new culvert which is being provided for Cantley Stream. Due to limited cover over the culvert, the proposed drainage carrier drainage is unable to cross over the culvert which has dictated the design in this location.

Catchment E2
Cantley Lane South, South of the proposed Cantley Lane culvert

6.2.16. This drainage network is located at the proposed junction of the Cantley Lane link road and Cantley Lane South. This drainage network is being attenuated by oversized pipes within the road verge (due to limited space). Once attenuated, it is proposed that the water will discharge to Cantley Stream via proposed ditches via headwalls. The proposed vegetated ditches will provide some benefit in terms of water quality prior to discharging into Cantley Stream.

6.2.17. The southern section of Cantley Lane South drainage system is subject to further drainage survey in order to determine the upstream catchment and pipe levels.

6.2.18. This is a small section of carriageway in cutting and therefore design options are limited.

Catchment F
A11/A47 connector road

6.2.19. The catchment includes the section of the A11-A47 connector road from ch.850 eastwards and outfalls via gravity to the proposed detention basin located on the west side of the existing A47.

6.2.20. It is proposed that a piped drainage network will be provided from this attenuation basin to Cantley Stream where a headwall outfall will be provided.

6.2.21. Other design considerations given to the design in this location include:

- In earlier design stages, the drainage layout for the entire length of the proposed A11-A47 connector road was connected to the proposed pump station located on the A11-A47 connector road and would have contributed to network B. This option would result in the pump installation being significantly larger. Furthermore, this would increase carriageway flood risk to the A11-A47 connector road during pump failure. On this basis, this option was discounted.

A47 Norwich Southern Bypass

6.2.22. The existing drainage network on the A47 becomes severed by the introduction of the proposed A11-A47 connector road underpass structure.

6.2.23. At the point at which the existing drainage networks is severed, a new drainage system is proposed which will route the existing drainage network down to the proposed A11/A47 connector road where it utilises the A11/A47 connector road drainage system. As explained above, this outfalls via gravity to the proposed detention basin located on the west side of the existing A47.

6.2.24. It is proposed that a piped drainage network will be provided from this attenuation basin to Cantley Stream where a headwall outfall will be provided.

6.2.25. Due to the introduction of the proposed A47 underpass to accommodate the A11-A47 connector road, it is proposed that the existing A47 edge of carriageway drainage channel and kerb on the westbound central reserve and the eastbound verge is replaced with combined kerb drainage for the length of the structure. Away from the structure, the existing channel and kerb is maintained as it is unaffected by the Proposed Scheme.

6.2.26. Other design considerations given to the design in this location include:

- In earlier design stages, the drainage layout placed the proposed detention basin for this catchment area to the eastern side of the A47 before discharging to Cantley Stream adjacent to the Breckland railway. Due to this land being subject to development, a decision was made to relocate the detention basin to the western side of the A47.
- The designer considered an option which involved provision for a separate drainage network along the top of the A11-A47 connector road cutting that would collect the severed drainage system and connect this to its existing outfall, however, this option was discounted as it would involve additional pipe infrastructure which would involve significant additional costs and maintenance liability. Furthermore, the proposed design discharges this water through the detention basin which provides both water quality and quantity benefits.
- Except for the proposed drainage network that takes this catchment to outfall, the A47 within this catchment is being mostly retained in its current form and therefore other options are limited.

Catchment F2
A47 Norwich Southern Bypass

6.2.27. On the A47 within this catchment area, the existing drainage infrastructure is being mostly retained as part of the scheme. The contributing area to this drainage network is being reduced significantly due to the introduction of the A47 underpass. The severed drainage now connects through Network F as explained above.

6.2.28. The proposed A11-A47 connector road merge involves widening the A47 carriageway surface and will require new edge of carriageway drainage to replace the existing as required in order to drain the road carriageway.

6.2.29. New outfall drainage is required to replace the existing due to it being impacted by the A47 road and associated embankment widening. At this stage, the design proposes a new outfall headwall to be constructed, however, further surveys in this area is being undertaken to determine if any existing outfalls can be utilised.

6.2.30. Except some local widening at the A11-A47 connector road merge, this proposed catchment is as per existing but significantly reduced due to the inclusion of the A11/A47 connector road. Drainage options in this are limited as the existing drainage is being mostly retained.

Catchment H
Thickthorn Junction widening and segregated left turn

6.2.31. The proposed A47-A11 segregated left turn lane involves the widening of the A47 westbound diverge, Thickthorn Junction and the A11 westbound. Through the areas of widening, new edge of carriageway drainage is proposed as a direct replacement of the existing.

6.2.32. This drainage network will continue to connect into the A11 drainage network contained within catchment B. Alterations to the A11 drainage network are discussed above.

6.2.33. Drainage design options in this area are limited as it primarily involves road widening and new edge of carriageway drainage only.

Catchment I
Thickthorn Junction internal widening

6.2.34. New edge of carriageway drainage is proposed within the central island of the roundabout due the widening of the circulatory carriageway. The new drainage will be a direct replacement of the existing.

6.2.35. This drainage network will continue to connect into the A11 drainage network contained within catchment B. Alterations to the A11 drainage network are discussed above.

6.2.36. Drainage design options in this area are limited as it primarily involves road widening and new edge of carriageway drainage only.

Catchment J
Existing A11 and layby removal

6.2.37. On the A11 within this catchment area, the existing drainage infrastructure is being mostly retained as part of the scheme.

6.2.38. The contributing area to this drainage network is being reduced significantly due to the introduction of the A11 underpass. The severed drainage now connects through network B as explained above.

6.2.39. The proposed design includes the removal of an existing lay-by which is located on the A11 eastbound carriageway. The preliminary design includes new edge of carriageway drainage along the extent of the existing lay-by: however, this section of drainage will be assessed at the next design stage to determine if the existing drainage can be retained with only minor road restraint system works to terminate the layby.

6.2.40. The existing drainage outfall at Cantley Stream is being retained as part of this drainage network.

6.2.41. As the existing drainage in this area is being mostly retained, there are limited design options.

Catchment K
Existing A11 and Station Lane junction

6.2.42. This is a junction improvement and primarily involves the widening of the A11 eastbound and Station Lane. Over the extent of the junction improvement, new edge of carriageway drainage is proposed to replace the existing as required to drain the carriageway.

6.2.43. This drainage network is part of catchment K but connects into the drainage infrastructure associated with catchment A.

6.2.44. Drainage design options in this area are limited as it primarily involves road widening and new edge of carriageway drainage only. Existing pre-earthworks drainage in this area is subject to additional survey to determine what options are considered viable for the Proposed Scheme, however, a filter drain, or ditch is the likely solution.

Table 6-1 : Proposed collection systems

Carriageway	Edge drainage
A47 Thickthorn Junction	Combined drainage kerb systems at central island. Combination of Kerb and Gully and combined drainage kerbs at road entry and exit flares Kerb and Gully including hard strip at slip roads except on the eastbound diverge where a surface water channel is present.
A47 Norwich Southern Bypass	Concrete surface water channel in central reserve for west bound carriageway. Concrete surface water channel in verge for east bound carriageway.
A11 Hethersett Bypass	Combined drains in cutting Kerb and Gully including hard strip to the new entry taper of the A11/A47 connector road North of the proposed A11 underpass, kerb and gully with combined and carrier drainage system to the westbound nearside verge.
B1172 Norwich Road	Combined drainage kerb systems to the west side and Kerb and Gully with carrier drain to the east side.
Cantley Lane South	Kerb and Gully with combined filter and carrier system. Combined drainage kerb systems over structures.

A11/A47 Connector Road	Combined drains in cutting. Kerb and Gully at with combined and carrier system. Combined drainage kerb systems through structures. Pumping station and rising main.
A11 and Station Lane Junction.	Kerb and Gully with carrier drain system.

6.3. Proposed outfalls and attenuation

6.3.1. An assessment has been undertaken to ascertain the volume of attenuation required for each drainage network. The allowable design discharge rate is deemed not to exceed the rate of existing discharge prior to the redevelopment at existing outfall locations.

6.3.2. The existing outfall rates has been calculated by modelling the existing network in the MicroDrainage software. The existing flows are noted in Table 6-2.

6.3.3. An initial assessment has been undertaken to ascertain the approximate volume of storage attenuation required for each catchment. The allowable discharge rate has been calculated using the IH124 calculation with the catchments noted in Table 6-2, an initial value for the greenfield run-off rate. (Note, this is yet to be agreed with the Environment Agency and are also subject to confirmation).

6.3.4. The storage volume has been estimated for a 100-year return period using Micro Drainage ‘Quick Storage Estimate’ hydraulic software. The software provides a lower and higher volume with the mid-range value being shown in the Table 6-2 below.

6.3.5. These volumes shall be contained in suitably sized SUDS systems such as tanks, oversized pipes, infiltration/detentions basins or ponds, pending outcomes of suitable ground investigations, the HEWRAT pollution assessments and EA consultation.

6.3.6. Table 6-2 below outlines the networks catchment details including an estimated required storage volume. The catchment areas shown are for the carriageway run-off only as it is assumed at this stage that any earthworks run-off will be collected and discharged separately. Drawings showing the individual networks are provided in Appendix B.

