A47 Blofield to North Burlingham Dualling

Scheme Number: TR010040

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6.2 Environmental Statement Appendices
Appendix 13.1 – Flood Risk Assessment

APFP Regulation 5(2)(a)

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

A47 Blofield to North Burlingham Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 13.1 Flood Risk Assessment

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1. Executive Summary

1.1.1. This Flood Risk Assessment (FRA) is a requirement of the National Planning Policy Framework (NPPF) and informs the environmental assessment presented in the Environmental Statement, Chapter 13 (Road Drainage and Water Environment (**TR010040/APP/6.1**)) for the A47 Blofield to North Burlingham Proposed Scheme (which is referred herein as the 'Proposed Scheme'). This report investigates all potential flood mechanisms relevant to the Proposed Scheme in accordance with the NPPF and the National Policy Statement for National Networks (NNNPS).

1.1.2. Consultation with the Environment Agency and Norfolk County Council was undertaken as part of this assessment and is ongoing.

1.1.3. The entire Proposed Scheme lies within Flood Zone 1, which is associated with a low risk of tidal and river flooding. Using information provided by the Environment Agency, the Proposed Scheme is not at risk of fluvial and tidal flooding from the River Yare and Run Dike when climate change is taken into consideration.

1.1.4. The majority of the Proposed Scheme is at very low risk of surface water flooding, with localised areas of low to high risk of flooding. One of these areas is associated with a flow pathway which crosses the Proposed Scheme in a south westerly direction towards a tributary of Run Dike. The Greater Norwich Area Strategic Flood Risk Assessment (JBA Consulting, 2017) shows that climate change increases the impact of surface water flooding along this existing flow pathway.

1.1.5. Historic flooding of the carriageway was associated with the existing drainage network and partly resulting from blocked gullies. These existing flooding hotspots are largely located outside of the Proposed Scheme boundary and are being investigated by Highways England as part of an ongoing process separate to the Proposed Scheme.

1.1.6. The majority of the Proposed Scheme has limited potential for groundwater flooding to occur. There is no evidence of previous groundwater flooding within the Proposed Scheme area. A ground investigation undertaken in 2018 found groundwater levels below the Proposed Scheme to be between 5 and 20m below ground level. Climate change is unlikely to result in an increase in groundwater flood risk due to the significant depth to groundwater.

1.1.7. The Proposed Scheme is at low risk of flooding from infrastructure failure and not at risk from tidal, reservoir failure or canal flooding.

1.1.8. The Proposed Scheme would result in an increase in areas of hardstanding which would, if not mitigated, would result in an increase in flood risk to surrounding areas. As part of the proposed drainage design, the Proposed Scheme will be drained entirely by infiltration methods through a combination of an infiltration basin and soakaway trenches. The infiltration drainage will be designed to accommodate proposed runoff from a 1 in 100-year rainfall event plus a 20% allowance for climate change. The infiltration drainage has also been tested and shown not to flood during a 1 in 100-year plus 40% allowance for climate change. Exceedance events greater than the design rainfall event shall be routed safely, along existing overland flow paths to avoid flooding the road and minimise impact on others. Therefore, there will be no increase in surface water flood risk as a result of the Proposed Scheme's highway drainage.

1.1.9. In addition to this, proposed mitigation shall include the provision of cross-drains or 'dry culverts' which would allow surface water flow pathways that cross the Proposed Scheme to be maintained where possible. 'Dry culverts' shall be sized for a 1 in 100-year event with a 65% allowance for climate change. Where it was not possible to connect directly with existing surface water pathways, infiltration via clean water soakaway trenches shall provide attenuation of natural overland flood flow pathways to a minimum of a 1 in 10-year flow plus a 20% climate change allowance. Where required to avoid downstream flood risk, the clean water soakaways will attenuate the natural catchment runoff that intercepts the Proposed Scheme to a 1 in 100-year event including an allowance for climate change. Exceedance from the clean water soakaways, and directly from cross-drains shall converge with existing flood flow pathways downstream of the Proposed Scheme. Therefore, there will be no increase in surface water flood risk to the development or to others resulting from the interception of surface water flood flow pathways by the Proposed Scheme.

1.1.10. Potential impacts on flood risk during construction will be mitigated by the implementation of appropriate temporary drainage measures which will be outlined in the water monitoring and management plan as part of the Environmental Management Plan (EMP (**TR010040/APP/7.7**)).

1.1.11. This FRA has considered the risk to the Proposed Scheme and the risk posed by the Proposed Scheme on flooding from all sources. With mitigation in place, the Proposed Scheme will not cause any increase in flood risk elsewhere. Therefore, the development is considered appropriate under the requirements of the NPPF and the NNNPS.

2. Introduction

2.1. Scope of the study

2.1.1. This appendix supports the environmental assessment presented in ES Chapter 13 Road drainage and water environment (**TR010040/APP/6.1**).

2.1.2. The principal aim of the FRA is to evaluate the risk of flooding to the Proposed Scheme and the risk of flooding to the surrounding areas posed by the Proposed Scheme itself. In addition, the FRA considers the impacts of climate change during the lifetime of the Proposed Scheme and identify mitigation measures that are required to minimise any potential effects.

2.2. Methodology

2.2.1. This FRA has been completed in accordance with current guidance contained in the National Planning Policy Framework (NPPF) (MHCLG, 2019) and the supporting online Planning Practice Guidance (PPG) for Flood Risk and Coastal Change (MHCLG, 2016). This FRA also adheres to the National Policy Statement for National Networks (NNNPS) (Department for Transport, 2014), for guidance on nationally significant infrastructure projects on the road network.

2.2.2. The assessment has been undertaken in accordance with Highways England's technical guidance provided in Design Manual for Roads and Bridges (DMRB) LA 113 (hereafter referred to as DMRB LA 113) (Highways England, 2019a). The steps for completing a site-specific FRA have also been followed using a range of data sources, listed below.

2.3. Data sources

2.3.1. The sources of information used as part of this assessment are listed below, along with the following key technical references that were utilised:

- The online NPPF and supporting PPG (MHCLG, 2019; 2016);
- The NNNPS (Department for Transport, 2014);
- Environment Agency Flood Risk Maps for Planning (Environment Agency, 2020a), Surface Water, Reservoir, River and Tidal Flood Risk (Environment Agency, 2020b)
- Drainage Strategy (ES Appendix 13.3 (**TR010040/APP/6.2**))
- PCF Stage 2 Environmental Study report (Amey, 2017)
- Environmental Scoping Report (Highways England, 2018)
- Norfolk County Council Local Flood Risk Management Strategy (LFRMS) (Norfolk County Council, 2015a)

- Norfolk County Council Preliminary Flood Risk Assessment (PFRA) (Norfolk County Council, 2011a)
- Norfolk County Council Norwich Urban Area Surface Water Management Plan (SWMP) (Norfolk County Council, 2011b)
- Greater Norwich Area Strategic Flood Risk Assessment (SFRA) (JBA Consulting, 2017)
- Norfolk County Council Flood Investigation Reports (Norfolk County Council, 2014; 2015b; 2019a; 2019b)
- Norfolk County Council Lead Local Flood Authority Information for Developers (Norfolk County Council, 2020)
- The Joint Core Strategy for Broadland, Norwich and South Norfolk (Broadland District Council, 2014)
- The Broadland District Council Local Plan Development Management Planning Document (DPD) (Broadland District Council, 2015)

3. Legislative and policy framework and climate change

3.1. Policy framework

National Planning Policy Framework

3.1.1. The NPPF (MHCLG, 2019), along with the PPG (MHCLG, 2016), provides the regulatory framework and guidance for planning authorities and developers in relation to flood risk issues for new developments. The Local Plan (Norfolk County Council, 2015a), informed by the SFRA (JBA Consulting, 2017), set out local planning issues and requirements. Any applications lodged with a planning authority will be considered in conjunction with this guidance and dependant on the nature and location of the application, the planning authority may request a FRA as part of the Planning Application documents.

National Policy Statement for National Networks

3.1.2. The National Policy Statement for National Networks (NNNPS) (Department for Transport, 2014), sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects on the national road and rail networks in England. It provides planning guidance for promoters of nationally significant infrastructure projects on the road and rail networks, and the basis for the examination by the Examining Authority and decisions by the Secretary of State. NNNPS is the primary basis for making decisions on development consent applications for national networks and nationally significant infrastructure projects in England.

Environment Agency

3.1.3. The Environment Agency is a statutory consultee to the planning authority in relation to flood risk issues. The Environment Agency has provided a matrix for local planning authorities, which provides advice in terms of the requirements for FRA. The Environment Agency Standing Advice outlines the requirements relative to the scale of development and the predicted Flood Zones. The assessment is required for all sites greater than 1 hectare in Flood Zone 1, and all sites in Flood Zones 2 and 3, regardless of size.

3.1.4. The Environment Agency publishes flood maps which indicates the probability of river and coastal flooding, the predicted extent of the natural floodplain and of extreme floods. The maps identify three zones which refer to the probability of river and coastal flooding:

- **Flood Zone 1**. This zone comprises of land with less than a 1 in 1000 annual probability of river or sea flooding in any one year (0.1%)

- **Flood Zone 2**. This zone comprises of land assessed as having between a 1 in 100 and a 1 in 1000 annual probability of river flooding (1%-0.1%) or between a 1 in 200 and a 1 in 1000 annual probability flooding from the sea (0.5%-0.1%) in any one year.
- **Flood Zone 3.** This zone comprises of land assessed as having a 1 in 100 year or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

3.1.5. Depending upon the NPPF flood risk vulnerability classification, and the Flood Zone in which the Proposed Scheme is designated, a Sequential and / or an Exception Test may be required. The Sequential Test ensures that alternative sites at lower flood risk are considered as part of the application, and that new developments are steered to areas with the lowest probability of flooding. An Exception Test may be needed to demonstrate that flood risk will be managed appropriately, that the development is safe for its lifetime, and that the wider sustainability benefits to the community outweigh the flood risk.

Flood and Water Management Act

3.1.6. The Flood and Water Management Act (FWMA) 2010 provides for better, more comprehensive management flood risk for people, homes and business estates. The Act states that the Lead Local Flood Authorities (LLFAs) (either unitary authorities or county councils) are responsible for developing and maintaining a register of flood risk assets. They also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses. Norfolk County Council is the LLFA in the area of the Proposed Scheme.

3.1.7. In 2012, various amendments were introduced to the FWMA 2010. Amongst other changes the amendments specified some new duties and responsibilities of the LLFAs, namely LLFAs must:

- Prepare and maintain a strategy for local flood risk management in their areas, coordinating views and activity with other local bodies and communities through public consultation and scrutiny, and delivery planning;
- Investigate significant local flooding incidents and publish the results of such investigations;
- Play a lead role in emergency planning and recovery after a flood event

3.1.8. An essential part of managing local flood risk will be taking account of new development in any plans or strategies.

3.1.9. The Act also states that if a flood happens, all local authorities are ‘category one responders’ under the Civil Contingencies Act. This means they must have plans in place to respond to emergencies, and control or reduce the impact of an emergency. LLFAs also have a duty to determine which risk management

authorities have relevant powers to investigate flood incidents to help understand how they happened.

Local policies

3.1.10. The relevant policies within the Joint Core Strategy for Broadland, Norwich and South Norfolk (Broadland District Council, 2014) in relation to flood risk are summarised below:

- Policy 1: addressing climate change and protecting environmental assets. Development should be located to minimise flood risk and mitigate any such risk through design and the implementation of sustainable drainage

3.1.11. The relevant policies within the Broadland District Council Development Management DPD (Broadland District Council, 2015) are summarised below:

- Policy CSU5 – Surface water drainage. Development should not increase flood risk elsewhere. Development should not:
  - increase the vulnerability of the site, or wider catchment, to flooding from surface water runoff
  - wherever practicable, development should have a positive impact on surface water flooding in the wider area

3.1.12. Norfolk County Council also provide guidance to developers on their role as LLFA and the information required from developers as part of planning applications (Norfolk County Council, 2020)

3.2. Climate change

3.2.1. For site specific flood risk assessments, the NPPF (MHCLG, 2018), Section 14 (Meeting the challenge of climate change, flooding and coastal change) states;

"163. When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported *by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*

- *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location*
- *the development is appropriately flood resistant and resilient;*
- *it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- *any residual risk can be safely managed; and*

- *safe access and escape routes are included where appropriate, as part of an agreed emergency plan."*

3.2.2. In addition to this, it also states:

"149. Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes… . Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for *the possible future relocation of vulnerable development and infrastructure."*

3.2.3. The current online PPG climate change allowance guidance (Environment Agency, 2020c) establishes the climate change allowances for river, rainfall and tidal sources for different regions of the UK. The PPG climate change allowance guidance (Environment Agency, 2020c) states the peak rainfall intensity (to assess surface water flood risk) climate change allowance is 20% and 40% for the 'Central' and 'Upper end' categories respectively for a time horizon of 2080s (2070 to 2115).

3.2.4. The guidance on climate change allowances is similar in DMRB CG 501, the Design of highway drainage systems (Highways England 2020b). The carriageway drainage shall be designed for a 20% uplift in peak rainfall intensity due to climate change together with a sensitivity test of 40% uplift in peak rainfall intensity.

3.2.5. The PPG climate change allowance guidance also states that the potential change in peak river flow ('Upper end' estimate in 2080s as the Proposed Scheme is classified as 'essential infrastructure' with a development lifetime of 100 years) would be 65% in the Anglian river basin district.

3.2.6. NNNPS policy (2014) relevant to flood risk is summarised below:

- The applicant should:
  - Consider the risk of all forms of flooding arising from the project (including in adjacent parts of the United Kingdom), in addition to the risk of flooding to the project, and demonstrate how these risks will be managed and, where relevant, mitigated, so that the development remains safe throughout its lifetime.
  - Take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made;
  - Consider the vulnerability of those using the infrastructure including arrangements for safe access and exit.

- Include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project.
- Consider if there is a need to remain operational during a worst-case flood event over the development's lifetime.
- Provide the evidence for the Secretary of State to apply the Sequential Test and Exception Test as appropriate.

- The Secretary of State should be satisfied that flood risk will not be increased elsewhere and should only consider development appropriate in areas at risk of flooding where it can be demonstrated that:
  - Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location.
  - Development is appropriately flood resilient and resistant, including safe access and escape routes where required; and that any residual risk can be safely managed, including by emergency planning; and that priority is given to the use of Sustainable Drainage Systems (SuDS).

4. Description of the Proposed Scheme

4.1. Existing site description

4.1.1. The A47 trunk road forms part of the Strategic Road Network (SRN) and provides for a variety of local, medium and long-distance trips through Norfolk to the eastern coastline. The Proposed Scheme is located approximately 9 kilometres to the east of Norwich. The section of single carriageway from Blofield to North Burlingham forms part of the main arterial highway route connecting Norwich and Great Yarmouth.

4.1.2. The existing 2.6km single carriageway section of the A47 from Blofield to North Burlingham acts as a bottleneck resulting in congestion and leading to longer and unreliable journey times. This section of the A47 also has a poor safety record.

4.1.3. The Proposed Scheme is located within the district of Broadland District Council and within the administrative boundary of Norfolk County Council. The area surrounding the Proposed Scheme is generally flat and elevations vary between 10m and 20m above sea level. The area is predominantly rural with arable farming representing the major land use. The villages of Blofield and North Burlingham are located as the western and eastern extents of the Proposed Scheme respectively, with several isolated residential properties and agricultural buildings adjacent to the middle portion of the Proposed Scheme.

4.1.4. The Highways Agency Drainage Data Management System (HA DDMS) (Highways England, 2020a) provides some details on the current drainage arrangements at the site. These are summarised below:

- The eastern end of the Proposed Scheme is currently drained by a network of carrier drains which outfall to 10 soakaway chambers.
- The central section of the Proposed Scheme is currently drained by several grip inlets suggesting runoff from the carriageway is routed locally to an adjacent ditch or grip.
- The western end of the Proposed Scheme is currently drained by a network of carrier drains which outfall to 10 soakaway chambers.
- HA DDMS did not indicate the presence of any existing attenuation features or pollution control devices within the existing drainage networks.

4.1.5. The western and eastern extents of the Proposed Scheme are partly urbanised. In these locations, surface water drainage is governed by local authority surface water and highways drainage networks as well as the Anglian Water sewerage network. A review of HA DDMS (Highways England, 2020a) suggests that the existing A47 drainage network does not connect with the local sewerage or

highways drainage networks. This was confirmed by existing services drawings provided by Anglian Water.

4.2. Description of the Proposed Scheme

4.2.1. The Proposed Scheme aims to address the above issues by providing a high-quality dual carriageway link. Further details of the Proposed Scheme can be found in ES Chapter 2 The Proposed Scheme (**TR010040/APP/6.1**).

4.2.2. The Proposed Scheme will involve:

- 2.6km of dual carriageway on the A47.
- de-trunking of the existing A47 section between Blofield and North Burlingham
- improvements at Yarmouth Road Junction, including closure of the central reserve, closure of High Noon Lane direct access, merge lane, realignment of Waterlow and local access improvements at the Sparrow Hall properties
- introduction of a compact grade separated junction at B1140 junction, including the B1140 Overbridge
- a new overbridge at Blofield traversing the proposed A47 dual carriageway, connecting Yarmouth Road with the existing A47
- provision of new drainage systems including an infiltration basin and retention of existing drainage systems where possible
- a retaining wall in the western extents
- introduction of lighting at the Yarmouth Road junction and new lighting layout at the B1140 Junction
- closure of an existing layby and provision of a new layby
- walking and cycling routes connecting Blofield and North Burlingham via the Blofield Overbridge to the west and the B1140 Overbridge to the east
- provision of North Burlingham Access
- an agricultural access track
- fencing, safety barriers and signage
- environmental mitigation
- diversions of a medium pressure gas main and other utilities

4.2.3. Further details of the Proposed Scheme including a description of the proposed drainage can be found in the ES Chapter 2 (The Proposed Scheme (**TR010040/APP/6.1**)) and a scheme overview is provided in ES Figure 1.1 (**TR010040/APP/6.3**). Further details of the proposed drainage can be found in the Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.1**)) and in Section 8.2 of this report.

4.2.4. For the purposes of the FRA alone, the lifetime of the development is considered to be 100 years.

Study area

4.2.5. The study area is defined in ES Chapter 13 Road drainage and the water environment (**TR010040/APP/6.1**) and in ES Figure 13.1 (**TR010040/APP/6.2**).

4.3. Existing hydrology and hydrogeology

Hydrology

4.3.1. There are several unnamed surface water features within the site. A site walkover in March 2020 identified a total of 13 drainage ditches and five culverted pipes (Figure 4-1).

4.3.2. The drainage ditches within the site typically run along the edge of fields that are located adjacent to a road. The ditches were unconnected to the wider river network and contained only standing water.

4.3.3. All the water features within the study area are designated as ordinary watercourses and as such, matters pertaining to flood risk on these watercourses is the responsibility of the Lead Local Flood Authority (Norfolk County Council).

4.3.4. Run Dike (an Environment Agency designated main river) is a tributary of the River Yare, located 1km south-west of the site which flows in a southerly direction, to the west of Blofield. A tributary to the Run Dike originates 580m away from the site, crossing under Braydeston Hall Lane.

4.3.5. There are no canals, reservoirs or lakes within the vicinity of the Proposed Scheme.

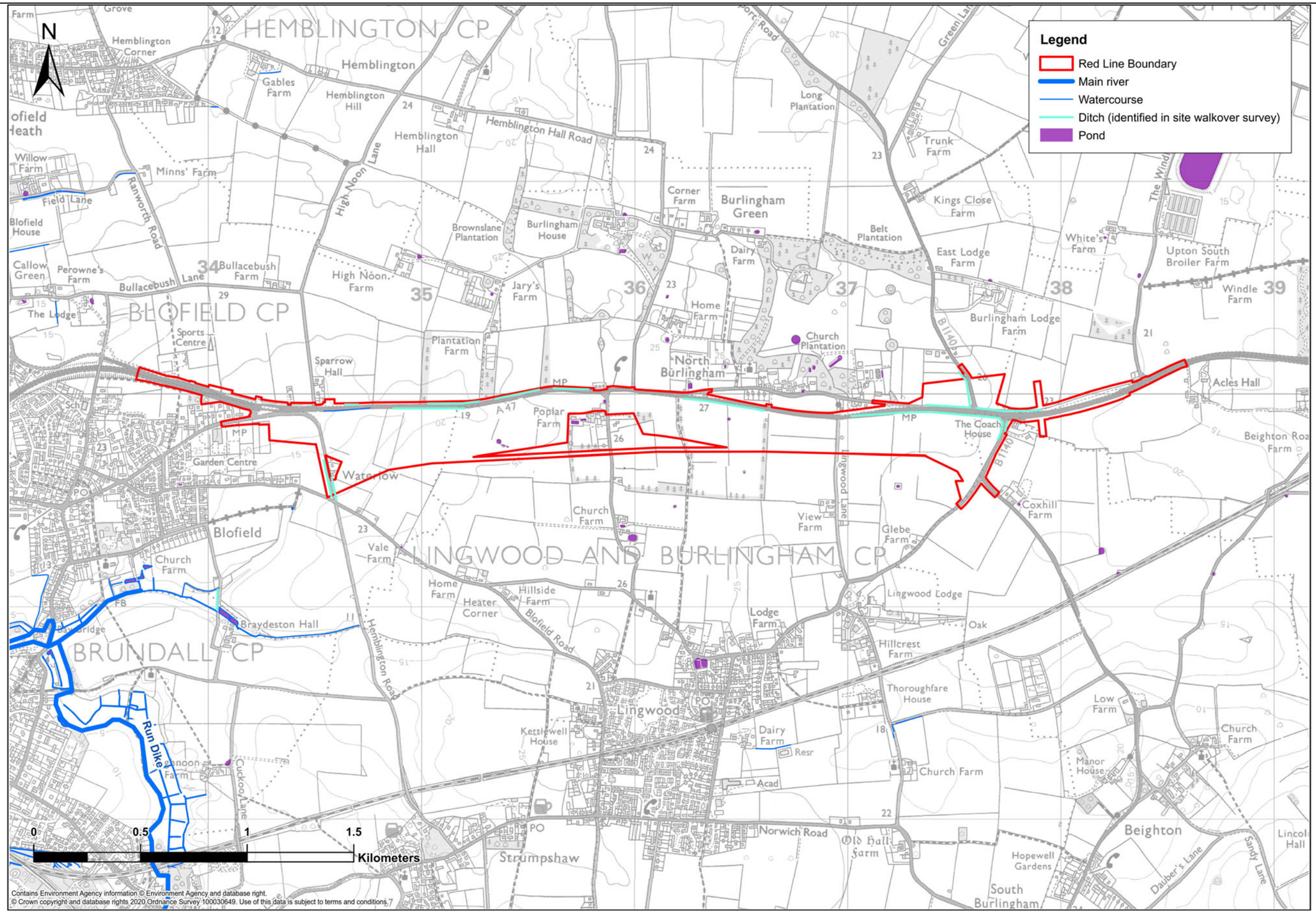

Figure 4-1 The Proposed Scheme area and water surface features. The red line is the Proposed Scheme boundary.

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Hydrogeology

4.3.6. The geology of the area can be an important influencing factor on the way the water runs off the ground surface causing adverse flood risk affects elsewhere. This is largely due to variations in the superficial (permeable, unconsolidated deposits) and bedrock (solid permeable) stratigraphy. The Greater Norwich Area Strategic Flood Risk Assessment (JBA Consulting,2017) classifies these as follows:

- Principal: layers of rock or drift deposits with high permeability which, therefore, provide a high level of water storage
- Secondary A: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- Secondary B: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- Secondary undifferentiated: rock types where it is not possible to attribute either category a or b
- Unproductive Strata: rock layers and drift deposits with low permeability and therefore have negligible significance for water supply or river base flow.

4.3.7. The majority of the study area has a cover of superficial geology. The area is underlain with the Secondary A aquifer, the Happisburgh Glacigenic Formation Sand and overlain by the Secondary (undifferentiated) aquifer, the Lowestoft Formation Diamicton. However, there are areas of no recorded superficial cover to the north-west of Braydeston Hall.

4.3.8. To the south of Blofield, the Crag Group and Bytham Sand and Gravel Formation (undifferentiated) and Lowestoft Formation Sand and Gravel are present at surface. These are classified as Secondary A aquifers. The Breydon Formation Peat is also present in this area and is classified as Unproductive Strata.

4.3.9. The bedrock geology underlying the study area is the Norwich Crag, which is classified as a Principal Aquifer, and is likely in hydraulic continuity with the underlying Chalk.

4.3.10. The bedrock and superficial aquifers have a combined groundwater vulnerability classification of Medium to High risk with small areas of Low and Medium – Low risk in the west and southwest.

4.4. Summary of consultation

4.4.1. The Environment Agency, Anglian Water and Norfolk County Council responded to the EIA Scoping Report[1] (Highways England, 2018) via the Planning Inspectorate. The responses relevant to flood risk which were documented in the Scoping Opinion (Planning Inspectorate, 2018 (**TR010040/APP/6.6**)) are summarised below:

- Norfolk County Council, acting as the LLFA, provided a map showing overland flow routes during periods of heavy rainfall
- Acknowledgment and reference to the Greater Norwich Area Strategic Flood Risk Assessment; Final Report: Level 1 must be made
- The FRA must include an assessment of groundwater flooding and a consideration of climate change and any necessary mitigation
- Drainage proposals must incorporate SuDS, where appropriate and carefully consider proposals for infiltration drainage. Any infiltration drainage must be supported by appropriate on-site 'soakaway' testing. SuDS schemes should be designed to provide for habitat enhancement.
- Anglian Water must be consulted as part of the FRA, if any connections to the public sewerage network are proposed
- Mitigation, through the form of 'dry culverts' must be provided to maintain continuity of any surface water flooding flow paths that may be interrupted by the Proposed Scheme
- Any new hydraulic structures, including 'dry culverts', must be designed to convey flows during a 1 in 100-year event including an allowance for future climate change
- Drainage mitigation should provide sufficient attenuation for a 1 in 100-year event including an allowance for future climate change
- Any works in or near to ordinary watercourses would require consent from the LLFA

4.4.2. A meeting was held with the Environment Agency and LLFA on 24 May 2018. Minutes of relevant meetings with these organisations are given in Annex A (Consultation Responses) and the key points are summarised below:

- The LLFA had informal accounts of flooding on the A47 resulting from overland surface water flow paths. The Proposed Scheme must accommodate these flow paths through the use of 'dry culverts'. Siting of the culverts must be based on topographic survey rather than relying on LiDAR data

[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010040/TR010040-000009-BLOF%20Scoping%20Report.pdf

- The LLFA requested that Norfolk County Council Highways department be consulted with regards to the nature of the pond at Lingwood Road and whether this receives highways runoff
- The LLFA stated that drainage design should be tested against a 40% allowance for climate change
- Any 'dry culverts' or alterations to ordinary watercourses would require consent from the LLFA
- The LLFA advised of the importance of reliable infiltration testing to inform the drainage design
- The assessment of climate change on groundwater features should take the form of a simple qualitative assessment. Currently Environment Agency projections suggest annual groundwater recharge would remain the same but with altered seasonal timing
- The Environment Agency requested that proposed groundwater monitoring as part of the ground investigation (GI) should allow for monitoring of groundwater levels until at least spring 2019

4.4.3. The Environment Agency provided comments on the draft Flood Risk Assessment on 17 August 2020 and, in particular, on tidal flood risk information for the River Yare and Witton Run. The FRA has been updated in response to this information.

4.4.4. Norfolk County Council provided comments on the draft Drainage Strategy and draft Flood Risk Assessment reports in August 2020 and a meeting was held on 24 and 25 September to discuss the comments. Norfolk County Council's comments on the Flood Risk Assessment have been addressed subject to review by the Council.

5. Existing sources of flooding

5.1. Potential sources of existing flood risk

5.1.1. Existing sources of flood risk that would potentially affect the Proposed Scheme must be assessed to determine the baseline conditions. Any impacts arising from the Proposed Scheme can then be evaluated. The assessment utilises existing flood information and will inform mitigation strategies, where required. All remaining site-relevant potential sources of existing flood risk include:

- Fluvial (rivers and tidal influences);
- Pluvial (surface water);
- Risk of flooding from sewers, and;
- Groundwater

5.1.2. There are no canals within the vicinity of the Proposed Scheme and there is no risk of flooding from reservoir failure, as such, these have not been considered as part of this assessment.

5.2. Historical flooding

5.2.1. The Greater Norwich SFRA (JBA Consulting, 2017) provides details on a number of flood events which affected the Greater Norwich area between 1273 and 2017. Coastal flooding events affected the Yare and Bure catchments in 1608, 1897, 1953, 1976, 1983, 1993, 2007 and 2013. A rainfall and snowmelt flooding event occurred in 1878. A number of these floods resulted in fatalities and damage to hundreds or thousands of properties. Heavy rainfall caused flooding within the Yare and Bure catchments in 1762, 1912, 1968, 1981, 1993, 2014, and 2017 where between tens and hundreds of properties were flooded.

5.2.2. The Greater Norwich SFRA (JBA Consulting, 2017) indicated that there have been 14 incidents of sewer flooding on the DG5 register in the Blofield / Strumpshaw postcode area.

5.2.3. The Norwich Urban Area SWMP (Norfolk County Council, 2011b) indicates that the Proposed Scheme area is not part of a Critical Drainage Area for surface water flooding. Norfolk County Council have records (Norfolk County Council, 2015b) of a single property on Norwich Road, Strumpshaw (approximately 2 km south of the Proposed Scheme) flooding internally in 2014 due to surface water flows; the public highway was also flooded.

5.2.4. Norfolk County Council has provided two pre-application surface water assessments at two locations within the Proposed Scheme boundary (Annex C).

One assessment (FW2020_0695_6) is centred on a location on the existing A47 approximately 500m east of Hemblington Road and lies on an area of high surface water flood risk. There are no incidents of internal property flooding (since April 2012) or properties included on the Anglian Water DG5 register within 500m of this location. There are 29 known incidents of internal flooding recorded by Norfolk County Council since April 2012 within 2.5km although no details of property flooding. The other assessment (FW2020_0695_7) is centred on a location on the existing A47 south of the village of North Burlingham and lies on an area of low surface water flood risk. There are no incidents of internal property flooding (since April 2012) or properties included on the Anglian Water DG5 register within 500m of this location. There are 13 known incidents of internal flooding recorded by Norfolk County Council since April 2012 within 2.5km although no details of property flooding.

5.2.5. The Highways Agency Drainage Data Management System (HA DDMS; (Highways England, 2020a) identified a number of previous flooding events on the A47 carriageway both inside and within 1km of the Proposed Scheme boundary (Figure 5-2). The flood impact is classified in terms of a flood severity index (FSI) based on road type, extent of closure, traffic flow and duration of closure and ranges from zero to ten (Highways England, 2020a):

- Events within Proposed Scheme boundary:
  - five very low severity (FSI rating 0-2) flood events between 2012 and 2018 east of North Burlingham where the carriageway and the layby were flooded
  - one low severity (FSI rating 3-4) flood event in June 2020 east of North Burlingham where the carriageway and layby were flooded
  - these events form part of a wider flooding hotspot with a ‘very high’ risk status which extends east more than 1km away from the Proposed Scheme boundary
- Events outside Proposed Scheme boundary:
  - two low severity events (FSI rating 3-4) in 2013 in the Blofield area where the carriageway was flooded.
  - these events form part of a wider flooding hotspot with a ‘not determined’ risk status which extends west, more than 1km away from the Proposed Scheme boundary. This includes the flood event of October 2019 described below.

5.2.6. No further information was available on HA DDMS (Highways England, 2020a) to indicate the cause of flooding except for three events which were known to be caused by blocked gullies.

5.2.7. On 6 October 2019, a section of the A47 in the Blofield area, outside of the Proposed Scheme area was forced to close due to a heavy rainfall event. This was part of much more widespread flooding throughout Norfolk after a wet September (151% of normal expected rainfall) followed by an intense rainfall event (up to 69mm) on the 6 October. During this event, 24 properties within the Lackford Run catchment were flooded internally, including a number of residential properties in Blofield, although these were located outside the Proposed Scheme boundary (Norfolk County Council, 2019b). During the same flood event, the A47 was closed by Norfolk Police due to flooding to the west of Blofield (outside of the Proposed Scheme). The Norfolk County Council Flood Investigation Report (Norfolk County Council, 2019a) recommended that Highways England should examine options to ensure water does not pool on the highway and to review the maintenance regime required to sustain the design efficiency of the drainage system.

5.2.8. Highways England are investigating the known flooding hotspots on HA DDMS to the east and west of the Proposed Scheme, including the October 2019 flooding event, and will review options to remediate the risk of flooding to the existing A47 carriageway. However, these works will be undertaken separately from the Proposed Scheme.

5.3. Fluvial and tidal flood risk

5.3.1. Fluvial flooding arises from high water levels in watercourses breaching the banks of the channel and flooding surrounding land. The whole of the site is within Flood Zone 1 (less than a 0.1% or 1 in 1000-year annual chance of flooding) and at a low risk to fluvial and tidal flooding, as evidenced by Figure 5-1.

5.3.2. The Environment Agency maps indicate that the Proposed Scheme is not adjacent to any flood storage areas nor is the Proposed Scheme contained within an area benefitting from flood defences.

5.3.3. Located approximately 750m from the site, Run Dike, the River Yare and the associated surrounding land are within Flood Zone 2 and 3a. At this location, the Run Dike is both fluvially and tidally influenced.

5.3.4. As stated in paragraph 3.2.7, the PPG climate change allowance for fluvial flood risk is a 65% increase in peak river flows by the 2080s. No information was available from the SFRA (JBA Consulting, 2017) with regards to this; however, the Environment Agency has confirmed that it is acceptable to use Flood Zone 2 as an indicator of the extent of the climate change impact on the 1 in 100-year flood event (Flood Zone 3). The peak river flow in the River Yare for a 1 in 1000-

year event is 1.85mAOD and therefore there will be no additional fluvial flood risk to the Proposed Scheme as a result of climate change.

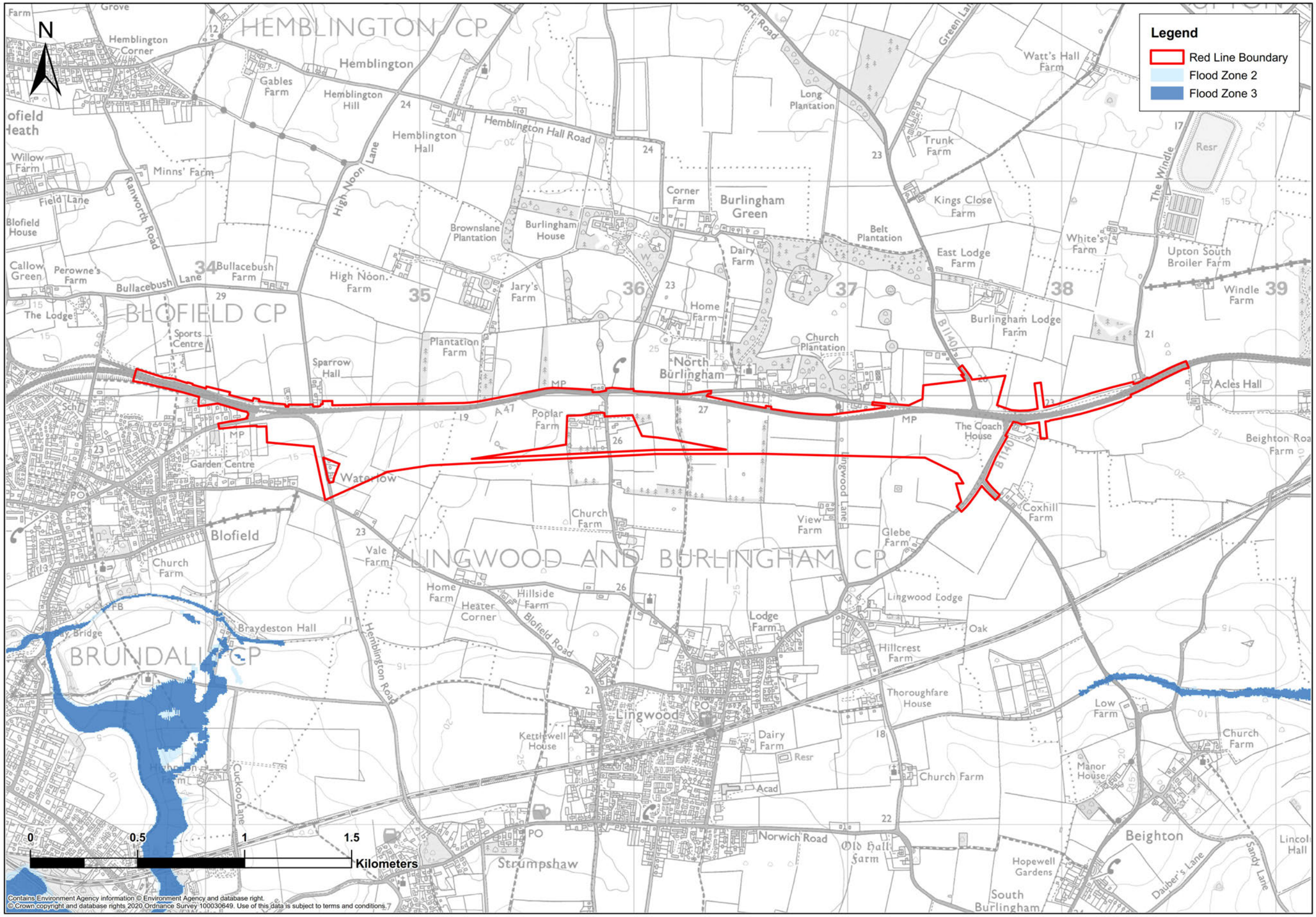

Figure 5-1 The Proposed Scheme area and the Flood Zones. The red line is the Proposed Scheme boundary.

