A47 Blofield to North Burlingham Dualling

Scheme Number: TR010040

Volume 6
6.2 Environmental Statement Appendices
Appendix 13.2 – Drainage Strategy

APFP Regulation 5(2)(a)

Planning Act 2008

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

September 2021

Deadline 4

Infrastructure Planning

Planning Act 2008

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

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

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 13.2 Drainage Strategy

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010040
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Author:	A47 Blofield to North Burlingham Dualling Project Team, Highways England

Version	Date	Status of Version
Rev 0	December 2020	Application Issue
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1. Introduction

1.1. Existing route corridor

1.1.1. The A47 Corridor is ranked second nationally for fatalities on A roads and the accident severity ratio is above average. The A47 is a mix of dual carriageway (47%) and single carriageway (53%) and the current traffic flows generally exceed capacity. Rapid growth is planned in the area. Norwich, Cambridge and Peterborough are amongst the fastest growing cities in the country.

1.2. Existing project road

1.2.1. The existing project road is a single carriageway. This means that the section of the A47 between Blofield and North Burlingham is already over capacity. Traffic is forecast to grow across the country and when combined with local growth, in Peterborough and Norwich, will exacerbate the condition.

1.2.2. The A47 Blofield to North Burlingham (eastbound) currently has an average speed significantly lower than the daily average during the morning peak. This is an indicator of congestion and affects journey times and journey time reliability on the road.

1.2.3. The resilience of the link is an issue as there are no alternative routes.

1.2.4. Dualling of the A47 will fill a gap in the dual carriageway section between Norwich and the Acle Straight.

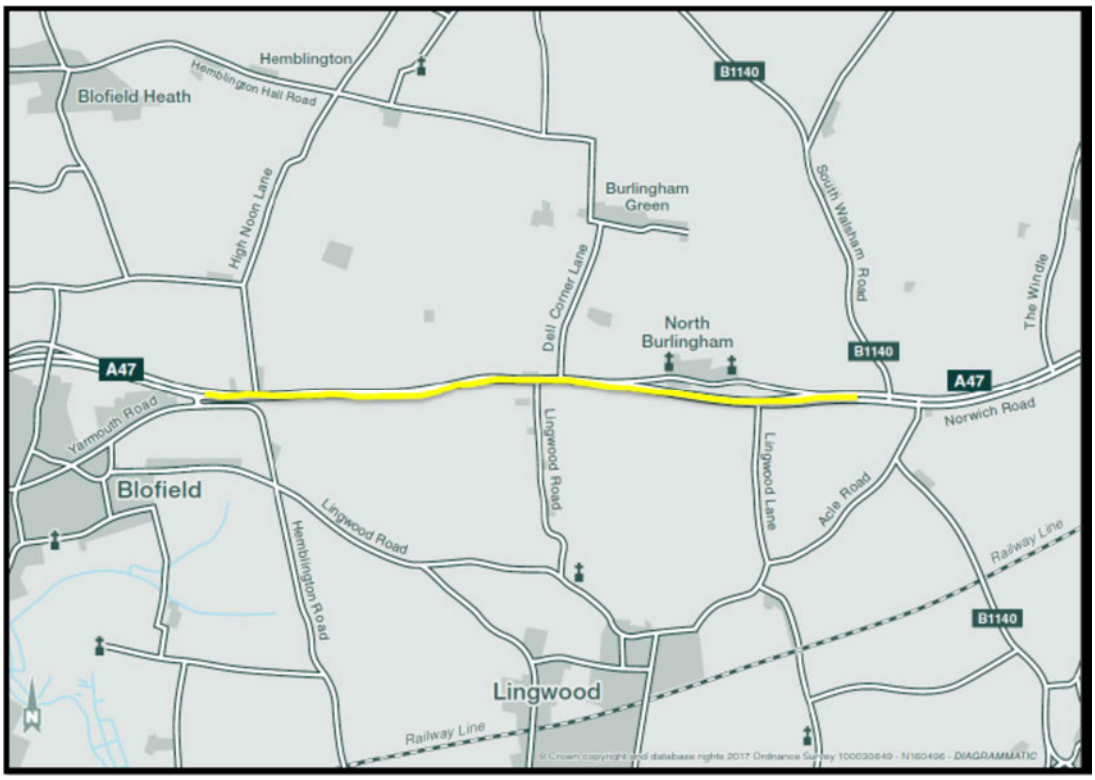
1.2.5. Dualling this single carriageway section of the A47 offers a solution to the congestion, will allow economic growth in the area and has the potential to reduce the number of accidents.