Table 6-2 : Attenuation Values

Catchment	Catchment Area (HA)	Greenfield Run-off (l/s)	Flow control diameter (mm)	Flow control type	Storage Volume (m3)
NW A*	1.299	n/a*	303	Orifice Plate	115
NW B	15.994	31.2	231	HydroBrake Optimum	4960
NW E**	0.451	3.5	80	HydroBrake Optimum	150
		5.5	116	HydroBrake Optimum	15
NW E2***	0.298	TBC	n/a	TBC	TBC
NW F	9.06	18.0	187	HydroBrake Optimum	1774
NW F2****	1.934	n/a	n/a	n/a	n/a
NW H	1.268	n/a	n/a	n/a	n/a
NW I	0.264	n/a	n/a	n/a	n/a
NW J****	0.574	n/a	n/a	n/a	n/a
NW K	0.516	n/a	n/a	n/a	n/a

* Flow is restricted to the existing flows

** Attenuation is in 2 sections with final flow restricted to greenfield run-off rate

*** This network is currently presumed to match existing flows; drainage survey is being undertaken to assess existing catchment.

**** This network is a betterment to the existing flows; no attenuation is required.

Networks H and I outfall to existing drainage network which in-turn is routed to the Network B basin.

Network K outfalls to existing drainage, this in-turn is captured in the Network A outfall.

6.4. Flood risk and mitigation

6.4.1. 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 existing outfalls. This has the potential to increase flood risk downstream on the outfalls.

6.4.2. The proposed pumping station will include telemetry to notify the maintaining authority of any failure. The design will incorporate emergency storage to provide resilience during pump failure. If the emergency storage is overwhelmed

surface water flooding will be contained within the deep cutting and will not affect third party land. It is noted that the volume of pump storage will be determined at the next design stage.

6.4.3. The proposed drainage system is designed to attenuate storms outlined in Table 6-2 above. There would be no (or negligible) increase in run-off 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 5-year storm, with no flooding of third-party land during a 1 in 100-year storm event including a 40% allowance for climate change. The final basin designs shall also be designed to accommodate the 1 in 100-year storm event plus a 40% allowance for climate change with no further increase in forward flow. This is in accordance with current guidance.

6.4.4. Flow paths of surface water run-off from the highway drainage arising from storm events in excess of the design standards would flow along the alignment within the carriageway and extend towards the lower elevations. Once an extreme storm event has passed, surcharging within the network would reduce, allowing any residual run-off back into the network away from the surface.

6.4.5. 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 climate change to mitigate impacts to the Proposed Scheme and to others.

6.4.6. 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) **(TR010037/APP/6.3)**.

6.5. Pollution control (HEWRAT)

6.5.1. An assessment of pollution impacts from routine run-off and spillages to surface waters was undertaken using the Highways England Water Risk Assessment Tool (HEWRAT), as described in DMRB LA113. The HEWRAT assessment uses information from the drainage design for the Proposed Scheme, the receiving local water environment and annual average daily traffic (AADT) data to establish potential impacts of pollutants in routine highway run-off and spillages from the Proposed Scheme upon the watercourses within the study area and the requirement for mitigation measures to adequately reduce the risk. The filter drains and swale measures were omitted from the surface water HEWRAT assessment to represent a worst-case scenario for surface water pollution risk. This is because further assessment of the pollution risk from discharging to

ground via filter drains and swales is required following supplementary ground investigations due to start in March 2021.

6.5.2. The routine run-off assessment shows that currently there is a negligible impact following dilution in the channel for both soluble and sediment-bound pollutants when the additional measures from the drainage design have been included. The results of this assessment, with and without mitigation measures in place are included in ES Appendix 13.4 of the Water quality assessment **(TR010037/APP/6.3)**. A drawing showing the catchments are included in Appendix E.

6.5.3. A summary of the HEWRAT routine run-off assessment for each outfall is as follows:

- Catchment A (proposed and existing) and K outfalls passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.
- Catchments B, H and I outfall initially failed step 2 (pre mitigation) due to acute copper concentrations, which would require treatment to mitigate this. However, with the inclusion of a vegetated detention basin as a proposed measure in step 3, this outfall passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants. The detention basin will be grassed and dry except at times of heavy rainfall. The vegetated detention basin provides the same or better removal rate of copper than a grass channel due to it being flatter and wider, more likely to disperse the water over the surface area and will have a longer detention time. For the purpose of the HEWRAT assessment, the removal rate of a grassed channel for copper (50%) has been included in step 3 of the assessment.
- Catchment E outfall passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.
- Catchment E2 outfall passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.
- Catchment F outfall passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.
- Catchment F2 outfall passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.
- Catchment J outfall passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.

6.5.4. A cumulative assessment was undertaken for the three outfalls which discharge to Cantley Stream from catchments A, K, B, H, I and J as they are within 100m of each other. This cumulative area initially failed step 2 (pre mitigation) due to acute copper concentrations, which would require treatment to mitigate this. However, with the inclusion of a vegetated detention basin as a proposed measure in step 3, these outfalls passed the HEWRAT assessment for soluble pollutants and sediment bound pollutants.

6.5.5. Assessment of pollution impacts from spillages using HEWRAT as described in Appendix D of DMRB LA113. The method initially estimates the risk of there being an incident causing the spillage of a potentially polluting substance somewhere on the length of road being assessed. It then calculates the risk, assuming a spillage has occurred, that the pollutant will reach and impact on the receiving watercourse. All outfalls passed this assessment with the results indicating all drainage areas would have <0.5% annual risk of pollution. The output from these assessments can be found in ES Appendix 13.4 of the Water quality assessment **(TR010037/APP/6.3)** and a summary of the outcome is provided in Table 6-3.

Table 6-3 Summary of predicted routine runoff and accidental spillages assessment. The Environmental Quality Standard (EQS) for dissolved copper in freshwaters is 1 µg/l and 10.9 µg/l for dissolved zinc (UKTAG, 2014).

Drainage catchment	Mitigation identified by HEWRAT	Mitigation proposed in drainage design (subject to supplementary ground investigation)	Soluble				Sediment	Spillage assessment
			EQS Annual average concentration		Acute impact			
			Copper (µg/l)	Zinc (µg/l)	Copper	Zinc		
A (existing and proposed) and K	None	Filter drains	Pass (0.22)	Pass (0.38)	Pass	Pass	Pass	Pass
B, H and I	Detention basin (grass lined)	Detention basin (grass lined) and filter drains	Pass (0.36)	Pass (1.08)	Pass	Pass	Pass	Pass
E	None	Filter drains and swale	Pass (0.10)	Pass (0.06)	Pass	Pass	Pass	Pass
E2	None	Filter drains and swale	Pass (0.09)	Pass (0.02)	Pass	Pass	Pass	Pass
F	None	Filter drains and detention basin (grass lined)	Pass (0.19)	Pass (0.31)	Pass	Pass	Pass	Pass
F2	None	Filter drains	Pass (0.16)	Pass (0.24)	Pass	Pass	Pass	Pass
J	None	Filter drains	Pass (0.13)	Pass (0.15)	Pass	Pass	Pass	Pass
A, K, B, H, I and J (cumulative)	Detention basin (grass lined)	Detention basin (grass lined) and filter drains	Pass (0.59)	Pass (1.88)	Pass	Pass	Pass	N/A

6.5.6. Routine runoff assessments have also been undertaken for discharges to ground, where permeable filter drains are used. These have been undertaken using HEWRAT. The results can be found in Appendix 13.3 Groundwater assessment **(TR010037/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 (sediment removal) and attenuation of flows, however. Filter drains may intercept a combination of granular and cohesive deposits, and therefore infiltration to groundwater may be limited.

6.6. Departures from standards

6.6.1. No Departure from Standards have been identified up to end of design Stage 3.

6.7. Design assumptions

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

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

6.7.3. 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.

6.8. Consultation

6.8.1. Consultation has been undertaken with the following organisations:

- The Environment Agency (EA) (May and June 2018, July, August, September and December 2020)
- Norfolk County Council (NCC) (February and May 2018, April, July and August 2020, January 2021)
- Norfolk Rivers Internal Drainage Board (NRIDB) (April and December 2020)

6.8.2. The Environment Agency were initially consulted on the environmental assessment scoping report and preliminary environmental information report in 2018. Their main concerns regarding water and drainage issues focussed on flood risk, SUDS design and CIRIA guidance, climate change projections, groundwater flow and the length of new culverts. Other concerns included loss of riparian habitat, ground water testing and monitoring and waste classifications. Designer responses at that time acknowledged Environment Agency's concerns

and committing to their request that shaped the development of the drainage design.

6.8.3. In April 2018, Sweco initiated a consultion via email to Norfolk Rivers Internal Drainage Board (NRIDB). An email response included standard IDB byelaws and guidance on consent.

6.8.4. A follow up meeting with the EA to further discuss scoping opinion occurred in June 2018. The main points of raised for discussion revolved around:

- groundwater data, EA confirmed they have provided all the information they have
- biodiversity and habit loss. The design has since developed, and no stream diversion is necessary so habitat loss is minimal
- dewatering, EA can give advice on dewatering prior to consultation with permitting team
- drainage team to produce maintenance management plans for drainage and particularly treatment. Consultation is ongoing.
- attenuation basin structures should include permanent standing water and marginal vegetation to improve biodiversity and treatment, if possible. The scoping boundary was subsequently tightened which left less land to develop a pond type basin. Dry basin is the current proposal.
- concerns with impacts on abstractions
- stream diversion and subsequent biodiversity facilitation; the design has since developed, and no stream diversion is necessary.

6.8.5. In May 2018 a meeting was held with NCC as LLFA and the EA to discuss the outline design consultation requests. The main points of discussion based on the new works scope inlcuded;

- 40% rainfall allowance for climate change for drainage should be tested. This has been included in the preliminary design.
- Discussion on dry culverts, NCC warned not to rely on LiDAR for siting these. The design was informed by topographical survey and managed known flowpaths.
- Consent for culverts / structures on Cantley Stream will be under NCC as LLFA. However, EA will review flood map outputs. Consultation is ongoing.
- Discussed need for site testing to ensure drainage follows the SUDS heirarchy. To be developed in detailed design.
- Drainage design must include full consideration of water quality. HEWRAT assessment shall inform the drainage design. Assessments are ongoing.