5.3.5. Sea level rise due to climate change is expected to increase the risk of tidal flooding. Information provided by the Environment Agency states that the peak 1 in 1000-year tidal level including sea level rise based on UKCP18 climate change projections is 1.75mAOD. Therefore, the Proposed Scheme will not be at additional risk of tidal flooding as a result of climate change.

5.4. Pluvial (surface water) flood risk

5.4.1. Surface water flooding occurs when intense rainfall is unable to infiltrate into the ground or enter the drainage system sufficiently quickly to prevent water ponding and then flowing on the surface. The Greater Norwich SFRA (JBA Consulting, 2017) highlighted the main areas at risk of surface water flooding which are located away from the Proposed Scheme.

5.4.2. The Environment Agency's Risk of Flooding from Surface Water Map (Environment Agency, 2020a) indicates that the majority of the Proposed Scheme is at very low risk (less than 1 in 1000 (<0.1%) chance of flooding occurring each year). However, as Figure 5-2 indicates, there are isolated areas of elevated risk:

- There are areas of medium risk (less than 1 in 30 (3.3%) or greater than or equal to 1 in 100 (1%) chance in any given year) and high risk (greater than 3.3% in any given year) within the site. These areas are largely associated with a surface water flood flow path running south west from the western edge of Blofield towards Run Dike.
- A number of areas of low risk (between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of flooding each year) within the site can be attributed to localised ponding. Two converging flow paths flow south, towards the A47, east of Blofield where the left fork is diverted to a 0.2m diameter pipe which flows beneath the road. Upon survey, it was unclear if the right fork is culverted beneath the road. These pathways link with the aforementioned flood flow path which runs towards Run Dike.

5.4.3. It is noted, however, that the derivation of the Risk of Flooding from Surface Water map (Environment Agency, 2020a) includes general assumptions for drainage which may not be representative of local conditions and hence should be treated with caution.

5.4.4. As part of the consultation response to the Scoping Report (Highways England, 2018), Norfolk County Council also provided a map of potential surface water flow pathways.

5.4.5. Information on HA DDMS (Highways England, 2020a) indicated a total of 8 previous flood events within 1km of the site and associated with flooding hotspots within the A47 drainage network. These were largely as a result of

blocked gullies (see Section 5.2 Historical flooding) and it does not appear that the previous flooding events within the site highlighted on HA DDMS coincide with those shown on the surface water flood map (see Figure 5-2).

5.4.6. Parts of the A47 to the west of Blofield, more than 1km from the Proposed Scheme boundary, were closed during significant widespread flooding throughout Norfolk in October 2019 (Norfolk County Council, 2019a). During the same event, a number of properties within Blofield were flooded internally (see Section 5.2 Historical flooding).

5.4.7. The PPG climate change allowance guidance for peak rainfall intensity is 40% for the 'Upper end' category for a time horizon of 2080s. The Greater Norwich Area SFRA (JBA Consulting, 2017) has mapped the potential increase in the 1% annual chance of flooding from surface water flood risk with an allowance for climate change. Climate change increases the impact of surface water flooding along the existing flow pathway which crosses the western part of the Proposed Scheme, leading to Run Dike (Figure 5.1). In addition to this, there is likely to be an increase in surface water ponding distributed across the site.

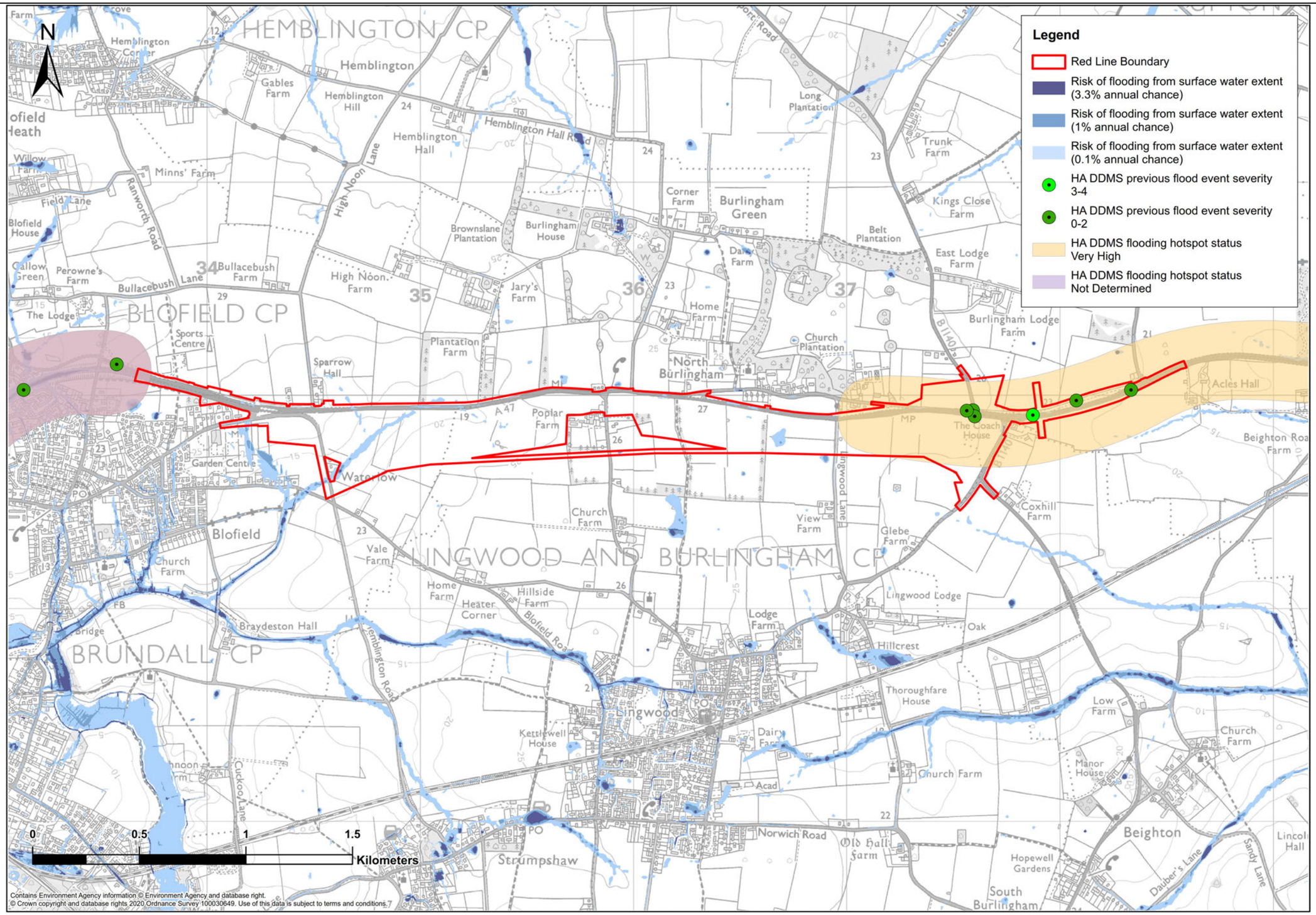

Figure 5-2 The Proposed Scheme indicating the surface water flood risk extent and the previous flood events and flooding hotspots identified by HA DDMS (Highways England, 2020a). The red line is the Proposed Scheme boundary.

5.5. Risk of flooding from sewers and drainage infrastructure

5.5.1. The Proposed Scheme lies within a largely rural area where the only drainage infrastructure is that pertinent to the existing A47 carriageway and associated side roads (see Section 4.1 Existing site description). Only the far western and eastern extents are contained with the partly urbanised areas of Blofield and North Burlingham, respectively. Existing services drawings show the drainage network of the existing A47 carriageway is isolated from the local networks.

5.5.2. Furthermore, the Greater Norwich SFRA (JBA Consulting, 2017) indicated a total of 14 incidents of sewer flooding from the DG5 register in the Blofield / Strumpshaw postcode area. No further detail on the precise locations, dates or extents of these flood events was available, however.

5.6. Groundwater flood risk

5.6.1. Figure 5-3 shows the British Geological Survey (BGS; British Geological Survey, 2020) groundwater flooding susceptibility for the area encompassing the Proposed Scheme. The entirety of the Proposed Scheme has limited potential for groundwater flooding to occur.

5.6.2. A ground investigation commencing in 2018 collected groundwater levels over an 11-month monitoring period between September 2018 and September 2019. Minimum groundwater depths below ground level (m bGL) range from 6.36m bGL at BH07 and 20.83m bGL at BH18. A location plan of the monitoring boreholes is found in ES Figure 13.4 (Ground investigation boreholes (**TR010040/APP/6.3**)). BH07 is located towards the western end of the Proposed Scheme and BH18 is located at the eastern end of the Proposed Scheme, near the B1140.

5.6.3. There is no potential for groundwater flooding to occur at surface in the Proposed Scheme. The groundwater susceptibility dataset is only available for a 500m corridor around the existing road, and as such there is no information available for the areas to the south of the Proposed Scheme that may be required for the drainage regime.

5.6.4. Climate change predictions suggest that the future annual recharge volumes for groundwater are broadly stable although the groundwater recharge season is likely to condense into a shorted period, leading to more variable groundwater levels. However, considering the significant depth to groundwater below the Proposed Scheme, climate change is not likely to result in groundwater flood risk.

5.6.5. The groundwater flood risk to the Proposed Scheme is therefore considered low.

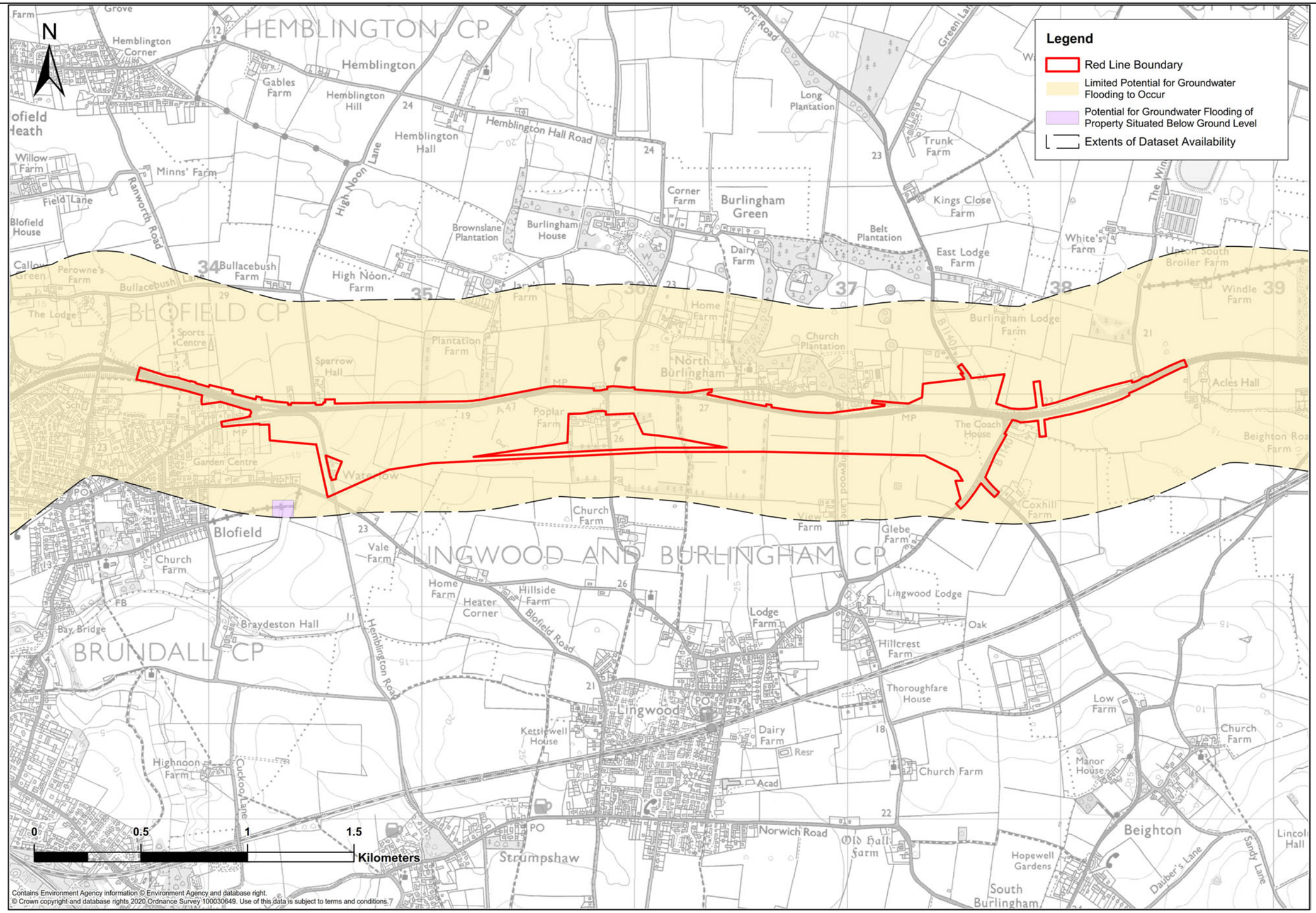

Figure 5-3 The Proposed Scheme indicating the BGS (2020) susceptibility to groundwater flooding. The red line is the Proposed Scheme boundary.

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5.7. Summary of existing flood risk to the Proposed Scheme

5.7.1. The entirety of the Proposed Scheme is located within Flood Zone 1. There is no historic record of fluvial flooding and there are no main rivers or large watercourses that form part of a river network. As such, the Proposed Scheme is at low risk of fluvial or tidal flooding.

5.7.2. The majority of the Proposed Scheme is at very low risk of surface water flooding. Within the site there are instances of low to high risk, one of which is a flow pathway that crosses the Proposed Scheme in a south westerly direction from the western edge of Blofield towards Run Dike. A site walkover identified two converging flow pathways flowing south towards the A47, where one is diverted under the road via a 0.2m diameter pipe. It is unclear if the other is culverted beneath the road.

5.7.3. There is a history of parts of the existing A47 within and outside of the Proposed Scheme boundary being affected by flooding probably due to heavy rainfall or blocked drainage infrastructure. A flood event in October 2019 resulted in closure of the A47 to the west of Blofield more than 1km from the Proposed Scheme area. Highways England are investigating the cause of flooding in the flooding hotspots that lie to the west and east of the Proposed Scheme in order to remediate the flooding.

5.7.4. Based on the available information, the Proposed Scheme is at low risk of flooding from sewers or other drainage infrastructure.

5.7.5. The majority of the Proposed Scheme has limited potential for groundwater flooding to occur.

5.7.6. Climate change will not increase the risk of flooding to the Proposed Scheme from groundwater, tidal or fluvial sources. Climate change is likely to increase surface water flood risk to the Proposed Scheme. According to the SFRA (JBA Consulting, 2017), the most significant impact is on the flow pathway crossing the Proposed Scheme, leading to Run Dike.

5.7.7. The Proposed Scheme is not at risk of flooding from canals or as a result of reservoir failure.

6. Sequential test

6.1.1. The Proposed Scheme is for construction of a new dual carriageway and partial upgrade to a pre-existing road. The proposed development, which will consist of a length of new dual carriageway, junction improvements, two new overbridges and upgrade to side roads, would have a footprint of greater than 1 hectare. According to Table 2 of the NPPF PPG: flood risk vulnerability classification table (MHCLG, 2016) the Proposed Scheme is classified as 'Essential Infrastructure'

6.1.2. Section 5.3 (Fluvial and tidal flood risk) indicated that the Proposed Scheme is within Flood Zone 1. According to Table 3 of the NPPF PPG on flood risk and coastal change (MHCLG, 2016), "essential infrastructure" is permitted within Flood Zone 1 (see Table 6-1 below). Therefore, the Proposed Scheme is 'appropriate' development and meets the requirements of the Sequential Test. As such, the Exception Test is not required for the Proposed Scheme.

Table 6-1: Flood Risk Vulnerability and Flood Zone Compatibility - National Planning Policy Framework

Flood Risk Vulnerability Classification	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a †	Exception Test Required †	×	Exception Test Required	✓	✓
Zone 3b *	Exception Test Required*	×	×	×	✓*

Key	
✓	Development is appropriate
×	Development should not be permitted
†	In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.
*	In Flood Zone 3b (functional floodplain) essential infrastructure that must be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to: • Remain operational and safe for users in times of flood; • Result in no net loss of floodplain storage; • Not impede water flows and not increase flood risk elsewhere.

7. Flood risk to others

7.1.1. The potential impacts of the Proposed Scheme on fluvial, surface water and groundwater flood risk to others is a key consideration. The Proposed Scheme would not increase the risk of reservoir, sewer or canal flooding to others.

7.2. Fluvial and tidal flood risk

7.2.1. The Proposed Scheme is entirely located in Flood Zone 1 and does not cross any main rivers or ordinary watercourses as part of the wider river network. The proposed drainage design will not discharge to surface water. Therefore, there would be no increase in fluvial and tidal flood risk as a result of the Proposed Scheme.

7.3. Surface water flood risk

7.3.1. There is a potential for an increase in surface water runoff rate and volume from the Proposed Scheme due to the increase in areas of hardstanding. An increase in the rate of surface water runoff tends to exacerbate downstream flood risk by, for example, overloading sewers or gullies, exceeding the capacity of watercourses, culverts and other associated drainage infrastructure. All surface water runoff would be discharged to ground.

7.3.2. The majority of the Proposed Scheme area is agricultural land which can be expected to generate runoff at typical greenfield rates. An increase in areas of hardstanding as part of the Proposed Scheme will, without mitigation, alter and increase rates and volumes of runoff when compared to greenfield conditions. Any interception of surface water flood flow pathways made by construction of the Proposed Scheme could cause localised flooding by diverting flood risk on to others or to the Proposed Scheme itself.

7.4. Groundwater flood risk

7.4.1. Although the proposed drainage design discharges to ground, this reflects the existing situation and does not result in a significant increase in recharge to groundwater. There is therefore no risk of increased groundwater flooding anticipated from the development post-construction.

8. Flood risk mitigation

8.1.1. Mitigation measures as a result of an increase in surface water flood risk to others have been assessed. The increase in fluvial, tidal and groundwater flood risk from the Proposed Scheme to others is considered negligible, therefore no mitigation is required.

8.2. Sustainable drainage systems (SuDS)

8.2.1. The overall philosophy of the Proposed Scheme drainage is to dispose of additional impermeable surface runoff entirely using infiltration based methods. Further details are provided in the Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.2**)) and the drainage layout plans are shown in Annex B. Deep soakaway designs have been considered necessary on the Proposed Scheme due to space restrictions to attain volumes of storage, inadequate infiltration test results at shallower depths and the avoidance of flow paths to properties downstream. In addition, due to the flat topography of the Proposed Scheme and the requirements for cover to the pipework in the road and fields, the road drainage network inlets to soakaways are already at least 2.0 m below ground. Considering Norfolk County Council's guidance (Norfolk County Council, 2020) on the SuDS hierarchy, shallow infiltration methods are preferred over surface water disposal, then sewer disposal and then deep infiltration. Surface water disposal options were considered including an attenuation pond in the location of the proposed infiltration basin (PR1) with an outfall to a tributary of Run Dike approximately 1km away; however, this was discounted due to the very low flows in the tributary that meant it was effectively acting as a soakaway outfall which was also in close proximity to source protection zone SPZ 3.

8.2.2. The Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.2**)) also provides details, including locations, of the infiltration testing that was undertaken to inform the placement of infiltration features as part of the drainage design development. The infiltration test results, undertaken as part of the ground investigations in 2018, presented in the Drainage Strategy (Annex D Technical Note on Deep Drainage) highlight that the infiltration capacity of both the Lowestoft Formation and the Happisburgh Glacigenic Formation is variable. Hydraulic modelling has used the infiltration results to confirm the half drain times and confirm the soakaway and basin sizing. Further infiltration testing will be required in locations not previously tested as part of a supplementary ground investigation scheduled for late 2020.

8.2.3. The drainage of the Proposed Scheme will include SuDS elements and shall be designed in accordance with relevant guidance in the DMRB (Highways England, 2019b; 2020a; 2020b). All of the Proposed Scheme will be drained via infiltration methods, mostly through soakaways and also through an infiltration

basin located towards the western end of the Proposed Scheme. As such, there will be no requirement to provide attenuation in order to maintain existing greenfield surface water runoff flow rates. The soakaways will be separated into those receiving road runoff and some embankment drainage (via filter drains, catch pits and carrier drains) and those receiving clean runoff from natural overland flow, some embankments and other green areas (via cross-drains and interceptor ditches). The drainage layout plans in Annex B identify the areas of highway drainage draining to soakaway.

8.2.4. The drainage design for the Proposed Scheme also ensures that any flooding up to and including the 1 in 100 year event with an allowance for climate change is contained within the highway boundary.

8.2.5. Table 8.1 below summarises the contributing areas and design volumes of the proposed soakaways receiving runoff from the new impermeable surfaces. Further detail, including soakaway dimensions, is available in the Drainage Strategy report (ES Appendix 13.2 (**TR010040/APP/6.2**)) and the highway drainage area catchment plans are provided in Annex B. The infiltration basin and soakaways receiving road runoff have been designed to accommodate a 1 in 100-year storm plus a 20% allowance for climate change. Hydraulic modelling of these soakaways in MicroDrainage 2019.1 (Innovyze) confirmed that water levels within the soakaways do not exceed adjacent ground levels or the capacity of the infiltration basin for all events modelled, up to 1 in 100 year with 40% allowance for climate change.

8.2.6. Sub-catchments 5 and 6 (see Table 8.1 and Annex B) drain parts of the Proposed Scheme at the eastern end which ties into the existing A47 carriageway. The impermeable contributing areas remains the same as existing for these catchments, which will discharge to the existing A47 drainage network outside the boundary of the Proposed Scheme. Additional drainage surveys are required to confirm the existing catchment areas.

8.2.7. Sub-catchment 8 (see Table 8.1 and Annex B) drains a local access road, formed from the existing A47, to an existing ditch adjacent to the existing A47 (Figure 4-1). Exceedance flows from this ditch will be conveyed along interceptor ditches and beneath the new A47 via a cross-drain before ultimately discharging to SC4 and SC5 clean water soakaways where it is attenuated. The Proposed Scheme reduces the impermeable contributing areas for this catchment. Sub-catchment 9 follows a similar arrangement before ultimately discharging to SC6 and SC7 clean water soakaways where it is attenuated. A small area of the existing A47 highway, that will become a local access road, drains to a clean water soakaway SC1 along with the natural drainage area; this is not shown on the drainage layout plans in Annex B.

Table 8-1: Soakaway contributing areas and volumes

Drainage sub catchment and soakaway ID	Contributing impermeable area (ha)	Runoff volume (m^3)			Half drain time (hrs)
		1 in 10 years plus 20%CC	**1 in 100 years plus 20%CC**	**1 in 100 years plus 40%CC**	
1 (PR1)	5.532	1586	2154	4350	40
2 (SR1)	1.524	617	1007	1230	9
3 (SR2)	1.527	523	950	1108	6
4 (SR3)	1.209	461	587	643	21
12 (SR4)	0.303	129	190	206	13
10 (SR5)	0.385	111	206	241	23
13 (SR6)	0.214	79	101	111	22
7 (SR7)	0.716	247	318	385	24
11 (SR8)	0.150	36	73	85	3
5	Estimated contributing area = 0.9 ha as existing - outfall to existing A47 drainage. No soakaway or infiltration basin as outfalls to existing A47 drainage				
6	Estimated contributing area = 0.6 ha as existing - outfall to existing A47 drainage. No soakaway or infiltration basin as outfalls to existing A47 drainage				
8	Drainage area = 0.657 ha (decrease from 1.74 ha) - Outfall to interceptor ditch which is routed through cleanwater soakaways SC4 and SC5 in series (see Table 8-3)				
9	Drainage area = 0.3 ha (no increase from existing) - Outfall to interceptor ditch which is routed through cleanwater soakaways SC6 and SC7 in series (see Table 8-3)				

8.2.8. Any discharge for exceedance events (i.e. those in excess of 1 in 100 year plus 40% climate change) shall be routed safely to avoid flooding the road and minimise impact upon adjacent land. Therefore, it is considered that the residual risk of flooding due to exceedance events from the highway drainage will be low.

8.2.9. Given the above mitigation via SuDS measures, it is considered that the Proposed Scheme will not increase surface water flood risk to others as a result of the increase in highway drainage area.

8.2.10. The surface water from the road drainage will follow a treatment train. The initial treatment for the surface water will be provided in the filter drains, where these are provided. Catch pits will capture the initial sediment accumulations which will also serve to collect other potential pollutants, adhering to the sediment. Secondly, the surface water runoff from the new road will discharge to an infiltration basin or to soakaway trenches, providing further treatment of the surface water runoff. Furthermore, penstocks will be provided at all outfalls which will allow the outfall to be shut off manually in the event of a spillage, before flows enter the soakaway trenches or the infiltration basin. The infiltration

basin will include a shallow lined settlement basin / forebay at the inlet to the infiltration basin to capture first flush discharges. Prior to treatment the pollution risk to groundwater is considered low (Annex D of ES Appendix 13.2 (Drainage Strategy) (**TR010040/APP/6.2**)). Further details of the treatment of drainage is provided in the Drainage Strategy (ES Appendix 13.2).

8.2.11. The proposed infiltration basin will provide opportunities for environmental enhancement through the planting of varied forms of species local to the area, in the margins and in areas that will have a through flow albeit with a relatively short residence time. This will improve the effectiveness of the filtration process for pollutants. The infiltration basins will also promote biodiversity as these will include a diverse range of local plants which will provide habitat and food for invertebrates and birds. The proposed basins are designed to be sympathetic with the surrounding landscape which will be further enhanced by the proposed planting. Furthermore, the cross-drains conveying natural catchment flows ('dry culverts') could double as crossing points to allow wildlife to cross the Proposed Scheme and the details of this will be examined at detailed design stage.

8.3. Continuity of surface water flow pathways

8.3.1. Construction of the Proposed Scheme could cause localised flooding by diverting surface water overland flow pathways resulting in increased flood risk to others or to the Proposed Scheme itself. The overland flow route map provided by Norfolk County Council in the Scoping Opinion (Highways England, 2018) alongside a detailed analysis of contributing surface water catchments (see Annex E) was used to determine the appropriate mitigation.

8.3.2. Annex E shows the catchment boundaries and sizes contributing flow to each of the 'dry culverts' as well as the flow paths. The contributing catchment areas are summarised in Table 8-2 below and are shown in Annex C.

Table 8-2 : Cross-drain contributing catchment areas

Catchment	Area (km^2)
C1	0.46
C2	0.46
C3	0.44
C4	0.08
C5	0.13
C6	0.10
C7	0.12

8.3.3. Mitigation shall include the provision of interceptor drains and cross-drains or 'dry culverts' where these pathways have been identified. Cross-drains shall be

designed to convey a 1 in 100-year flow including an additional 65% climate change allowance in order to maintain connectivity of surface water flooding pathways and avoid localised flooding upstream of the Proposed Scheme. Where it was not possible to connect cross-drains directly with their downstream existing surface water pathways, infiltration of flow from the cross-drains via clean water soakaway trenches shall provide attenuation. Exceedance from the clean water soakaways, and directly from cross-drains shall converge with existing overland pathways downstream of the Proposed Scheme. The locations of existing overland flow pathways and the clean water soakaways can be found in Annex B. Due to a lack of detailed topographical survey data, Environment Agency LiDAR has been used to determine flow direction, the size and location of 'dry culverts'. This will be reviewed at detailed design once a detailed topographic survey has been undertaken.

8.3.4. General flow direction in catchment C1 is north to south and this will be maintained by a cross-drain beneath the Proposed Scheme. Flow in catchment C2 is also north to south and this will be maintained by a cross-drain beneath the Proposed Scheme before being combined with flows from catchment C3 which are being diverted to join the C2 catchment further south to avoid the need for a double cross-drain (Figure C-1 in Annex C).

8.3.5. The flow lines derived from Environment Agency LiDAR information show that catchment C3 currently flows north and contributes flow to catchment C2. However, it is proposed to retain flow in catchment C3 south of the Proposed Scheme and route the flow along the southern boundary of the carriageway, partly along a driveable swale, before the redirected flow reaches its existing flow location and joins the flow pathway of catchments C1 and C2 heading south of the Proposed Scheme (Figure C-1 in Annex C). This arrangement avoids the need for a double cross-drain for catchment C3 which would otherwise require a culvert to convey the flow south-to-north before being re-culverted beneath the A47 north-to south.

8.3.6. Catchments C1, C2 and C3 all join a common flow pathway which ultimately drains to the Run Dike / Witton Run catchment to the south of the Proposed Scheme. Overland flow from catchment C1 will be receive additional attenuation through the clean water soakaways SC4 and SC5 and catchments C2 and C3 will receive additional attenuation through the clean water soakaways SC6 and SC7. Therefore, there will be no increase in flood risk to property receptors downstream of these catchments.

8.3.7. A small surface water catchment of the order of 3,800m^2, which is part of catchment C3, drains to the clean water soakaway (SC1) (Annex B).

8.3.8. The flow lines derived from Environment Agency LiDAR information show that catchment C4 currently flows north and contributes flow to catchment C5. However, it is proposed to retain flow in catchment C4 south of the Proposed Scheme and route the flow along the southern boundary of the carriageway, partly along a driveable swale, before the redirected flow reaches its current flow location and joins the flow pathway of C5 flowing south-east away from the Proposed Scheme (Figure C-2 in Annex C). This arrangement avoids the need for a double cross-drain for catchment C4 which would otherwise require a culvert to convey the flow south-to-north before being re-culverted beneath the A47 north-to south.

8.3.9. Catchments C4 and C5 both join a common flow pathway which flows away to the south-east of the Proposed Scheme towards a tributary of the River Bure and are not routed through clean water soakaways. There are no property receptors within the vicinity of the proposed cross-drains for these catchments.

8.3.10. The above arrangements for catchments C3 and C4 do not divert flow from one catchment to another catchment which it would not currently contribute to. The diversion of flows for C3 and C4 still retains flow within the natural catchments to which they currently drain. Therefore, no surface water flow catchment receives additional surface water flow.

8.3.11. Flows from catchments C6 and C7 are generally west to east and these will be generally maintained beneath new side roads by providing cross-drains as part of the Proposed Scheme.

8.3.12. The existing surface water catchment, C6 North (Figure 8-1) currently drains to an existing surface water pathway which continues eastwards north of the existing A47. However, due to the low road levels in the proposed South Walsham Road junction it is not possible to provide a cross-drain to maintain this pathway. Therefore, the overland flow is routed through the clean water soakaway SC3 where it is attenuated.

8.3.13. Due to the layout of the junction and side roads of the Proposed Scheme, a proportion (C6 South - 0.05km^2) of catchment C6 will be diverted, via cross-drains, away from the existing surface water pathway north of the existing A47, towards the surface water pathway that drains south of the existing A47 in catchment C7 (Figure C-2 in Annex C and enlarged in Figure 8-1). This has the potential to increase surface water flood risk to the properties immediately to the east of the existing B1140 – A47 junction. Any potential increase in flood risk to the properties will be mitigated by attenuation in clean water soakaway SC2. Surface water runoff from catchment C7 will maintain the existing surface water flow path through the use of cross-drains.

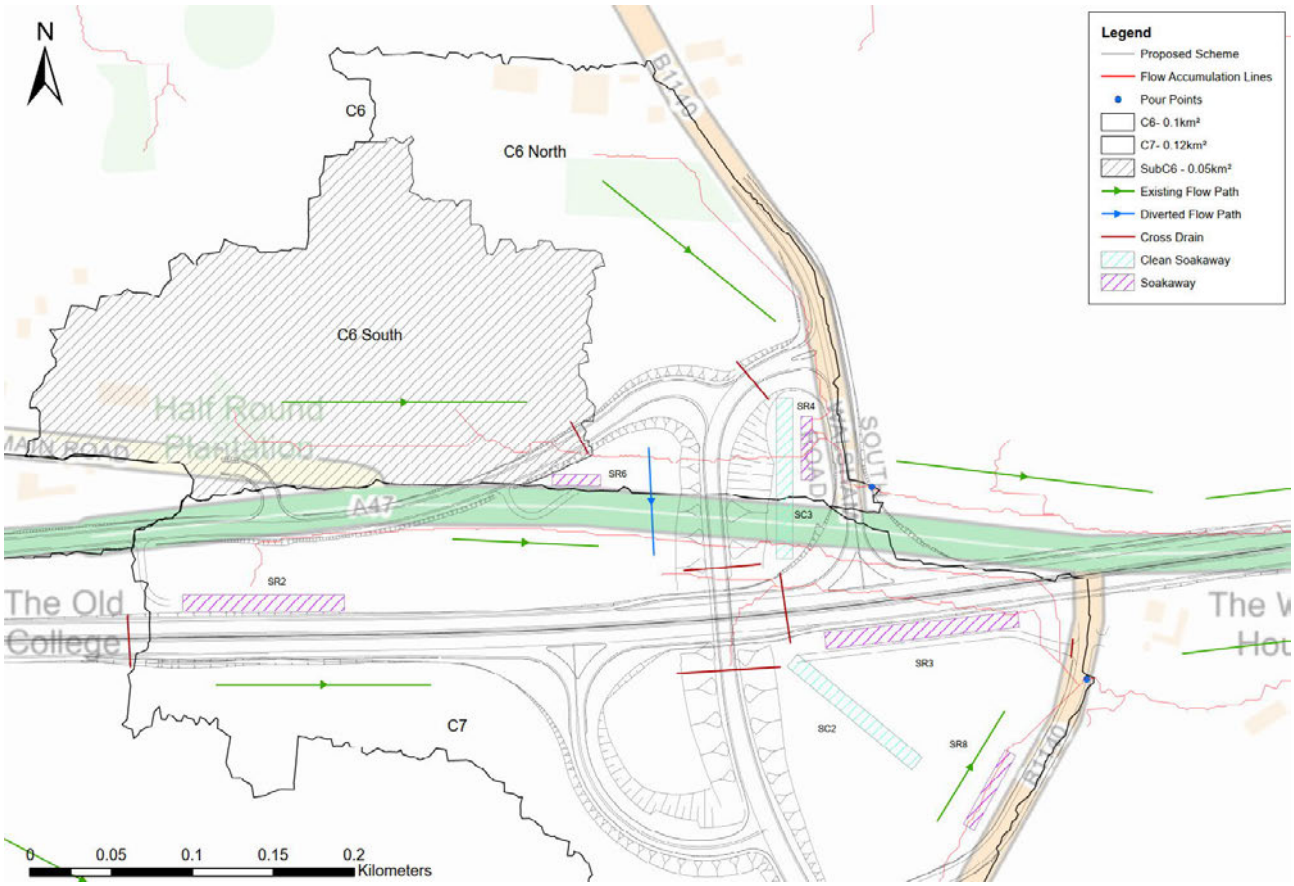


Figure 8-1 Natural catchment drainage around South Walsham Junction

8.3.14. Clean water soakaways SC1, SC4, SC5, SC6, SC7 and SC8 have been designed to provide infiltration for the volume of natural catchment runoff generated during a 1 in 10-year rainfall event plus a 20% allowance for climate change. Table 8-3 shows the attenuation provided by these clean water soakaways provide a significant degree of attenuation of the natural overland flood pathway. As such, they provide a benefit in terms of flood risk to any potential downstream receptors. Half drain times for the clean water soakaways are provided in the Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.2**)).