1.2.6. There are three villages close to the existing A47; Blofield, North Burlingham and Lingwood. Other farm and commercial buildings are close to the existing A47. In addition, there are churches and community facilities near to the road and there are also properties scattered throughout the rural area.

1.2.7. A number of local side roads join the A47 and there are a number of direct property accesses both commercial and residential on to the existing A47.

1.2.8. The extents of the scheme are illustrated in Figure 1-1 below. A47 Blofield to North Burlingham Environmental Statement (Development Consent Order (DCO) document 6.3) Figure 1.1 Scheme overview shows the proposed red line boundary for the scheme.

Figure 1-1 : Scheme extents



1.3. Scheme proposals

1.3.1. The Proposed Scheme is to provide a continuous dual-carriageway linking Blofield and North Burlingham Bypass. The scheme would involve the removal of direct accesses. The Yarmouth Road and B1140 Junctions will be constructed to CD 123 and CD 122 of DMRB standards and the Blofield and B1140 Overbridges will be constructed to CD 127 of DMRB standards, as illustrated in A47 Blofield to North Burlingham Environmental Statement DCO Document 2.2.

1.4. Purpose of this report

1.4.1. This report describes the key aspects that have influenced the preliminary design of the drainage system for the Proposed Scheme. This includes; design criteria, catchment areas, collection and conveyance systems, water quality and quantity controls.

1.4.2. For motorways and trunk roads for which Highways England Company Limited is the overseeing organisation, the technical compliance of the proposal must be demonstrated, certified and recorded as set out in CG 502, The certification of drainage design. This report documents the drainage strategy and selection process, demonstrating compliance with technical standards under the prescribed headings as set out in Appendix B of CG 502.

1.4.3. This report has been prepared to support the A47 Blofield to North Burlingham Environmental Statement (DCO Document 6.1 - Volume 1 Environmental Statement). The report should be read in conjunction with the documents listed in Table 1-1 below.

Table 1-1 : Documents relating to Drainage Strategy Report

Title	Document reference
Flood Risk Assessment	Appendix 13.1 of Chapter 13 Road Drainage and Water Environment
Groundwater Assessment	Appendix 13.3 of Chapter 13 Road Drainage and Water Environment
Technical Note on Deep Drainage	Annex D of this report
Technical Note on Catchment Hydrology	Annex E of this report
Ground Investigation Report	Galliford Try Sweco (2020) A47 Blofield to North Burlingham Dualling Ground Investigation Report. Report No. HE551490-GTY-HGT-000-RP-CE-30001

1.5. Background

1.5.1. Dualling of the A47 between Blofield and North Burlingham was announced in the Road Investment Strategy: for the 2015 / 16 – 2019 / 20 Road Period (Department for Transport, December 2014, update March 2015).

1.6. Proposed Scheme description

1.6.1. An overview of the A47 Blofield to North Burlingham scheme is included in the Environmental Statement (ES) Volume 1 (DCO Document 6.1).

The route

1.6.2. The A47 Blofield to North Burlingham improvement scheme includes conversion of almost 4km of single carriageway to dual carriageway. The route is offline and joins the existing A47 at the tie-in sections. Accommodation works include two overbridges and connecting link roads.

Main alignment

1.6.3. From west to east, the scheme starts to the north east of Blofield Village where it breaks into an offline section to the south of the existing single carriageway. The surrounding land is gently undulating and ranges between 17 m to 27 m in elevation above ordnance datum (mAOD). The main alignment continues in an easterly direction through farmland, until the tie-in, where it meets the dual carriageway section of the Norwich Road on the A47.

1.6.4. An existing layby is to be closed off at the eastern tie-in, with a new layby being provided at a more suitable location mid-scheme.

Junctions

1.6.5. At the western end of the scheme, a new junction is proposed to connect the Yarmouth Road and the existing A47 with a new overbridge (Blofield overbridge) crossing over the new dual carriageway to the north east of Blofield. Just before the tie-in at the eastern end of the scheme, another new junction is proposed to connect Acle Road, B1140 Coxhill Road and South Walsham Road with the existing A47 and includes another new overbridge (B1140 overbridge) crossing over the new dual carriageway.