6.8.6. In July 2020 a meeting was held with NCC as LLFA and the EA as part of the ongoing consulation process. The reason for the meeting was to discuss the

proposed redesigned Cantley Stream culvert and any issue it raises. The culvert increased in size, widened to optimise the level difference between existing road and the river bed. The freeboard topic was raised and the stakeholders insisted on the prefered 600mm freeboad depth. The EA also agreed that the increased culvert size reduces upstream flooding, then no requirement to provide compenasatory flood storage.

6.8.7. In August 2020 a meeting was held with NCC as LLFA as a follow-up meeting for the revised Cantley Stream culvert that achieves 600mm freeboard whilst accommodating a favourable road alignment. The stream bed levels remain unchanged. The NCC confirmed requrement for 600mm freeboard and mammal shelfs and agreed in principal subject to modeling evidence and final confirmation with the EA. The NCC raised concerns that a hydraulic jump may be caused by the gardient changes and scour protection may be required. However the NCC agreed in principle with the gradients but will be subject to final confirmation with the EA.

6.8.8. In August and September 2020, the EA provided by email their hydrology review of the Flood Risk Assessment report. Consultation is ongoing to enable the delivery of the final model for agreement with EA / NCC.

6.8.9. NCC accepted the reduced culvert freeboard of 428mm within letter dated 27 January 2021.

6.8.10. The Drainage Strategy Report has been reviewed by the EA and NCC and feedback was provided in letters dated 22 December 2020 and 20 January 2021 respectively.

6.8.11. Utility providers have been contacted and the proposed drainage design has been provided to them to assist in designing their proposed diversions. It is anticipated that the proposed drainage design may need to be modified at detailed design stage to facilitate the planned diversions.

7. Residual risks

7.1.1. Storms in exceedance of the proposed drainage design storm (1 in 100 year with 40% rainfall climate change allowance) should be retained within the highway boundaries and eventually routed back into the drainage networks once the extreme event has receded. Should exceedance events extend beyond the highway boundary overland flows would follow existing surface water flow paths towards Cantley Stream; there are no flood-sensitive downstream receptors between the proposed highway drainage system and the stream. Surface water exceedance events for Cantley Lane link road and Cantley Lane South (catchments E and E2 in Annex D) would be retained within the carriageway but if exceeded would flow eastwards towards Cantley Stream.

7.1.2. Significant ground water flows to the pumping station may be encountered and persistent over time within the cutting for the A11-A47 connector road. Natural ground water and increased ground water flows could lead to larger pumping requirements as well as additional storage and drainage provisions, additional ground investigation being undertaken to further understand ground water in this area.

7.1.3. Further consultation with Highways England and Highways England Operations drainage specialists is required to determine the requirements for the proposed pumping station. Requirements to be confirmed include normal operation design storm criteria and failure provision, which may include additional emergency storage provision to mitigate flooding on the carriageway. No formal design guidance or specifications are available to inform the design.

7.1.4. Deep drainage runs are proposed in the southbound A11-A47 connector road to the A47, directional drilling is proposed to construct the pipe beneath the A47 to the new basin on the west of the A47.

7.1.5. Further ground investigation works are required to obtain infiltration values for the infiltration basin located on the west side of the A47. This will allow infiltration potential to be fully considered at stage 5.

7.1.6. Results of additional drainage surveys may have impact on the design and will be reviewed once the survey work is undertaken.

7.1.7. The proposed drainage has been considered as part of the flood risk assessment, this shows a negligible flooding impact of the proposed and existing drainage outfalls on Cantley Stream.

7.2. Pollution

7.2.1. HEWRAT assessments for soluble pollutants and sediment bound pollutants indicate that no special pollution mitigation is necessary for each of the outfalls beyond what is proposed within the current design and therefore, the potential of residual pollution risk is likely to be low.

7.3. Erosion

7.3.1. 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.

7.3.2. Flow velocities at outfalls are kept to a minimum and not greater than existing flows. Erosion protection measures will be assessed and implemented within final detailed design.

7.3.3. At the proposed Cantley Lane culvert, scour protection may be required if further analysis and investigation suggests that a hydraulic jump may be possible.

8. Maintenance

8.1. Responsibility

8.1.1. Maintenance responsibility of drainage assets will be assigned between Highways England and Norfolk County Council.

8.1.2. Highways England would take responsibility of drainage assets along the A47 Norwich Southern Bypass, Thickthorn junction, A11 Hethersett Bypass, A11 Newmarket Road and the A11-A47 connector road including the new pump station.

8.1.3. Norfolk County Council would adopt responsibility of drainage assets along the widened B1172 Norwich Road, the proposed Cantley Lane link road and the realigned Cantley Lane South and culvert. The exact boundary of asset ownership is yet to be determined and agreed between the two organisations.

8.2. Provision

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

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

8.2.3. A maintenance hard-standing is proposed to provide easy maintenance access to the proposed pump station.

8.2.4. A maintenance lay-by is provided on the Thickthorn Junction island opposite the A47 westbound diverge entry to the roundabout. This lay-by is primarily for signal and lighting maintenance but will be useful for other maintenance tasks including drainage.

8.2.5. Dedicated maintenance tracks are proposed from the local road network to the detention basins. The proposed tracks are continuous around the detention basins.

8.2.6. All other proposed outfall assets are accessible from the Cantley Lane South, the proposed Cantley Lane link road and the proposed accommodation track from Cantley Lane South to the field north of the A11.

9. References

HIGHWAYS ENGLAND (2016) Highways Agency Drainage Data Management System. Available at: http://www.haddms.com/

DEPARTMENT FOR COMMUNITIES AND LOCAL GOVERNMENT, National Planning Policy Framework 2012 (NPPF) 10 meeting the challenge of climate change, flooding and coastal change. Available at: www.gov.uk/government/publications/national-planning-policy-framework--2

DEPARTMENT FOR TRANSPORT. The National Planning Policy Statement for National Networks. December 2014.

GOVERNMENT OFFICE FOR THE EAST OF ENGLAND (2008) East of England Plan >2031 - Draft revision to the Regional Spatial Strategy for the East of England. Available at: https://www.fenland.gov.uk/media/7775/Regional-Spatial-Strategy-Review/pdf/RSS_East_of_England_Plan_-_Draft_Revision_March_2010.pdf

SOUTH NORFOLK COUNCIL (2015) Development Management Policies Document. Available at: https://www.south-norfolk.gov.uk/residents/planning/planning-policy/adopted-south-norfolk-local-plan/development-management-policies

NORFOLK COUNTY COUNCIL (2015) Local Flood Risk Management Strategy for the Norfolk region. Available at: https://norfolk.citizenspace.com/consultation/draft-local-flood-risk-management-strategy/supporting_documents/01_Norfolk_LFRMS_v12.3_Draft.pdf

UKTAG (2014) Updated recommendations on environmental standards; river basin management (2015-21). Available at: http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/UKTAG%20Environmental%20Standards%20Phase%203%20Final%20Report%2004112013.pdf accessed September 2020

Appendix A. Drainage design certificate

A1 Thickthorn Improvement - 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
HE551492-GTY-HDG-000-RP-CD-30003	Drainage Strategy Report
HE551492-GTY-HDG-000-DR-CD-30001	Drainage Layout Sheet 1 of 6
HE551492-GTY-HDG-000-DR-CD-30002	Drainage Layout Sheet 2 of 6
HE551492-GTY-HDG-000-DR-CD-30003	Drainage Layout Sheet 3 of 6
HE551492-GTY-HDG-000-DR-CD-30004	Drainage Layout Sheet 4 of 6
HE551492-GTY-HDG-000-DR-CD-30005	Drainage Layout Sheet 5 of 6
HE551492-GTY-HDG-000-DR-CD-30006	Drainage Layout Sheet 6 of 6

A3 Departures from standard (where applicable)

N/A

A4 Report on the drainage design

Drainage Strategy report - HE551492-GTY-HDG-000-RP-CD-30003

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]