Table 8-3: Clean water soakaway contributing catchments, runoff volumes and flood volumes

Clean water soakaway ID	Catchment Area (km^2)	Natural catchment ID	1 in 10-year plus 20% CC		1 in 100-year plus 20% CC		1 in 100-year plus 40% CC	
			Runoff volume (m^3)	Flood volume (m^3)	Runoff volume (m^3)	Flood volume (m^3)	Runoff volume (m^3)	Flood volume (m^3)
SC1	0.0038	Part of C3	29.3	0	86	0	101.4	0
SC2	0.05	C6 South	456.7	0	877.4	0	971.3	0
SC3	0.05	C6 North	456.6	0	763.2	0	810.5	13.0
SC4	0.46	C1	4186.4	0	10745	765.3	12356.9	1229.1
SC5								
SC6	0.46	C2	4186.4	0	10744.3	1035.2	12536.2	1549.2
SC7								
SC8	0.44	C3	4005.1	0	10280.2	919	11992.7	1403.9

8.3.15. Soakaway SC3 provides attenuation, from catchment C6 North, up to a 1 in 100 year event with a 20% climate change allowance without any flood exceedance volume. At the 1 in 100 year event with a 40% climate change allowance, a minor flood exceedance volume of $13m^3$ is generated. It is considered that this does not present a significant increase in flood risk to the Proposed Scheme or to downstream receptors as it will largely be contained within the junction.

8.3.16. Soakaway SC2, which attenuates the diverted natural catchment C6 South, can attenuate a flood volume generated by a 1 in 100 year event including a 65% climate change allowance (equivalent to the design flow of the cross-drains – Annex E). As such, there is no increase in surface water flood risk to the properties immediately to the east of the existing B1140 junction with the existing A47.

8.3.17. In summary, with the appropriate placement of cross-drains and the associated attenuation provided by the clean water soakaways, the Proposed Scheme does not result in an increase in surface water flood risk to itself and other receptors.

8.3.18. During consultation, Norfolk County Council noted that use of Lidar data alone could be inaccurate in relation to the sizing and placement (vertical and horizontal) of cross-drains or ‘dry culverts’. It is noted that when local topographic survey data is collected prior to detailed design, the mitigation provided by the cross-drains shall be reassessed to ensure there is no flood risk impact to the Proposed Scheme and other receptors.

8.4. Maintenance and management

8.4.1. Details of the proposed maintenance regime for the Proposed Scheme drainage is given in the Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.2**)) but is also summarised here.

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

8.4.3. It is proposed that the infiltration basin, soakaways and ancillaries associated with the mainline drainage will be maintained by Highways England. Any soakaways receiving runoff from the de-trunked carriageway and new links are proposed to be maintained by Norfolk County Council.

8.4.4. Access for maintenance will be via a four-metre strip adjacent to all proposed soakaway trenches and the infiltration basin. Access will be via existing agricultural pathways, where possible although driveable swales will be incorporated where access pathways intercept overland flow pathways. Access will be gated to prevent public access.

8.4.5. Detailed maintenance regimes for the SuDS components (including frequencies for inspection and mowing etc) will be in accordance with the CIRIA SuDS Manual (CIRIA, 2015) and are provided for the infiltration basin, soakaway trenches, filter drains, ditches and driveable swales in Tables 13-1 to 13-5 of the Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.2**)).

8.5. Existing carriageway flooding

8.5.1. Section 5.2 (Historical flooding) highlighted existing known flooding ‘hotspots’ on the A47 to the east and west of the Proposed Scheme. These hotspots fall largely outside the proposed development boundary. Options for mitigation of the flood risk in these areas falls outside the remit of the Proposed Scheme but will be assessed and addressed by Highways England.

9. Construction related flood risk and mitigation

9.1. Construction related flood risk

9.1.1. This section details the potential impacts on flood risk to the Proposed Scheme and elsewhere during the construction phase. Further information is available in the ES Chapter 2 (The Proposed Scheme (**TR010040/APP/6.1**)).

9.1.2. During construction there will be an increase in new hardstanding areas, including the main site and satellite compounds, which, if not mitigated, would increase the flow rate and volume of runoff from the construction areas. The proposed locations of construction compounds are given in Annex D. This could result in the increased localised flooding to the Proposed Scheme and other flood-sensitive downstream receptors. Additionally, this could adversely impact upon surface water features such as unnamed watercourses, ditches and ponds, Run Dike tributary and tributaries of the River Bure.

9.1.3. During construction, there is an increased risk of flooding during and following extreme rainfall events, including those areas identified as at risk of surface water flooding. Works may lead to temporary changes in the surface water runoff regime by the alteration of ground elevations, diversion of drainage ditches, alteration of overland flow pathways or the construction of new structures. This could cause localised flooding to the Proposed Scheme and nearby receptors due to changes in surface water flood flow pathways. Indirectly, overloading of the temporary drainage system could adversely impact on surface water features. This could include local watercourses, ditches and ponds, Run Dike tributary and tributaries of the River Bure due to overloading of the potential flood flow pathway connection.

9.2. Mitigation of construction related flood risk

9.2.1. This section sets out the proposed mitigation to ensure the construction phase of the Proposed Scheme is not at significant flood risk nor does it pose additional flood risk elsewhere.

9.2.2. During construction, best practice methods for mitigation of temporary flood risk to and from the Proposed Scheme would be implemented as part of the wider Environmental Management Plan (EMP (**TR010040/APP/7.7**)). There are construction activities planned immediately adjacent to a number of ordinary watercourses or drainage ditches. As such, consent from Norfolk County Council may be required.

9.2.3. A temporary surface water drainage strategy will be specified within the water monitoring and management plan as part of the EMP. This will include measures to attenuate runoff from construction sites, compounds and material lay down areas; this will be informed by the Drainage Strategy (ES Appendix 13.2 (**TR010040/APP/6.2**)). Temporary drainage from the main construction compound will likely be collected within a ditch surrounding the compound and will pass via settlement ponds before being discharged to ground. Discharges to ground will only be made with the appropriate consents or permits in place and infiltration features will be suitably designed considering local ground conditions.

9.2.4. The compaction of soils, alteration of ground levels, alteration of overland flow pathways and increases in hardstanding areas during construction have the potential to impact on flood risk. This will be managed by the implementation of a construction-phase drainage system which will include cross-drains where overland flow pathways are intercepted by construction activities.

9.2.5. Given the above mitigation, it is anticipated that the Proposed Scheme will be at low risk of flooding during construction and will not cause an increase in flood risk elsewhere.

10. Conclusions

10.1.1. The assessment of flood risk to the Proposed Scheme, and the risk posed by the Proposed Scheme to others, has been undertaken in accordance with the NPPF (MHCLG, 2019), associated PPG (MHCLG, 2016) and the NNNPS (Department for Transport, 2014).

10.1.2. There are a number of unnamed surface water features located within the Proposed Scheme area which were identified during a site walkover survey. These were generally found to be unconnected and run along the edge of fields adjacent to roads.

10.1.3. Historic flooding of the carriageway was associated with the existing drainage network and partly resulting from blocked gullies. These existing flooding hotspots are largely located outside of the Proposed Scheme boundary and are being investigated by Highways England as part of an ongoing process separate to the Proposed Scheme.

10.1.4. The Proposed Scheme is located within Flood Zone 1 and as such the risk of fluvial and tidal flooding is low. Using information provided by the Environment Agency, the Proposed Scheme is not at risk of fluvial and tidal flooding from the River Yare and Run Dike when climate change is taken into consideration.

10.1.5. The Environment Agency Flood Risk from Surface Water map (Environment Agency, 2020b) indicates the majority of the Proposed Scheme is at very low risk of surface water flooding with isolated areas of low to high risk, which includes a flow pathway that crosses the Proposed Scheme in a south westerly direction towards Run Dike. The Greater Norwich Area SFRA (JBA Consulting, 2017) shows that climate change increases the impact of surface water flooding along this existing flow pathway.

10.1.6. The Proposed Scheme is at low risk of flooding from the sewerage network.

10.1.7. The entirety of the Proposed Scheme has limited potential for groundwater flooding to occur. A ground investigation undertaken in 2018 found groundwater levels below the Proposed Scheme to be between 5 and 20m below ground level. Climate change is unlikely to result in an increase in groundwater flood risk due to the significant depth to groundwater.

10.1.8. The Proposed Scheme is not at risk from canal, tidal or reservoir flooding.

10.1.9. The Proposed Scheme will result in an increase in areas of hardstanding which would, if not mitigated, cause a potential increase in surface water flood risk to surrounding areas. To mitigate against this risk, the road drainage shall drain at source via the road drainage network using soakaway trenches and an

infiltration basin. These shall be designed to attenuate a 1 in 100-year rainfall event including a 20% climate change allowance. Hydraulic modelling has confirmed that water levels within the soakaways do not exceed adjacent ground levels or the capacity of the infiltration basin for all events modelled, up to 1 in 100 year with 40% allowance for climate change. Exceedance events greater than the 1 in 100-year rainfall event (including climate change) shall be routed safely, along existing overland flow paths to avoid flooding the road and minimise impact on others. Therefore, there will be no increase in surface water flood risk as a result of the Proposed Scheme's highway drainage.

10.1.10. In addition, cross-drains or 'dry culverts' shall be provided, where required, to maintain continuity of surface water flood flow pathways, to minimise potential ponding of water adjacent to the carriageway which may pose additional flood risk to the Proposed Scheme as well as minimising an increase in flood risk to nearby flood receptors. The 'dry culverts' shall be designed to convey the 1 in 100-year plus 65% climate change flows from their respective contributing catchments. Where it was not possible to connect directly with existing surface water pathways, infiltration via clean water soakaway trenches shall provide a degree of attenuation up to a minimum of a 1 in 10-year flow plus a 20% climate change allowance The clean water soakaway SC2, which receives additional runoff diverted from the north of the A47, has been designed to ensure no increase in flood risk to properties immediately to the east of the existing B1140 junction for events up to a 1 in 100-year return period with a 65% allowance for climate change. Exceedance from the clean water soakaways, and directly from cross-drains shall converge with existing flood flow pathways downstream of the Proposed Scheme. Therefore, there will be no increase in surface water flood risk resulting from the interception of surface water flood flow pathways by the Proposed Scheme.

10.1.11. Potential impacts on flood risk during construction will be mitigated by the implementation of appropriate temporary drainage measures which will be outlined in the water monitoring and management plan as part of EMP (**TR010040/APP/7.7**).

10.1.12. The Proposed Scheme is an upgrade of existing road and is classified as 'essential infrastructure'. According, to the NPPF, 'essential infrastructure' is appropriate development in Flood Zone 1. Therefore, the Proposed Scheme meets the requirements of the Sequential Test and no Exception Test is required.

10.1.13. Based on the findings of this FRA, it is considered the Proposed Scheme meets the requirements of the NNNPS.

11. References

Amey (2017). Road Investment Strategy East Area 6, A47 Blofield to North Burlingham, Environmental Assessment Report (A47 IMPS2-AMY-BB-ZZ-DO-J0024)

British Geological Survey (2020) Geoindex Onshore. Available at https://mapapps2.bgs.ac.uk/geoindex/home.html, accessed June 2020.

Broadland District Council (2014) Greater Norwich Development Partnership, Joint Core Strategy for Broadland, Norwich and South Norfolk, Adopted March 2011, amendments adopted January 2014. Available at https://www.broadland.gov.uk/downloads/file/1310/joint_core_strategy_adopted_document_2014, last accessed April 2020

CIRIA (2015) The SuDS Manual (C753). Available online at https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx, last accessed October 2020.

Department for Transport (2014) National Policy Statement for National Networks. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/387222/npsnn-print.pdf, accessed 2020

Environment Agency (2019) National Groundwater Recharge Assessment Under Climate Change – Project Summary SC160018

Environment Agency (2020a) Flood Map for Planning. Available online at: https://flood-map-for-planning.service.gov.uk/, accessed April 2020

Environment Agency (2020b) Long Term Risk Assessment for Locations in England. Available online at https://flood-warning-information.service.gov.uk/long-term-flood-risk, accessed April 2020

Environment Agency (2020c) Flood risk assessments: climate change allowances. Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances, last accessed April 2020

Highways England (2018). A47 Blofield to North Burlingham EIA Scoping Report (HEBLOFLD-MMSJV-EGN-000-RP-LX-00001)

Highways England (2019a). Highways England Design Manual for Road and Bridges (DMRB) LA 113, Road Drainage and the Water Environment

Highways England (2019b) Highways England Design Manual for Roads and Bridges (DMRB) CG 502, The Certification of Drainage Design

Highways England (2020a) Highways England Drainage Data Management System v5.12.0 (HADDMS). Available online at http://www.haddms.com/index.cfm?fuseaction=home.main , last accessed April 2020

Highways England (2020b) Highways England Design Manual for Roads and Bridges (DMRB) CG 501, Design of highway drainage systems

Highways England (2020c) Highways England Design Manual for Roads and Bridges (DMRB) CD 530, Design of soakaways

Highways England (2020d) A47 Blofield to North Burlingham EIA Drainage Strategy Report (HE551490-GTY-EWE-000-RP-LE-30003)

JBA Consulting (2017) Greater Norwich Area Strategic Flood Risk Assessment Final Report: Level 1, November 2017. Available online at https://www.broads-authority.gov.uk/__data/assets/pdf_file/0024/244437/2017s5962-Greater-Norwich-Area-SFRA-Final-v2.0.pdf, last accessed June 2020

Ministry of Housing, Communities and Local Government (2016). Planning Practice guidance- Flood Risk and Coastal Change. Available online at https://www.gov.uk/guidance/flood-risk-and-coastal-change , accessed April 2020

Ministry of Housing, Communities and Local Government (2018) Meeting the challenge of climate change, flooding and coastal change. Available online at:https://www.gov.uk/guidance/national-planning-policy-framework/10-meeting-the-challenge-of-climate-change-flooding-and-coastal-change, last accessed April 2020

Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework. Available at https://www.gov.uk/government/publications/national-planning-policy-framework--2 , accessed April 2020

Norfolk County Council (2011a) Preliminary Flood Risk Assessment Report, July 2011. Available online at https://www.norfolk.gov.uk/-/media/norfolk/downloads/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management/preliminary-flood-risk-assessment-report.pdf?la=en&hash=62588C95940F99ABD42FEE40B74942074C62A2F5 , last accessed April 2020

Norfolk County Council (2011b) Norwich Urban Area Surface Water Management Plan 2 Final Report, November 2011. Available online at https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies/surface-water-management-plans/norwich-urban-area-swmp, last accessed April 2020

Norfolk County Council (2014) Investigation Report into the flooding within the Norwich Area During the summer of 2014. Report Reference 622. Available at https://ww

w.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/norwich-and-broadland-2014.pdf?la=en&hash=FAB6186A43C6456FEDC80F022F433F19ADE15CA3, last accessed April 2020

Norfolk County Council (2015a) Norfolk Local Flood Risk Management Strategy, v13.1 July 2015. Available online at https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies/local-flood-risk-management-strategy , last accessed April 2020

Norfolk County Council (2015b) Flood Investigation Report: Broadland, Norwich Road, Strumpshaw Y/5/14/000467, 29 April 2015. Available online at https://www.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/norwich-road-strumpshaw.pdf?la=en&hash=FF9626AA1EB0C9AF729383E68E5129A9E0E67783, last accessed April 2020

Norfolk County Council (2019a) Flood Investigation Report: Norfolk 6 October 2019 FIR048. Available online at https://www.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/norfolk-6-october-2019-fir048-amended-sept-2020.pdf , last accessed October 2020

Norfolk County Council (2019b) Flood Investigation Report: Norfolk - 6 October 2019 - Additional Properties - FIR056. Available online at https://www.norfolk.gov.uk/-/media/norfolk/downloads/rubbish-recycling-planning/flood-and-water-management/flood-investigation-reports/norfolk-6-october-2019-additional-properties-fir056.pdf , last accessed October 2020

Norfolk County Council (2020) Flood and Water Management – Information for Developers. Available online at https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers, last accessed October 2020

Planning Inspectorate (2018) Scoping Opinion: Proposed A47 Blofield to North Burlingham. Available online at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010040/TR010040-000008-BLOF%20-%20Scoping%20Opinion.pdf , last accessed May 2020

Annex A. Consultation responses

Strategic Planning Team
Water Resources
Anglian Water Services Ltd
Thorpe Wood House,
Thorpe Wood,
Peterborough
PE3 6WT

Tel (0345) 0265 458
www.anglianwater.co.uk
Our ref 00026295

Your ref TR010040-000004

Richard Hunt
Senior EIA and Land Rights Advisor
The Planning Inspectorate
3D Eagle Wing
Temple Quay House
2 The Square
Bristol, BS1 6PN

2 March 2018

Dear Richard,

A47 Blofield to North Burlingham: Environmental Statement Scoping Report

Thank you for the opportunity to comment on the scoping report for the above project. Anglian Water is the water and sewerage undertaker for the above site. The following response is submitted on behalf of Anglian Water.

General comments

Anglian Water would welcome further discussions with Highways England prior to the submission of the Draft DCO for examination.

In particular it would be helpful if we could discuss the following issues:

- Wording of the Draft DCO including protective provisions specifically for the benefit of Anglian Water.
- Requirement for water and wastewater services.
- Impact of development on Anglian Water's assets and the need for mitigation.
- Pre-construction surveys.

13 Road Drainage and water environment

Reference is made to principal risks of flooding from the above project being fluvial flooding as set out in Table 13.1of the report.

Registered Office
Anglian Water Services Ltd
Lancaster House, Lancaster Way,
Ermine Business Park, Huntingdon,
Cambridgeshire. PE29 6YJ
Registered in England
No. 2366656.

an AWG Company

Anglian Water is responsible for managing the risks of flooding from surface water, foul water or combined water sewer systems. At this stage it is unclear whether there is a requirement for a connection(s) to the public sewerage network for the above site or as part of the construction phase. Consideration should be given to all potential sources of flooding including sewer flooding (where relevant) as part of the Environmental Statement and related Flood Risk Assessment.

Anglian Water would also wish to be consulted on the content of the proposed Flood Risk Assessment if a connection to the public sewerage network is required.

We welcome the intention to have further discussions with Anglian Water throughout the EIA process.

As set out in the EIA Scoping Report there are existing sewers within the boundary of the site. There are existing water mains and fouls sewers in Anglian Water's ownership which potentially could be affected by the development. It is therefore suggested that the Environmental Statement should include reference to existing water mains and foul sewers in Anglian Water's ownership.

Maps of Anglian Water's assets are available to view at the following address:

http://www.digdat.co.uk/

Should you have any queries relating to this response please let me know.

Yours sincerely

Stewart Patience

Spatial Planning Manager

Ball, Jason

From: Planning Department <Planning@wlma.org.uk>
Sent: 21 May 2020 09:23
To: [redacted]
Subject: RE: A47 Blofield to North Burlingham

Categories: Blofield

Dear Karen,

Thank you for consulting us at this early stage in the process.

While the site in question is not within the Broads Internal Drainage District as you mention, it is within our catchment (see our mapping of the catchment here), thus any surface water discharged would eventually run into our system (unless it were immediately discharged into a Main river). Considering your current plan is to infiltrate we do not have any comments to make, however please be aware that if this changes to discharge water to a riparian watercourse, or any watercourse that is not a Main river (including the below specified tributary of Run Dyke), then you may require land drainage consent in line with the Board's byelaws (specifically byelaw 3). Any consent granted will likely be conditional, pending the payment of a Surface Water Development Contribution fee, calculated in line with the Board's charging policy, available online (https://www.wlma.org.uk/uploads/WMA_Table_of_Charges_and_Fees.pdf).

Our local engineer has no comments regarding specific issues of flooding in the area, however as you already mentioned the Lead Local Flood Authority are a good source for records of flooding in this location. You can also directly consult the long term flood risk information available here or check if the Lead Local Flood Authority have undertaken studies into local flood risk in this area, a list of which can be found here.

Please do not hesitate to contact me again if you have any further questions,
Kind regards,
Yvonne

Yvonne Smith
Sustainable Development Officer
e: [redacted]

Water Management Alliance
Kettlewell House, Austin Fields Industrial Estate, King's Lynn, Norfolk, PE30 1PH, UK
t: [redacted] | **e:** info@wlma.org.uk | www.wlma.org.uk

Consisting of Broads Drainage Board, East Suffolk Drainage Board, King's Lynn Drainage Board, Norfolk Rivers Drainage Board and South Holland Drainage Board in association with Pevensey and Cuckmere Water Level Management Board

From: Dunton, Karen [redacted]
Sent: 15 May 2020 11:00
[redacted]
Subject: A47 Blofield to North Burlingham

Good Morning,

Sweco has been appointed by Galliford Try on behalf of Highways England to design the proposed scheme to improve the A47 between Blofield to North Burlingham. Details of scheme can be found on the Planning Inspector website, for example,
A47 Blofield Scoping Report - https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010040/TR010040-000009-BLOF%20Scoping%20Report.pdf
A47 Blofield Scoping Opinion - https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010040/TR010040-000008-BLOF%20-%20Scoping%20Opinion.pdf

I am working on the environmental impact assessment for the road drainage and water environment and I am contacting you as the IDB catchment area falls within the 1km study area of the proposed scheme (but not within the draft red line boundary). I have attached a map indicating the current proposed red line boundary and the 1km study area. As such, I am trying to ascertain whether the IDB require any further information regarding this scheme or if there is anything you feel needs to be discussed?

The proposed scheme comprises the construction of new dual carriageway immediately to the south of the existing A47 and will include two new over bridges for local access at Blofield and Acle Road. There would also be alterations to the surrounding nearby local road network and new on/off slips to connect to the local road network.

At this time, the proposed option is to drain surface water from the new carriageway to an infiltration basins or to infiltration strips / soakaways. Kerbed sections of the mainline will include gullies or combined kerb and gulley, discharging to filter drains or carrier drains in the verges. There will be no new discharges to surface watercourses or drainage ditches from the proposed scheme.

Natural overland drainage and existing ditches / streams between the existing A47 and the proposed new mainline will be intercepted by new collector drains and conveyed along the natural drainage paths as far as possible. This will involve culvert crossings of the proposed new mainline. Where it was not possible to connect directly with existing surface water pathways, locations for proposed infiltration via clean water soakaways were identified.

The current red line boundary (which includes a section from Waterlow to Run Dike tributary at Braydston Hall Lane) was informed by the existing drainage design, where surface water run-off from the road would be directed to an

attenuation pond and then discharge to an outfall at a tributary of Run Dike. Further development of the drainage for the proposed scheme has concluded that this was deemed unsuitable and inappropriate and that all road drainage will drain by infiltration methods. The current drainage design is subject to consultation with the Environment Agency. However, currently it is proposed there will be no works within the area surrounding or discharging to Run Dike tributary.

We are also about to consult with the Environment Agency and Norfolk County Council on the drainage proposals above.

I look forward to hearing back from you.

Kind Regards,
Karen Dunton

Dr Karen Dunton

[redacted]

Sweco UK Limited

[redacted]

www.sweco.co.uk

Environment Agency

Mr Richard Hunt - Senior EIA Adviser
The Planning Inspectorate

Via email only:
A47BlofieldtoNorthBurlingham@pins.gsi.gov.uk

Our ref: AE/2018/122555/01-L01
Your ref: TR010040-000004

Date: 07 March 2018

Dear Mr Hunt

PLANNING ACT 2008 (AS AMENDED) AND THE INFRASTRUCTURE PLANNING (ENVIRONMENTAL IMPACT ASSESSMENT) REGULATIONS 2017(THE EIA REGULATIONS) – REGULATIONS 10 AND 11

APPLICATION BY HIGHWAYS ENGLAND (THE APPLICANT) FOR AN ORDER GRANTING DEVELOPMENT CONSENT FOR THE A47 BLOFIELD TO NORTH BURLINGHAM (THE PROPOSED DEVELOPMENT)

SCOPING CONSULTATION AND NOTIFICATION OF THE APPLICANT'S CONTACT DETAILS AND DUTY TO MAKE AVAILABLE INFORMATION TO THE APPLICANT IF REQUESTED

Thank you for consulting us on the A47 Blofield to North Burlingham EIA Scoping Report, dated February 2018. We have reviewed the submitted document and have the following comments:

Chapter 8 Biodiversity.
We are satisfied at this stage that all species of primary concern for us have been identified. Further ecological surveys for bats, water voles and reptiles are to be carried out during the optimal survey time for each of the species during 2018. The presence of water voles is recorded to the north of the proposed works at Home Farm (TG3613210311), but further survey work may find evidence of water voles in the ditches or water features along the route. Further species information can be found through the Norfolk Biodiversity Information Service (NBIS: www.nbis.org.uk).

There is no evidence of any surveys for non-native invasive species. There are records of Winter Heliotrope (*Petasites fragrans*) at Burlingham. Appropriate measures should be in place to prevent the spread of this species within or between sites during excavations. More information can be found at http://www.nonnativespecies.org

East Anglia area (East) - Iceni House
Cobham Road, Ipswich, Suffolk, IP3 9JD
General Enquiries: 08708 506506 Fax: 01473 724205
Weekday Daytime calls cost 8p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary
Email: enquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

Within this type of landscape, this scheme should aim to bring an overall increase in the biodiversity, replacing habitats where loss in unavoidable, creating new habitat and enhancing existing habitats. Habitat creation should be considered for inclusion alongside or as part of roadside sustainable drainage schemes (SuDS), as well as roadside tree planting.

Chapter 9 Geology and Soils
Table 9.1 Baseline data - Hydrogeology
The Lowestoft Formation at this location is designated secondary aquifer (undifferentiated) not unproductive as stated.

Table 9.4 needs to include explicit reference to changes in groundwater flow and baseflow.

9.7.3 & 9.10.1
Prior to the investigation works, a preliminary risk assessment (PRA) for the area of interest will need to be undertaken to identify any other previous land uses which may have resulted in land contamination. We agree that a ground investigation will be required to determine the nature and extent of any contamination.

Chapter 13 Road Drainage and the Water Environment
Table 13.1 Summary of Existing Baseline
Flood risk is considered as part of the baseline data. The scoping report does not refer to the recently published Greater Norwich Area Strategic Flood Risk Assessment; Final Report: Level 1; November 2017. This provides information on all sources of flooding and is available from both the Greater Norwich and Broads Authority websites.

The potential for groundwater flooding is mentioned in both Chapters 13 and 9. Full details of the potential for flooding should be provided along with any necessary mitigation measures and an assessment of the degree to which mitigation measures might alter local groundwater flow and baseflow to local watercourses, other surface water features and abstractions.

We concur that full lists of all unlicensed abstractions should be sought and that all assessments should include the potential for an impact on them.

In respect of the baseline and Groundwater, we would highlight that the source protection zones (SPZs) in this area are currently under review and will be published later in 2018.

An assessment of climate change risks should include reference to impacts on groundwater levels and flow and potential impacts on all receptors i.e. surface water features, groundwater-fed features and surface and groundwater abstractions.

The ‘Bure Operational’ catchment needs to be assessed.

Future work needs to include a full assessment of the hydraulic connections between the shallow and in some cases deeper aquifer and surface water features, in particular in the Witton Run catchment.

WFD groundwater quality failures in terms of chemistry are to do with diffuse groundwater pollution.

It is important that shallow groundwater flow to watercourses is not significantly altered in the area of consented discharges.

The depth of any excavations needs to be assessed in terms of the depth of underlying deposits for the entire route to determine where working will extend into the shallow aquifer or chalk and where they will be in low permeability strata.

The report identifies that there may be opportunities for SuDS where this is appropriate, which we would support although see comments below. As mentioned above, SuDS schemes should be designed to provide for habitat enhancements.

The water framework directive (WFD) status of the river systems identified within the scoping report are sufficient for the Bure, Yare and Witton Run. However there is no mention of the WFD mitigation measures in place for each waterbody. Where appropriate this information can assist with identifying opportunity for enhancements.

With reference to 13.4.2; drainage proposals need to be carefully considered. Any infiltration proposals within SPZs for public water supply will need rigorous assessment concerning pollution potential; significant treatment trains may be required; it's possible that drainage in a public water supply SPZ may be unacceptable and will need to be relocated.

Similarly, more information will be required with regards to mitigating against pollution from road run off into the surrounding ditch and Dike networks, regardless of their WFD status. This will include an assessment of pollution impacts from routine run off to surface water.

Construction and demolition
13.7.2 & 13.7.9
We agree with the comments in these paragraphs. However, no provision appears to have been included to confirm the depth of groundwater beneath the application area. The depth of groundwater has implications both for construction and drainage design (particularly with regard to meeting our requirements for SuDS, see below).

We would also advise that it should be considered whether any required dewatering is an exempt activity in terms of environmental permitting. Further information can be found at: https://www.gov.uk/government/publications/temporary-dewatering-from-excavations-to-surface-water

Full details of any dewatering activities should be submitted for review along with a hydrogeological impact assessment.

13.7.4.
The location of all unlicensed abstraction needs to be known before any conclusions can be drawn regarding the risk of mobilising nitrates.

13.7.5.
Metaldehyde may rapidly degrade but it is still an issue in local watercourses.

Operation
13.7.12
We note that options for new road drainage are currently being assessed. We would recommend a review of the existing drainage to determine the location of outfalls, receptors and the presence of any water pollution control systems.

Any soakaways, infiltration basins and settlement ponds will require a full hydrogeological impact assessment with regards to aquifer and surface water quality and local abstractions; the location of such features in a public water supply SPZ will require rigorous assessment; it is possible that such schemes may be unacceptable depending on the proximity to significant abstractions.

Our general requirements with respect to SuDS drainage are as follows:
1. Infiltration sustainable drainage systems (SuDS) such as soakaways, unsealed porous pavement systems or infiltration basins shall only be used where it can be demonstrated that they will not pose a risk to the water environment.

2. Infiltration SuDS have the potential to provide a pathway for pollutants and must not be constructed in contaminated ground. They would only be acceptable if a phased site investigation showed the presence of no significant contamination.

3. Only clean water from roofs can be directly discharged to any soakaway or watercourse. Systems for the discharge of surface water from associated hard-standing, roads and impermeable vehicle parking areas shall incorporate appropriate pollution prevention measures and a suitable number of SuDS treatment train components appropriate to the environmental sensitivity of the receiving waters.

4. The maximum acceptable depth for infiltration SuDS is 2.0 m below ground level, with a minimum of 1.2 m clearance between the base of infiltration SuDS and peak seasonal groundwater levels.

5. Deep bore and other deep soakaway systems are not appropriate in areas where groundwater constitutes a significant resource (that is where aquifer yield may support or already supports abstraction).

6. SuDS should be constructed in line with good practice and guidance documents which include the SuDS Manual (CIRIA C753, 2015 – the current reference in the report is to the 2007 document) and the Susdrain website.

For further information on our requirements with regard to SuDS see our Groundwater protection position statements (2017), in particular Position Statements G1 and G9 – G13 available at: https://www.gov.uk/government/publications/groundwater-protection-position-statements

13.8.5 – 18
We concur that groundwater levels and quality and discharges, abstractions and groundwater flooding will all need full assessment.

13.8.15 &13.9.7
The drainage strategy developed must include sufficient pollution control and pollution prevention measures to ensure protection of the water environment.

13.9.2
Please be aware that the direct discharge of road drainage to groundwater would not be acceptable given the potential presence of hazardous substances, whose entry to groundwater must be prevented. This is likely to have implications for the use of deep bore soakaways.

Assessment of magnitude of impacts and significance of effects
Table 13.2 Criteria for estimating the importance of water environment attributes
Table 13.3 Estimating the magnitude of an impact on an attribute
Table 13.4 Definitions of overall significance of effect
These tables all appear to relate the value/importance of waterbodies to WFD status alone, which in our view is not appropriate. It is important that Water Framework Directive Classification is not used as a proxy for ecological value or sensitivity to impacts.The basic overarching requirements of the Directive are that there will be no deterioration from the class status as defined in the River Basin Management Plan, whatever that status is; and that there should be improvement where required to 'Good' ecological status or potential by 2027.

Given that those requirements apply to all water bodies, it is not appropriate to suggest that magnitude of impacts will vary with status. Additionally, status classification is defined by the lowest of up to 37 elements, meaning that sensitivity to particular impacts and the resulting effect on status can vary between water bodies depending on their particular characteristics, irrespective of status.

However, we do welcome the statement at 13.8.10 & 13.9.3 confirming that a preliminary WFD compliance assessment will be carried out in respect of both surface and groundwater bodies within the study area.

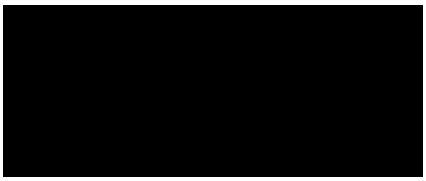
We would also suggest that Table 13.3 should explicitly include changes to groundwater flow.

Conclusion
13.10.1
Potential receptors need to also include the Happisburgh Glacigenic Formation, a secondary A aquifer and groundwater within the Lowestoft Formation.

13.10.4
Although 13.10.1 identifies surface waterbodies as potential receptors, this paragraph only refers to a WFD assessment being required in order to consider effects on groundwater bodies. Reference to surface waterbodies should be included in line with 13.8.10 & 13.9.3.

We trust this advice is helpful.

Yours sincerely



MR MARTIN BARRELL
Sustainable Places - Planning Specialist

Direct dial 020 302 58450
Direct e-mail martin.barrell@environment-agency.gov.uk

Dr Stephen Hughes
Sweco UK limited

Via email only:
stephen.hughes@sweco.co.uk

Our ref: AE/2020/125347/01-L01
Your ref: *

Date: 17 August 2020

Dear Steve

FRA REVIEW - A47 SCHEME BLOFIELD TO NORTH BURLINGHAM

Thank you for providing us with the draft FRA for this scheme to review. Please find below our comments in respect of document HE551490-GTY-EWE-000-RP-LE-30003 – Revision P01 and dated 16/07/2020.

- Section 4.3.4 of the FRA states that "Matters pertaining to flood risk from the Run Dike are the responsibility of the Broad's Internal Drainage Board (IDB)". This is not completely correct. Witton Dyke also known as Run Dyke is designated as Main River and so the Environment Agency will deal with flood risk matters that fall into the Environmental Permitting Regulations (amended) 2019. Please see the EPR Flood Risk Activity permit section further below for more information. The above comments also applies to section 5.7.1 of the FRA.
- Section 1.1.10 of the FRA states that Run Dyke Flood Zones are fluvial. In actuality the Flood Zones for Witton Dyke also known as Run Dyke are both fluvial and tidal. The above comment also applies to sections 5.3.4 and 5.7.6 of the FRA.
- We note that section 5.3.3 of the FRA states that climate change has been applied by using the current day Flood Zone 2 to assess future Flood Zone 3a, which is our accepted approach in the Norfolk Broads area.
- In assessing tidal flood risk at this location the Broads 2008 model doesn't assess the upper end allowance for tidal climate change as a detailed in UKCP18. You will need to add 0.31m of additional tidal flooding to take account of the new upper end allowance. This would need to be applied on top of the current day tidal Flood Zone 2.

Flood Event	River Yare in-channel flood level
0.1% (1 in 1000) fluvial	1.85m AOD
0.1% (1 in 1000) tidal	1.44m AOD
0.1% (1 in 1000) tidal + 0.31m for UKCP18	1.75m AOD

East Anglia area (East) - Iceni House
Cobham Road, Ipswich, Suffolk, IP3 9JD
General Enquiries: 08708 506506 Fax: 01473 724205
Weekday Daytime calls cost 8p plus up to 6p per minute from BT Weekend Unlimited.
Mobile and other providers' charges may vary
Email: enquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

- As shown in the table above, the tidal Flood Zone 2 that is used to assess future tidal Flood Zone 3a, is not as significant as fluvial flood risk within the study area. However the FRA must show that it has made an assessment of the tidal flood risk that is present within the study area.
- Section 7 and 9 of the FRA should also be updated to refer to tidal flood risk, as appropriate.

Informative – Environmental Permit for Flood Risk Activities

The applicant may need an environmental permit for flood risk activities if they want to do work in, under, over or within 8 metres (m) from a fluvial main river and from any flood defence structure or culvert or 16m from a tidal main river and from any flood defence structure or culvert. The Witton Run (also known as Run Dyke), is designated a 'main river'.

Application forms and further information can be found at: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits. Anyone carrying out these activities without a permit where one is required, is breaking the law.

We trust that this advice is useful.

Yours sincerely

[redacted]

MR MARTIN BARRELL
Sustainable Places - Planning Specialist

[redacted]

Norfolk County Council
Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG

[redacted]

via e-mail
The Planning Inspectorate
Temple Quay House
Temple Quay
Bristol
BS1 6PN

Your Ref: NA
Date: 26 February 2018

My Ref: FWS/18/8/6074
Tel No.: 0344 800 8020
Email: llfa@norfolk.gov.uk

Dear Sir,

A47 Blofield to North Burlingham – Development Consent Order

Thank you for your consultation on the above site, received on 8 February 2018. We have reviewed the request as submitted and wish to make the following comments.

We note that the proposed scheme will:

- Have a total length of new carriageway of 4.5km, including an upgrade of a 2.6km section of single carriageway to dual carriageway between Blofield and North Burlingham.
- Consist of a site area within the DCO site boundary of 104ha.
- Construct a new section of off-line dual carriageway.
- Provide appropriate junction improvements.