Local Roads

1.6.6. The proposed junctions as described will provide access to local roads. At the western end of the scheme the Yarmouth Road will be cut off by the proposed new dual carriageway just to the north east of Blofield Village, where the Yarmouth Road Junction will provide Left-in, Left-out manoeuvres only from and to the dual carriageway. Connecting traffic from Yarmouth Road to the existing A47 will be diverted eastwards and onto the Blofield Overbridge to make that connection. Some local access to an existing allotment, Hemblington Road and onto an Agricultural Access Track will be provided along this new section of roadway. To the north of the Blofield Overbridge traffic can access to and from properties on the existing A47 using a Left-in, Left-out manoeuvre and traffic can continue along the existing A47 to North Burlingham to the north of Blofield overbridge. A new footpath is proposed along the existing A47 to facilitate pedestrian access.

1.6.7. At the eastern end of the scheme a new link road will be provided from the existing A47 and North Burlingham Access onto the South Walsham Road which will facilitate traffic coming onto the dual carriageway. Similarly, at the B1140 junction traffic can connect from the dual carriageway onto Acle Road and the B1140 Coxhill Road. A link will be left in place from the B1140 to access properties along the existing Acle Road where these will be cut off from the new dual carriageway. All accesses at the B1140 junction will be Left-in, Left-out only and the B1140 overbridge provides the connection from the south to the north of the dual carriageway.

1.6.8. A description of the scheme is provided within Chapter 2 (The Proposed Scheme) of Environmental Statement Volume 1 (DCO document 6.1)

2. Data sources

2.1. Existing drainage records

2.1.1. Existing records of drainage were examined on the Highways England HA DDMS website portal and screenshots taken of the relevant study area are included in Annex A. There is evidence of filter drains and gullies leading to soakaways in the western and eastern end of the scheme and gripes and gullies leading to discontinuous ditches elsewhere along the existing road. The existing drainage is included in the site description in Section 4.

2.1.2. There is an absence of streams along the route of the scheme. The nearest stream is approximately 1 km from the proposed road. Any existing ditches in the vicinity have indeterminate outfalls and it is assumed that any standing water in the ditches infiltrates to ground or overflows along surface water pathways (depressions and valleys in the topography in extreme storm conditions). Where existing drainage on side roads drained to ditches and road modifications proposed were minor, the status quo was left in place at these outfalls.

2.1.3. Norfolk County Council provided mapping of the surface water pathways that were known to them. The surface water pathways were further generated and mapped as part of the Technical Note on Catchment Hydrology which is included in Annex E of this report. The mapped surface water pathways are largely dry and only convey surface water runoff in wet weather. The drainage design took account of these surface water pathways and the routes using LIDAR survey, to accommodate and maintain the natural catchment drainage regime. However, the surface water pathways did not offer any potential as outfall locations for the drainage of the proposed new dual carriageway.

2.1.4. As there was evidence that existing drainage along the existing A47 drained to soakaways, historical data sources were investigated for infiltration potential along the proposed road.

2.2. Existing flood records

2.2.1. 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 (see Figure 5-2 in the Flood Risk Assessment in Appendix 13.1 of Chapter 13 Road Drainage and Water Environment):

- Events within Proposed Scheme boundary:
  - five very low severity (0-2) flood events between 2012 and 2018 east of North Burlingham where the carriageway and the layby were flooded

  - one low severity (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 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.

2.2.2. 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.

2.2.3. 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.

2.2.4. 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.

3. Field studies

3.1.1. Sweco drainage team attended a site visit on 29 September 2017. During this site visit observations were made of the existing highway drainage and external catchment runoff system.

3.1.2. Subsequent site visits and a water features survey early in 2020 provided further information on existing drainage on side roads, external drainage and at potential outfalls.

4. Site Description

4.1. Overview of catchments

4.1.1. A Site Location Plan is provided in the Environmental Statement (DCO Document 6.1 - Volume 1). The western extents of the Proposed Scheme (including Blofield to North Burlingham) is located in the Witton Run catchment area. The Witton Run catchment forms the eastern section of the larger River Yare catchment. The source of the Witton Run is located in Plumstead Green. The river migrates in a north-south direction through Brundall before merging with the River Yare. The main channel of the Witton Run is beyond the study area.