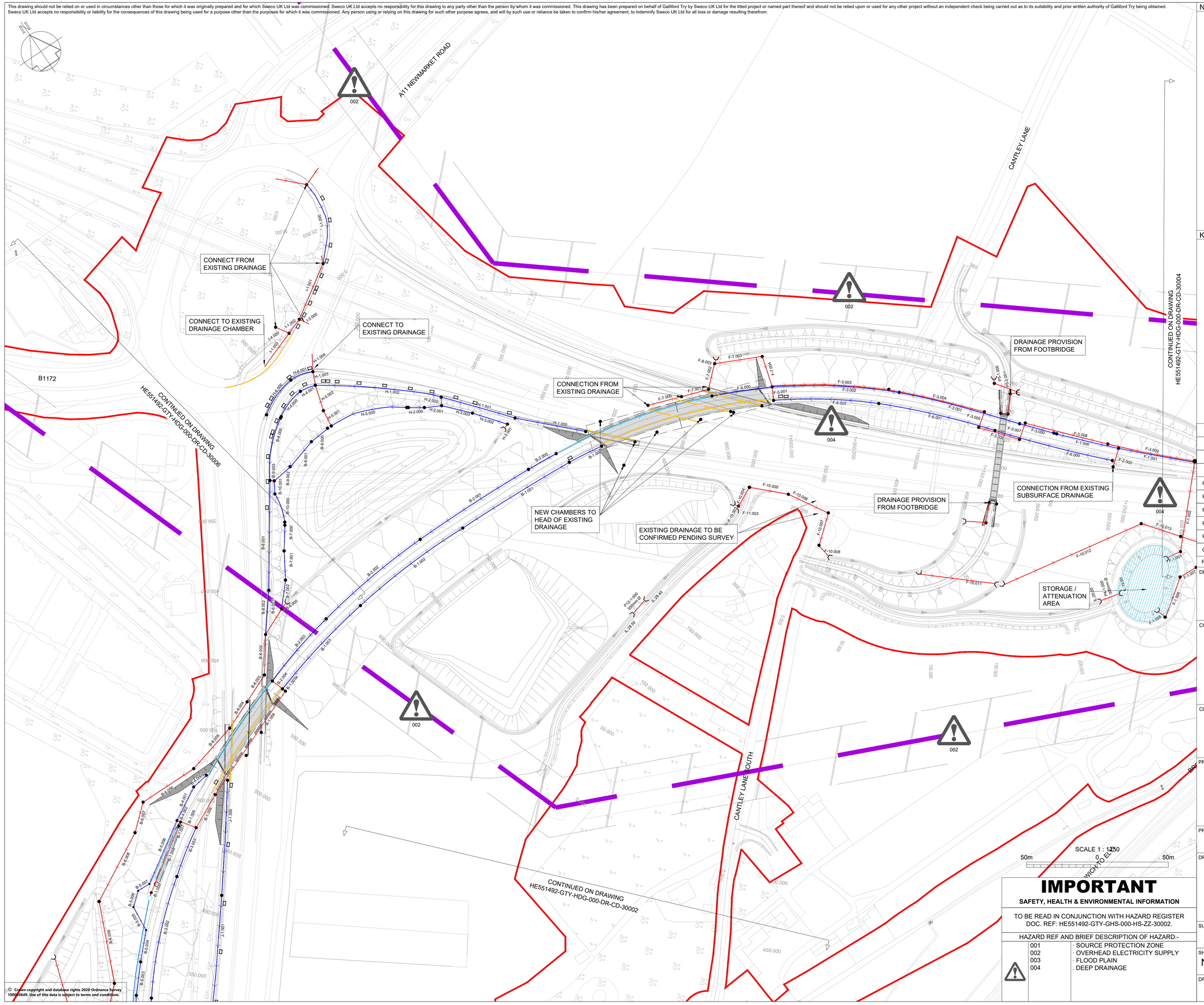
Position: **Senior Engineer**, Qualification(s): **Incorporated Engineer** Date: **26/11/2020**

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: **26/11/2020**

Appendix B. Proposed drainage drawings



NOTES

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ALL DIMENSION IN METRES (m) UNLESS OTHERWISE STATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. DRAWINGS ARE TO READ IN COLOUR.

KEY TO SYMBOLS

- FILTER DRAIN (HCD F2) — A 1.002
- CARRIER DRAIN (HCD F1) — A 1.002
- NFD / FIN DRAIN (HCD F18 / 19 / 20)
- SURFACE WATER CHANNEL
- COMBINED KERB DRAINAGE
- LINEAR DRAINAGE SYSTEM
- RISING MAIN
- ATTENUATION STORAGE TANK / AREA
- CATCHPIT / MANHOLE (HCD F11) (HCD F3 TO F7)
- GULLY (HCD F13) & CONNECTOR
- PROPOSED HEADWALL
- BYPASS INTERCEPTORS
- PUMP SHAFT
- CULVERT/PIPE CROSSING
- PED DITCH

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	27/03/20	Design developed	SG	CB	XC
P02	30/03/20	Work in progress	SG	CB	XC
P03	11/09/20	DEISGN DEVELOPMENT	RE	CB	BA
P04	27/11/20	DRAWING UPDATED FOR DFC	CMun	CBuc	BWil
P05	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
C01	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT
GENERAL LAYOUT PLAN
SHEET 3 OF 6

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
N/A	1:1250	A3	C01

DRAWING NUMBER: HE551492-GTY-HDG-000-DR-CD-30003

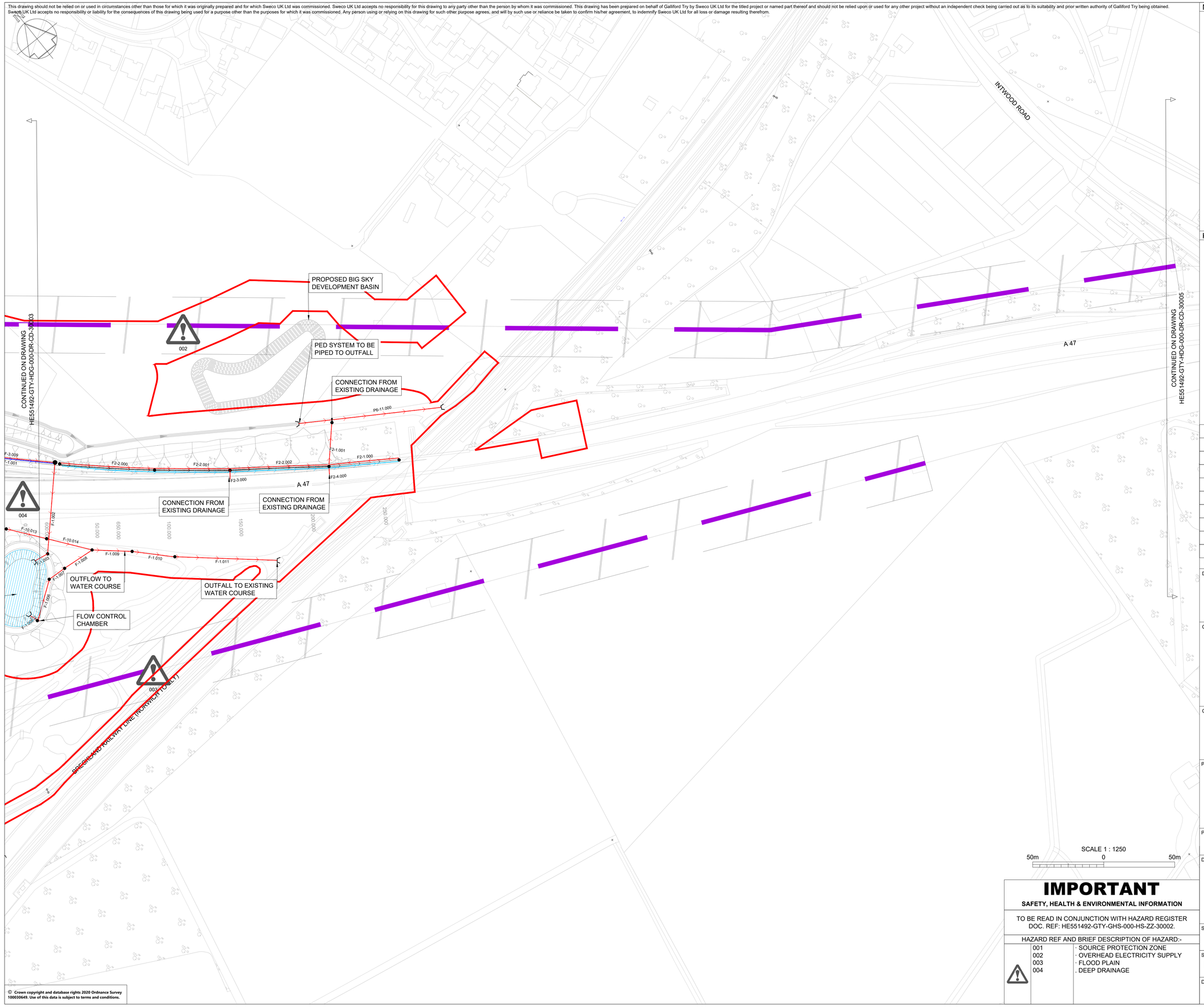
IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

001	· SOURCE PROTECTION ZONE
002	· OVERHEAD ELECTRICITY SUPPLY
003	· FLOOD PLAIN
004	. DEEP DRAINAGE



NOTES

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ALL DIMENSION IN METRES (m) UNLESS OTHERWISE STATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. DRAWINGS ARE TO READ IN COLOUR.

KEY TO SYMBOLS

- FILTER DRAIN (HCD F2) — A 1.002
- CARRIER DRAIN (HCD F1) — A 1.002
- NFD / FIN DRAIN (HCD F18 / 19 / 20)
- SURFACE WATER CHANNEL
- COMBINED KERB DRAINAGE
- LINEAR DRAINAGE SYSTEM
- RISING MAIN
- ATTENUATION STORAGE TANK / AREA
- CATCHPIT / MANHOLE (HCD F11) (HCD F3 TO F7)
- GULLY (HCD F13) & CONNECTOR
- PROPOSED HEADWALL
- BYPASS INTERCEPTORS
- PUMP SHAFT
- CULVERT/PIPE CROSSING
- PED DITCH

P01	27/03/20	Design developed	SG	CB	XC
P02	30/03/20	Work in progress	SG	CB	XC
P03	11/09/20	DESIGN DEVELOPMENT	RE	CB	BA
P04	27/11/20	DRAWING UPDATED FOR DFC	CMun	CBuc	BWil
P05	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
C01	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47/A11 THICKTHORN JUNCTION

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT
GENERAL LAYOUT PLAN
SHEET 4 OF 6