For information we are aware from local knowledge that the A47 flooded in the summer of 2014 at the location of the overland flow path shown on the Environment Agency Surface Water Mapping. The flood event was not formally investigated by us, the LLFA, and impacts of the flooding are unknown. It does however highlight that the design of the scheme in this area of the scheme should be carefully considered and mitigation proposed to avoid the overland flow path.

The Surface Water Management Strategy for Norfolk and the Surface Water Management Plan for Norwich urban area can be found on our website at https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies

Whether or not an EIA/ES is required we consider that the following issues should be considered and addressed as part of the development and mitigation agreed in conjunction with the LLFA and other appropriate authorities prior to commencement of the scheme;

Continued…/

We strongly recommend that any EIA/ES includes or planning application for development is accompanied by a flood risk assessment (FRA) / surface water drainage strategy to address

- local sources of flood risk, including those from ordinary watercourses, surface water flow and groundwater
- how surface water drainage will be managed on site and show compliance with the written Ministerial Statement HCWS 161 by ensuring that Sustainable Drainage Systems for the management of run-off are put in place.

This supporting information would assess the potential for the development to increase the risk of flooding from the proposal or how surface water runoff through the addition of hard surfaces. It will show how this will be managed to ensure that the development does not increase flood risk on the site or elsewhere, in line with National Planning Policy Framework (paragraph 103).

In this particular case this would include appropriate information on;

- Sustainable Drainage Systems (SuDS) proposals in accordance with appropriate guidance including "Non-statutory technical standards for sustainable drainage systems" March 2015 by Department for Environment, Food and Rural Affairs.
- Appropriate assessment and mitigation of sources of fluvial (ordinary watercourse) flooding, surface water flooding originating from offsite that may affect the development and any potential for groundwater flooding.
- Provision of surface water modelling of overland flow routes and mitigation provided to show how flood risk will not be increased elsewhere. This may include dry culverts sized for the 1 in 100 year plus climate change allowance.
- Where any SuDS are proposed it is important to demonstrate that the SuDS hierarchy has been followed both in terms of:
  - surface water disposal location, prioritised in the following order: disposal of water to shallow infiltration, to a watercourse, to a surface water sewer, combined sewer / deep infiltration (generally greater than 2m below ground level),
  - the SuDS components used within the management train (source, site and regional control) to address flood risk and water quality mitigation required from the new development
  - As there are few watercourses marked on Ordnance Survey mapping any constructed (conveyance ditch) connection to an existing watercourse must be clearly demonstrated to be feasible and provide the in principal agreements from any landowners. It would also have to clearly be shown what appropriate body would maintain it.

At least one feasible proposal for the disposal of surface water drainage should be demonstrated and should be supported by the inclusion of appropriate supporting information. Onsite, infiltration testing, in accordance with BRE365 or equivalent should be undertaken to find out if infiltration is viable across the site and at the depth and location of any infiltration drainage feature. Infiltration testing should be undertaken 3 times in quick succession at each location. Any drainage mitigation for the site should attenuate the post development runoff rate and volume to the equivalent pre development greenfield rate and volume up to the 1 in 100 plus climate change allowance.

Continued…/

We advise that any formal or informal drainage associated with existing developments or farmland should be maintained or diverted by the scheme to avoid future ponding against any infrastructure including embankments that may be created

We welcome that the applicant indicates that a Flood Risk Assessment (FRA) will be undertaken based on the requirements of National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG), Design Manual for Roads and Bridges (DMRB) and the CIRIA SuDS Manual (Section 13 of the EIA Scoping Report (A47 Blofield to North Burlingham by Highways England, dated February 2018 version P02 PINS project reference number: TR010040 Highways England document reference: HEBLOFLD-MMSJV-EGN-000-RP-LX-00001.) It is noted that this report indicates some historical flooding experienced on the highway previously. The Scoping Report also identifies the area highlighted by the Environment Agency Risk of Surface Water Flood Map. There is one flow path which crosses the existing road and will also cross the proposed road (for all options) and there are ordinary watercourses / ditches that cross the area. Any ordinary watercourse has a fluvial flood risk attached to it but is not shown on the EA national scale fluvial flood mapping due to the modelling limitations. We expect that any ordinary watercourse be assessed and modelled if appropriate to should the associated flood zones, development is acceptable with or without mitigation and flood risk is not increased.

We suggest the flowing be considered:

- A site walkover to confirm the location of ordinary watercourses and any modelling that is required to inform the design of culvert crossings.
- If you intend to carry out a river survey to inform the hydraulic modelling any collected data and model produced should include all tributaries. We have included provided information on the flowlines of surface water which may help identify these on the ground if not shown on the Ordnance Survey or Environment Agency Fluvial Flood Map.
- Any collected topographic survey data should extend across the watercourse and any likely flood plain to enable modelling to accurately represent pre and post development scenarios.
- New culverts across the tributaries should be designed to an appropriate size to pass the 100 year plus climate change allowance.
- Any upgrades of culverts should aim to allow the flow of 1 in 100 year plus climate change design event but must also include an assessment to show how passing any additional flow downstream will not increase the current flood risk scenario.
- If there are any surface water flow paths identified crossing the development area, dry culverts may need to be provide up to the 1 in 100 year plus climate change design event. This would prevent ponding against infrastructure and prevent an increase of flood risk.
- Any new drainage infrastructure should include appropriate sustainable drainage design and address the appropriate flood risk and water quality mitigation requirements.
- New drainage infrastructure that is designed to attenuate any additional surface water runoff should remain outside the 1 in100 year plus climate change flood areas for any source of flooding. This is to prevent the drainage becoming overwhelmed by flood water prior to being available for the runoff from the development.

Any Ordinary Watercourse Consent application would need to show how the flow in the watercourse will be maintained and how flood risk will not be increased elsewhere. It

Continued…/

would be supported by the relevant documents and technical drawings. We do not have detailed guidance on information required for consenting, however, the LLFA guidance on development (as a statutory consultee) with regard to the prevention of the increase in flood risk can be used as a general guide. This can be found on our website https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers

We advise that any formal or informal drainage associated with existing developments or farmland should be maintained or diverted by the scheme to avoid future ponding against any embankments that may be created. In there is infilling of ponds, the inflows and outflows of these should be identified and diverted or other mitigation provided if they are found to be groundwater fed.

We also welcome that the applicant indicates that an FRA will include a drainage strategy and design appropriate SUDS features including the must up to date climate change allowances in accordance with current policy guidelines. The proposed drainage scheme should be tested with an addition of 20% and 40% climate change to consider if additional mitigation is required. It is also noted that the existing drainage scheme will only be utilised where the new development joins the existing. We note that the scoping report highlights that construction of large development schemes can cause additional runoff through the nature of removing topsoil and having temporary works. We would like to see that adequate measures are put in place to minimise temporary additional runoff and that this is diverted away from any final drainage scheme. This would be to minimise siltation and blockage of newly created drainage infrastructure.

We would like to highlight that; the drainage strategy should also contain a maintenance and management plan detailing the activities required and details of who will adopt and maintain the all the surface water drainage features for the lifetime of the development.

Please note, as there are works proposed as part of this application that are likely to affect flows in an ordinary watercourse, then the applicant is likely to need the approval of LLFA as Norfolk County Council. It should be noted that this approval is separate from planning approval. We would expect to be consulted on both the temporary works and permanent works required

Yours faithfully

Elaine

Elaine Simpson
Lead Local Flood Authority

Norfolk County Council Comments on the:
A47 Blofield to Burlingham Dualling - Scoping Report

7th March 2018

1. Preface

1.1. The officer-level comments below are made on a without prejudice basis and the County Council reserves the right to make further comments on the emerging A47 Blofield to Burlingham Dualling project.

2. General Comments

2.1. The County Council (CC) welcomes the opportunity to comment on the above Scoping Report.

2.2. The CC welcomes reference in paragraphs 12.2.1 - 12.2.4 to the need to assess the Local Impact Area; the Wider Impact Area; and the Cumulative Impacts associated with other proposed A47 schemes on the County of Norfolk.

2.3. The EIA will need to assess the wider economic benefits arising from the above Road Improvement scheme both in terms of the scheme coming forward on its own and in combination with the other proposed A47 road schemes.

2.4. Welcome reference in the Report to the potential for community severance in paragraph 12.5.9 and reference to local community facilities in the table 12.1 on page 105 (including reference to Blofield Primary School). The EIA/ES will need to consider the potential issues of community severance and where necessary set out how this will be mitigated.

2.5. There is reference in paragraph 12.7.25 to a proposed NMU Overbridge which could potentially address some of the community severance issues. It is unclear whether the proposed overbridge forms part of the NSIP scheme. The status of the overbridge therefore needs to be clarified and its proposed route/alignment shown in the Scoping and other documents.

2.6. Paragraph 12.9.6 – welcome the list of social and community receptors which includes primary and secondary schools and community health facilities.

2.7. In addition to the above comments – Highways England (HE) needs to clarify the scope of the project. Paragraph 1.3.1 refers to the project comprising 2.6 km of new dual carriageway; whereas paragraph 2.4.1 refers to 4.5 km of improvements of which 2.6 km will be dualled. The Scoping Report and emerging documents need to clearly set out the scope of the project.

2.8. Should you have any queries with the above comments please call or email Stephen

Faulkner on 01603 222752 or email stephen.faulkner@norfolk.gov.uk.

3. Transport

3.1. Norfolk County Council supports the scheme objectives set out in Section 2.2

3.2. The description of the project in Section 2.4.2 does not make it clear exactly what the proposals are (eg NMU provision, extent of dualling, proposals for changes to local road network, junction standards). Because of this, it is also difficult to assess proposals to deal with impacts, such as those caused by diversions of traffic, not necessarily in the immediate vicinity of the proposed dualling scheme. Some of these impacts might affect areas outside of the DCO area set out in Appendix A of the scoping report.

3.3. Without knowing the broader likely impacts of the proposal, it is difficult to know whether the proposed areas to be assessed are correct. This comment applies to most if not all of the things proposed to be assessed.

The following sets out some areas for clarification:

- Air Quality: 5.2.2 sets out that "The study area for the local air quality assessment covers human health receptors and ecologically Designated Sites within 200m of roads that are expected to be affected by the Proposed Scheme" As stated, it is not clear what this extent might be (although 5.2.3 does give the criteria to be taken into account)
- Landscape: 6.2.1 states "The study area includes designated and non-designated cultural heritage assets within 1km of the Proposed Scheme." Again, it is not known whether this is the correct area since it is not known how widespread the effects are likely to be (and in this case there is no criteria about changes that might lead to a substantive impact)
- People and Communities, Section 12: This is probably quite important to set some criteria about impacts because, if there is significant diversion of traffic during either operation or construction it could affect people and communities living some distance from the proposal and therefore outside of the areas proposed to be assessed.

3.4. Should you have any queries with the above comments please call or email David Cumming on 01603 224225 or email david.cumming@norfolk.gov.uk.

4. Environment

4.1. Ecology

The CC welcomes the Biodiversity Section (Section 8) of the EIA Scoping Report which includes sufficient information to inform the Environmental Statement (ES) part of the EIA.

4.2. The desktop study identifies all sites designated for nature conservation within 2km including locally designated County Wildlife Sites, and the Norfolk Biodiversity Information Service has been consulted for records of protected species within the

search area. This information guided the surveys undertaken as part of the Extended Phase 1 Habitat survey April 2016 and updated in 2017.
(The full findings of the surveys are reported in the A47 Blofield to North Burlingham Junction Stage 2 Preliminary Ecological Appraisal).

A Habitat Regulations Assessment Screening Report (HRA) was undertaken to determine whether any adverse impacts on Natura 2000 sites.
The HRA screening determined that there was the potential for effects on the following sites:
• The Broads SAC
• Broadland SPA
• Broadland Ramsar
• Breydon Water SPA
• Breydon Water Ramsar
• Paston Great Barn SAC

Detailed consultations have yet to be undertaken with various statutory and non-statutory bodies including Natural England, Environment Agency, Norfolk County Council, Norfolk Wildlife Trust and the RSPB. These organisations will need to be consulted fully during the EIA process and their responses will be included in the associated reporting.

There is potential for the scheme to have a direct impact on habitats and species including European and Internationally designated sites and protected species. These impacts have been identified and will be assessed appropriately in conversation with the appropriate responsible organisations.
Mitigation will be proposed and replacement habitat or habitat improvements will be proposed within the ES.

The CC is satisfied that this has been identified and surveys will be ongoing in the first half of 2018. Monitoring will be proposed where required and will continue after construction of the scheme to monitor impacts.

All surveys and mitigation references, the accepted industry standard methodologies, will need to be outlined fully in the ES.

4.3. The CC agrees with the conclusion of the Ecology Section of the Scoping report that;

8.10.1 *There is potential for significant direct and indirect effects to protected species, designated sites, and sensitive habitats as a result of the Proposed Scheme.*
Subsequently, this warrants assessment to a Detailed level, in accordance with IAN 130/10.

8.10.2 This assessment will be presented within the ES.

4.4. **Landscape**

The CC is satisfied that HE have used the most appropriate guidance to undertake

the Scoping Report, and also that an appropriate study area has been considered. The existing and baseline knowledge seems accurate and considers the varying landscape characters along the length of the proposal, including the consideration of visual amenity, particularly from the extensive PRoW network in the vicinity of the proposals.

The assessment of Landscape and Visual affects seems thorough and the CC satisfied that the conclusion of requiring a 'Detailed' level of assessment was reached correctly due to the potential significant effects on both landscape character and visual amenity. The proposals for this further assessment (a Detailed LVIA within the ES) including site visit appear suitable. This will allow a further understanding of the local landscape character to better assess the landscape value and sensitivity to change.

NB: 7.3.2 Broadland District Council, not Broadlands District Council

4.5. Should you have any queries with the above comments please call or email Ed Stocker on 01603 222218 or email NETI@norfolk.gov.uk.

5. Historic Environment

5.1. The Cultural Heritage chapter could be more explicit about what will actually be included in the corresponding chapter of the Environmental Statement. The ES should include both a desk-based assessment and the results of the archaeological field evaluation (geophysical survey and trial trenching).

5.2. Should you have any queries with the above comments please call or email Dr James Albone on 01362 869279 or email james.albone@norfolk.gov.uk.

6. Lead Local Flood Authority (LLFA)

6.1. Detailed LLFA comments are attached, see documents titled *'FWS_18_8_6074 LLFA Response Blo-Burl'* and *'Blofield to Burlingham Flow Map'*.

The Blofield to Burlingham Flow Map has been provided for information and should not be reproduced without the express permission of Norfolk County Council.

Catchment and flowpath caveats:

- Catchments and flowpaths have been created using a bare earth DTM derived from a LIDAR / NextMap composite at a horizontal grid resolution of 2m.
- The "bare earth" model means that most elevated features such as buildings and trees are ignored. Ground levels within these features are interpolated from the surrounding ground levels.
- In some cases the top of features may be represented rather than the opening through it.
- These features include road and railway embankments, bridges, subways and tunnels

- Other real world features such as walls, drop kerbs and speed bumps are not represented.
- Catchments and flow paths were created which do not take into consideration these real world features

6.2. Should you have any queries with the above comments please email the LLFA at llfa@norfolk.gov.uk.

7. Minerals and Waste

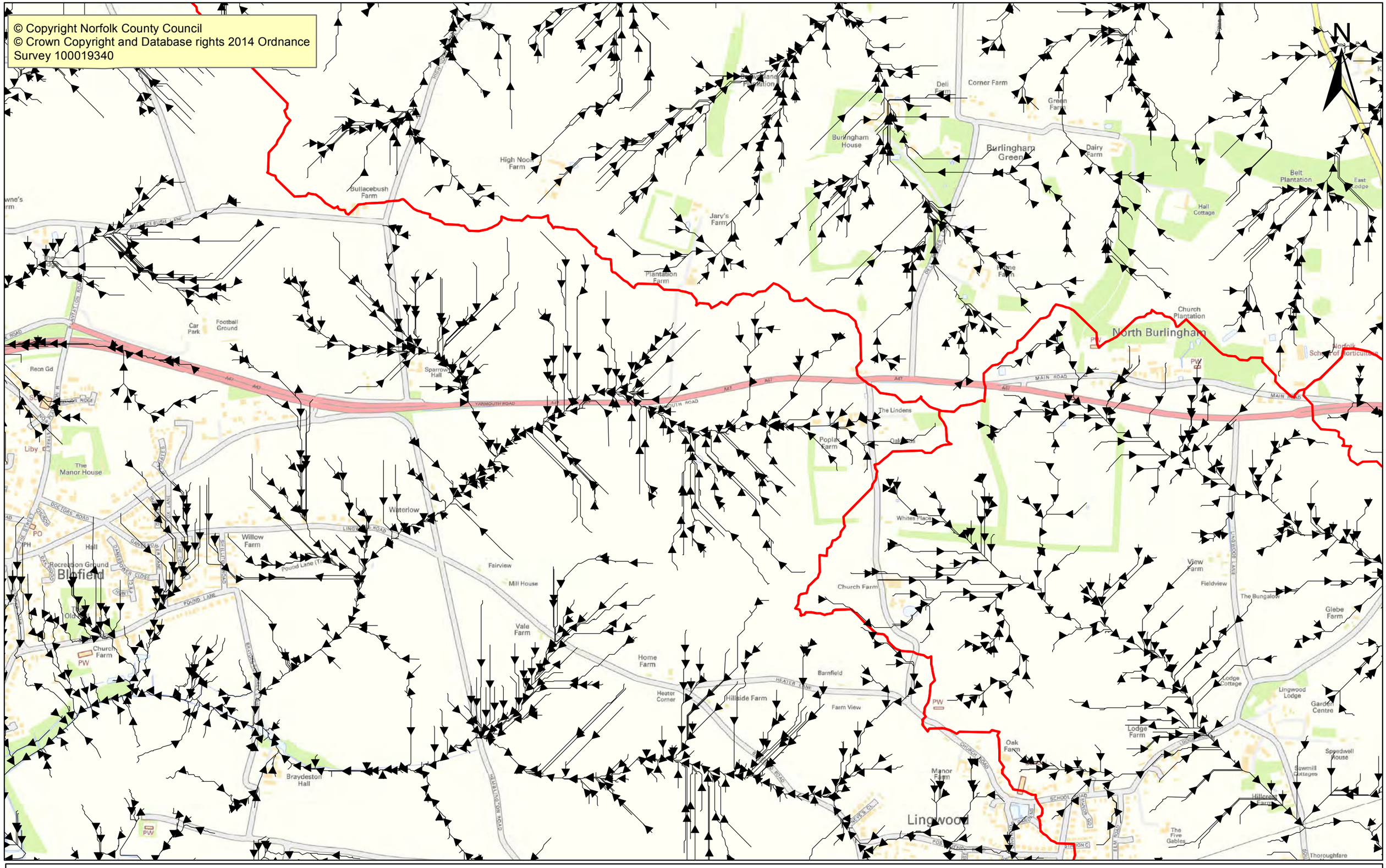
7.1. The Planning Policy context in the Scoping report only details the national planning policy context. Therefore the Scoping Report has not referred to Policy CS16 of the adopted Norfolk Core Strategy and Minerals and Waste Development Management Policies DPD (the 'Norfolk Minerals and Waste Core Strategy'). Policy CS16 is applicable to this proposal because part of the DCO site area is underlain by a mineral resource (sand and gravel) which is safeguarded as part of the Norfolk Minerals and Waste Core Strategy. Safeguarded mineral resources are derived primarily from the BGS mineral resources map (2004) as amended by the DiGMapGB-50 dataset. A duty is placed upon planning authorities to ensure that mineral resources are not needlessly sterilised, as indicated in National Planning Policy Framework paragraph 143, and 'A guide to mineral safeguarding in England' published jointly by DCLG and the BGS. Chapter 9 of the Scoping Report provides information on the geology of the DCO site. Paragraph 9.7.6 states *"Where practicable, material should be re-used on site provided performance criteria are met with respect to chemical composition and geotechnical parameters. This may be managed under a Materials Management Plan prepared in accordance with the CL: AIRE Code of Practice."* Therefore, it is considered that the re-use of materials on site should include the use of sand and gravel mineral resources in the construction of the scheme, if the material meets the required specifications for highway construction and that this should be managed under a Materials Management Plan.

7.2. Norfolk County Council's Norfolk Core Strategy and Minerals and Waste Development Management Policies DPD is available on our website here: https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/minerals-and-waste-planning-policies/adopted-policy-documents

A map of the Mineral Safeguarding Areas is available on our website here: https://norfolk.jdi-consult.net/localplan/mapping2.php?mapid=201

Norfolk County Council's safeguarding guidance is available on our website here: https://www.norfolk.gov.uk/-/media/norfolk/downloads/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/minerals-and-waste-planning/aggregates-sand-gravel-and-carstone.pdf?la=en

7.3. Should you have any queries with the above comments please call or email Caroline Jeffery on 01603 222193 or email caroline.jeffery@norfolk.gov.uk.



0 0.1 0.2 0.4 0.6 0.8 Kilometers

Site Name: A47 North Burlingham
Reference: FWS/18/8/6074
Date Created: 27 Feb 2018

Legend
- Flow Paths
- Catchments

N

Norfolk County Council

1:10,000

Norfolk County Council

Community and Environmental Services Department
Planning & Flood and Water Management Team
Minutes of Meeting

A47 Thickthorn Junction with A11 Improvements, A47 Blofield to North Burlingham Dualling

Held on: **24 May 2018** Time: 13:00
Venue: **County Hall, Norfolk County Council, Norwich**

Present:	Elaine Simpson	Lead Local Flood Authority	**ES**
	Martin Barrell	Environment Agency	**MB**
	Ben Freeman	Environment Agency	**BF**
	Stephen Hughes	Mott MacDonald / Sweco	**SH**

Apologies: None

Minute Taker: ES
Cfi:

Action

1.0 Welcome, apologies and introductions

2.0 A47 / A11 Thickthorn Scheme

Discussed the outline of the scheme so far and how information is being collected to address the concerns raised in the PINS responses of the LLFA and EA.

1D/2D model being undertaken for the watercourse. BF offered that may have another 1D model downstream that may be of help. SH indicated that topographic survey completed to assist. Discussion of climate change allowances. BF requested that 65% undertaken unless it's a critical network then 75% should be allowed.

ES indicated that 40% climate change be tested for the drainage and include if possible for strategic infrastructure. SH highlighted that DMRB suggested only design to 20% but will look at 40%. **SH**

Plan to lengthen A11 culvert on the watercourse and keep as is, other culvert on A47 will be considered when upgrading but also likely just lengthen. **MB**

ES outlined that consent would fall to LLFA for culverts to ensure that flow is not adversely affected but EA would review the flood map outputs and compensatory storage required for floodplain taken up in the development. MB confirmed that environmental permit will not be required on the watercourse for flooding reasons but may for other reasons, will confirm e.g. groundwater dewatering **SH**

SH indicated that surface water flow and dry culverts had been considered, ES suggested to put into same model if possible but could be separate if informed by outputs of the river model. SH would look into the possibly catchment or if a watercourse for the flow path to the northwest of the A11 and give further thought as new road crosses it. . ES warned not to use LIDAR data on its own as may be inaccurate and to use local topographic information and site visits prior to final design. **SH**

EA and SH will have meeting regarding groundwater / geomorphology / biodiversity issues separately. **SH/MB**

ES highlighted an additional area of flooding that may need to consider, Cantley Lane, near railways line. ES will summarise issue to SH so it can be considered in a robust way to show that not making an existing issue worse. ES highlighted that need to keep drainage out of areas of flooding so they are not overwhelmed, SH indicated would consider drainage further in this area to consider if can improve the existing scheme where new road will meet Cantley Lane. SH also indicted that hotspot flooding at thickthorn junction would also be investigated and upgraded if possible. Full survey of the existing drainage has been carried out. **ES** **SH**

SH indicated that area to the northeast joining to Roundhouse way has been removed from the red line boundary as no longer part of the scheme

MB and ES highlighted the need for information on drainage scheme to meet the SuDS hierarchy e.g. infiltration supported by testing (at a early stage to ensure that a scheme will work) but also that connections to a watercourse can also be achieved if infiltration not viable. Geology is very variable so comprehensive testing is advised. Also to ensure that there is an unsaturated zone to any groundwater. SH to review ground investigation and include in pre- environmental submission stage. **ES**

Water quality discussion highlighted that oil interceptors are not a treatment in the drainage design but a pre-treatment step. Full consideration to be given for water quality especially when considering different outfalls e.g. infiltration to groundwater vs to a surface watercourse.

3.0 A47 Blofield to North Burlingham Scheme

Discussed outline scheme. Infiltration soakaways at either end are likely but middle section will go to watercourse network. SH to ensure that these are connected to the wider watercourse network (as indicated in draft strategy). **SH**

MB highlighted that groundwater team had raised issues which will discuss at a separate meeting.

ES highlighted area that LLFA had records of flooding and need to consider flow paths and need for dry culverts. SH did not have information but was of the understanding these had been included in the scheme. ES warned not to use LIDAR data on its own as may be inaccurate and to use local topographic information and site visits prior to final design. **SH**

SH indicated that likely to fill in the pond on the Lingwood Road junction. ES requested that contact NCC highways (David Cummings or Phil Moulson) if part of a local road scheme.

Water quality discussion highlighted that oil interceptors are not a treatment in the drainage design but a pre-treatment step. Full consideration to be given for water quality especially when considering different outfalls e.g. infiltration to groundwater vs to a surface watercourse.

4.0 Any other business

NA

Date and venue of next meeting:

EA and SWECO meeting re groundwater TBC

Norfolk County Council
Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG

via e-mail
FAO: Stephen Hughes
SWECO

NCC contact number: 0344 800 8020
Textphone: 0344 800 8011

CC: Stephen Faulkner
Norfolk County Council Principal Planner

Your Ref:	A47 Blofield – Drainage Strategy	My Ref:	FW/2020_0514
Date:	14/08/2020	Tel No.:	0344 800 8020
		Email:	llfa@norfolk.gov.uk

Dear Mr Hughes,

Town and County Planning (Development Management Procedure) (England) Order 2015
The dualling of the A47 Blofield to North Burlingham and associated junction improvement works – Flood Risk Assessment

Thank you for the providing the draft Flood Risk Assessment (FRA) for initial review issued by your email on 6th August 2020.

We note that the FRA has been submitted to support the previously submitted draft drainage strategy. The draft drainage strategy currently states in section 1.4.3 that the drainage strategy should be read in conjunction with other documents that included the Flood Risk Assessment, which was unavailable at the time.

The LLFA had previously responded in a combined letter from Norfolk County Council dated 26th February 2018 regarding our expectations of any flood risk assessment and sustainable drainage system. These expectations are in accordance with the LLFA's developer guidance, which is available on our webpage (https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers).

We note that the LLFA guidance is not mentioned in the FRA, even though the current Environment Agency guidance on the preparation of FRA clearly states that plans for managing surface water are in line with guidance from your lead local flood authority and sustainable drainage principles. Further information can be found at https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zone-1-and-critical-drainage-areas

There is currently no reporting or summary of the pre-development and post-development runoff rates and the associated attenuation volumes within the FRA.

The FRA does not currently include an assessment of suitable SuDS options. While infiltration has been selected as a means of surface water disposal, there is no recorded consideration of the SuDS in terms of water quantity, water quality, amenity and

biodiversity. The FRA summarises the scoping opinion response from the Planning Inspectorate and states that

> *"SuDS schemes should be designed to provide for habitat enhancement."*

There is no indication in either the FRA or the Drainage Strategy that habitat or environmental enhancement opportunities have been considered in relation to SuDS selection and design. Please could a summary of enhancement opportunities considered relating to SuDS be included in the FRA.

We are aware from the drainage strategy that infiltration testing has been undertaken, there is no discussion of the infiltration testing or its results in the FRA. As the surface water flood risk management approach depends on infiltration, it would be appropriate for the FRA to report on these results.

In relation to the drainage design, the FRA confirms that during consultation with the LLFA, it was requested that:

> *"Drainage mitigation should provide sufficient attenuation for a 1 in 100-year event including an allowance for future climate change"*

At present, some elements of the current drainage design do not meet these standards. Previously the LLFA provided comments on the Drainage Strategy's surface water drainage design approach in a letter dated 6th August 2020. On review of the FRA, it is clear the same drainage design was used in the FRA. Therefore, our comments on the surface water drainage design approach remain unchanged at this time.

The FRA discusses the surface water flood history and notes the 'high impact' flooding incident of 2019 which closed the western bound carriageway in Blofield. As a 'high impact' local flood event, the LLFA would expect further comment regarding the cause, impacts and remedial works within the body of the report. At present there are only limited remarks in the conclusion. A plan with the approximate location and extent of this specific flood would be considered appropriate for inclusion (either as a separate plan or on an existing plan). As some of the existing drainage systems are proposed to remain in use and unchanged, it would be appropriate to confirm whether the area of the flood is served by highway drainage that is proposed to remain unaltered. If these two areas overlap, it would be appropriate for the FRA to discuss whether the existing drainage system has been reviewed to confirm its current design capacity is acceptable.

The groundwater flood risk is considered throughout the FRA. The FRA mentions the groundwater is a considerable depth below the surface, however, no evidence or indication of the groundwater level is given in the report. We are aware that the groundwater has had further assessment and consideration in the EIA, the Groundwater Assessment and the Technical Note on the Deep Drainage.

Some reference to the surface water flow paths has been given in the FRA. However, there are no plans with clearly marked up areas that identify the flow paths in conjunction with the proposed road and drainage design. This would be beneficial for assessing the interaction of the scheme with the flow paths and should be prepared.

In addition, the FRA does not report on the matter of surface water being redirected along existing flow paths as indicated in the drainage strategy. The LLFA would seek confirmation that the redirected flow does not increase the on-site and off-site flood risk. Therefore, as indicated in our letter of 6th August 2020, the further information the LLFA would seek is to address this concerns is;

- identification of the redirected flow path;
- identification of the flow paths receiving the additional flow;
- the anticipated additional amount of overland flow; and
- the identification of off-site property likely to be impacted.

The FRA has not included any consideration of the future maintenance and management provisions proposed for the future maintenance of the surface water management features and structures. Please could this be clarified in the report.

In addition, the FRA has not provided any information about the management of surface water flood risk during the construction phase. Please could the FRA contain information about the construction phase surface water management and any temporary measures that would be in place.

Should you have any further queries, please contact the LLFA directly.

Yours sincerely,

Sarah

Sarah Luff
Strategic Flood Risk Planning Officer

Lead Local Flood Authority

Norfolk County Council
Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG

via e-mail
FAO: Karen Dunton
SWECO

NCC contact number: 0344 800 8020
Textphone: 0344 800 8011

CC: Stephen Faulkner
Norfolk County Council Principal Planner

Your Ref: A47 Tuddenham/Thickthorn/Blofield My Ref: FW2020_0695
Date: 15 September 2020 Tel No.: 0344 800 8020
Email: llfa@norfolk.gov.uk

Dear Mrs Dunton,

Request for Flooding information on A47 Schemes (location codes can be found on email) at A47 Thickthorn Junction, A47 North Tuddenham to Easton and A47 Blofield to north Burlingham

Thank you for your request for Pre-application surface water assessment by email on 11th September 2020. The sites that you requested are listed in the table below along with the corresponding easting and northings and the Pre-application surface water assessment document references.

Scheme	Site NGR	Site Eastings	Site Northings	DTS Ref
A47 North Tuddenham to Easton	TG 06247 13512	606247	313512	FW2020_0695_1 - DTS
	TG 07770 12603	607770	312603	FW2020_0695_2 - DTS
	TG 10602 11827	610602	311827	FW2020_0695_3 - DTS
A47 Thickthorn Junction	TG 17930 04858	617930	304858	FW2020_0695_4 - DTS
	TG 19050 04856	619050	304856	FW2020_0695_5 - DTS
A47 Blofield to north Burlingham	TG 34985 09940	634985	309940	FW2020_0695_6 - DTS
	TG 36637 09929	636637	309929	FW2020_0695_7 - DTS

The Pre-app Service Terms and Conditions can be seen at https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers/terms-and-conditions.

Continued…/

Further information and guidance to support developers is available at https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers.

Should you have any further queries, please contact the LLFA directly.

Yours sincerely,

Sarah

Sarah Luff
Strategic Flood Risk Planning Officer

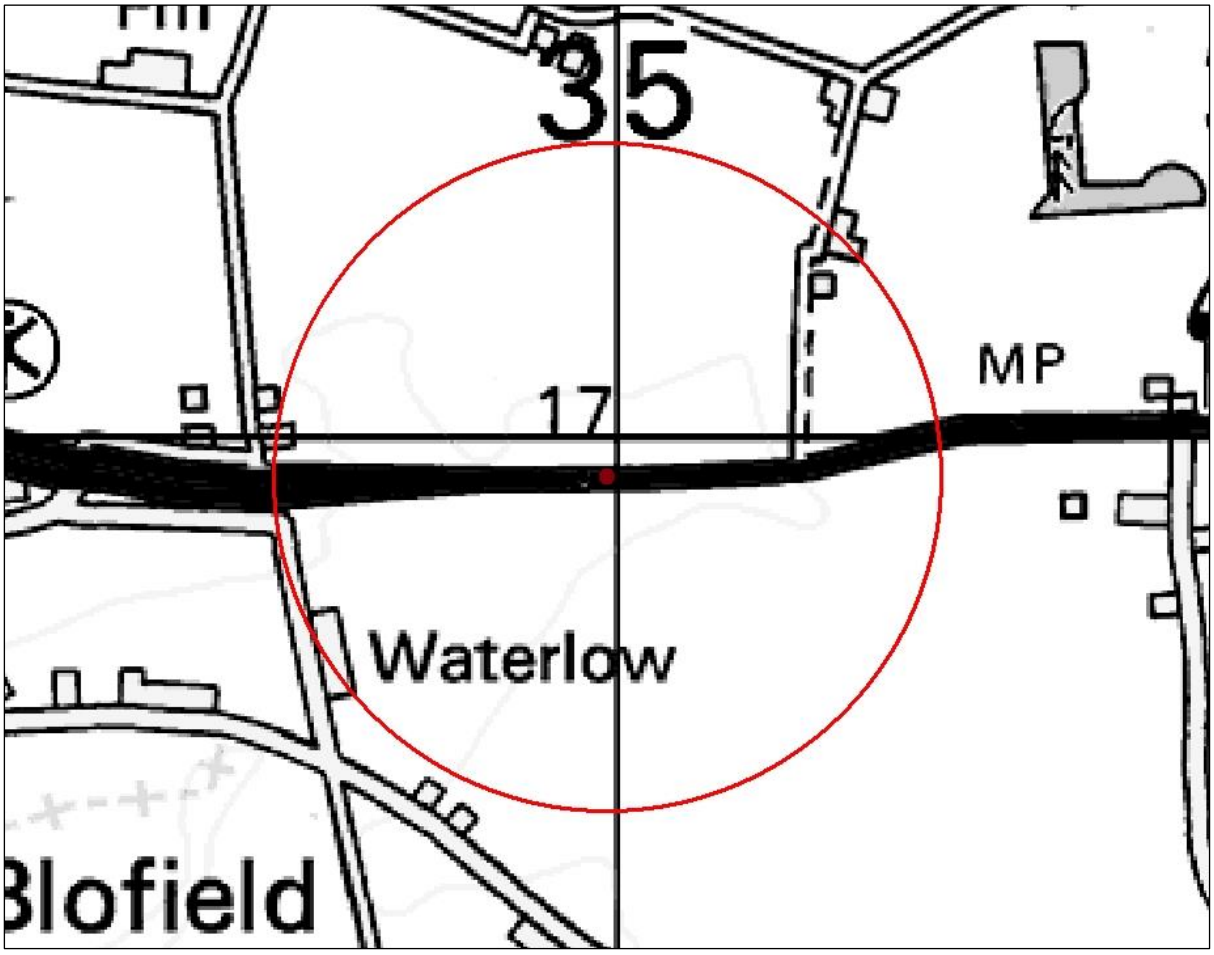
Lead Local Flood Authority

Enc: Seven pre-application surface water assessment documents.

Pre-application surface water assessment

This desktop study is for Flood and Water Planning case reference **FW2020_0695_6** and was completed on the 15 September 2020.

The location of the site is centred on Ordnance Survey Grid Reference 634985, 309940. This location is known as **Request for Flooding information on A47 Schemes (location codes can be found on email) at A47 Thickthorn Junction, A47 North Tuddenham to Easton and A47 Blofield to north Burlingham** and is in the Parish(s) of Blofield.