4.1.2. The central and eastern extents of the Proposed Scheme (including North Burlingham and Acle) are located in the River Bure catchment area. The River Bure rises at Melton Constable and flows south west to the Broads towards the sea at Great Yarmouth. The main channel of the River Bure is beyond the study area.

4.1.3. The entire study area is found within the Broadland rivers Chalk and Crag WFD groundwater body (GB40501G400300) for which the overall classification is poor (2016). The aquifers have a combined groundwater vulnerability classification of medium to high risk, with a small area of low risk in the west.

4.1.4. There are some small field drains and ponds located along the extents and adjacent to the Proposed Scheme.

4.1.5. The Proposed Scheme is not affected by fluvial or groundwater flooding. The nearest watercourse, a tributary of Run Dike, is approximately 1km away, to the south of Blofield. As the proposed drainage is to be discharged by infiltration, it is considered that the Proposed Scheme will have no impact on fluvial flood risk.

4.1.6. There are some localised areas of surface water flood risk including potential flood flow pathways in the vicinity of the Proposed Scheme as indicated in Environment Agency's flood maps and the locations where existing flooding was recorded in the HA DDMS information supplied by Highways England and subsequent flood records provided as outlined in Section 2.2. Further details are provided in the Flood Risk Assessment (Appendix 13.1 of Volume 3 Appendices).

4.1.7. A natural catchment hydrology assessment has been undertaken and is included in Annex E of this report; this assessment determines the natural catchment areas crossing the catchments and the associated flood flows for a 1 in 100 year event with an allowance for climate change. This will support the drainage design to ensure the continuity of surface water flood flows is accommodated

through the use of ‘dry culverts’ or cross drains and these are appropriately sized.

4.2. Existing drainage on A47 Blofield to North Burlingham

4.2.1. The existing carriageway is drained through a highway drainage network utilising a variety of drainage systems including:

- kerb and gully or drainage channel
- over the edge runoff
- underground carrier pipes and filter drains with associated chambers
- ditches
- soakaways

4.2.2. The existing drainage, as evidenced on Google Drive Through mapping appears to be ‘over the edge’ mostly over grassy margins which are kept tightly mowed. Where gullies exist at low points, these seem to be near ditches, which either apparently infiltrate to ground or drain to nearby ponds. Site visits were undertaken, which provided further information on the pathways of the existing drainage. Existing records of drainage were also examined on the HA DDMS website portal and screenshots taken of the relevant study area are included in Annex A. There is evidence of filter drains and gullies leading to soakaways in the western and eastern end of the scheme. Some small stream channels exist and low-lying wet areas of standing water including ponds. Inlets and grips lead to ditches. It is not clear where some of these ditches discharge to. A CCTV drainage survey of the existing drainage was recently completed and this confirmed some of the HA DDMS records, while providing additional information at the tie-ins.

4.3. Existing surface water features

4.3.1. Early reviews of Ordnance Survey (OS) mapping and surveys of the site for the Stage 2 Environmental Assessment Report (EAR) of the study area which encompassed eight scheme options, indicated that there were approximately thirty ponds and approximately seven drainage channels located within the study area. It was noted that the drainage channels flowed discontinuously and thus they were unlikely to contribute to the flows of the proximate watercourses, such as the River Bure, Witton Run or Run Dike. The ponds within the study area were noted as likely to have a strong dependence on groundwater as there are no surface water inflows present as shown in Figure 3-1 (Source: Stage 2 EAR). Observations made during early site surveys during the EAR indicated that the majority of the drainage channels (including roadside swales) within the study area were either void of water or contained small amounts of water which flowed

discontinuously. A site walkover survey and Ground Investigation was undertaken to determine the source of the pond which is located along the proposed route of the scheme, adjacent to Lingwood Road as shown in Figure 4-1. Findings from the Ground Investigation concluded that surface water levels in the pond were not influenced by groundwater. The pond adjacent to Lingwood Road, also receives some road drainage from a ditch at the junction with the existing A47. It is proposed to intercept this road drainage with the proposed new drainage design.

Figure 4-1 : Surface water pond located south of the existing A47 adjacent to Lingwood Road

4.3.2. According to the Environment Agency, there are no licensed surface water abstractions or Surface Water Safeguard Zones located within the study area.