SCALE 1 : 1250

50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

001	· SOURCE PROTECTION ZONE
002	· OVERHEAD ELECTRICITY SUPPLY
003	· FLOOD PLAIN
004	. DEEP DRAINAGE

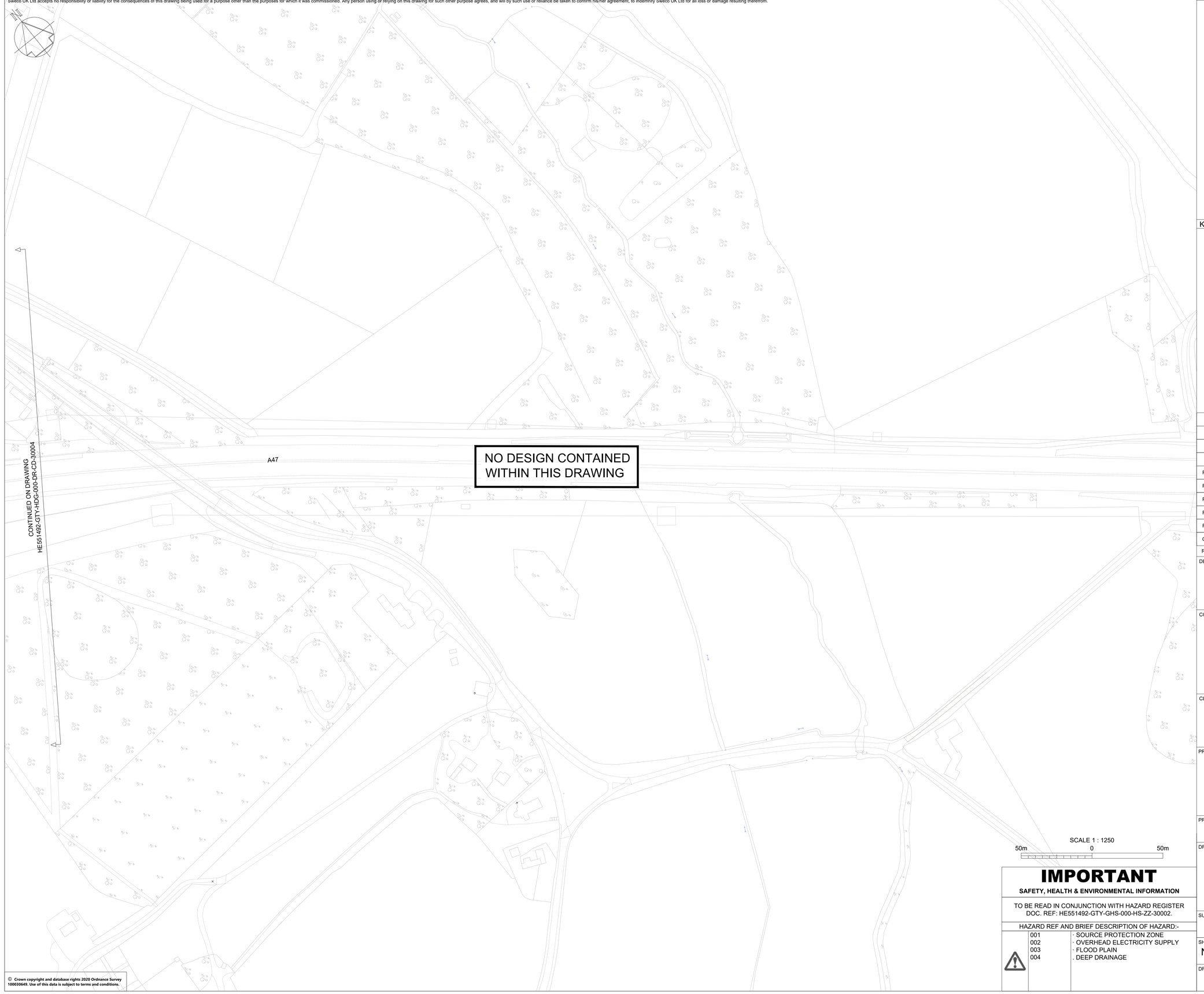
SUITABILITY

AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
N/A	1:1250	A3	C01

DRAWING NUMBER

HE551492-GTY-HDG-000-DR-CD-30004



NOTES

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ALL DIMENSION IN METRES (m) UNLESS OTHERWISE STATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. DRAWINGS ARE TO READ IN COLOUR.

KEY TO SYMBOLS

- FILTER DRAIN (HCD F2) — A 1.002
- CARRIER DRAIN (HCD F1) — A 1.002
- NFD / FIN DRAIN (HCD F18 / 19 / 20)
- SURFACE WATER CHANNEL
- COMBINED KERB DRAINAGE
- LINEAR DRAINAGE SYSTEM
- RISING MAIN
- ATTENUATION STORAGE TANK / AREA
- CATCHPIT / MANHOLE (HCD F11) (HCD F3 TO F7)
- GULLY (HCD F13) & CONNECTOR
- PROPOSED HEADWALL
- BYPASS INTERCEPTORS
- PUMP SHAFT
- CULVERT/PIPE CROSSING

SCALE 1 : 1250

50m 0 50m

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	27/03/20	Design developed	SG	CB	XC
P02	30/03/20	Work in progress	SG	CB	XC
P03	11/09/20	DESIGN DEVELOPMENT	RE	CB	BA
P04	27/11/20	DRAWING UPDATED FOR DFC	CMun	CBuc	BWil
P05	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
C01	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

001	· SOURCE PROTECTION ZONE
002	· OVERHEAD ELECTRICITY SUPPLY
003	· FLOOD PLAIN
004	. DEEP DRAINAGE

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

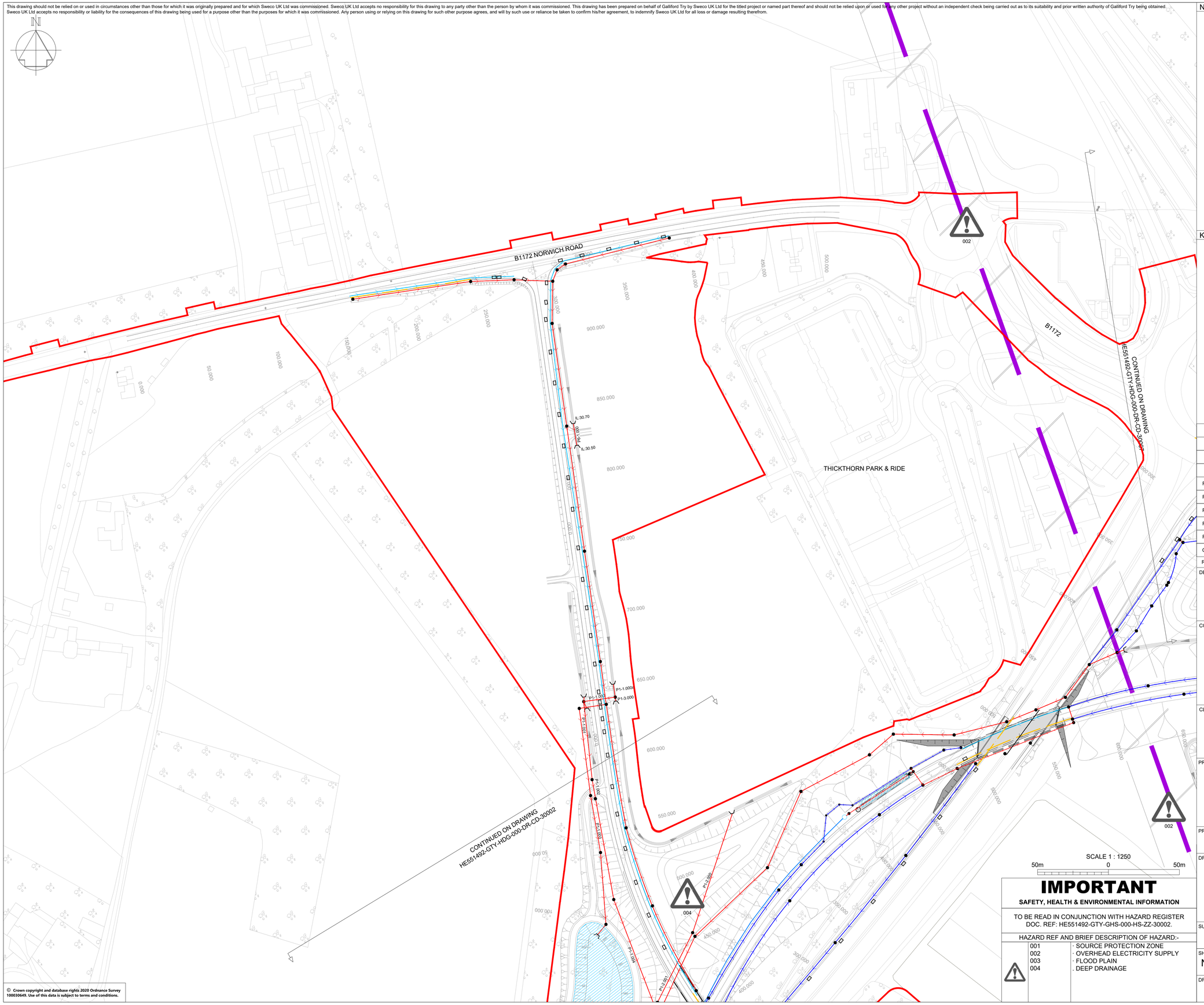
PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT
GENERAL LAYOUT PLAN
SHEET 5 OF 6

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
N/A	1:1250	A3	C01

DRAWING NUMBER: HE551492-GTY-HDG-000-DR-CD-30005



NOTES

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ALL DIMENSION IN METRES (m) UNLESS OTHERWISE STATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. DRAWINGS ARE TO READ IN COLOUR.