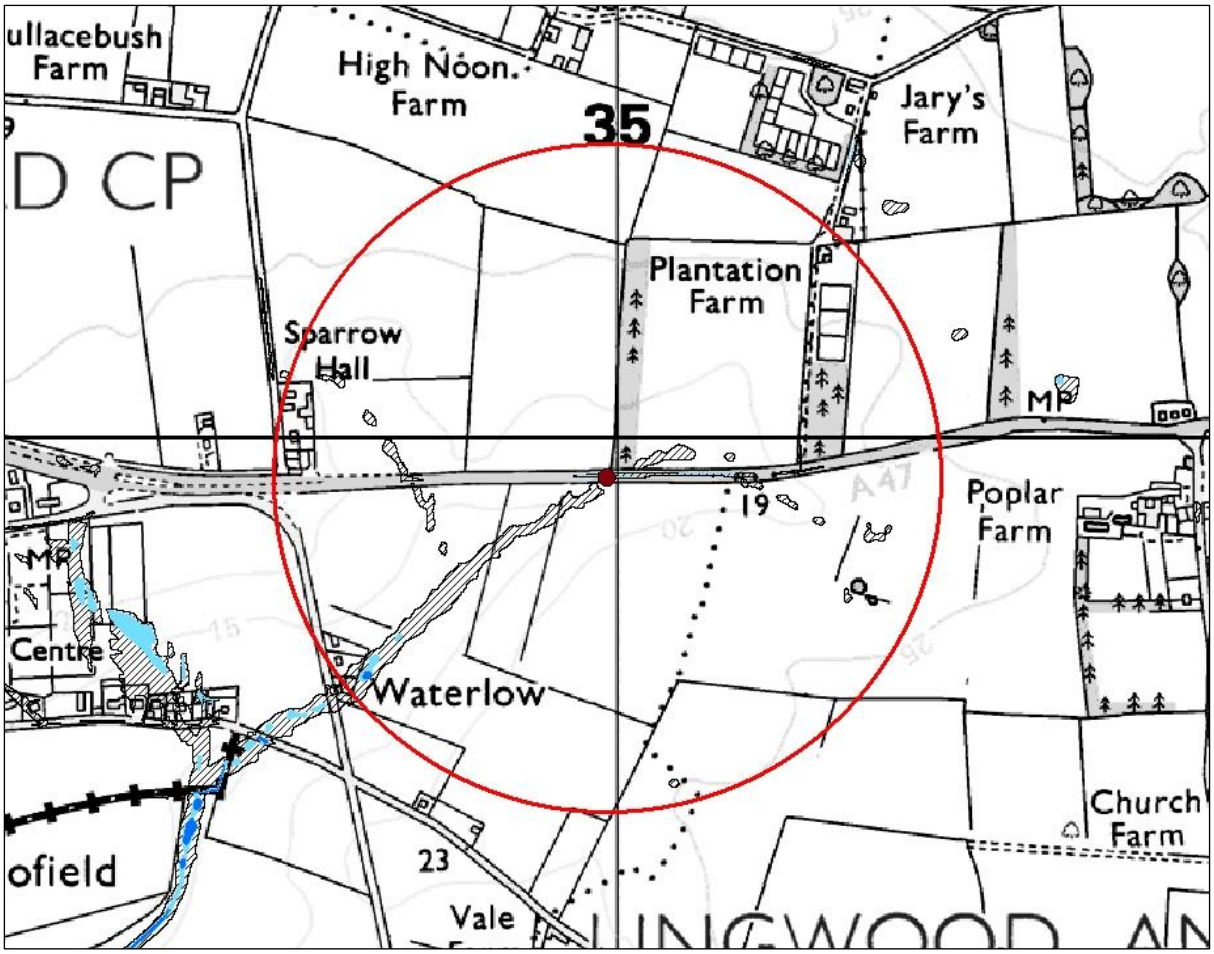
Norfolk County Council Case Reference: FW2020_0695_6

Map 1 - General site location plan.

This site has been ranked as being at a high risk of surface water flooding.

This site is within the Lackford Run (5) catchment(s) and is;

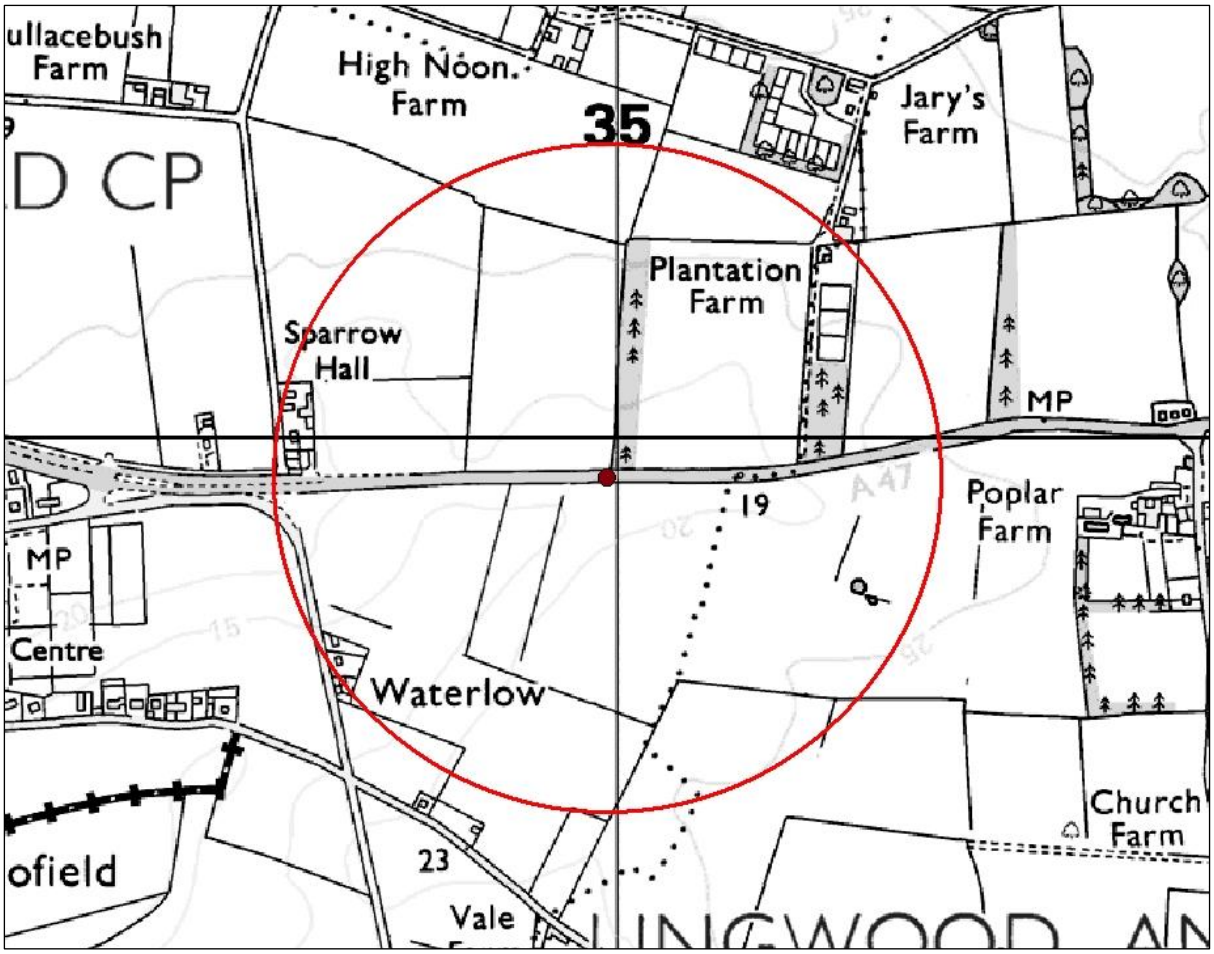
- Located within the Blofield and Brundall electoral division(s).
- Located within the Environment Agency's East Anglia administrative area(s) and Environment Agency's Eastern Area water management area(s).
- Not within 2.5 km of any Environment Agency Rain Gauges.
- Not within Flood Zone 2 and not within Flood Zone 3. (See map 3)
- Located within the Norfolk LLFA area(s) for the regulation of ordinary watercourses.
- Not identified as being near to a watercourse. (See map 6)
- Located within the Anglian Water Services Ltd area for the management of public sewers.
- Shown by Anglian Water records not to be served by public foul, combined or surface water sewers.
- Associated with significant overland flow path(s). (See map 2)
- Not within a Critical Drainage Catchment
- Within 1 km of 1 structure and within 2.5 km of 15 structures recorded on Norfolk County Council's Bridges layer. (See map 4)
- Is adjacent to highway that is publically maintainable. No highway drainage features are visible on Google Street View.
- Not located near to old drainage features highlighted by historic mapping (See map 5)
- Not within 0.5 km of any known incidents of internal flooding recorded by Norfolk County Council since April 2012.
- Within 2.5 km of 29 known incidents of internal flooding recorded by Norfolk County Council since April 2012.
  Norfolk County Council are unable to provide further details for any of the internally flooded properties.
- Not within 0.5 km of any properties included on the Anglian Water DG5 register.
- Not mentioned in any previously published flood studies or reports



Norfolk County Council Case Reference: FW2020_0695_6

Map 2 - The extent of surface water flooding in the vicinity of the site.

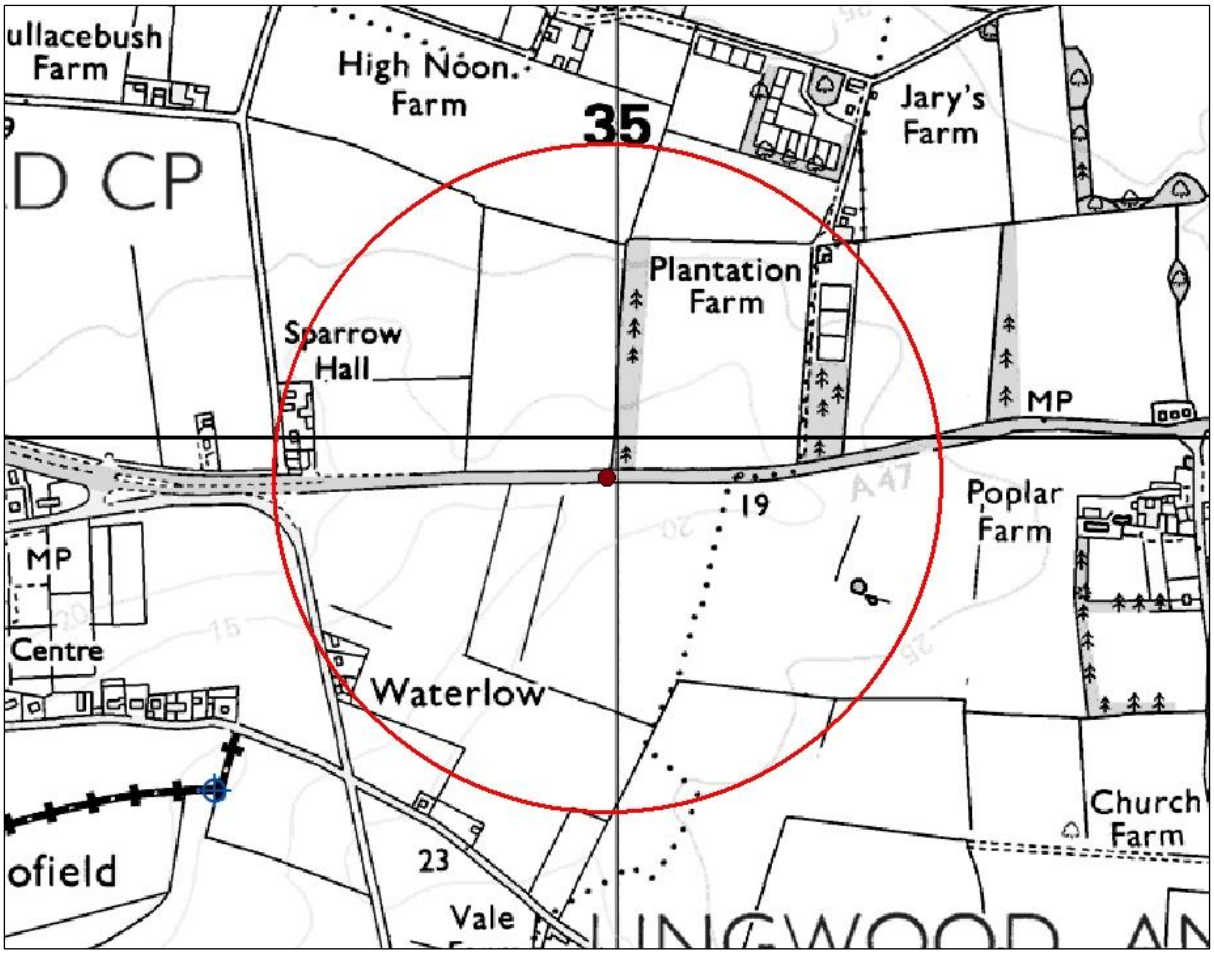
Dark blue shows flooding in a 3.33% AEP rainfall event.
Light blue shows the extent of flooding in a 1% AEP rainfall event.
The hatched area shows the extent of flooding in a 0.1% AEP rainfall event.



Norfolk County Council Case Reference: FW2020_0695_6

Map 3 - The extent of the flood zone coverage in the vicinity of the site.

Dark blue shows flood zone 3
Light blue shows flood zone 2.

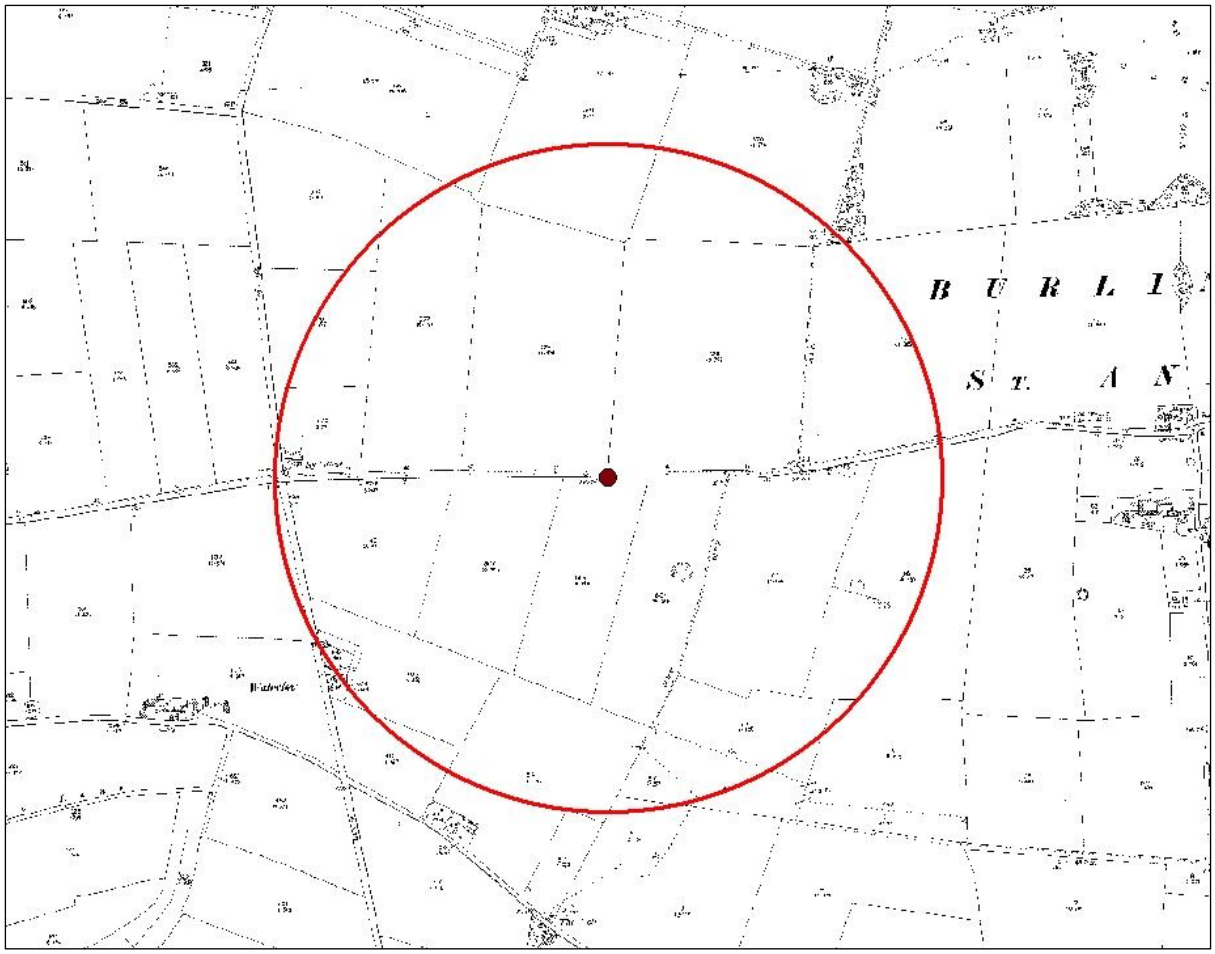


Norfolk County Council Case Reference: FW2020_0695_6

Map 4 - Structures in the vicinity of the site listed in Norfolk County Council's bridges dataset.

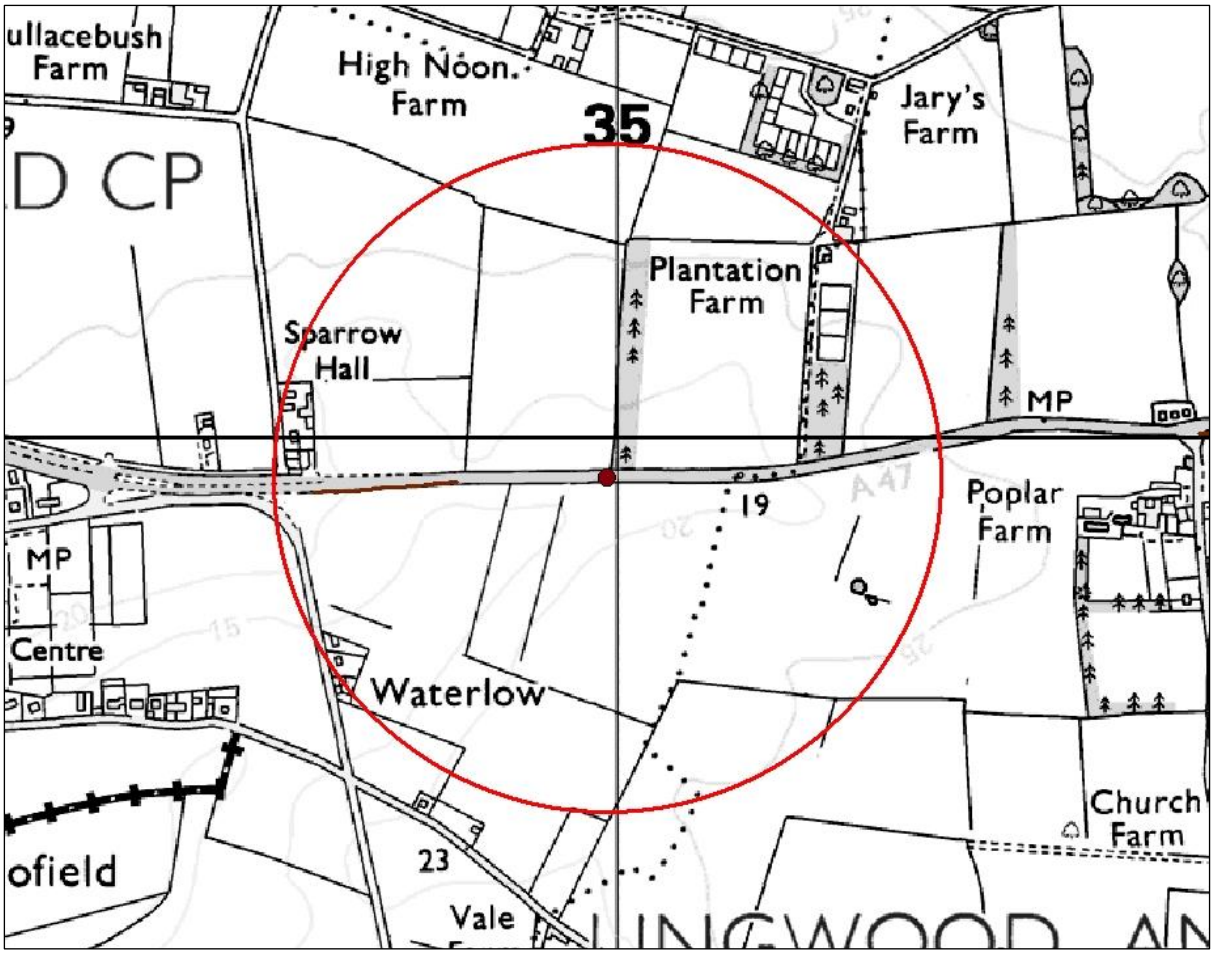
Please note this list is not exhaustive and does not confirm Norfolk County Council's ownership of or responsibility for these structures.

Not all structures listed on this dataset are associated with drainage features.



Norfolk County Council Case Reference: FW2020_0695_6

Map 5 - Land use and features in the vicinity of the site as shown on the Ordnance Survey First Edition or Second Edition maps



Norfolk County Council Case Reference: FW2020_0695_6

Map 6 - Mapped watercourses in the vicinity of the site.

This desktop study has been created by the Lead Local Flood Authority (LLFA) at Norfolk County Council.

Lead Local Flood Authority
Norfolk County Council
County Hall
Martineau Lane
Norwich
Norfolk
NR1 2SG

Email: llfa@norfolk.gov.uk

Norfolk County Council:
The information in this assessment is supplied 'as is' and we exclude all liabilities in relation to the information. We are not liable for any errors or omissions in the information and shall not be liable for any loss, injury or damage of any kind caused by its use.
Where a site boundary has been provided the study area has been captured at a scale of 1:10000 using the information provided.
A buffer centered on a supplied Ordnance Survey Grid Reference may be used as the study area where a site boundary is not provided.
The study area is solely for the purposes of producing this report and it may extend beyond the site shown in the information provided.

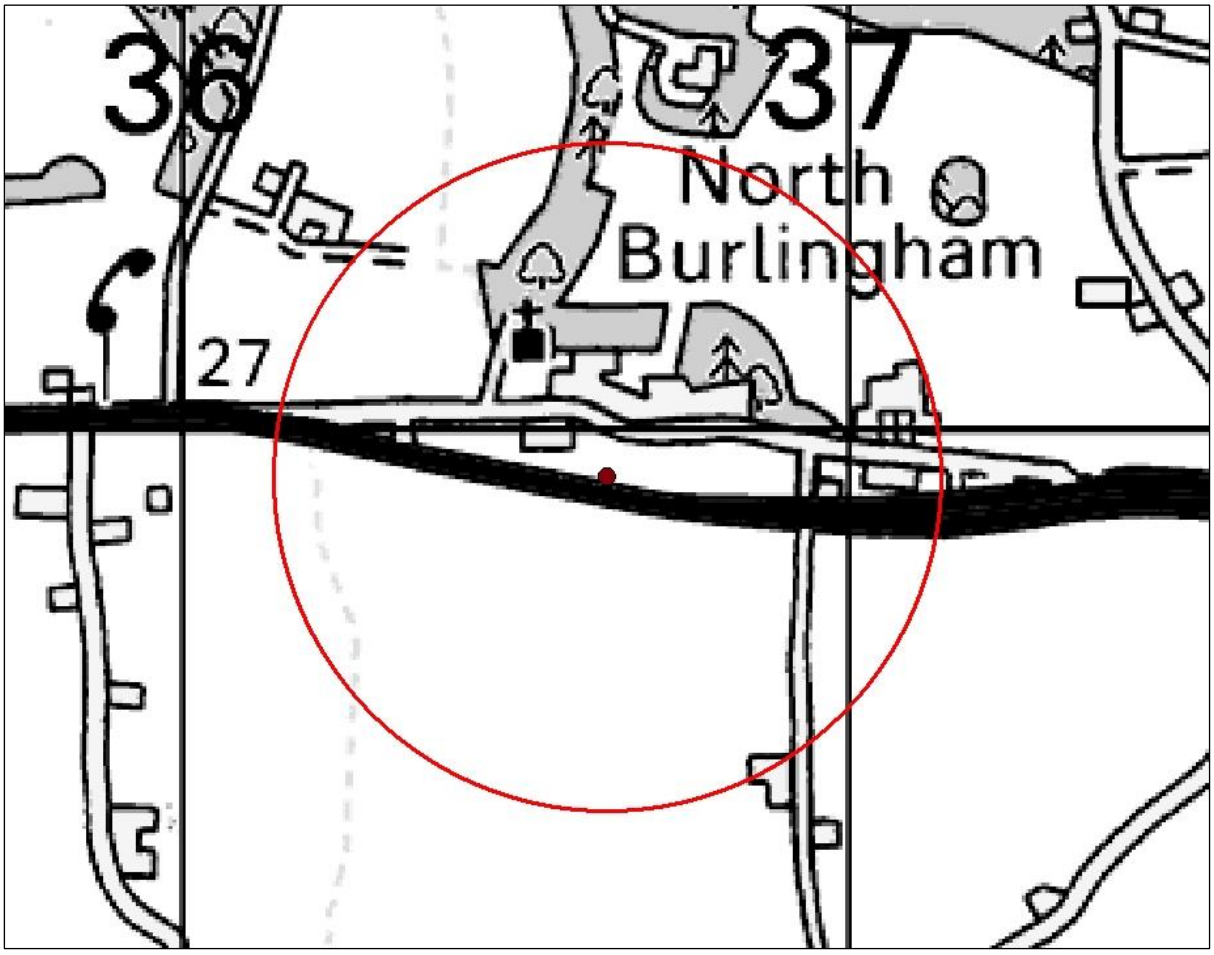
Environment Agency:
Flood zone maps are modelled using local and national river and sea data. This information provides an indication of the likelihood of flooding and is intended for planning use only.
The information on the Flood Map is designed to only give an indication of flood risk to an area of land and is not sufficiently detailed to show whether an individual property is at risk of flooding. This is because we cannot know all the details about each property.

Flood Map for Surface Water is not to be used at property level. It is not recommended to be used with more detailed background than 1:10,000 as the data is open to misinterpretation if used at a more detailed scale.

Pre-application surface water assessment

This desktop study is for Flood and Water Planning case reference **FW2020_0695_7** and was completed on the 15 September 2020.

The location of the site is centred on Ordnance Survey Grid Reference 636637, 309929. This location is known as **Request for Flooding information on A47 Schemes (location codes can be found on email) at A47 Thickthorn Junction, A47 North Tuddenham to Easton and A47 Blofield to north Burlingham** and is in the Parish(s) of Lingwood and Burlingham.



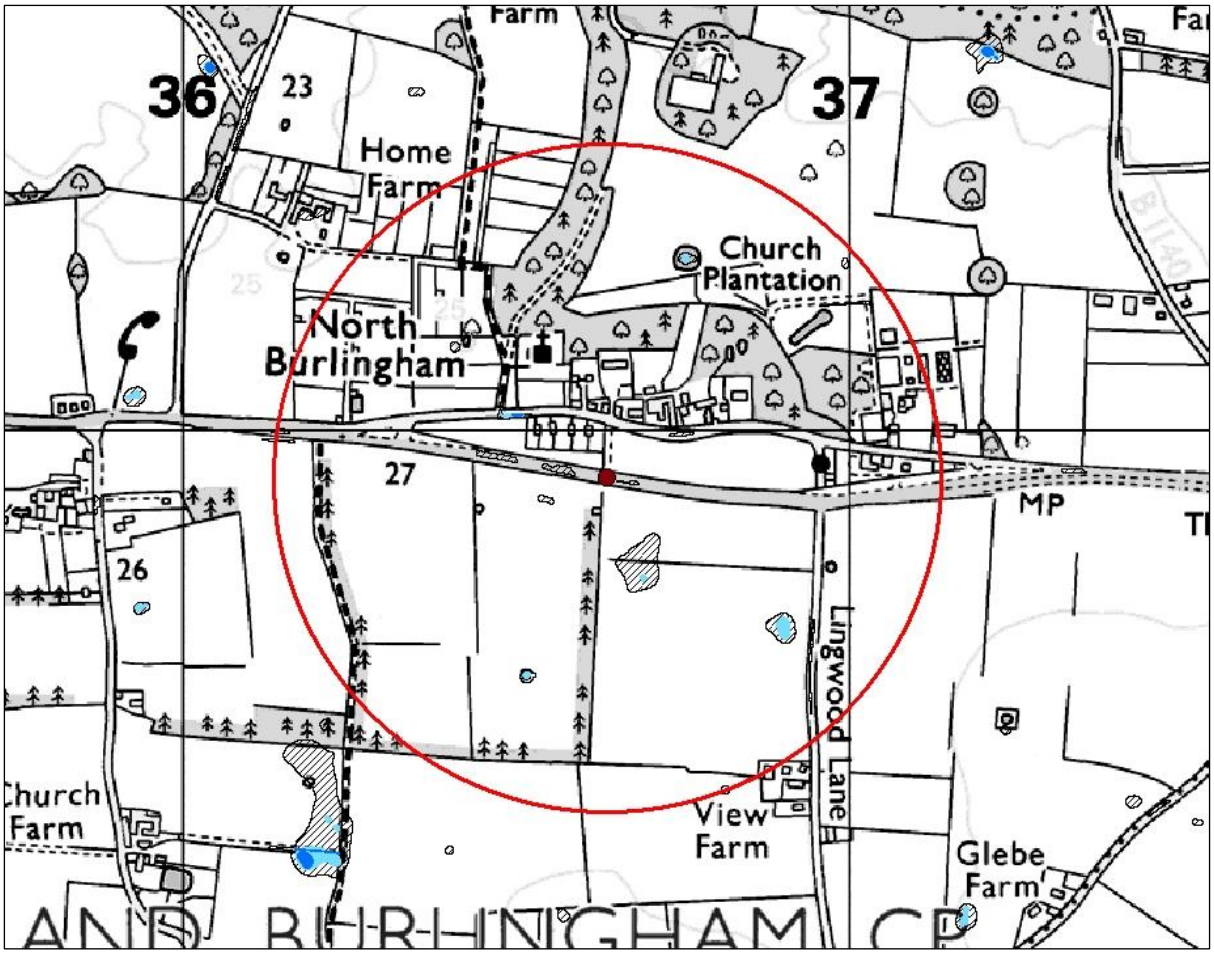
Norfolk County Council Case Reference: FW2020_0695_7

Map 1 - General site location plan.

This site has been ranked as being at a low risk of surface water flooding.

This site is within the Acle Dike (100) catchment(s) and is;

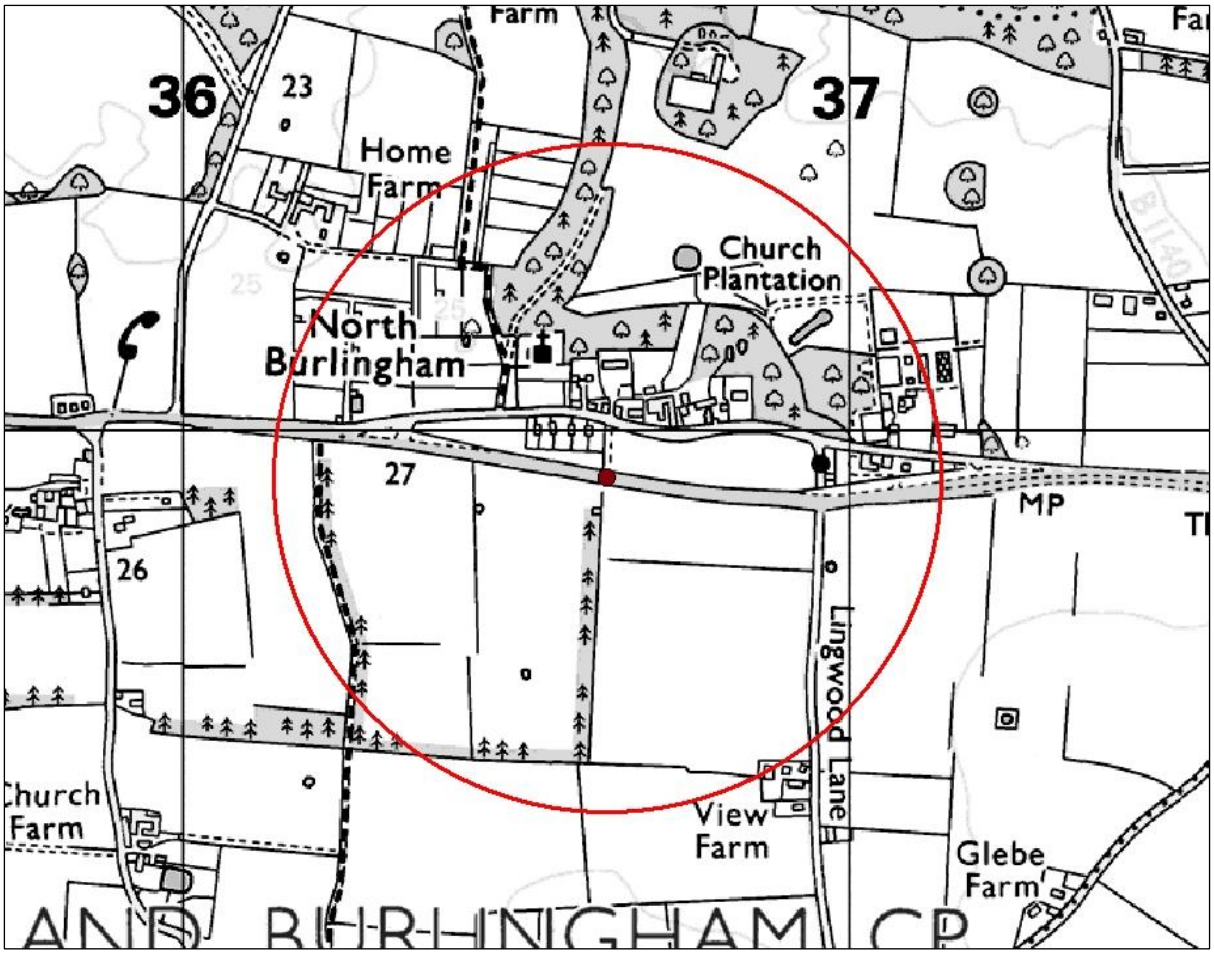
- Located within the Acle electoral division(s).
- Located within the Environment Agency's East Anglia administrative area(s) and Environment Agency's Eastern Area water management area(s).
- Not within 2.5 km of any Environment Agency Rain Gauges.
- Not within Flood Zone 2 and not within Flood Zone 3. (See map 3)
- Located within the Norfolk LLFA area(s) for the regulation of ordinary watercourses.
- Not identified as being near to a watercourse. (See map 6)
- Located within the Anglian Water Services Ltd area for the management of public sewers.
- Shown by Anglian Water records not to be served by public foul, combined or surface water sewers.
- Not identified as being affected by, or adjacent to, surface water flood mapping. (See map 2)
- Not within a Critical Drainage Catchment
- Not within 1 km of any structures and within 2.5 km of 7 structures recorded on Norfolk County Council's Bridges layer. (See map 4)
- Is adjacent to highway that is publically maintainable. No highway drainage features are visible on Google Street View.
- Not located near to old drainage features highlighted by historic mapping (See map 5)
- Not within 0.5 km of any known incidents of internal flooding recorded by Norfolk County Council since April 2012.
- Within 2.5 km of 13 known incidents of internal flooding recorded by Norfolk County Council since April 2012.
  Norfolk County Council are unable to provide further details for any of the internally flooded properties.
- Not within 0.5 km of any properties included on the Anglian Water DG5 register.
- Not mentioned in any previously published flood studies or reports



Norfolk County Council Case Reference: FW2020_0695_7

Map 2 - The extent of surface water flooding in the vicinity of the site.

Dark blue shows flooding in a 3.33% AEP rainfall event.
Light blue shows the extent of flooding in a 1% AEP rainfall event.
The hatched area shows the extent of flooding in a 0.1% AEP rainfall event.



Norfolk County Council Case Reference: FW2020_0695_7

Map 3 - The extent of the flood zone coverage in the vicinity of the site.