4.3.3. The location of drainage ditches recorded during a water features survey in March 2020 were examined to ensure the drainage design was maintaining connectivity and keeping natural catchment drainage within catchment where this would be severed by the scheme. The locations of the drainage ditches identified are shown in Figure 13.1 (Surface water features, consented discharges and fluvial flood risk) of Volume 3.

4.4. Existing groundwater features

4.4.1. A source protection zone (SPZ) 3 (Total Catchment) is located at the western extents of the Scheme and approximately 0.5km from the nearest infiltration feature in the proposed drainage design. This is associated with groundwater abstractions at Postwick, located approximately 4.5km to the west of the Proposed Scheme. There are a further five licensed groundwater abstractions within the study area, which are used for spray irrigation. Abstractions are

generally clustered at the eastern and western extents of the scheme, around Blofield and to the east of North Burlingham. These features are discussed in more detail in the Technical Note on Deep Drainage included in Annex D of this report.

5. Design options

5.1. Design considerations

5.1.1. Drainage design considerations along the new dualled alignment of the Proposed Scheme including the associated upgraded junctions and new structures are discussed in the following paragraphs.

Mainline A47

5.1.2. Where possible existing drainage on the A47 will remain in place, except for the approaches to junctions at the eastern and western tie-ins where filter drains will be moved out and soakaways relocated to maintain the operation system of the drainage on the existing A47. Some replacement of existing gulleys and clearing of existing drains is expected here. It has been confirmed from the recent CCTV drainage survey where existing drainage will be severed and where connections will be required into the new drainage networks. The results of the recently completed CCTV drainage survey will be incorporated into the detailed design of the drainage for the scheme. There is a risk that the extent of existing drainage to be retained could be under-estimated and a greater scope of works may be required in the design to provide connections to and from existing drainage. This may also involve a re-work of the proposed drainage design for the scheme at the eastern end at the link roads. It was assumed that approximately 400 m of existing road runoff on the A47 may have to be brought into the new section of the drainage system as a result of the road improvements. These discharges will be attenuated along with the new section of widened roadway. This will result in an improvement of any flood issues downstream.

5.1.3. A retaining wall is required at the Yarmouth Road junction to avoid encroaching on properties. Back of wall drainage will drain to an existing ditch at this location.

5.1.4. Where existing direct discharges to existing streams or ditches are not taking any increased road runoff from the proposed improvements scheme, these outfalls will remain in place. It should be noted that the existing streams or ditches referred to do not have an outfall and in practice they drain via a combination of infiltration; evaporation and overflow along surface water pathways. The road improvements will lead to a decrease in the traffic levels in those areas where direct discharges to existing streams or ditches remains unchanged. This is because the through traffic will be diverted onto the new road to the south of the existing A47. The AADT forecasted in these areas for 2025 and 2040 is significantly less than the current traffic levels on the existing A47. Where exceedance flows from routine runoff from retained roads are redirected

to a new soakaway feature, a HEWRAT assessment has been undertaken. These have all been found to be low risk and therefore no additional water treatment measures were required. Attenuation is provided in the soakaway feature.

5.1.5. Filter drains will be provided in verges where the embankment is not greater than 1.5 m and along the toe of any cuttings on the mainline. The filter drains will drain the cuttings and the road runoff. The first flush surface water runoff will be treated in the filter drains.

5.1.6. Where the road drains towards the median, median drainage will be provided. An appropriate vehicle restraint system (steel barrier) with a paved median is proposed therefore gullies or concrete channels will drain down into a pipe in the central reserve.

5.1.7. Catchpits will be provided throughout the scheme except in the median and at road crossing locations, where manholes are preferred for safety during maintenance.

5.1.8. Kerbed sections of the mainline will include gullies or combined kerb and gulley, discharging to the filter drains in the verges.

5.1.9. The outfalls from the drainage on the new road will discharge to an infiltration basin or soakaways, providing further treatment of the surface water runoff and reducing the discharges to Greenfield runoff rates.

5.1.10. Shut off facilities, for example, penstocks will be provided upstream of the infiltration facilities to allow for the containment of spillages.

5.1.11. A catchpit will be provided at the upstream chamber before discharge to the soakaway or infiltration basin.

5.1.12. The realignment of the new road at the tie-ins will improve falls in the road, leading to improvements at existing flooding hotspots within the scheme extents where identified in Section 2.2.