KEY TO SYMBOLS

- FILTER DRAIN (HCD F2)
- CARRIER DRAIN (HCD F1)
- NFD / FIN DRAIN (HCD F18 / 19 / 20)
- SURFACE WATER CHANNEL
- COMBINED KERB DRAINAGE
- LINEAR DRAINAGE SYSTEM
- RISING MAIN
- ATTENUATION STORAGE TANK / AREA
- CATCHPIT / MANHOLE (HCD F11) (HCD F3 TO F7)
- GULLY (HCD F13) & CONNECTOR
- PROPOSED HEADWALL
- BYPASS INTERCEPTORS
- PUMP SHAFT
- CULVERT/PIPE CROSSING
- PED DITCH

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	27/03/20	Design developed	SG	CB	XC
P02	30/03/20	Work in progress	SG	CB	XC
P03	11/09/20	DESIGN DEVELOPMENT	RE	CB	BA
P04	27/11/20	DRAWING UPDATED FOR DFC	CMun	CBuc	BWil
P05	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
C01	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil

SCALE 1 : 1250

50m 0 50m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

001	· SOURCE PROTECTION ZONE
002	· OVERHEAD ELECTRICITY SUPPLY
003	· FLOOD PLAIN
004	. DEEP DRAINAGE

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT
GENERAL LAYOUT PLAN
SHEET 6 OF 6

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
N/A	1:1250	A3	C01

DRAWING NUMBER: HE551492-GTY-HDG-000-DR-CD-30006

DESIGN SUBJECT TO CONFIRMATORY DRAINAGE SURVEY TO CONFIRM DRAINAGE TIE-INS

THE DRAINAGE INTO EXISTING SYSTEM

NEW CONNECTION FROM EXISTING SYSTEM

P10-1.000
P10-1.001
P10-1.002
K-1.000
K-1.001
K-1.002

A11

BRECKLAND RAILWAY LINE (NORWICH TO ELY)

CONTINUED ON DRAWING HE551492-GTY-HDG-000-DR-CD-30002

NOTES

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ALL DIMENSION IN METRES (m) UNLESS OTHERWISE STATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. DRAWINGS ARE TO READ IN COLOUR.

KEY TO SYMBOLS

- FILTER DRAIN (HCD F2) — A 1.002
- CARRIER DRAIN (HCD F1) — A 1.002
- NFD / FIN DRAIN (HCD F18 / 19 / 20)
- SURFACE WATER CHANNEL
- COMBINED KERB DRAINAGE
- LINEAR DRAINAGE SYSTEM
- RISING MAIN
- ATTENUATION STORAGE TANK / AREA
- CATCHPIT / MANHOLE (HCD F11) (HCD F3 TO F7)
- GULLY (HCD F13) & CONNECTOR
- PROPOSED HEADWALL
- BYPASS INTERCEPTORS
- PUMP SHAFT
- CULVERT/PIPE CROSSING
- PED DITCH

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	27/03/20	Design developed	SG	CB	XC
P02	30/03/20	Work in progress	SG	CB	XC
P03	11/09/20	DESIGN DEVELOPMENT	RE	CB	BA
P04	27/11/20	DRAWING UPDATED FOR DFC	CMun	CBuc	BWil
P05	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
C01	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT
GENERAL LAYOUT PLAN
SHEET 1 OF 6

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SCALE 1 : 1250
50m 0 50m

IMPORTANT
SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

001	· SOURCE PROTECTION ZONE
002	· OVERHEAD ELECTRICITY SUPPLY
003	· FLOOD PLAIN
004	. DEEP DRAINAGE

SHEET SIZE	SCALE	STATUS	REVISION
N/A	1:1250	A3	C01

DRAWING NUMBER: HE551492-GTY-HDG-000-DR-CD-30001

CONTINUED ON DRAWING HE551492-GTY-HDG-000-DR-CD-30006

CONTINUED ON DRAWING HE551492-GTY-HDG-000-DR-CD-30003

CONTINUED ON DRAWING HE551492-GTY-HDG-000-DR-CD-30001

EMERGENCY STORAGE

DOWNSTREAM DEFENDER PROVIDED PRIOR TO PUMP

PUMPING CHAMBER

CONNECTION FROM EXISTING DRAINAGE

RISING MAIN

STORAGE / ATTENUATION AREA

OVERFLOW ROUTE

FLOW CONTROL CHAMBER

OUTFLOW TO CANTLEY STREAM

OUTFLOW PIPED TO CANTLEY STREAM

FLOW CONTROL CHAMBER

TIE EXISTING DRAINAGE SYSTEM INTO HEAD OF NEW SYSTEM

STORAGE / ATTENUATION PIPE

PIPE RUN LOCATED IN BOTTOM SECTION OF STRUCTURE (BOX OPTION)

NEW CHAMBERS TO HEAD OF EXISTING DRAINAGE ON A11

CONNECT TO EXISTING DRAINAGE

REALIGNED CANTLEY STREAM

OUTFLOW PIPED TO CANTLEY STREAM SYSTEM

UNDERGROUND STORAGE ATTENUATION TANK

AREA OF GROUND INFILLED TO ALLOW FOR PED DRAIN

FLOW CONTROL CHAMBER

UNDERGROUND STORAGE ATTENUATION TANK

UNDERGROUND STORAGE ATTENUATION TANK

FLOW CONTROL CHAMBER

CONNECTION FROM EXISTING TBC PENDING SURVEY

FLOW CONTROL CHAMBER

SCALE 1 : 1250

50m 0 50m

NOTES

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ALL DIMENSION IN METRES (m) UNLESS OTHERWISE STATED.
3. DO NOT SCALE FROM THIS DRAWING.
4. DRAWINGS ARE TO READ IN COLOUR.

KEY TO SYMBOLS

- FILTER DRAIN (HCD F2) — A 1.002
- CARRIER DRAIN (HCD F1) — A 1.002
- NFD / FIN DRAIN (HCD F18 / 19 / 20)
- SURFACE WATER CHANNEL
- COMBINED KERB DRAINAGE
- LINEAR DRAINAGE SYSTEM
- RISING MAIN
- ATTENUATION STORAGE TANK / AREA
- CATCHPIT / MANHOLE (HCD F11) (HCD F3 TO F7)
- GULLY (HCD F13) & CONNECTOR
- PROPOSED HEADWALL
- BYPASS INTERCEPTORS
- PUMP SHAFT
- CULVERT/PIPE CROSSING
- PED DITCH
- INDICATES THE EXTENTS OF THE FLOOD RISK BOUNDARY FOR LOCAL WATERCOURSE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	27/03/20	Design developed	SG	CB	XC
P02	30/03/20	Work in progress	SG	CB	XC
P03	11/09/20	DESIGN DEVELOPMENT	RE	CB	BA
P04	27/11/20	DRAWING UPDATED FOR DFC	CMun	CBuc	BWil
P05	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil
C01	12/01/21	GT COMMENTS INCORPORATED	KMcC	CBuc	BWil

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

001	· SOURCE PROTECTION ZONE
002	· OVERHEAD ELECTRICITY SUPPLY
003	· FLOOD PLAIN
004	. DEEP DRAINAGE

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT
GENERAL LAYOUT PLAN
SHEET 2 OF 6

SUITABILITY: AUTHORISED AS STAGE 3 COMPLETED

SHEET SIZE	SCALE	STATUS	REVISION
N/A	1:1250	A3	C01

DRAWING NUMBER: HE551492-GTY-HDG-000-DR-CD-30002

Appendix C. Existing record drawings

Notes

1. Chainage marked out on site in yellow paint down centre of the carriageway.

2. All gully connections to be 150mm diameter.

3. Carriageway reinstatement to be HAUC type 3.

4. Works under rail bridge between Ch450 to Ch470.

5. Existing gullies under rail bridge to be connected into proposed system.

6. New railing to be erected around new headwall. See drawing BMWGEN/BM/C12.

7. Headwall to be J.K.H pre-cast concrete. See drawing 7-C175-SQ2969-8 for details.

8. Clean out and deepen existing ditch.

Key

- New Gullies
- Existing Gullies
- 225mm Pipe
- 150mm Pipe
- Headwall

Connect existing gullies with 150mm pipe into 225mm pipe.

See insert.

Ch600

Ch500 TBM=134.722
Road Nail LHS

Ch550

Catchpit 4

CANTLEY LANE SOUTH

Ch500

Catchpit 2

Catchpit 3

Ch400 TBM=137.568
Road Nail LHS

Ch450

Ch400

Headwall

New Steel Railing

Ch600 TBM=134.133
Road Nail LHS

Catchpit 5

Existing Steel Railing

Ch600

For reference purposes only
No further copies may be made

Norfolk County Council
working with
Mott MacDonald
MAY GURNEY

Mike Jackson
Director of Planning and Transportation
Norfolk County Council
County Hall
Martineau Lane
Norwich NR1 2SG

DRAWING TITLE

C175 Hethersett - Cantley Lane
Drainage Scheme
Scheme Plan

REV.	DESCRIPTION	CHECKED	DATE

	INITIALS	DATE
SURVEYED BY	OS	
DESIGNED BY	PWG	12/05
DRAWN BY	PWG	12/05
CHECKED BY	PSM	02/06

DRAWING No. 7-C175-SQ2969-7
PROJECT TITLE: C175 Hethersett Cantley Lane Drainage
SCALE: 1:500
FILE No. SQ2969