Dark blue shows flood zone 3
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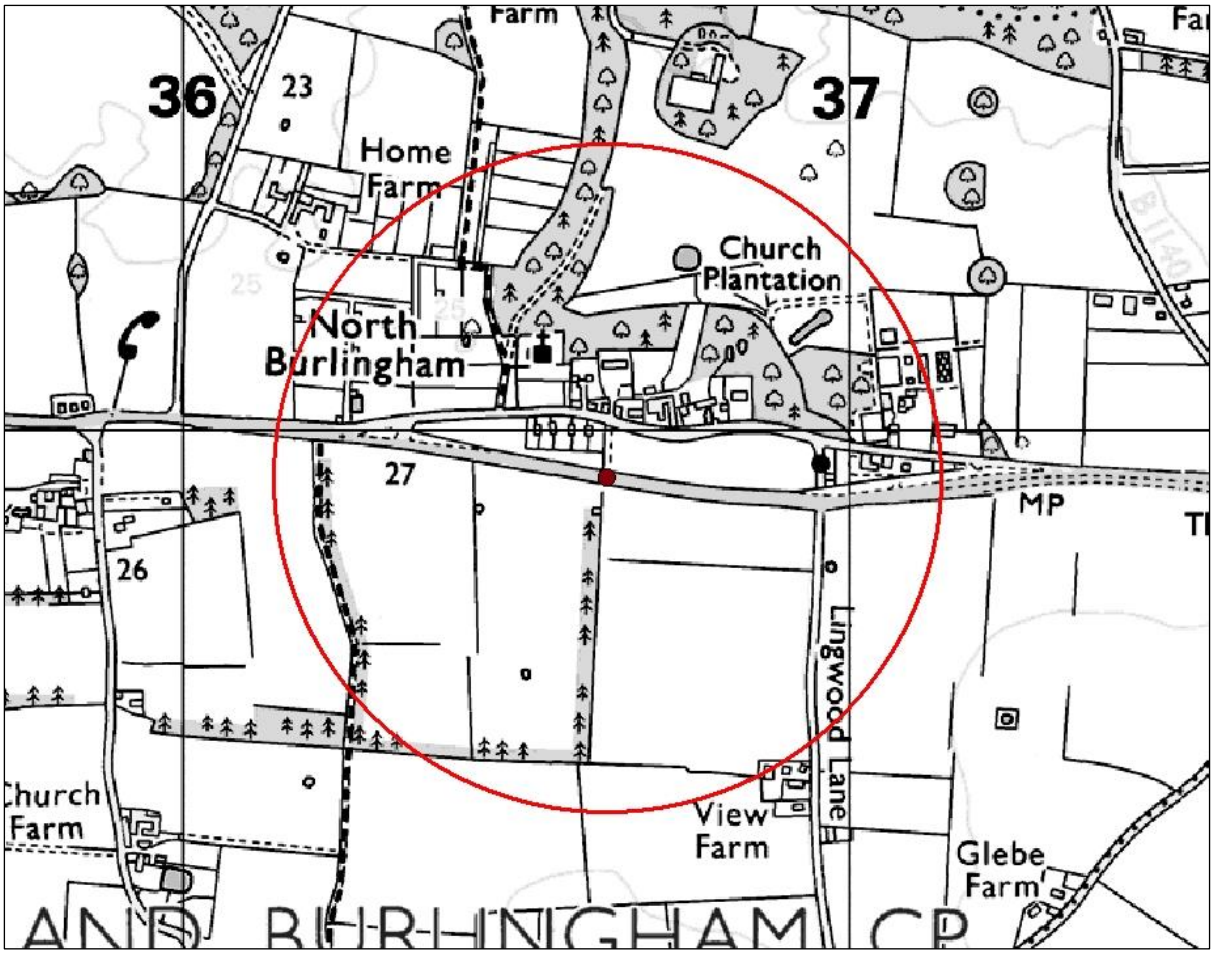

Norfolk County Council Case Reference: FW2020_0695_7

Map 4 - Structures in the vicinity of the site listed in Norfolk County Council's bridges dataset.

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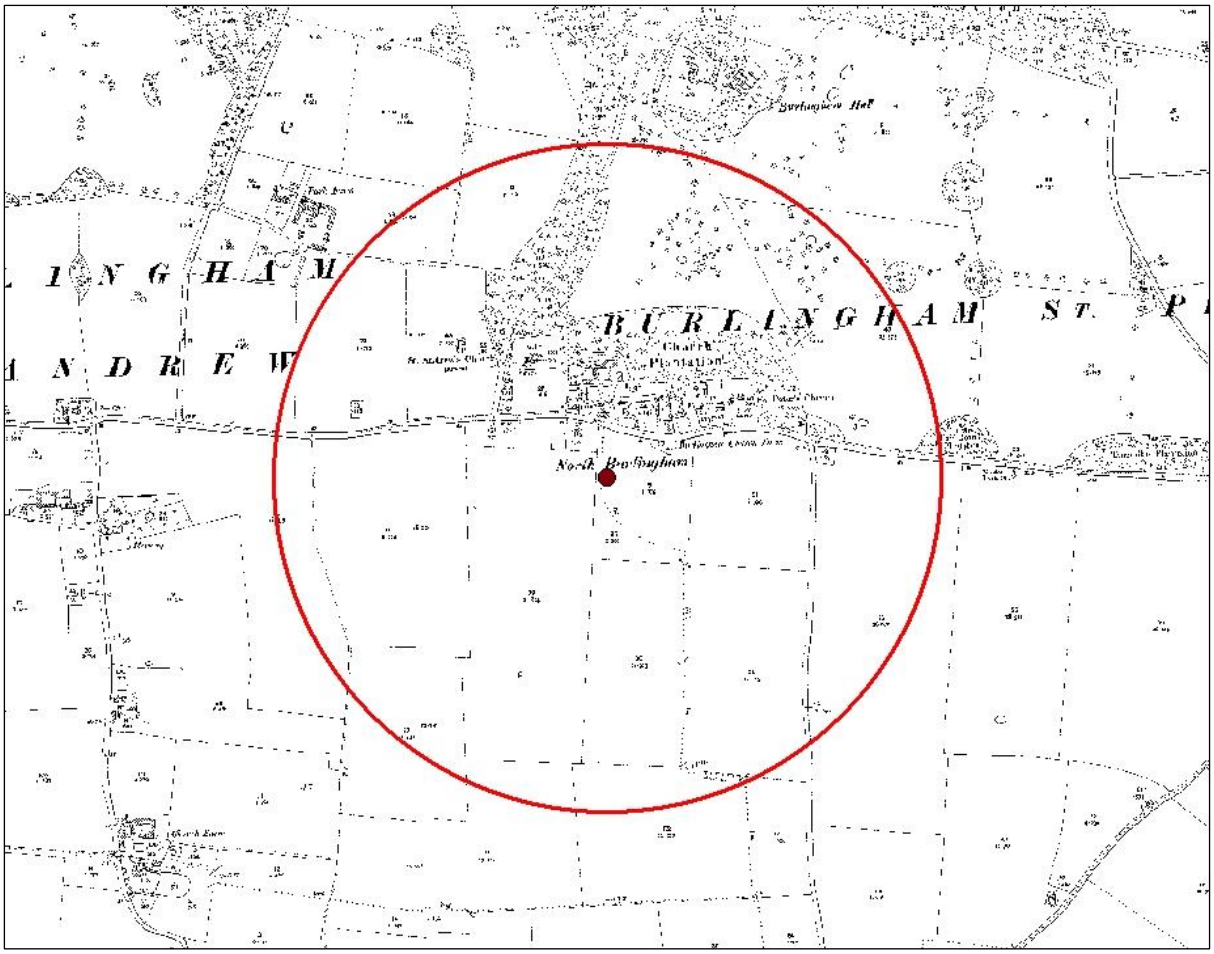
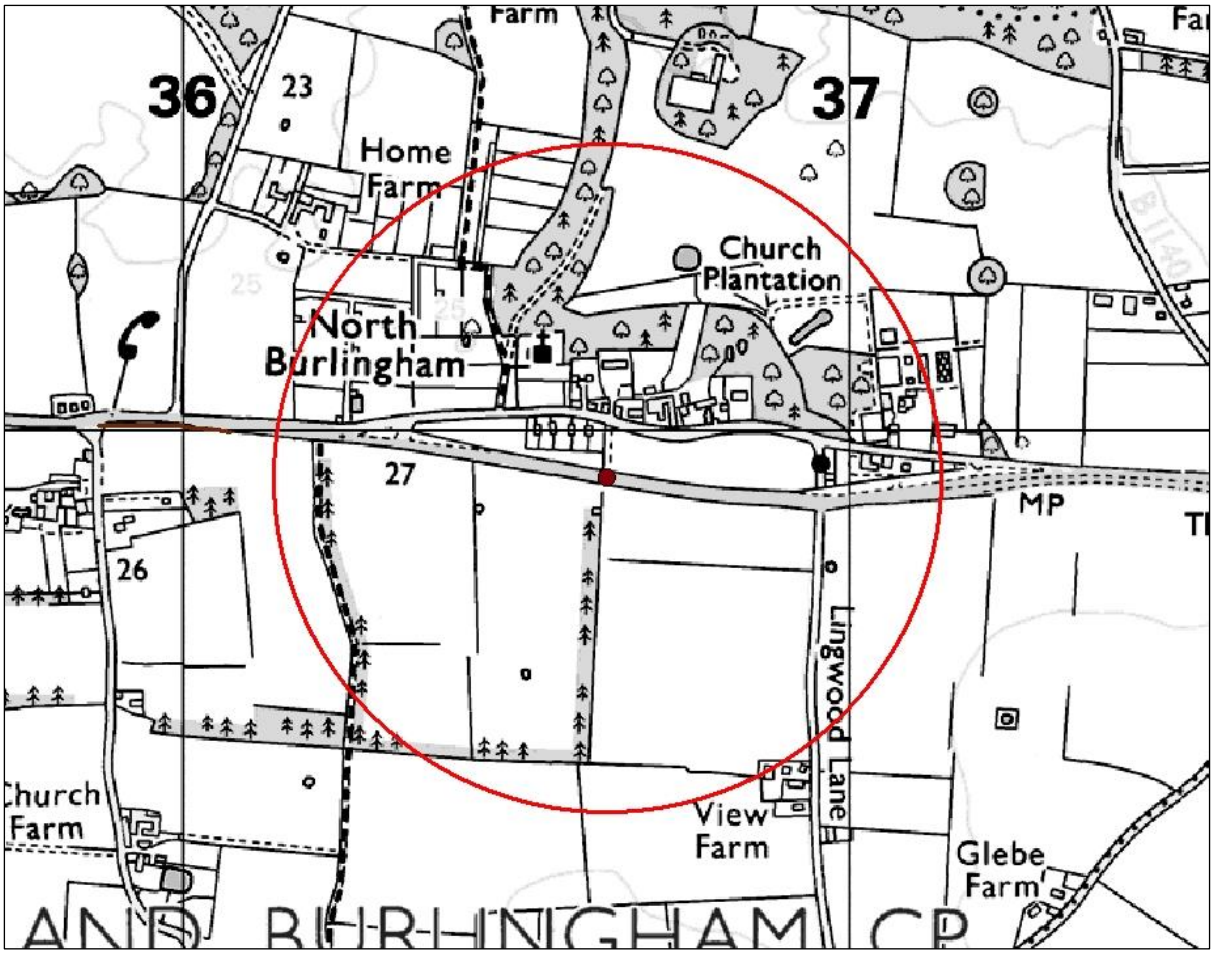


Norfolk County Council Case Reference: FW2020_0695_7

Map 5 - Land use and features in the vicinity of the site as shown on the Ordnance Survey First Edition or Second Edition maps



Norfolk County Council Case Reference: FW2020_0695_7

Map 6 - Mapped watercourses in the vicinity of the site.

This desktop study has been created by the Lead Local Flood Authority (LLFA) at Norfolk County Council.

Lead Local Flood Authority
Norfolk County Council
County Hall
Martineau Lane
Norwich
Norfolk
NR1 2SG

Email: llfa@norfolk.gov.uk

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The information on the Flood Map is designed to only give an indication of flood risk to an area of land and is not sufficiently detailed to show whether an individual property is at risk of flooding. This is because we cannot know all the details about each property.

Flood Map for Surface Water is not to be used at property level. It is not recommended to be used with more detailed background than 1:10,000 as the data is open to misinterpretation if used at a more detailed scale.

Norfolk County Council
Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG

via e-mail
FAO: Nikki Rowley-Todd
Highways England – Project Manager

NCC contact number: 0344 800 8020
Textphone: 0344 800 8011

Your Ref: A47 Blofield
Date: 16/09/2020

My Ref: FW/2020_0688
Tel No.: 0344 800 8020
Email: llfa@norfolk.gov.uk

Dear Mrs Rowley-Todd,

The Dualling of the A47 Blofield to North Burlingham and Associated Junction Improvement Works – Consultation Response to the Scheme Update

Thank you for your letter dated 9th September 2020 requesting consultation feedback on the scheme update. We have had a look through this letter and the attached document. We have also been indirect consultation with the Highways England design team at SWECO who have approached us on a number of occasions to discuss the design since 2018. A summary of the recent correspondence relating to this scheme in 2020 is given in the table below.

Date	LLFA Letter Ref	Content
17/08/2020	FW2020_0514	Initial review of the Drainage Strategy
04/08/2020	FW2020_0560	Initial review of the Flood Risk Assessment
16/08/2020	FW2020_0688	Consultation response to the scheme update
15/9/2020	FW2020_0695	Provision of pre-application flood risk information for two points within the scheme area.
16/9/2020	FW2020_0703	Consultation response

Flood Risk Assessment Comments

Within the Flood Risk Assessment (FRA), the LLFA guidance is not mentioned, even though the current Environment Agency guidance on the preparation of FRA clearly states that plans for managing surface water should be in line with guidance from the Lead Local Flood Authority and sustainable drainage principles.

The FRA discusses the surface water flood history and notes the ‘high impact’ flooding incident of 2019 which closed the western bound carriageway in Blofield. As a ‘high impact’ local flood event, the LLFA would expect further comment regarding the cause, impacts and remedial works within the body of the report. At present there are only limited remarks in the conclusion. A plan with the approximate location and extent of this specific flood would be considered appropriate for inclusion (either as a separate plan or on an existing plan). As some of the existing drainage systems are proposed to remain in use and unchanged, it would be appropriate to confirm whether the area of the flood is served by highway drainage that is proposed to remain unaltered. If these two areas overlap, it

would be appropriate for the FRA to discuss whether the existing drainage system has been reviewed to confirm its current design capacity is acceptable.

The groundwater flood risk is considered throughout the FRA and is indicated to be at a considerable depth below the surface. Yet within the FRA, no evidence or indication of the groundwater level is given. We are aware that groundwater has had further assessment and consideration in the EIA, the Groundwater Assessment and the Technical Note on the Deep Drainage. It is reasonable to expect the FRA to contain a summary of the existing ground water conditions and an assessment of the associated flood risk at and surrounding the site.

The site crosses some surface water flow paths. Some reference to the surface water flow paths has been made in the FRA. However, there are no plans with clearly marked up areas that identify the flow paths in conjunction with the proposed road and drainage design. This would be beneficial for assessing the interaction of the scheme with the flow paths and should be prepared.

In addition, the FRA does not report on the matter of surface water being redirected along existing flow paths as indicated in the drainage strategy. The LLFA would seek confirmation that the redirected flow does not increase the on-site and off-site flood risk. The further information the LLFA would seek is to address this concerns is;

- identification of the redirected flow path;
- identification of the flow paths receiving the additional flow;
- the anticipated additional amount of overland flow; and
- the identification of off-site property likely to be impacted.

There is currently no reporting or summary of the pre-development and post-development runoff rates and the associated attenuation volumes within the FRA.

The FRA does not currently include an assessment of suitable SuDS options. The FRA indicates that infiltration has been selected as a means of surface water disposal. The LLFA is aware from the drainage strategy that infiltration testing has been undertaken. However, there is no discussion of the infiltration testing or its results in the FRA. As the surface water flood risk management approach depends on infiltration to dispose of surface water, it would be appropriate for the FRA to report on these results.

Furthermore, there is no recorded consideration of the SuDS in terms of water quantity, water quality, amenity and biodiversity.

A summary of the Planning Inspectorate scoping opinion response in the FRA states that

> *“SuDS schemes should be designed to provide for habitat enhancement.”*

However, there is no indication in either the FRA or the Drainage Strategy that habitat or environmental enhancement opportunities have been either sought or considered in relation to SuDS selection and design. A summary of enhancement opportunities considered relating to SuDS be included in the FRA.

In relation to the drainage design, the FRA confirms that during consultation with the LLFA, it was requested that

> *"Drainage mitigation should provide sufficient attenuation for a 1 in 100-year event including an allowance for future climate change"*

At present, some elements of the current drainage design do not meet these standards.

The FRA has not provided any information about the management of surface water flood risk during the construction phase. The FRA should be revised to contain information about the construction phase surface water management and any temporary measures that would be in place.

The FRA has not included any consideration of the future maintenance and management provisions proposed for the surface water management features and structures. This should be clarified in the revised FRA report.

Drainage Strategy Comments

As previously discussed in the FRA section, the LLFA had stated the requirement for the surface water drainage to attenuate the 1% AEP (1 in 100 year) plus climate change event. This is supported by the DMRB document CG 501 – Design of Highway Drainage Systems, NPPF and the SuDS National Technical Standards.

However, at present the drainage design does not meet this standard. The drainage strategy has stated it would only design the highway drainage systems up to a 2% AEP (1 in 50 year) storm. There is no mention of designing for the 1% AEP (1 in 100 year) plus climate change storm, rather than the 1% AEP storm with climate change allowance would be used to assess the risk.

In addition, the infiltration basin and the soakaways are stated as being design to a 10% AEP (1 in 10 year) storm with 20% climate change. The drainage strategy states that a "check for flooding in a 1 in 100 year storm with 40% allowance for climate change" would be performed rather than designing for the 1% AEP storm with climate change.

The LLFA have been clear in previous correspondence (which are appended to the drainage strategy) and in their policy guidance document (*Norfolk LLFA Statutory Consultee Guidance Document)* that they will seek the nationally accepted standard that restricts the surface water runoff from a greenfield site to the greenfield runoff. In addition, the correspondence appended to the drainage strategy clear states

> *"Any drainage mitigation for the should attenuate the post development runoff rate and volume to the equivalent pre development greenfield rate and volume up to the 1 in 100 plus climate change allowance."*

Therefore, a suitably sized attenuation for the additional runoff volume for the 1% AEP storm plus climate change will be sought by the LLFA.

The LLFA recommends the attenuation provided in the infiltration basin and soakaways proposed drainage design is reviewed and brought into accordance with these standards.

Furthermore, the drawings provide the soakaways and infiltration basin size and the drainage strategy report discusses the infiltration testing. However, no half drain times are made available at present. In future drawing and report revisions, the half drain times are expected to be provided.

The drainage design reviewed with the drainage strategy indicated the soakaways were very close to the infiltration as shown in drawing HE551490-GTY-HDG-000-DR-CD-30002. One of the soakaways is drawn very close beside the infiltration basin and the LLFA is concerned the performance of the soakaway and the basin could be reduced due to their close proximity to each other. Furthermore, the reasoning supporting the position of some of the soakaways is not apparent. Some soakaways are located behind residential properties some distance away from the road, while other soakaways are positioned to the south and south east of the infiltration basin with a large amount of space between the features. Please clarify the use of space in relation to the positioning of the soakaways and whether the distances between the soakaways, the basin and the properties are appropriate? The LLFA will await the submission of appropriate supporting evidence.

The use of swales as vehicle access ways is unusual due to pollution control and user safety issues. At present the *"drivable swale"* features are identified on the plans included in the drainage strategy. However, no outline design information has been provided about these features, such as a typical cross section. Further information is required about the design of these dual-purpose features that demonstrates they are both safe to the environment and the site users. The LLFA requests the provision of information regarding the maximum depth of water expected and the supporting environment assessment for the drivable swale at each location.

Within the drainage strategy there is mention of constraints to the drainage design to the proposed footpaths. However, it is not clear from the drainage strategy what these constraints are. Clarification of what the constraints are and the options that have been discounted for managing the runoff from the footpaths are requested by the LLFA.

The drainage strategy has identified that some drainage areas would remain unchanged on the existing carriageway, although these are not identified specifically report. For the existing drainage areas that would remain unchanged, the LLFA is interested in the water quality management aspects of these systems. While the surface water runoff maybe unaltered as there is no change in the impermeable area, there is an increase an expected increase in future traffic. Therefore, an increase in the future pollution and contaminates in the surface water runoff is expected. The LLFA is seeking confirmation whether an assessment of the water quality on these retained drainage areas has been undertake and requests the results. Further information is requested should any additional water treatment measures be included.

It is noted that vortex interceptors and dedicated spillage containment tanks have been mentioned in the initial design summary and on occasion through the report. However, there is no confirmation as to whether these features will be included in the scheme's design. Please clarify whether these features will be included in the design or not.

Within the drainage strategy, there has been minimal mention about any required remedial works within existing unchanged systems. The LLFA seeks confirmation from Highways

England of any potential remedial works are considered necessary and whether they will be undertaking them within the project area and this scheme.

The drainage strategy indicates there was no ground investigation was conducted to the north of the eastern tie-in. At present, the design is reliant on historical infiltration rates and there is an intent to undertake infiltration test at detailed design stage. The LLFA can confirm that infiltration testing would be required in this location in accordance with BRE365. Please can you confirm in the drainage strategy when this is likely to occur.

The future maintenance and management provisions are proposed at a high level in the drainage strategy. This responsibility is proposed to be split between Highways England and Norfolk County Council. However, a few of the structures need further clarification about who is anticipated to be responsible for them in the future, such as the drivable swales, the dry culverts and drainage from the allotments. Clarification within the drainage strategy will be sought by the LLFA.

In addition, the drainage strategy has not provided any information about the construction phase drainage works that would be installed or any information regarding the phasing of the construction works. Further information within the drainage strategy about the construction phase drainage works and any temporary measures that would be in place is requested.

Groundwater Assessment Comments

To date, no Groundwater Assessment has been provided for review. It is noted that the current drainage strategy specifically mentions that the drainage strategy should be read in conjunction with other documents including the groundwater assessment.

Should you or your design team have any further queries, please contact the LLFA directly.

Yours sincerely,

Sarah

Sarah Luff
Strategic Flood Risk Planning Officer

Lead Local Flood Authority

Disclaimer
We have relied on the accuracy and completeness of the information supplied to us in providing the above advice and can take no responsibility for incorrect data or interpretation, or omissions, in such information. If we have not referred to a particular issue in our response, it should not be assumed that there is no impact associated with that issue.

Norfolk County Council
Community and Environmental Services
County Hall
Martineau Lane
Norwich
NR1 2SG

via e-mail
FAO: Jason Ball
SWECO

NCC contact number: 0344 800 8020
Textphone: 0344 800 8011

CC: Stephen Faulkner
Norfolk County Council Principal Planner

Your Ref:	A47 Blofield – SW Management	My Ref:	FW2020_0786
Date:	07 October 2020	Tel No.:	0344 800 8020
		Email:	llfa@norfolk.gov.uk

Dear Mr Ball,

The dualling of the A47 Blofield to North Burlingham and associated junction improvement works – Drainage Strategy and Flood Risk Assessment

Thank you for the two-part discussion on the drainage strategy (24th September 2020) and the Flood Risk Assessment (FRA) (25th September 2020) regarding feedback to the LLFA's response to the initial review of these documents. This letter is to provide a high-level summary on the feedback that you provided on 24th September 2020 by email.

For the majority of the comments relating to both the drainage strategy and the flood risk assessment, your team has made us aware of the intent to address our comments through either the amendment of text within the reports or by updating the appropriate plans. The LLFA looks forward to reviewing these updated documents.

The remaining matters predominately relate to the sizing of the soakaways. We are grateful for the constructive discussion that the meeting enabled us to have with the design team. The LLFA now has a better understanding of the design development and approach your designers have applied. Both the drainage strategy and the FRA for this scheme would benefit greatly from the enhancing of the documents that report on the design development and decisions made that lead to the presented design. At present a moderate amount of this information is either not held or has not been conveyed effectively within the reports.

Following our discussion, it is now understood that some of the clean water soakaways have been designed to manage the overland flow routes. These flow routes were previously identified by the LLFA and in 2018 the LLFA requested that any proposed road scheme provided

> *"surface water modelling of overland flow routes and mitigation provided to show how flood risk will not be increased elsewhere. This may include dry culverts sized for the 1 in 100 year plus climate change allowance."*
>
> *(Source: Norfolk CC - LLFA Letter FWS/18/8/6074 dated 26th February 2018*)

The LLFAs understanding is the current design aims to keep the clean surface water runoff and the road surface water runoff separate as far as possible. The overland runoff

flow is to be altered to reduce the number of occasions when it crosses the proposed new road. The overland runoff diversion also contains some surface water runoff from the embankments (which is considered to be clean surface water runoff by the designers in their assumptions). Some of the surface water runoff from both the embankments and the overland flow route will be discharged to ground within soakaways sized for up to the 10% AEP (1 in 10 year) event. The remaining flow would be allowed to pass along its existing flow route. This overland flow diversion does need to be better explained in both the report and the supporting schematics. Evidence to support this design approach and suitable hydraulic modelled would be required (as previously stated in the LLFA's correspondence dated 26th February 2018) to demonstrate that the proposed design does not increase off site flood risk in accordance with the requirements of NPPF.

The proposed embankments included within the road design are not considered to be permeable surfaces by the LLFA as these are engineered geotechnical structures that would have been compacted significantly to meet with the specified design and structural stability. Therefore, the surface water runoff rate from the proposed embankments should be reviewed to ensure that the runoff rates reflect this design constraint appropriately.

Should you have any further queries, please contact the LLFA directly.

Yours sincerely,

Sarah

Sarah Luff
Strategic Flood Risk Planning Officer

Lead Local Flood Authority

Ball, Caroline

From:	May, Sophie
Sent:	27 October 2020 09:24
To:	Lead Local Flood Authority; sarah.luff@norfolk.gov.uk
Cc:	Creedon, Mary; Murphy, Mark; Casey, Mark; Faulkner, Stephen; Ball, Jason
Subject:	RE: A47 Blofield DSR - LLFA comments
Follow Up Flag:	Follow up
Flag Status:	Completed

Dear Sarah,

Following your letter of 7th October 2020 (FW2020_0786), I am writing to provide a response following the discussions on embankment drainage at the meeting of 24th September. The Design Manual for Roads and Bridges (DMRB) CG501 Rev 2, paragraph 2.1, 4) requires that the drainage design manages water flows from earthworks and structures associated with the roads; there is no requirement to include the embankment drainage within the attenuation of the highway drainage. In the current scheme design, embankment runoff is collected and directed towards the proposed clean water soakaways and ultimately the existing surface water overland flow pathways.

With respect to the request by Norfolk County Council to attenuate the embankment run-off, the design was examined retrospectively. The scheme does not have very large embankments, being overall quite a flat scheme. The larger embankments are proximate to the infiltration basin and as such will drain directly to the basin where they will be attenuated to a 1 in 100 year event with a 40% allowance for climate change. This has already been taken into account in the design. To discharge embankment drainage where this occurs locally in a few locations across the rest of the scheme into the highway drainage infiltration systems, would require that toe-drains are routed below the natural catchment cross-drains. This would require that levels of the road drainage are further lowered resulting in the further lowering of the road drainage infiltration systems' inlet invert level. Therefore to get the effective depth and storage required of the infiltration systems they would need to be lowered by between a further 0.5m and 1m. The Environment Agency are not in favour of the infiltration systems being installed any deeper than the 4.5m maximum depth currently proposed; this would have the effect of reducing the unsaturated zone thickness beneath soakaway systems further.

Please don't hesitate to get in touch if you would like to discuss further.

Kind Regards,

Sophie May
Senior Project Manager

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+44 7921 819 992
sophie.may@sweco.co.uk

Sweco UK Limited
5th Floor, Programme
All Saints Street
Bristol, BS1 2LZ
+44 117 332 1100
www.sweco.co.uk

Ball, Jason

From:	Lead Local Flood Authority <llfa@norfolk.gov.uk>
Sent:	30 October 2020 06:49
To:	May, Sophie
Cc:	Creedon, Mary; Murphy, Mark; Casey, Mark; Faulkner, Stephen; Ball, Jason
Subject:	RE: A47 Blofield DSR - LLFA comments

Dear Sophie,

Thank you for your email confirming your position regarding the review of the drainage of the new road embankments.

The LLFA has considered your response in conjunction with the recent design update meeting. On this occasion due to the advanced stage of the design, the impending DCO submission and the limited amount of embankment surface water runoff, the LLFA will not pursue the inclusion of surface water toe drains at the base of the embankments within this scheme.

However, the LLFA does reiterate our stance and expectation that in the future, all developments (including road improvement schemes) will need to manage the surface water runoff from geotechnical structures. These structures have altered the existing ground conditions through their construction process (such as compaction) and their geometry (such as slopes gradients and the local topography). Therefore they are not able to drain in the same manner as before the land was developed.

We have not yet seen the updated the drainage strategy, flood risk assessment and other supporting documents to date and anticipate their arrival shortly.

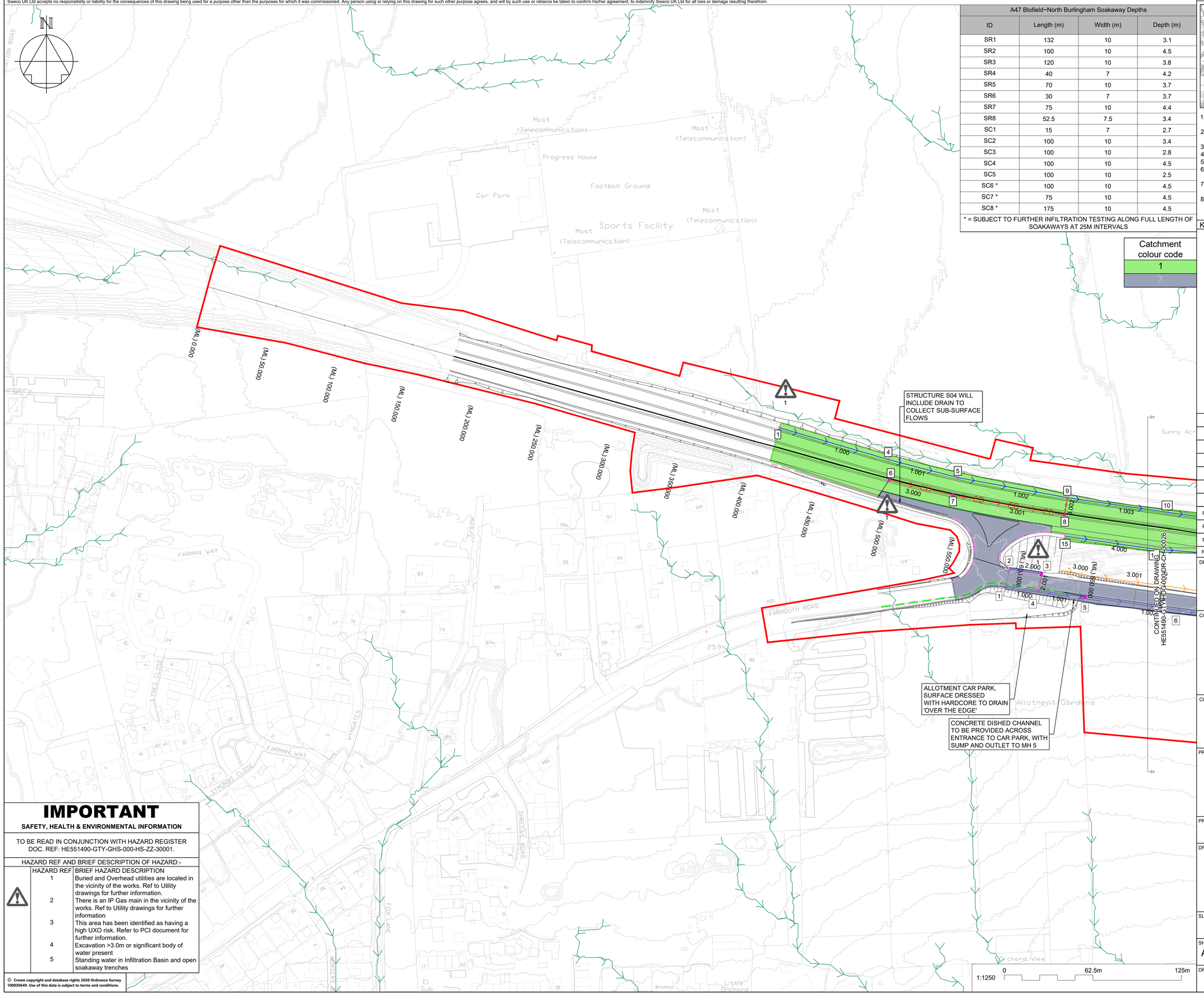
Kind regards

Sarah

Sarah Luff **BSc Hons CWEM CEnv IEng MCIWEM**
Strategic Flood Risk Planning Officer
Community and Environmental Services
Tel: 0344 800 8020
The LLFA Teams are working remotely in response to COVID-19 health advice. The teams will be available by email and Teams. If you wish to speak to one of us, please email us at the addresses shown below and we will endeavour to contact you.
Email: llfa@norfolk.gov.uk for any pre-planning or statutory consultee enquiries
Email: water.management@norfolk.gov.uk for any reports of flooding, watercourse regulation or general enquiries

From: May, Sophie <Sophie.May@sweco.co.uk>
Sent: Tuesday, October 27, 2020 9:24 AM

Annex B. Proposed drainage layout plans



A47 Blofield~North Burlingham Soakaway Depths			
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SR1	132	10	3.1
SR2	100	10	4.5
SR3	120	10	3.8
SR4	40	7	4.2
SR5	70	10	3.7
SR6	30	7	3.7
SR7	75	10	4.4
SR8	52.5	7.5	3.4
SC1	15	7	2.7
SC2	100	10	3.4
SC3	100	10	2.8
SC4	100	10	4.5
SC5	100	10	2.5
SC6 *	100	10	4.5
SC7 *	75	10	4.5
SC8 *	175	10	4.5

* = SUBJECT TO FURTHER INFILTRATION TESTING ALONG FULL LENGTH OF SOAKAWAYS AT 25M INTERVALS

Catchment colour code
1
7

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

TO BE READ IN CONJUNCTION WITH HAZARD REGISTER DOC. REF: HE551490-GTY-GHS-000-HS-ZZ-30001.

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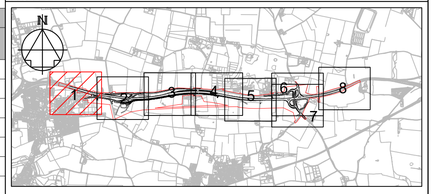
4	Excavation >3.0m or significant body of water present
5	Standing water in Infiltration Basin and open soakaway trenches

NOTES



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7. CATCHPITS PROVIDED THROUGHOUT EXCEPT IN THE MEDIAN AND AT ROAD CROSSINGS WHERE MANHOLES ARE PROVIDED.
8. ALL SOAKAWAYS AND THE INFILTRATION BASIN WILL HAVE A SEPARATION DISTANCE OF 10M AND WILL BE OFFSET AT LEAST 10M FROM THE FOOTPRINT OF THE ROAD DEVELOPMENT.

KEY TO SYMBOLS

- INTERCEPTOR DITCH
- CLEAN WATER OUTFALL TO SOAKWAY
- TOE DRAIN
- DRIVEABLE SWALE
- DRY CULVERT
- INFILTRATION BASIN
- SOAKAWAY
- CLEAN WATER SOAKAWAY
- GULLY/CKDU OUTFALL
- PROPOSED DCO SITE BOUNDARY
- FILTER DRAIN
- NARROW FILTER DRAIN
- ROAD CARRIER DRAIN
- OUTFALL DRAIN
- CHAMBER LABELS
- CATCHPIT
- MANHOLE
- HEADWALL
- CKDU KERB SPLAY
- CKDU KERB HALF BATTER
- CONTOURS
- SURFACE WATER FLOW PATHWAYS

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	21/09/20	FIRST ISSUE	BS	MC	SM
P02	30/10/20	FINAL ISSUE FOR DSR	PE	PE	SMay
P03	12/04/21	UPDATED FOLLOWING CONSULTATION	MMcD	MCre	SMay

DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
TO SUPPORT DRAINAGE STRATEGY REPORT
SHEET 1 OF 8

SUITABILITY

SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER

HE551490-GTY-HDG-000-DR-CD-30025

Catchment colour code
1
7
8
9

A47 Blofield~North Burlingham Soakaway Depths

ID	Length (m)	Width (m)	Depth (m)
SR1	132	10	3.1
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CROSSING FROM EXISTING DITCH TO BE ACCOMMODATED

CONNECTIONS FROM A47 DRAINAGE REQUIRED HERE AS CLASHES WITH EXISTING DITCH OUTFALLS

ROAD DRAINAGE OUTFALL TO EXISTING DITCH.