ORIGINAL SIZE: A3

Car Park Chamber Schedule

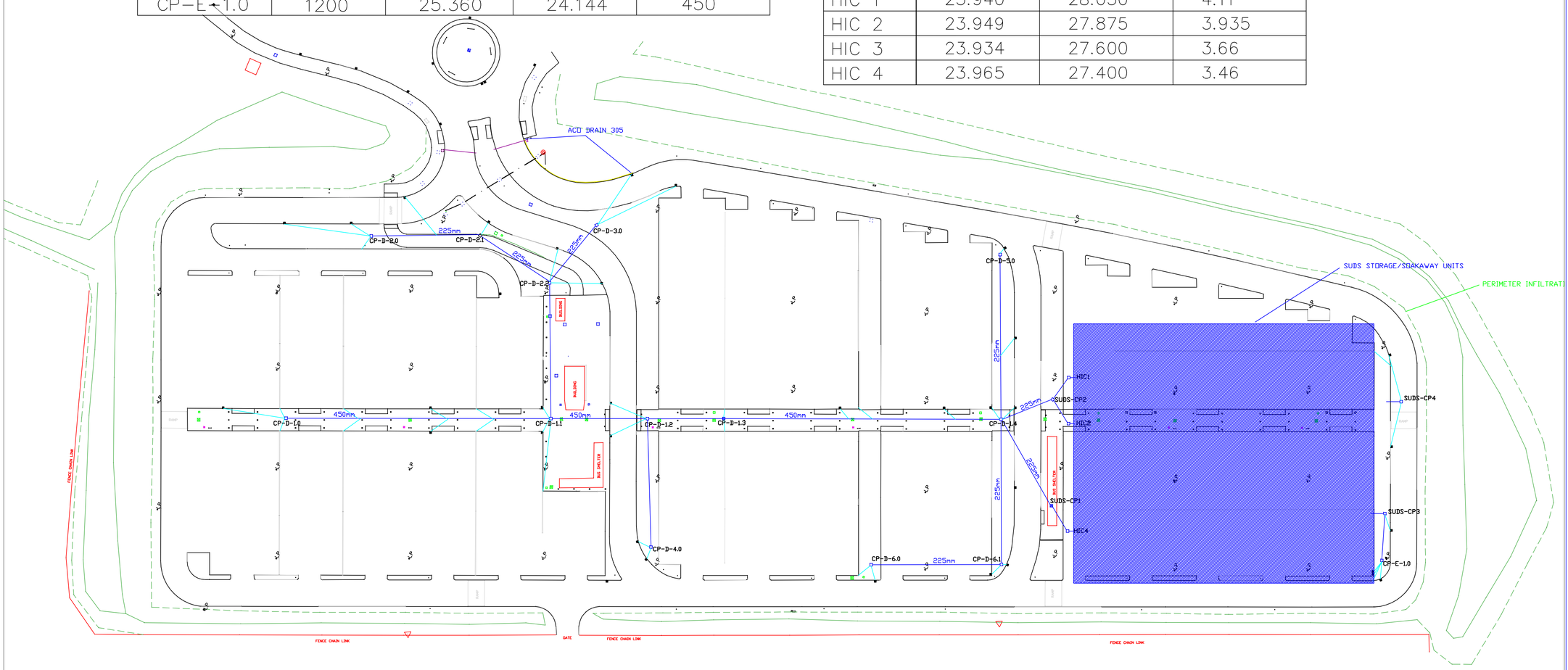
Ref.	Size, ø	Cover Level	Invert Level	Sump, mm
CP-D-1.0	1200	30.302	28.666	450
CP-D-1.1	1500	29.556	27.899	450
CP-D-1.2	1500	29.799	27.831	450
CP-D-1.3	1350	29.429	27.758	450
CP-D-1.4	1800	28.168	25.799	450
CP-D-2.0	1200	30.409	28.971	450
CP-D-2.1	1050	30.414	28.862	450
CP-D-2.2	1350	29.997	28.599	450
CP-D-3.0	1050	30.614	29.155	450
CP-D-4.0	1050	29.885	28.444	450
CP-D-5.0	1050	28.917	27.467	450
CP-D-6.0	1200	28.661	27.132	450
CP-D-6.1	1500	27.724	26.039	450
CP-E-1.0	1200	25.360	24.144	450

SUDS Catchpit Schedule

Ref.	Size, ø	Cover Level	Invert Level	Sump, mm
SUDS CP1	1500	27.800	24.620	450
SUDS CP2	1500	28.225	24.618	450
SUDS CP3	1500	25.575	24.064	450
SUDS CP4	1500	25.977	24.632	450

Hydro Inspection Chamber Schedule

Ref.	Invert Level	Cover Level	Depth, m
HIC 1	23.940	28.050	4.11
HIC 2	23.949	27.875	3.935
HIC 3	23.934	27.600	3.66
HIC 4	23.965	27.400	3.46



DRAWING NUMBER:
DRAINAGE LAYOUT ASBUILT

NOTES:

DATE	REF.	REVISIONS

C:\logo\MG%20Logo%20Pos%20(RGB).jpg

TROWSE,NORWICH
Tel(01603)727272

PROJECT:
THICKTHORN PARK AND RIDE
THICKTHORN ROUNDABOUT
A11/A47

TITLE:
DRAINAGE LAYOUT ASBUILT
AND CHAMBER DETAILS
THICKTHORN PARK AND RIDE

SCALE:	DRAWN:	CHECKED:	DATE:
1:500	M.M		08/12/05

DRAWING No.
DRAINAGE LAYOUT ASBUILT

Appendix D. Existing catchment plan

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER
DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

	HAZARD REF	CATCHMENT INFO ONLY
⚠		

Catchment Reference	Pre development Catchment Area (m2)	Pre development Catchment Area (Ha)
Catchment A (existing)	29230	2.923
Catchment F2	68675	6.868
Catchment J	120971	12.097
Natural A	244783	24.478
Natural B	115207	11.521
Natural B1	1553765	155.377
Natural C	191876	19.188
Natural D	56164	5.616

NOTES

KEY TO SYMBOLS

- CATCHMENT A
- CATCHMENT F2
- CATCHMENT J
- CATCHMENT E
- NATURAL CATCHMENT A
- NATURAL CATCHMENT B
- NATURAL CATCHMENT C
- NATURAL CATCHMENT D
- DCO BOUNDARY
- OVERLAND FLOW PATHS

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	02/02/21	general updates	SG	CBuc	BWil
P02	09/03/21	area updated	SG	CBuc	BWil
P03	12/03/21	areas updated	SG	CBuc	BWil

DESIGNER
SWECO

CONTRACTOR
GallifordTry

CLIENT
highways england

PROJECT TITLE
A47/A11 THICKTHORN JUNCTION

PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
EXISTING DRAINAGE CATCHMENTS

SUITABILITY
SUITABLE FOR INFORMATION

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:2500	S2	P03

DRAWING NUMBER
HE551492-GTY-HDG-000-SK-CD-30010

Appendix E. Proposed catchment plan

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER
DOC. REF: HE551492-GTY-GHS-000-HS-ZZ-30002.

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

HAZARD REF	CATCHMENT INFO ONLY

Catchment Reference	*Post development Catchment Area (m2)	*Post development Catchment Area (Ha)
Catchment A (existing retained)	15476	1.548
Catchment A (new)	14728	1.473
Catchment B	141464	14.146
Catchment E	4479	0.448
Catchment E2	2980	0.298
Catchment F	63456	6.346
Catchment F2	17042	1.704
Catchment H	12473	1.247
Catchment I	3811	0.381
Catchment J	16580	1.658
Catchment K	1738	0.174
Natural A	81222	8.122
Natural A2	128346	12.835
Natural B	81402	8.140
Natural B1	1549251	154.925
Natural C	148213	14.821
Natural C2	32954	3.295
Natural D	53850	5.385

* These are whole unfactored areas

EXISTING ROAD & COMMERCIAL CATCHMENT UNDEFINED; 11849m² & 19788m²

EXISTING CAR PARK OUTFALLS TO SOAKAWAY

NATURAL CATCHMENT A (SPLIT BY NEW ROAD) CONVEYED TO EXISTING OUTFALL VIA NEW DRAINAGE SYSTEM 81222m²

NATURAL CATCHMENT A2 CONVEYED TO EXISTING OUTFALL VIA NEW DRAINAGE SYSTEM 128346m²

CATCHMENT B CONTINUES THROUGH UNDERPASS

NATURAL CATCHMENT A & A2 COLLECTION POINT AND NEW DRAINAGE OUTFALL

BASIN 1

CATCHMENT B OUTFALL VIA BASIN 1 TO CANTLEY STREAM

NETWORK A OUTFALL

EXISTING CATCHMENT J REDUCED AREA 12500m²

EXISTING CATCHMENT J OUTFALL RETAINED

EXISTING CATCHMENT A OUTFALL RETAINED

EXISTING CATCHMENT A REDUCED AREA 15476m²

REDUCED NATURAL CATCHMENT B1 1431655m²

PROPOSED NETWORK J 5470m²

NATURAL CATCHMENT C2 DISCHARGES TO CANTLEY STREAM VIA NEW COLLECTION SYSTEM AND NEW OUTFALL

NATURAL CATCHMENT B COLLECTION POINT AND NEW DRAINAGE OUTFALL

A47 UNDERPASS

A11 UNDERPASS

CATCHMENT E OUTFALL

CATCHMENT E2 OUTFALL

NEW CANTLEY LANE CULVERT

CANTLEY LANE RAILWAY BRIDGE

EXISTING NATURAL CATCHMENT D REDUCED AREA 53850m²

EXISTING CATCHMENT F2 REDUCED AREA 17042m²

BASIN 2

CATCHMENT F OUTFALL TO CANTLEY STREAM VIA BASIN 2

CATCHMENT F2 OUTFALL TO EXISTING DRAINAGE

BRECKLAND RAILWAY BRIDGE

B1172 Norwich Rd

A47

A11 New market Rd

A11

New Cantley Lane Link

New A11-A47 Link

Cantley Lane South

A11 Hethersett Bypass

Inset X-X

PROPOSED NETWORK K 5160m²

Inset X-X

NOTES

KEY TO SYMBOLS

- DIRECTION OF SURFACE WATER DRAINAGE
- ATTENUATION TANK
- PUMPING CHAMBER
- PUMP SHAFT
- FLOW CONTROL DEVICE
- SHUT-OFF VALVE
- CATCHMENT A (existing)
- CATCHMENT A (new)
- CATCHMENT B
- CATCHMENT E
- CATCHMENT E2
- CATCHMENT F
- CATCHMENT F2
- CATCHMENT H
- CATCHMENT I
- CATCHMENT J
- CATCHMENT K
- NATURAL CATCHMENT A & A1
- NATURAL CATCHMENT B & B1
- NATURAL CATCHMENT C
- NATURAL CATCHMENT C 2
- NATURAL CATCHMENT D
- DCO BOUNDARY
- OVERLAND FLOW PATHS

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	02/02/21	GENERAL UPDATES	SG	CBuc	BWil
P02	12/03/21	area updated	SG	CBuc	BWil

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE OUTFALL CATCHMENTS SCHEME LAYOUT PLAN SHEET 1 OF 1

SUITABILITY: SUITABLE FOR INFORMATION

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:2500	S2	P02

DRAWING NUMBER: HE551492-GTY-HDG-000-DR-CD-30009

Appendix F. Aquifer designations and source protection zone figures

N

LEGEND

- DCO boundary
- Study area
- County wildlife site

Priority Habitat

- Coastal and floodplain grazing marsh
- Lowland fens

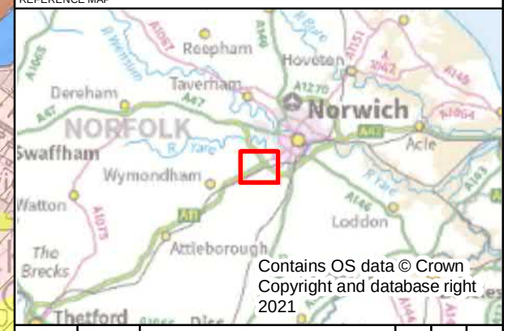
BGS Aquifer Designation - Superficial

- Secondary A
- Secondary (undifferentiated)

BGS Aquifer Designation - Bedrock

- Principal

REFERENCE MAP



REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	09/03/2021	First Edition	AC	JB	JB

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47/A11 THICKTHORN JUNCTION

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

FIGURE 13.3 - AQUIFER DESIGNATIONS
TR010037/APP/6.2

SUITABILITY

FOR INFORMATION

SHEET SIZE	SCALE	STATUS
A3	1:16,000	S2

DRAWING NUMBER

HE551492-GTY-EWE-000-DR-GI-30003

0 250 500 750 1,000 Metres

N

0 250 500 750 1,000 Metres

LEGEND

- DCO boundary
- Study area
- Source Protection Zone III - Total Catchment
- Existing Highways England soakaways

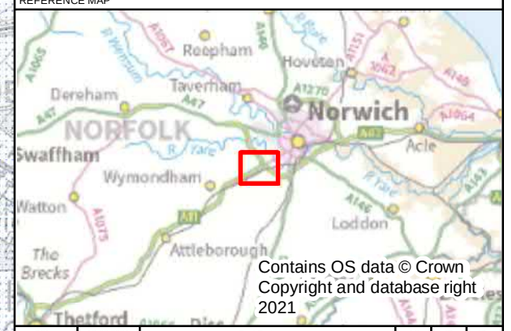
Licensed abstractions

- Groundwater source of supply

Consented discharge location

- Groundwater consented discharge

REFERENCE MAP



REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	10/03/2021	First Edition	AC	JB	JB

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47/A11 THICKTHORN JUNCTION

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

FIGURE 13.5 - GROUNDWATER ABSTRACTIONS, DISCHARGES AND SOURCE PROTECTION ZONES
TR010037/APP/6.2

SUITABILITY

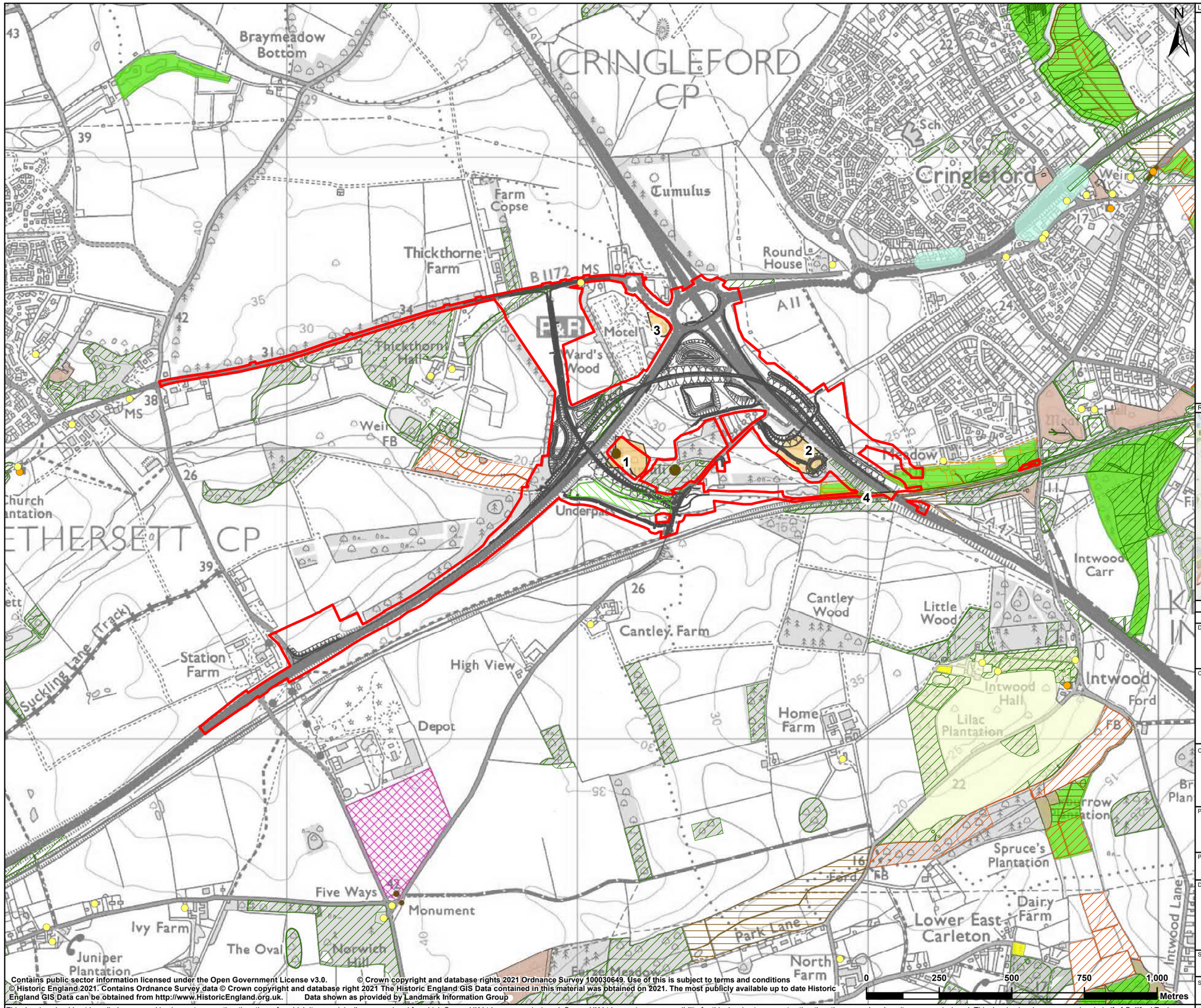
FOR INFORMATION

SHEET SIZE	SCALE	STATUS
A3	1:16,000	S2

DRAWING NUMBER

HE551492-GTY-EWE-000-DR-GI-30005

Appendix G. Environmental constraints



LEGEND

- Proposed scheme design
- DCO boundary

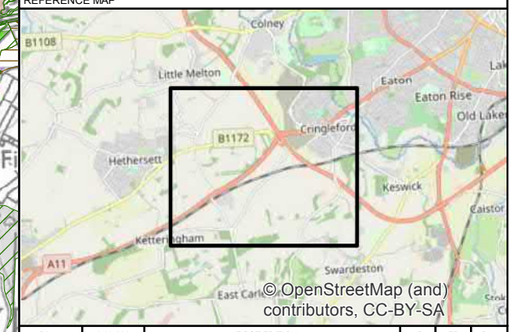
Listed Building - Grade

- II
- II*
- Registered parks & gardens
- Scheduled monument
- Noise important area (NIA)
- County wildlife site

Priority habitats

- Coastal and floodplain grazing marsh
- Deciduous woodland
- Good quality semi-improved grassland
- Lowland fens
- Lowland meadows
- No main habitat but additional habitats present
- Traditional orchard
- Historic landfill site
- Potential source of contamination
  - Source 1 - Cantley Lane landfill site
  - Source 2 - Infilled gravel pit
  - Source 3 - Petrol filling station
  - Source 4 - Railway land

REFERENCE MAP



REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	12/03/2021	FIRST EDITION	JB	FB	BA

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47/A11 THICKTHORN JUNCTION

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: FIGURE 1.2 ENVIRONMENTAL CONSTRAINTS

SUITABILITY: FOR INFORMATION

SHEET SIZE	SCALE	STATUS
A3	1:12,500	S3

DRAWING NUMBER: HE551492-GTY-EGN-000-DR-LX-00008