PICK UP STREAM

EXISTING DITCH

PENSTOCK AND CATCHPIT CHAMBER

PENSTOCK AND CATCHPIT CHAMBER

SR7 5,6

CLEAN WATER TO OUTFALL TO SOAKAWAYS

SC4 5,6

SC5 5,6

PR1 5,6

SC6

SC7

SC8

DRIVEABLE SWALE FOR ACCESS TO INFILTRATION BASIN

TRACK DRAINAGE TO OUTFALL OVER THE EDGE TO INTERCEPTOR DITCH (COMBINED DRAINAGE)

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30025

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30027

Sparrow Hall

Sunny Acres

Sparrow Hall Bungalow

Brienz

Kyrenia

Meadow Cottage

1:1250 0 62.5m 125m

IMPORTANT

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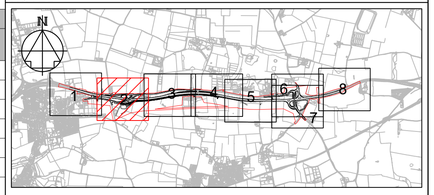

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DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS TO SUPPORT DRAINAGE STRATEGY REPORT SHEET 2 OF 8

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER: HE551490-GTY-HDG-000-DR-CD-30026

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Catchment colour code
1

SC8

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30026

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30028

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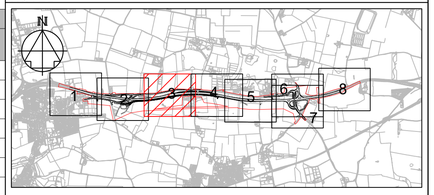

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- CLEAN WATER SOAKAWAY
- GULLY/CKDU OUTFALL
- PROPOSED DCO SITE BOUNDARY
- FILTER DRAIN
- NARROW FILTER DRAIN
- ROAD CARRIER DRAIN
- OUTFALL DRAIN
- CHAMBER LABELS
- CATCHPIT
- MANHOLE
- HEADWALL
- CKDU KERB SPLAY
- CKDU KERB HALF BATTER
- CONTOURS
- SURFACE WATER FLOW PATHWAYS

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	21/09/20	FIRST ISSUE	BS	MC	SM
P02	30/10/20	FINAL ISSUE FOR DSR	PE	PE	SMay
P03	12/04/21	UPDATED FOLLOWING CONSULTATION	MMcD	MCre	SMay

DESIGNER
SWECO

CONTRACTOR
GallifordTry

CLIENT
highways england

PROJECT TITLE
A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

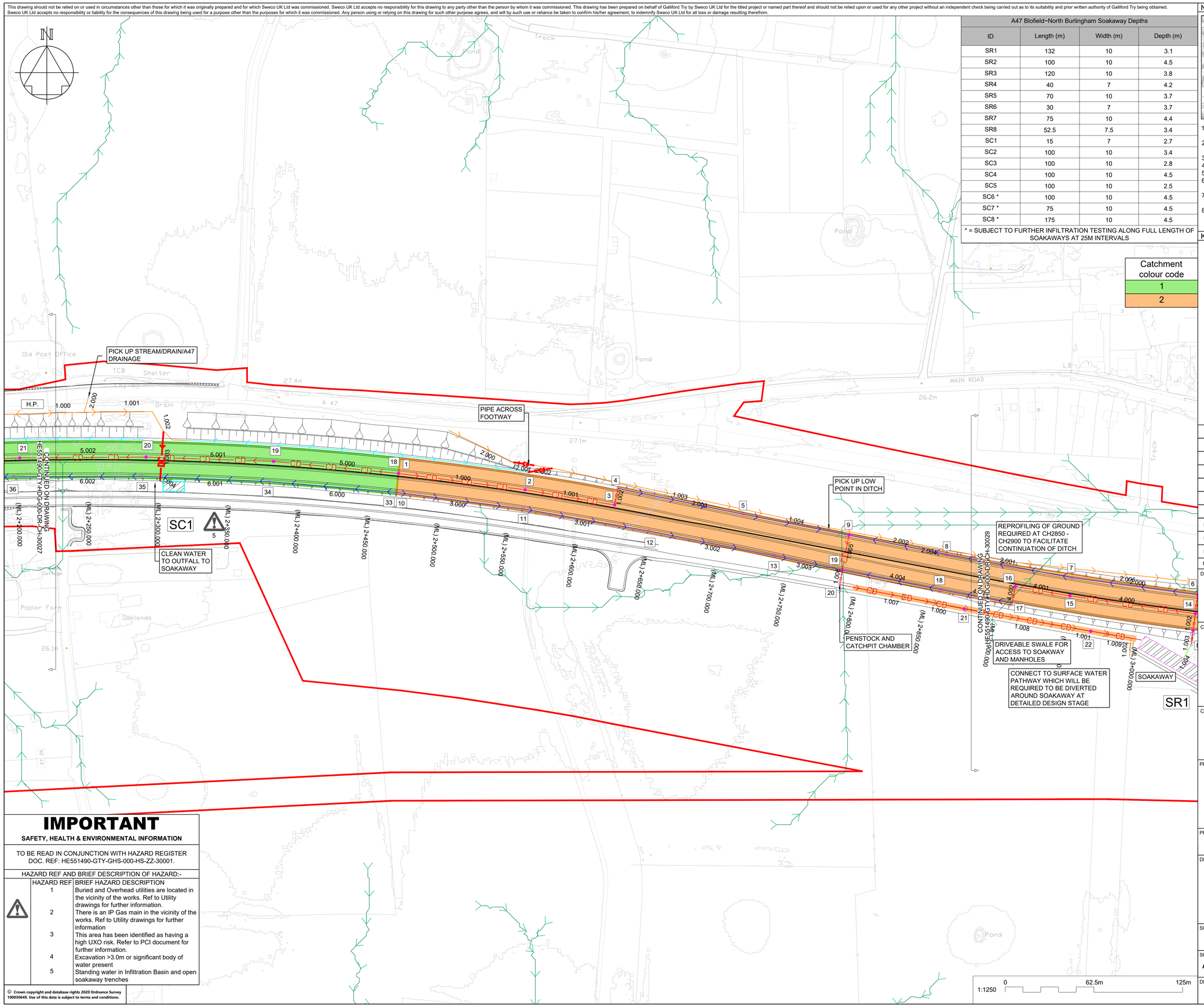
PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
DRAINAGE LAYOUT PLANS
TO SUPPORT DRAINAGE STRATEGY REPORT
SHEET 3 OF 8

SUITABILITY
SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER
HE551490-GTY-HDG-000-DR-CD-30027



A47 Blofield~North Burlingham Soakaway Depths			
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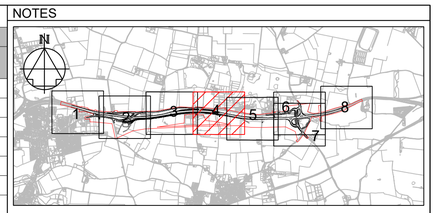
SC7 *	75	10	4.5
SC8 *	175	10	4.5

* = SUBJECT TO FURTHER INFILTRATION TESTING ALONG FULL LENGTH OF SOAKAWAYS AT 25M INTERVALS

Catchment colour code
1
2

NOTES



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KEY TO SYMBOLS

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DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS TO SUPPORT DRAINAGE STRATEGY REPORT SHEET 4 OF 8

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER: HE551490-GTY-HDG-000-DR-CD-30028

1:1250 0 62.5m 125m

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

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Catchment colour code
2
3

PICK UP LOW POINT IN DITCH

REPROFILING OF GROUND REQUIRED AT CH2850 - CH2900 TO FACILITATE CONTINUATION OF DITCH

RELIEF PIPE AT NATURAL CATCHMENT LOW POINT

EXISTING DRAINAGE TO BE MAINTAINED WITH MINOR MODIFICATIONS INCLUDING ADDITIONAL GULLEYS AND CONNECTIONS

RELIEF PIPE FOR DITCH AT LINGWOOD LANE

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CD-30028

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CD-30030

PENSTOCK AND CATCHPIT CHAMBER

DRIVEABLE SWALE FOR ACCESS TO SOAKWAY AND MANHOLES

CONNECT TO SURFACE WATER PATHWAY WHICH WILL BE REQUIRED TO BE DIVERTED AROUND SOAKAWAY AT DETAILED DESIGN STAGE

SOAKAWAY

CONNECT TO SURFACE WATER PATHWAY

SR1

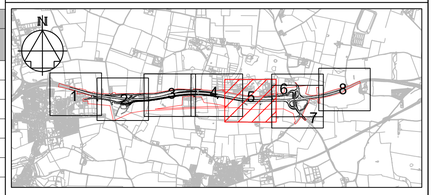
SR2

RELIEF PIPE AT NATURAL CATCHMENT LOW POINT

PENSTOCK AND CATCHPIT CHAMBER

1:1250 0 62.5m 125m

NOTES



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IMPORTANT

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DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS TO SUPPORT DRAINAGE STRATEGY REPORT SHEET 5 OF 8

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER: HE551490-GTY-HDG-000-DR-CD-30029

A47 Blofield~North Burlingham Soakaway Depths

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Catchment colour code
3
4
5
6
10
11
12
13

FINAL LOCATIONS OF SOAKAWAYS SC3 & SR4 SUBJECT TO AT-SITE INFILTRATION TESTING

CLEAN WATER TO OUTFALL TO SOAKAWAY

RELIEF PIPE AT NATURAL CATCHMENT LOW POINT

CONNECTIONS FROM A47 DRAINAGE REQUIRED HERE AS CLASHES WITH EXISTING SOAKAWAYS

PENSTOCK AND CATCHPIT CHAMBER

FINAL LOCATIONS OF SOAKAWAYS SC3 & SR4 SUBJECT TO AT-SITE INFILTRATION TESTING

PENSTOCK AND CATCHPIT CHAMBER

DRAINAGE ON OLD A47 TO BE KEPT LIVE THROUGH THE LINK ROAD AND SOUTH WALSHAM ROAD FOR CONNECTION INTO MAINLINE TO THE EAST OF SOUTH WALSHAM ROAD

PENSTOCK AND CATCHPIT CHAMBER

PENSTOCK AND CATCHPIT CHAMBER

SOAKAWAYS SR3 & SC2 MAY NEED TO BE MOVED SUBJECT TO AT-SITE INFILTRATION TESTING

EXISTING DITCH PATHWAY TO BE MAINTAINED

CLEAN WATER TO OUTFALL TO SOAKAWAY

CONNECT DRAINAGE TO EXISTING DITCH OR OPTIONAL SOAKAWAY SR8

OVERLAND FLOW INTERCEPTED TO FOLLOW EXISTING DRAINAGE PATHS.

PENSTOCK AND CATCHPIT CHAMBER

PENSTOCK AND CATCHPIT CHAMBER

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30029

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30032

CONTINUED ON DRAWING HE551490-GTY-HDG-000-DR-CH-30031

SC1 SC2 SC3 SC4 SC5 SC6 SC7 SC8 SR1 SR2 SR3 SR4 SR5 SR6 SR7 SR8

IMPORTANT

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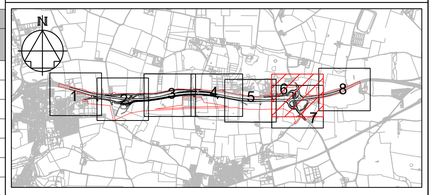

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DESIGNER

SWECO

CONTRACTOR

GallifordTry

CLIENT

highways england

PROJECT TITLE

A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

PROJECT STAGE

PCF STAGE 3

DRAWING TITLE

DRAINAGE LAYOUT PLANS
TO SUPPORT DRAINAGE STRATEGY REPORT
SHEET 6 OF 8

SUITABILITY

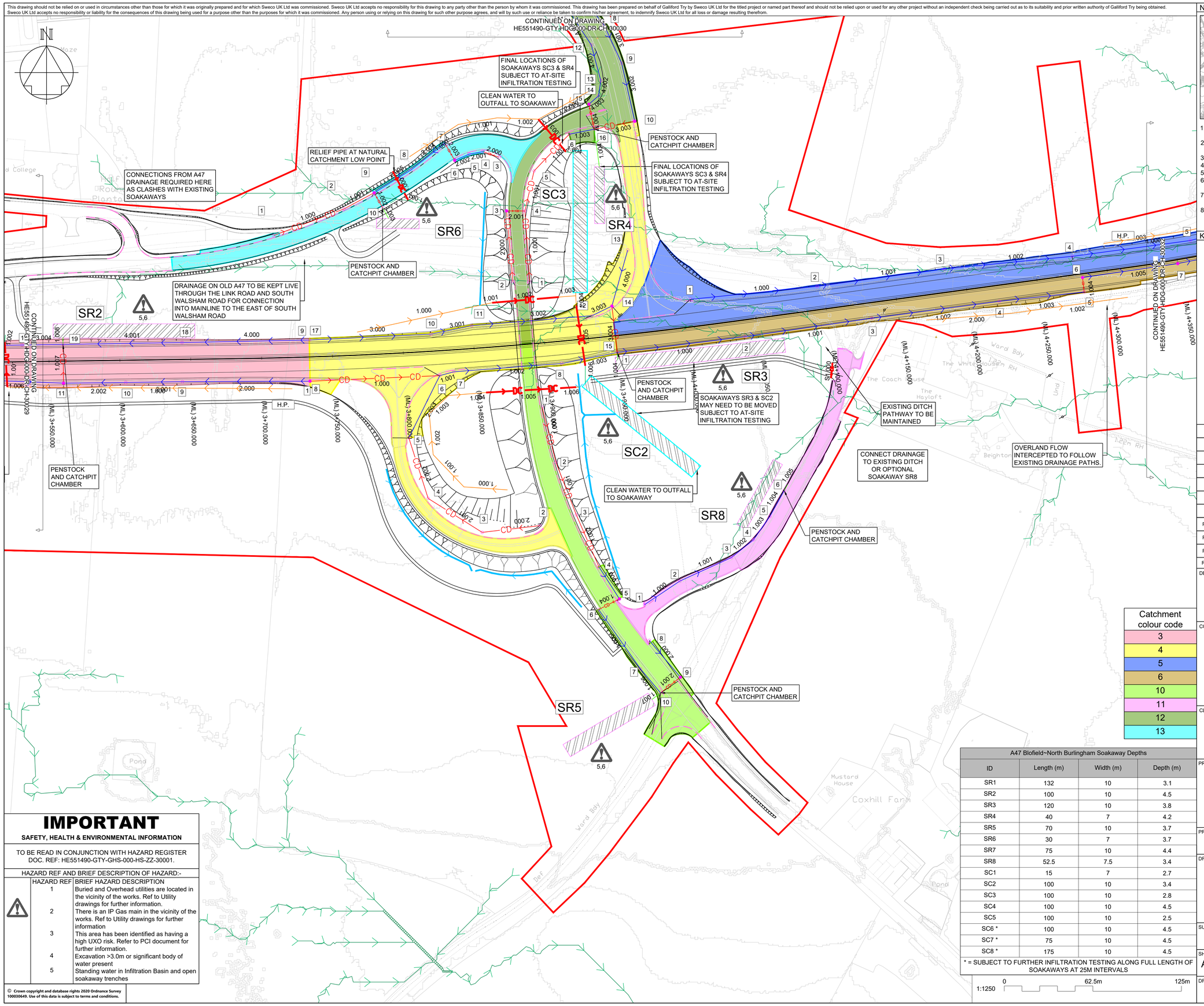
SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER

HE551490-GTY-HDG-000-DR-CD-30030

1:1250 0 62.5m 125m



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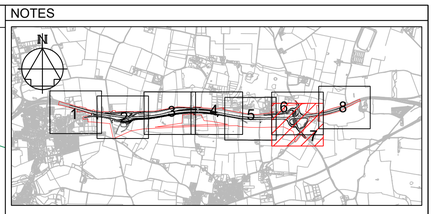

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4
5
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10
11
12
13

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1:1250 0 62.5m 125m

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

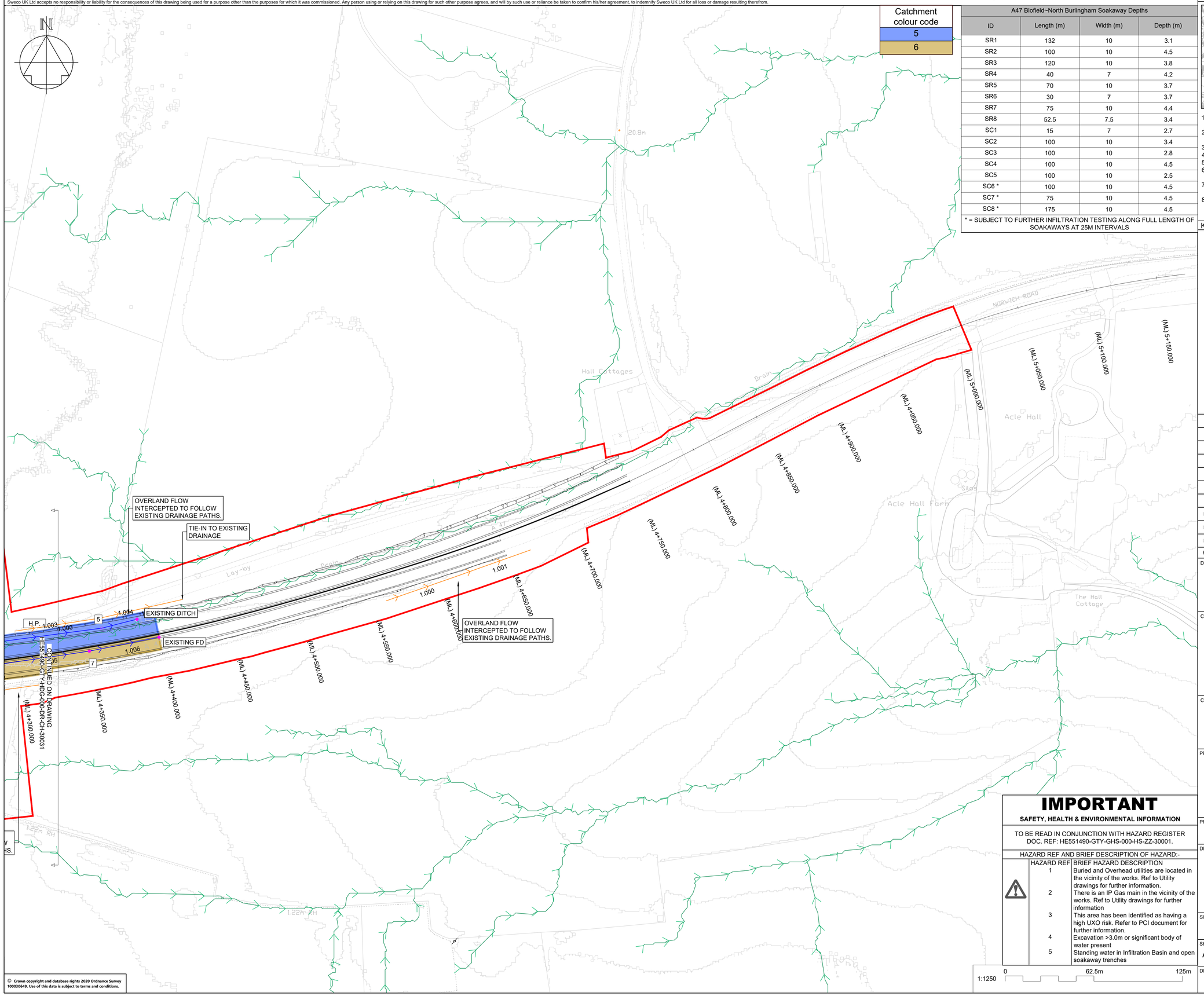
PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS TO SUPPORT DRAINAGE STRATEGY REPORT SHEET 7 OF 8

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER: HE551490-GTY-HDG-000-DR-CD-30031



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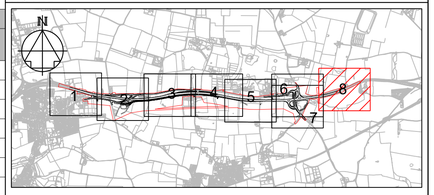

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1:1250 0 62.5m 125m

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	21/09/20	FIRST ISSUE	BS	MC	SM
P02	30/10/20	FINAL ISSUE FOR DSR	PE	PE	SMay
P03	12/04/21	UPDATED FOLLOWING CONSULTATION	MMcD	MCre	SMay

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: DRAINAGE LAYOUT PLANS TO SUPPORT DRAINAGE STRATEGY REPORT SHEET 8 OF 8

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P03

DRAWING NUMBER: HE551490-GTY-HDG-000-DR-CD-30032

Annex C. Overland flow pathways and cross-drains

Figure C-1: Overland flow catchments and flow pathways for catchments C1 to C3

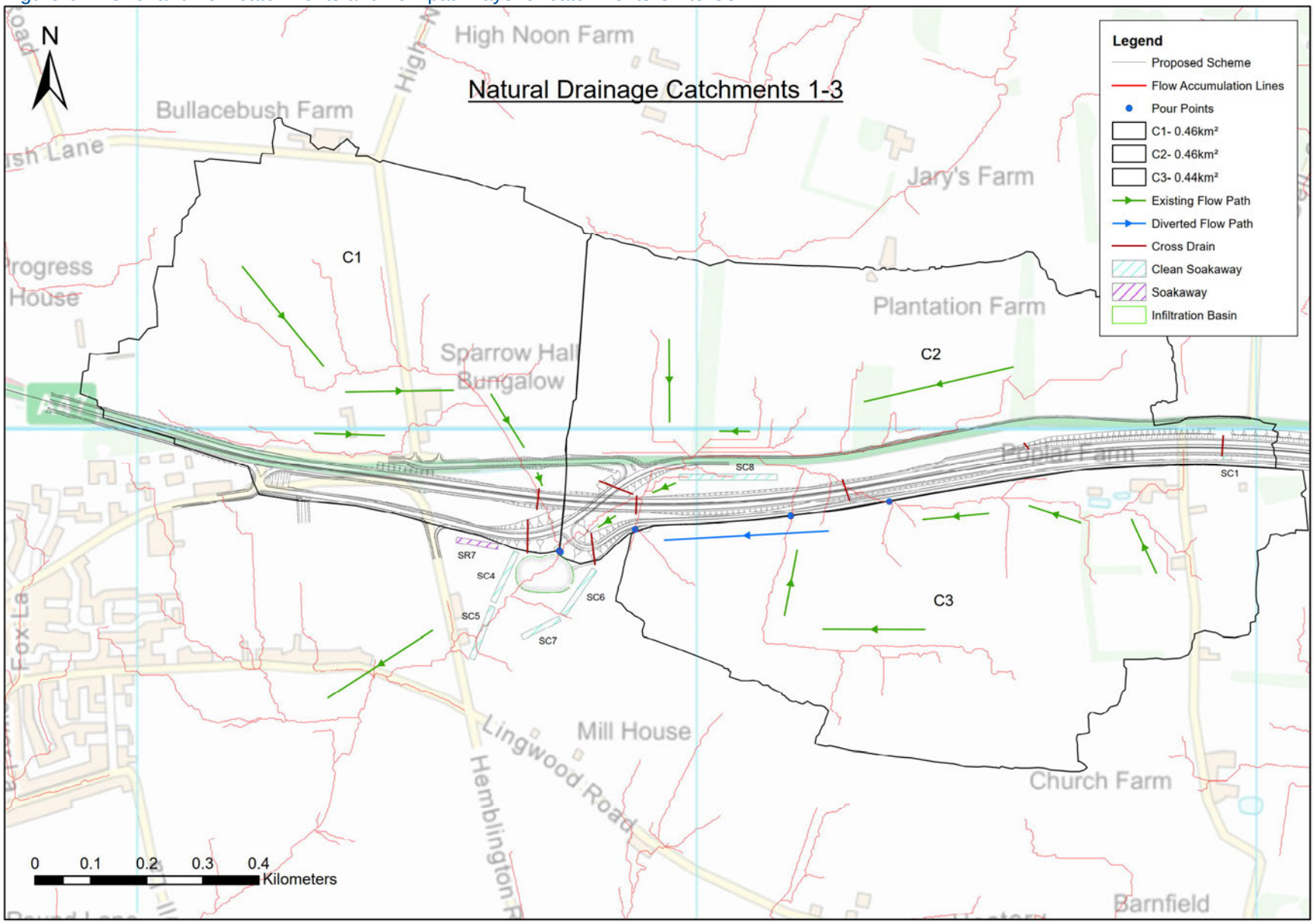
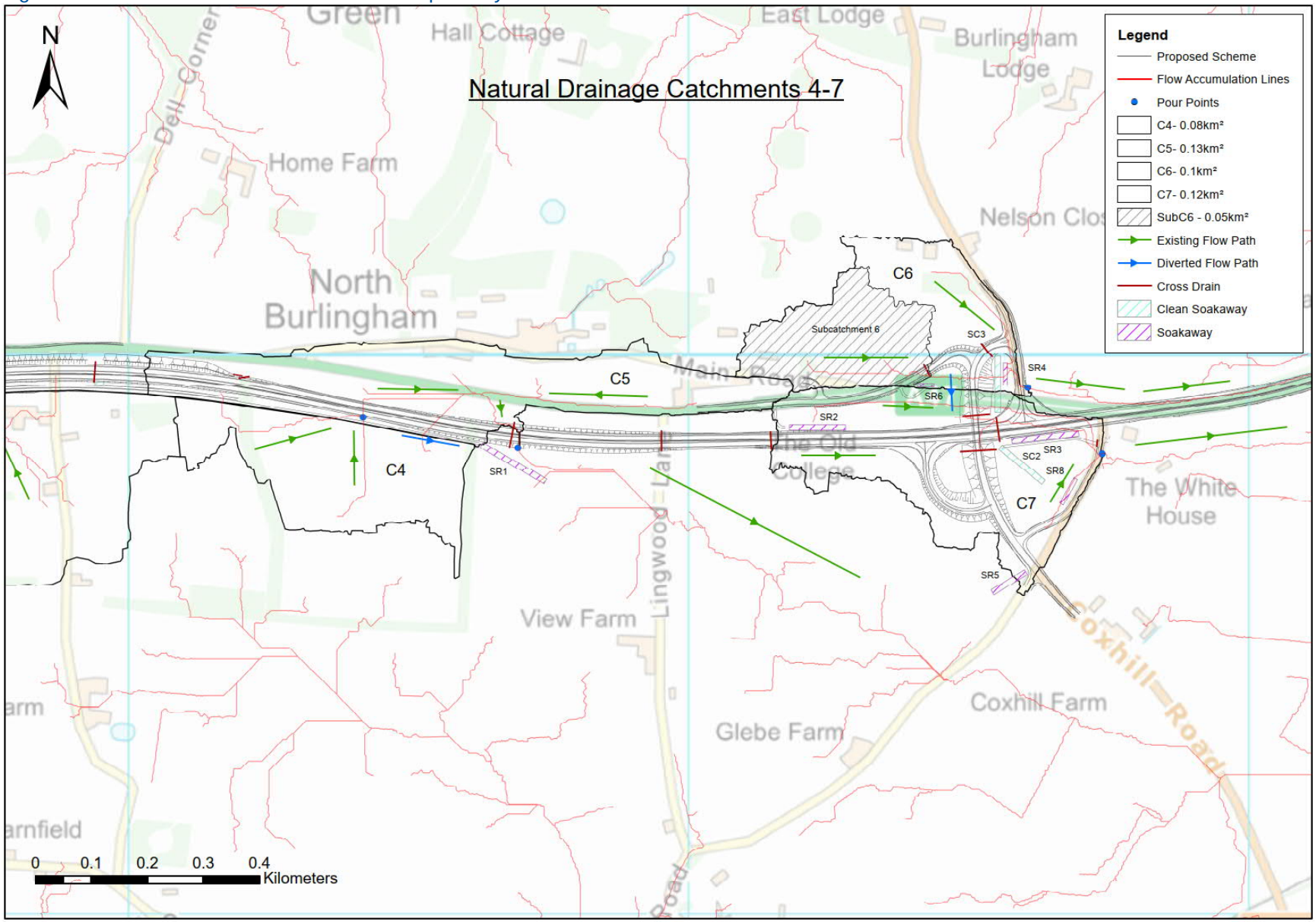
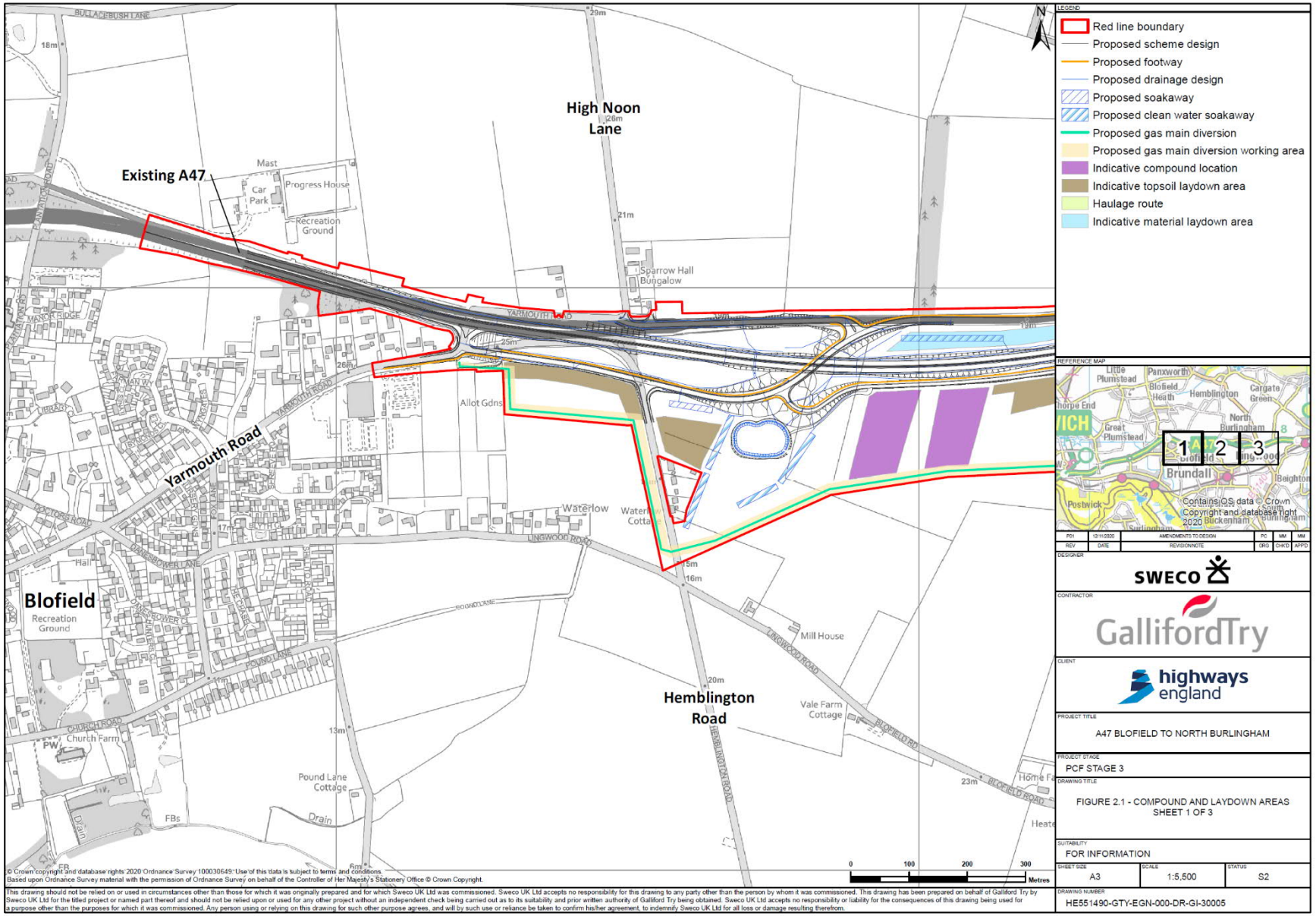


Figure C-2: Overland flow catchments and flow pathways for catchments C4 to C6



Annex D. Proposed construction compounds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Yarmouth Road
Blofield
Recreation Ground
Hemblington Road
Waterlow
Mill House
Vale Farm Cottage
Pound Lane Cottage
Church Farm
Sparrow Hall Bungalow
Allot Gdns
Progress House
Car Park
Recreation Ground
Mast
LEGEND
Red line boundary
Proposed scheme design
Proposed footway
Proposed drainage design
Proposed soakaway
Proposed clean water soakaway
Proposed gas main diversion
Proposed gas main diversion working area
Indicative compound location
Indicative topsoil laydown area
Haulage route
Indicative material laydown area
REFERENCE MAP
Contains OS data © Crown Copyright and database right 2020
P01 12/11/2020 AMENDMENTS TO DESIGN PC MM MM
REV DATE REVISION/NOTE ORG CHKD APPD
DESIGNER
SWECO
CONTRACTOR
GallifordTry
CLIENT
highways england
PROJECT TITLE
A47 BLOFIELD TO NORTH BURLINGHAM
PROJECT STAGE
PCF STAGE 3
DRAWING TITLE
FIGURE 2.1 - COMPOUND AND LAYDOWN AREAS SHEET 1 OF 3
SUITABILITY
FOR INFORMATION
SHEET SIZE
A3
SCALE
1:5,500
STATUS
S2
DRAWING NUMBER
HE551490-GTY-EGN-000-DR-GI-30005
0 100 200 300 Metres
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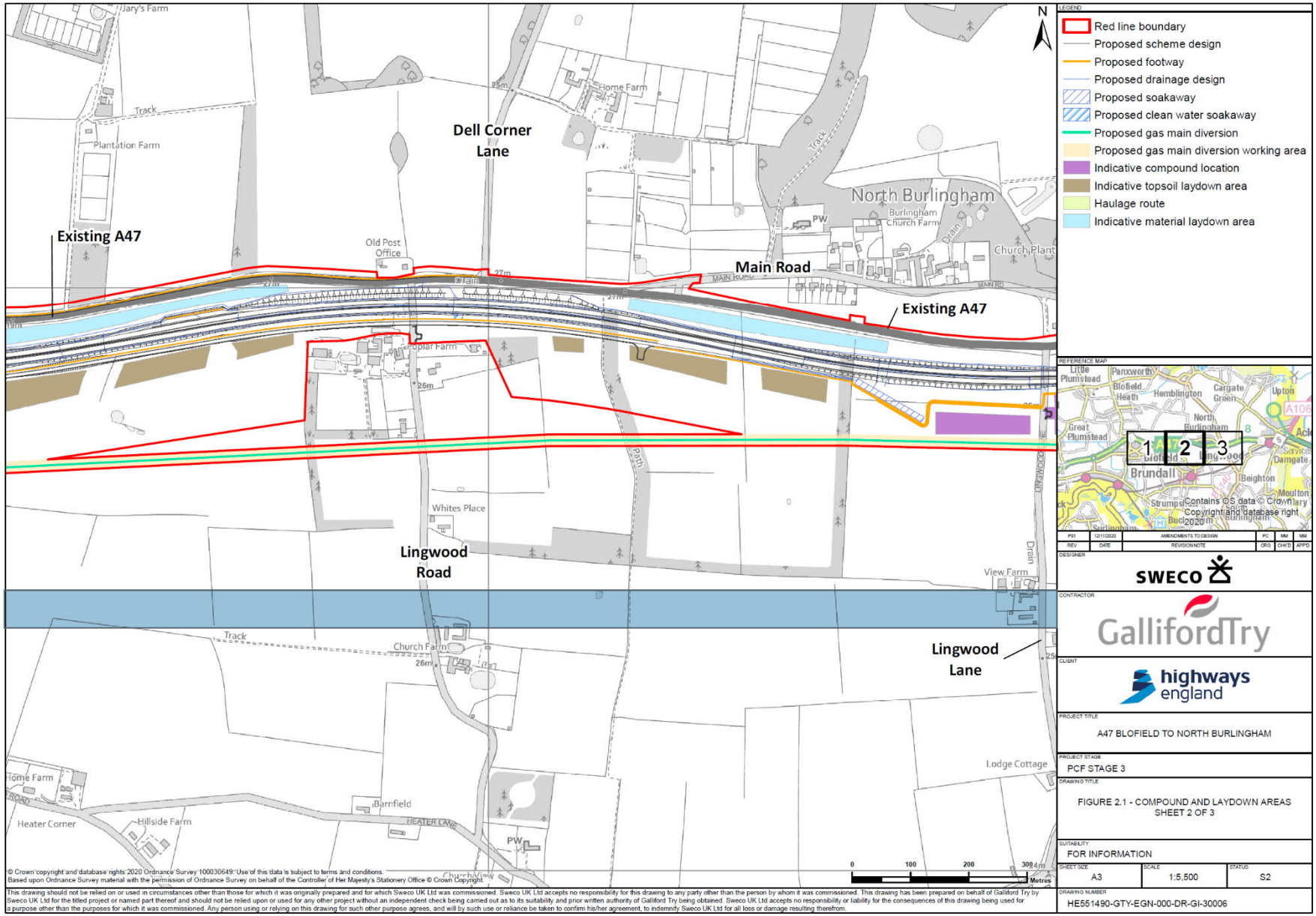
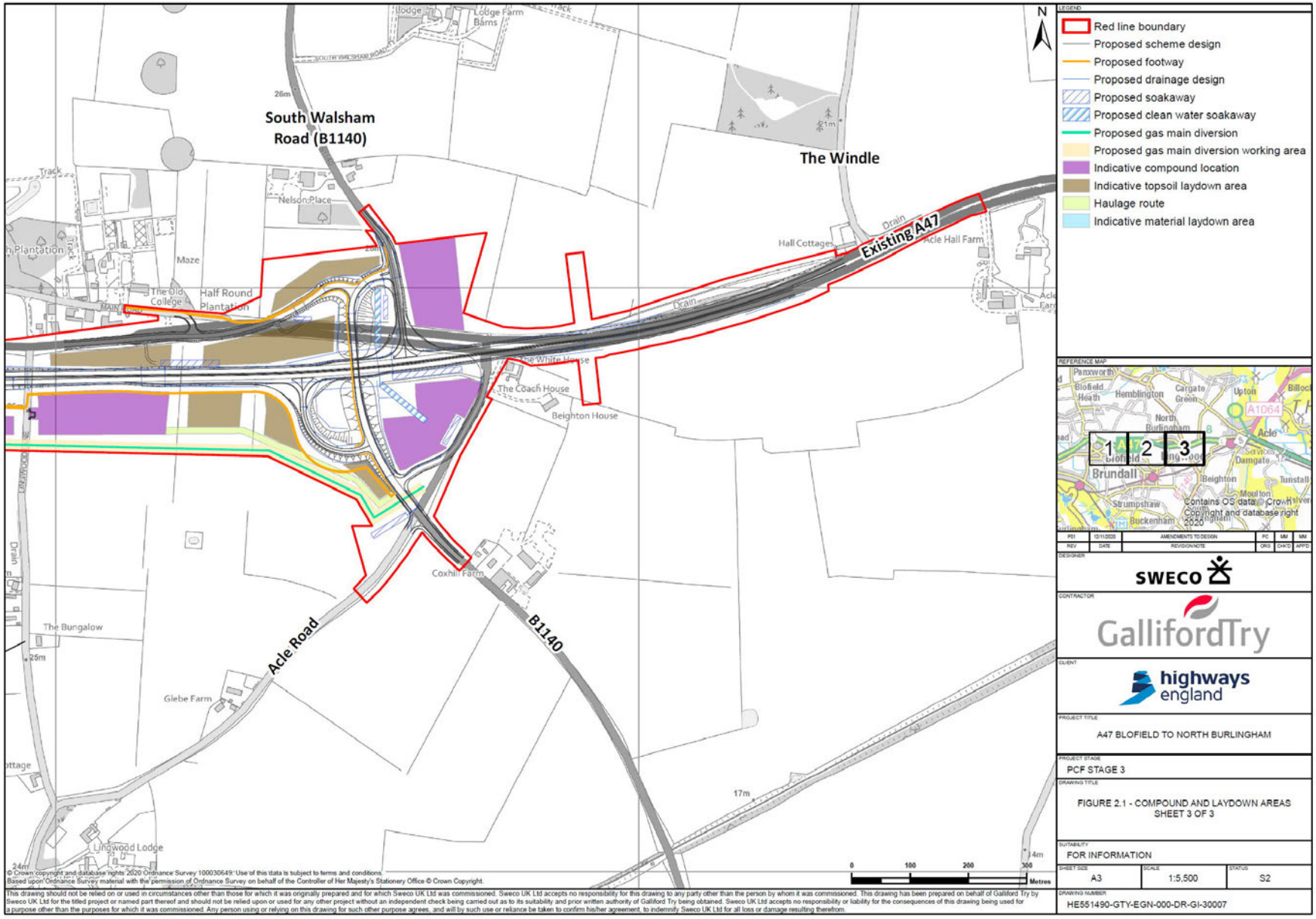




Annex E. Technical note on catchment hydrology

Table of contents

Tables

1. Introduction

1.1.1. As part of the A47 Blofield to North Burlingham scheme (referred to as 'the Proposed Scheme'), Norfolk County Council requested a detailed assessment of surface water overland flow pathways via the Scoping Opinion (Planning Inspectorate, 2018). Providing continuity of overland flow paths is critical in ensuring the Proposed Scheme does not increase flood risk on the site or elsewhere, in line with the National Planning Policy Framework (MHCLG, 2019).

1.1.2. As such, appropriate mitigation in the form of 'dry culverts' or interceptor \ cross drains are to be designed for the 1 in 100-year event plus an allowance for climate change. This report assesses the methodology used and results generated using two Flood Estimation Handbook (FEH) methods.

2. Methodology

2.1.1. The method adopts a three-stage approach by firstly calculating the catchment areas where they intercept the Proposed Scheme, then assessing both of the core Flood Estimation Handbook (FEH) methods used for estimating peak design flood flows for each catchment.

2.2. Catchment boundary assessment

2.2.1. Topographic data was initially required to calculate overland flow routes and ultimately contributing catchment areas. A digital terrain model (DTM) with a one metre spatial resolution, generated from light detection and ranging (Lidar) survey from 2018 was imported from the National Lidar Programme into ArcGIS from which ground level contours were derived. Using a variety of 'Hydrology' methods in the ArcGIS Spatial Analyst toolset, overland flow accumulation lines were generated from higher order topographically contributing cells. Catchment outlets or 'pour points' were specified in locations where flow accumulation lines crossed the Proposed Scheme. In instances where the Proposed Scheme created isolated areas between the existing and proposed A47 carriageways, the most downstream crossing location was used for the pour point. This method was chosen as it generated the most conservative (i.e. larger) catchment areas.

2.2.2. Additional ArcGIS Spatial Analyst tools were used to create contributing catchment areas of all 1 metre grid cells upstream of the pour points. The catchment areas could then be extracted for further analysis.

2.2.3. During consultation Norfolk County Council noted that use of Lidar data alone could be inaccurate in relation to the sizing and placement (vertical and horizontal) of cross-drains or 'dry culverts'. It is noted that when local topographic survey data is collected prior to detailed design, this assessment will be revisited to ensure local drainage catchment areas, and hence flow estimates, are accurately assessed.

2.3. Suitable catchment allocation

2.3.1. FEH methods require catchment descriptors for a given catchment in order to calculate flows. No information is available for the catchment areas and they all qualify as 'small catchments' (<0.5km^2). Following Environment Agency (2012) guidance, FEH methods should be applied to the nearest suitable catchment greater than 0.5km^2 that is indicated on the FEH web service (UK Centre for Ecology and Hydrology, 2020) and flows scaled down by the ratio of catchment areas.

2.3.2. The catchment chosen for analysis was the largest centrally located catchment over the Proposed Scheme. This method assumes that hydrological characteristics for this catchment are representative of the smaller catchments across the Proposed Scheme area. The chosen catchment:

- has an area of 1.16km^2
- is considered reasonably permeable (BFIHOST19=0.866)
- is not influenced by lake or reservoir attenuation (FARL=1.0)
- has no urban land cover (URBEXT2000=0)
- has a Standard Average Annual Rainfall (SAAR) of 601mm and
- is partially contained in the 100-yr floodplain (FPEXT=0.27)

2.4. FEH statistical method

2.4.1. This analysis was carried out using WINFAP 4 (Wallingford HydroSolutions, 2019). The FEH statistical method using catchment descriptors was required since the catchment in question possessed no observed (i.e. gauged) flow data. A pooling group was created with other hydrologically similar catchments totalling 500 years of data. From this, pooled growth curves and flood frequency curves were created to estimate the 1 in 100-year peak flood flow. Consideration was given to the removal of specific catchments which did not display similar characteristics, and as such, contributed to heterogeneity within the pooling group.

2.4.2. A value of QMED (the mean annual maxima flood with an annual exceedance probability of 0.5 (or 50%) and a return period of 2 years.) was calculated utilising the catchment descriptor equation below:

$$QMED = 8.3062\ x\ 0.1536^{\frac{100}{SAAR}}\ x\ FARL^{3.4451}\ x\ 0.046^{BFIHOST^2}$$

2.4.3. Suitability for a data transfer using a donor site was assessed, with the aim of reducing the uncertainty of the calculation of QMED using catchment descriptors alone.

2.4.4. Multiplying the growth curve by the most conservative value of QMED (i.e. without donor adjustment) produced the most conservative flood flow estimates. The event was scaled using a climate change allowance factor. Following the estimation of flood peaks for small catchment guidelines, the 1 in 100-year flows plus climate change were scaled down to represent the overland flows for the natural drainage catchments calculated in Section 2.2.

2.5. ReFH2 method

2.5.1. This analysis was carried out using the ReFH2 software (version 2.3, Wallingford HydroSolutions, 2019). The catchment was tested against the event-based rainfall runoff method for comparison of flow rates. Various storm durations and timesteps were used to check the variation in flow of the 100-year summer storm. Since the catchment has an URBEXT2000=0, the results for the peak 'rural' flow were analysed. Once the climate change factor was applied, the flows were scaled by area of each of the natural catchment drainage areas intercepted by the Proposed Scheme.

3. Climate change

3.1.1. The current online PPG climate change allowance guidance (Environment Agency, 2020) establishes the climate change allowances for river, rainfall and tidal sources for different regions of the UK. The guidance states that the potential change in peak river flow 'upper end' estimate for the Anglian basin is 65% for the '2080s'. This factor was applied to the 1 in 100-year flow to estimate the potential impacts climate change could have on the peak flood events.

4. Results

4.1. Catchment boundary assessment

4.1.1. The FEH web service extracted catchment and natural drainage ('dry culvert') catchment areas are shown in Appendix A and Appendix B. The pour points denoting locations of overland flow lines crossing the scheme are shown in blue. Some catchment boundaries produced from the pour points crossed the scheme, creating unnecessary flow pathways back and forth across the carriageway. Where this was the case, any smaller catchments bounded by the carriageway north of the Scheme were manually adjusted post-analysis and included within neighbouring catchments. The process was repeated for all smaller catchments bounded by the carriageway south of the Scheme. This was done to limit the necessity of crossings and utilise carrier drains, ultimately aiding drainage design. The catchment areas are shown in Table 1.

Table 1: Summary of catchment areas

Catchment	Area (km^2)
C1	0.46
C2	0.46
C3	0.44
C4	0.08
C5	0.13
C6	0.10
C7	0.12

4.2. FEH statistical method

Analysis of pooling group

4.2.1. The WINFAP 4 software used a pooled analysis to produce catchments that were hydrologically similar to the catchment in question (see Table 2). Catchments highlighted in yellow were subject to detailed review for potential removal from the pooling group.

Table 2: Pooling group produced in WINFAP 4

Catchment	Distance	Years of data	Discordancy	Area	SAAR	FPEXT	FARL	URBEXT 2000
999200- FEH Catchment	-	-	-	1.16	601	0.271	1.000	0.000
76011 (Coal Burn @ Coalburn)	2.529	41	0.692	1.630	1096	0.074	1.000	0.000
27073 (Brompton	2.757	37	0.802	8.060	721	0.237	1.000	0.008

Beck @ Snainton Ings)								
27051 (Crimple @ Burn Bridge)	4.021	46	0.167	8.170	855	0.013	1.000	0.006
45816 (Haddeo @ Upton)	4.038	25	1.034	6.810	1210	0.011	1.000	0.005
28033 (Dove @ Hollinsclough)	4.270	43	0.523	7.920	1346	0.007	1.000	0.000
26802 (Gypsey Race @ Kirby Grindalythe)	4.556	19	0.960	15.850	757	0.030	1.000	0.000
25019 (Leven @ Easby)	4.595	40	1.823	15.090	830	0.019	1.000	0.004
25003 (Trout Beck @ Moor House)	4.654	45	0.652	11.400	1905	0.041	1.000	0.000
47022 (Tory Brook @ Newnham Park)	4.704	25	0.468	13.430	1403	0.023	0.942	0.014
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	4.721	8	2.454	16.080	1044	0.023	0.991	0.006
91802 (Allt Leachdach @ Intake)	4.737	34	0.887	6.540	2554	0.003	0.992	0.000
25011 (Langdon Beck @ Langdon)	4.741	32	1.090	12.790	1463	0.012	1.000	0.001
71003 (Croasdale Beck @ Croasdale Flume)	4.743	37	0.256	10.710	1882	0.016	1.000	0.000
54022 (Severn @ Plynlimon Flume)	4.880	38	0.987	8.750	2481	0.010	1.000	0.000
206006 (Annalong @ Recorder)	4.905	48	2.205	14.440	1704	0.023	0.981	0.000

4.2.2. Catchment 49005 Bolingey Stream @ Bolingey Cocks Bridge possessed a short record length which could, if not rectified, skew the growth curve fittings. On removal of the catchment the pooling group became more homogenous and the

gradient of growth curve fittings became more conservative for higher return periods. The decision was made to remove the catchment from the pooling group.

4.2.3. Catchment 27073 Brompton Beck @ Snainton Ings had a significantly higher influence from the 100-year floodplain (FPEXT) than others in the pooling group. The catchment was replaced with 27010 Hodge Beck @ Bransdale Weir (see Table 3) which caused the pooling group to become more homogenous. Furthermore, the gradient of growth curve fittings became more conservative for higher return periods and the decision was made to replace the catchment.

Table 3: Catchment 27010 catchment descriptors and AM data

Catchment	Distance	Years of data	Discordancy	Area	SAAR	FPEXT	FARL	URBEXT 2000
27010 (Hodge Beck @ Bransdale Weir)	4.959	41	0.105	18.820	987	0.009	1.000	0.001

QMED adjustment using donor site

4.2.4. The suitability of donor catchments for data transfer adjustment of QMED is shown in Table 4.

Table 4: Catchments suitable for data transfer

Catchment	Distance	Area	BFIHOST	FARL	Years of data	Weight
999200- FEH Catchment	-	1.16	0.861	1.000	-	-
34001 (Yare @ Colney)	29.07	228.81	0.528	0.971	60	0.257
34005 (Tud @ Costessey Park)	29.8	72.11	0.598	0.973	57	0.253
34003 (Bure @ Ingworth)	32.07	161.27	0.778	0.974	58	0.242
33046 (Thet @Redbridge)	36.38	143.43	0.581	0.946	51	0.222
33045 (Wittle @ Quidenham)	37.95	27.45	0.534	0.974	49	0.215
33044 (Thet @ Bridgham)	39.78	274.99	0.681	0.942	52	0.208

4.2.5. QMED obtained from catchment descriptors alone (0.042m^3/s) was more conservative than the donor adjusted QMED (0.037m^3/s). The donor catchments were also deemed unsuitable given the size differences. Therefore, unadjusted QMED values were used in the subsequent analysis.

Flood frequency curve fittings

4.2.6. Multiplying the growth curve fitting by the value of QMED gave the following estimates of 1 in 100-year peak flow (see Table 5). The results below also include a 65% allowance for climate change on peak flow.

Table 5: Peak flow estimates for the FEH catchment

Area (km^2)	QMED (m^3/s)	GL 100yr growth curve fitting	100yr flow (m^3/s)	
			100	100*1.65 CC
1.16	0.042	2.981	0.125	0.207

4.2.7. The peak flows were then scaled by a ratio of areas for the natural drainage catchments that cross the Proposed Scheme (see Table 6).

Table 6: 1 in 100-year peak flow estimates for the natural drainage catchments

Catchment	Catchment area (km^2)	Peak flow (m^3/s)	
		100	100*1.65 CC
C1	0.46	0.05	0.08
C2	0.46	0.05	0.08
C3	0.44	0.05	0.08
C4	0.08	0.01	0.01
C5	0.13	0.01	0.02
C6	0.1	0.01	0.02
C7	0.12	0.01	0.02

4.3. ReFH2 method

4.3.1. The event-based rainfall runoff method produced a peak 1 in 100-year summer flow of $0.22m^3/s$ for a recommended storm duration of 7.5 hours and a time-step of 0.5 hours. The results were tested for varying durations, however minimal differences in flow were observed for even large changes in storm duration. Table 7 shows the 1 in 100-year flow plus an allowance for climate change for the subject catchment.

Table 7: ReFH2 1 in 100-year event flow with an allowance for climate change for the FEH catchment

Area (km^2)	Peak flow (m^3/s)	
	100	100*1.65 CC
1.16	0.22	0.363

4.3.2. The flows were scaled by a ratio of areas for the natural drainage catchments that cross the Proposed Scheme (see Table 8).

Table 8: ReFH2 1 in 100-year event flows for the natural drainage catchment areas

Catchment	Area (km^2)	Peak flow (m^3/s)	
		100	100*1.65 CC
C1	0.46	0.09	0.14
C2	0.46	0.09	0.14
C3	0.44	0.08	0.14
C4	0.08	0.02	0.03
C5	0.13	0.02	0.04
C6	0.10	0.02	0.03
C7	0.12	0.02	0.04

4.4. Discussion

4.4.1. The ReFH2 event-based rainfall runoff method produced more conservative flows than the FEH statistical method. Pooling groups used in the WINFAP 4 method can introduce uncertainty due to the relatively small sized area of the FEH catchment. The pooled analysis used catchments with areas in the order of ten times greater, compared with other descriptors such as FARL and SAAR which showed little discrepancy. Factors such as this may be responsible for skewing the results and underestimating event flows.

4.4.2. The ReFH2 event-based rainfall runoff method flows were chosen as final flow estimates for the specified catchments and for input into the design of the ‘dry culverts’ or interceptor \ cross drains.

5. Conclusion

5.1.1. Norfolk County Council requested an assessment of overland flow routes via the Scoping Opinion (Planning Inspectorate, 2018). Maintaining continuity of these flow paths is critical in ensuring the Proposed Scheme does not increase flood risk elsewhere in line with the National Planning Policy Framework (MHCLG, 2019). 'Dry culverts' or interceptor \ cross drains for the 1 in 100-year flood event plus an allowance for climate change are to be designed for the Proposed Scheme using the drainage catchment areas and flows calculated in this report.

5.1.2. The catchment boundaries for overland flow routes were calculated using ArcGIS software and manually adjusted to include any isolated areas between the existing and proposed A47 carriageways.

5.1.3. The two core FEH methods were used to estimate peak flood flows. The statistical method used a pooled analysis to estimate growth factors and flood frequency curves. Catchment descriptors produced a more conservative value for QMED than a donor site and was used to calculate the 100-year flood event flow. The ReFH2 event-based rainfall runoff method used a rainfall depth over a specified duration and frequency to estimate the peak flood hydrograph. The flows were scaled down using a ratio of areas to produce the 1 in 100-year flood event flows for the natural drainage catchment areas that cross the Proposed Scheme.

5.1.4. The ReFH2 rainfall runoff method produced more conservative flow values and these values should be used in the design of the 'dry culverts' or interceptor \ cross drains.

6. References

Environment Agency (2012) Estimating flood peaks and hydrographs for small catchments. Bristol: Environment Agency

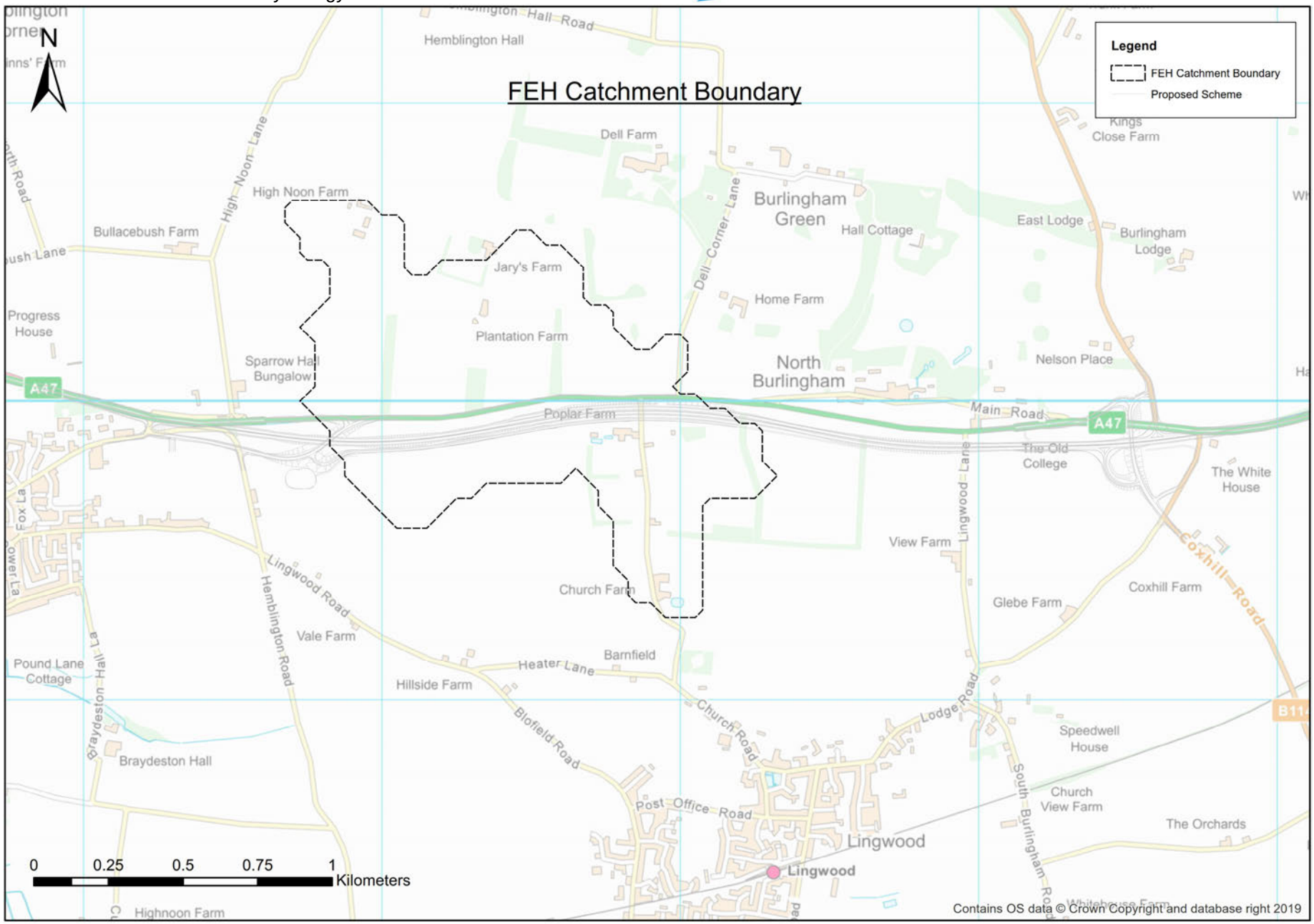
Environment Agency (2020c) Flood risk assessments: climate change allowances. Available online at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances, last accessed June 2020

Ministry of Housing, Communities and Local Government (2019). National Planning Policy Framework. Available at https://www.gov.uk/government/publications/national-planning-policy-framework--2, last accessed June 2020

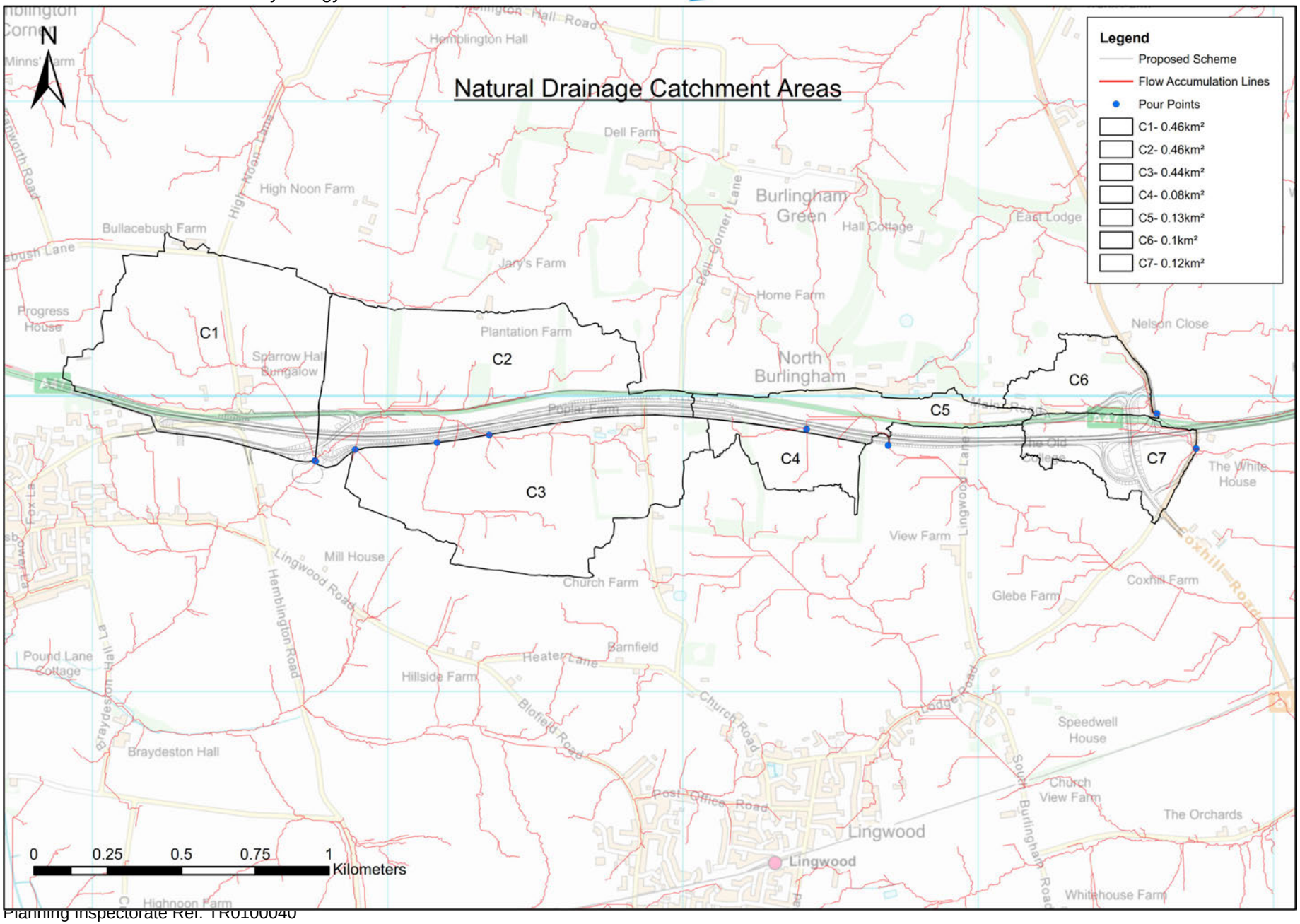
Planning Inspectorate (2018) Scoping Opinion: Proposed A47 Blofield to North Burlingham. Available online at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010040/TR010040-000008-BLOF%20-%20Scoping%20Opinion.pdf, last accessed June 2020

UK Centre for Ecology and Hydrology (2020) Flood Estimation Handbook Web Service. Available online at https://fehweb.ceh.ac.uk/, last accessed June 2020

Appendix A. FEH catchment boundary


FEH Catchment Boundary
N
Legend
FEH Catchment Boundary
Proposed Scheme
Hemblington Hall
Dell Farm
High Noon Farm
Bullacebush Farm
Jary's Farm
Burlingham Green
Hall Cottage
East Lodge
Burlingham Lodge
Kings Close Farm
Home Farm
Plantation Farm
Progress House
Sparrow Hall Bungalow
North Burlingham
Nelson Place
A47
Poplar Farm
Main Road
The Old College
The White House
View Farm
Church Farm
Glebe Farm
Coxhill Farm
Coxhill Road
Lingwood Road
Vale Farm
Barnfield
Heater Lane
Hillside Farm
Pound Lane Cottage
Braydeston Hall
Blofield Road
Church Road
Lodge Road
Speedwell House
Church View Farm
The Orchards
Post Office Road
Lingwood
Lingwood
Highnoon Farm
0 0.25 0.5 0.75 1 Kilometers
Contains OS data © Crown Copyright and database right 2019

Appendix B. Natural drainage catchment areas


Natural Drainage Catchment Areas
N
Legend
Proposed Scheme
Flow Accumulation Lines
Pour Points
C1- 0.46km²
C2- 0.46km²
C3- 0.44km²
C4- 0.08km²
C5- 0.13km²
C6- 0.1km²
C7- 0.12km²
C1
C2
C3
C4
C5
C6
C7
0 0.25 0.5 0.75 1
Kilometers
Hemblington Hall
Dell Farm
High Noon Farm
Bullacebush Farm
Burlingham Green
Hall Cottage
East Lodge
Jary's Farm
Home Farm
Progress House
Plantation Farm
Sparrow Hall Bungalow
North Burlingham
Nelson Close
Poplar Farm
The White House
View Farm
Mill House
Church Farm
Glebe Farm
Coxhill Farm
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Barnfield
Hillside Farm
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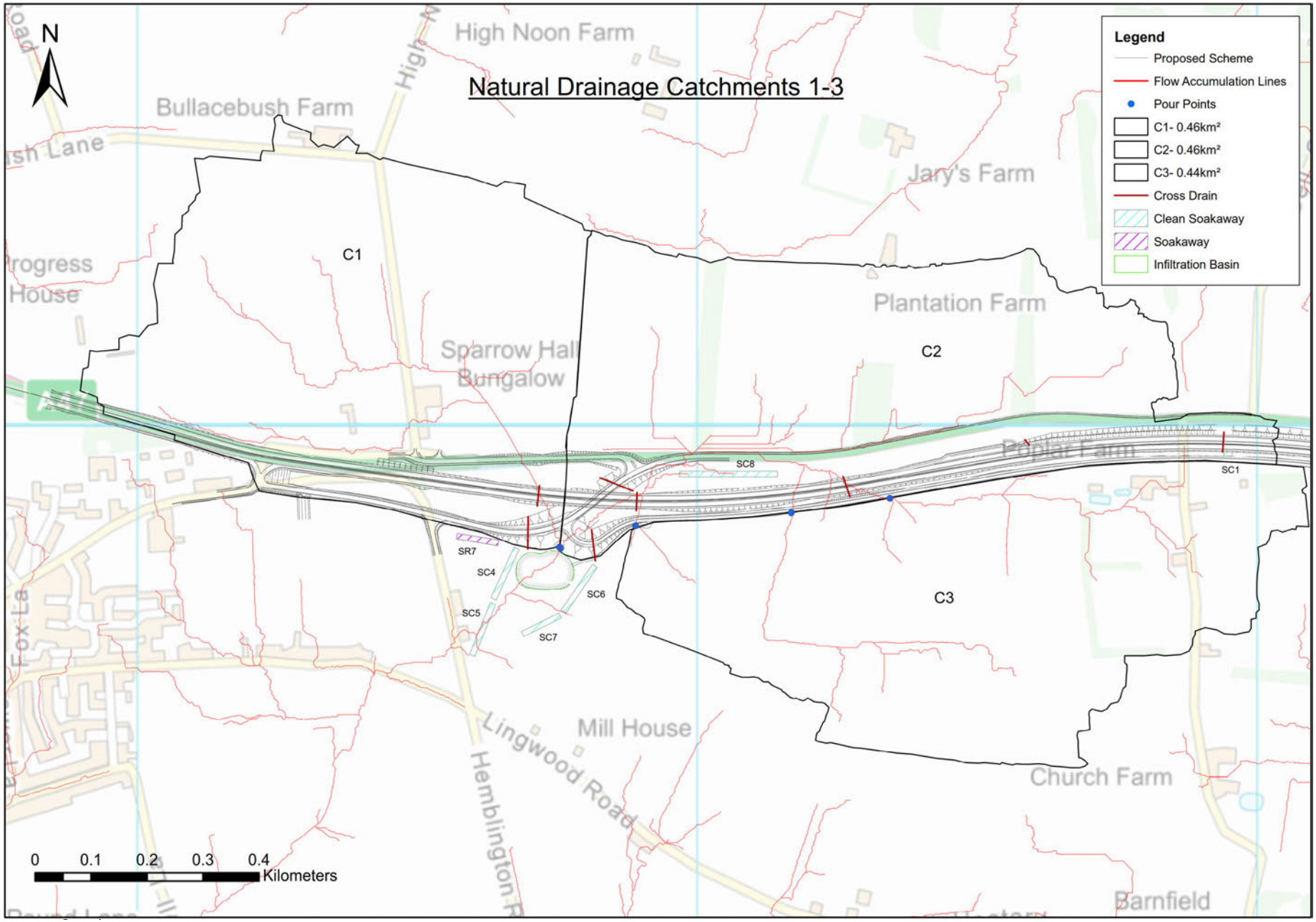
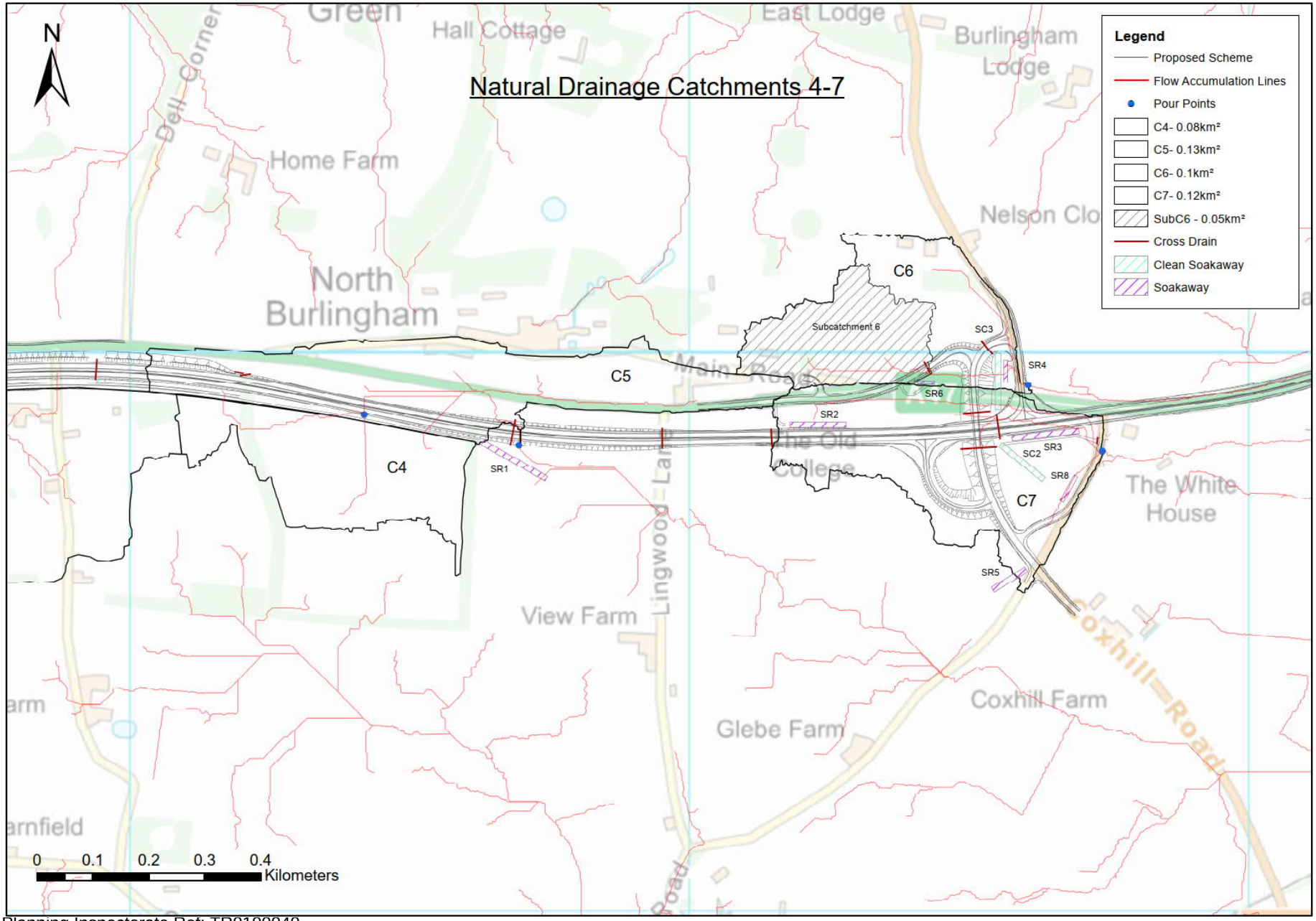
Speedwell House
Church View Farm
The Orchards
Lingwood
Whitehouse Farm
Highnoon Farm


Natural Drainage Catchments 1-3
N
Legend
Proposed Scheme
Flow Accumulation Lines
Pour Points
C1- 0.46km²
C2- 0.46km²
C3- 0.44km²
Cross Drain
Clean Soakaway
Soakaway
Infiltration Basin
C1
C2
C3
SC1
SC4
SC5
SC6
SC7
SC8
SR7
High Noon Farm
Bullacebush Farm
Jary's Farm
Plantation Farm
Sparrow Hall Bungalow
Poplar Farm
Mill House
Church Farm
Barnfield
Lingwood Road
Hemblington
0 0.1 0.2 0.3 0.4
Kilometers


Natural Drainage Catchments 4-7
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Legend
Proposed Scheme
Flow Accumulation Lines
Pour Points
C4- 0.08km²
C5- 0.13km²
C6- 0.1km²
C7- 0.12km²
SubC6 - 0.05km²
Cross Drain
Clean Soakaway
Soakaway
C4
C5
C6
C7
Subcatchment 6
SR1
SR2
SR3
SR4
SR5
SR6
SR8
SC2
SC3
Hall Cottage
East Lodge
Burlingham Lodge
Home Farm
Nelson Clo
North Burlingham
Main Road
The Old College
The White House
Lingwood Lane
View Farm
Coxhill Farm
Glebe Farm
Coxhill Road
0 0.1 0.2 0.3 0.4
Kilometers