5.1.13. New sections of side roads will drain to soakaways, to be maintained by Norfolk County Council.

5.1.14. New on-road and off-road footways will be accommodated in the scheme providing strategic links for Blofield - North Burlingham – South Walsham Road – B1140 Road. The installation of these new footways will not allow the road to drain to filter drains in these areas, requiring kerbing and closed systems instead.

Natural catchment overland flow

5.1.15. Overland flow will be intercepted in cut-off ditches and directed along existing flow pathways or to soakaways. This will involve cross-drains in the new A47 roadway.

5.1.16. Where minor overland flows and embankment runoff drains towards maintenance access tracks which lead to the infiltration basin or to soakaways, the interceptor ditches will be replaced by driveable swales in two locations (see typical detail in Figure 5-1), which will provide a dual function of access track and drainage conveyance. This is to avoid a doubling up of embankment toe drains and overland flow ditches next to the access track. The driveable swale will convey low volumes of clean water only (maximum depth of 0.18 m). A flood hazard assessment was undertaken for the driveable swales in accordance with Flood Risk Assessment Guidance for New Development Phase 2 Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools R&D Technical Report FD2320/TR2 using the Intermediate Approach.

Swale No. 1 at Ch 150 south of the Farmer's track to the south of Blofield Junction:

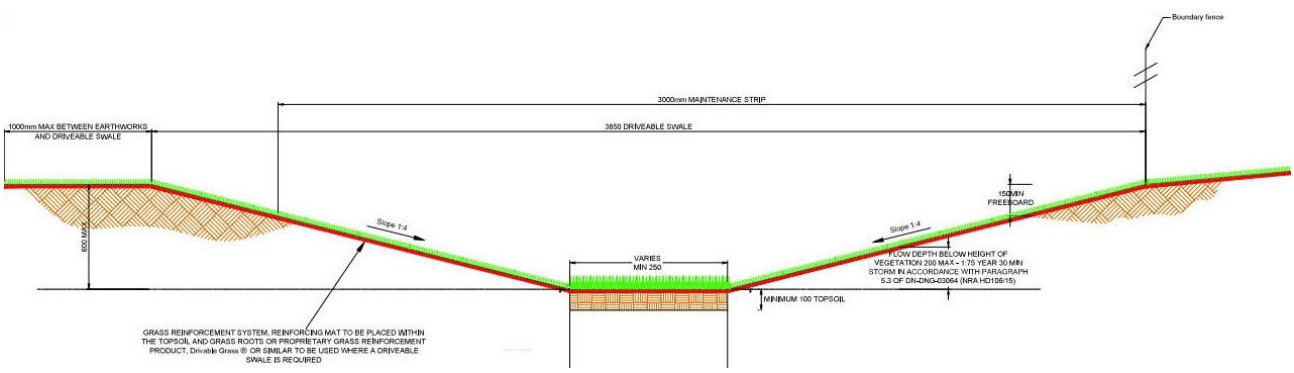
For a 1 in 100 year return period storm with an allowance for Climate Change this yields a velocity = 0.17 m/s and flood depth of 0.1m. Table 13.1 of the guidance rates the danger to people as very low hazard.

Swale No. 2 at Ch 2800 south of the mainline:

For a 1 in 100 year return period storm with an allowance for Climate Change this yields a velocity = 0.16 m/s and flood depth of 0.18m. Table 13.1 of the guidance rates the danger to people as very low hazard.

We can deduce therefore that there would be no residual risk in the use of these driveable swales to serve the dual function as proposed.

Figure 5-1 : Typical detail for driveable swale



5.1.17. Natural overland drainage and existing ditches and streams between the existing A47 and the proposed new road will be intercepted and conveyed along the natural drainage paths as far as possible. This will involve pipe crossings of the proposed new road.

Pre-earthworks drainage

5.1.18. Toe drains, where required, draining embankments greater than 1m, will drain via ditches to soakaways or along existing surface water pathways.

5.2. Description of options considered

5.2.1. The drainage design has progressed through the following stages:

- Design Fix A (2017) – carried forward from the Stage 2.
- Design Fix B (2018) – design progressed from Design Fix A
- Design Fix B (2020) – design further progressed in preparation for
- Design Fix C (July 2020) – final design for Stage 3

5.2.2. The progression of the drainage should be read along with the drainage drawings in Annex B so that the locations of where changes were made can be understood from the chainage references.

5.2.3. Initially at Design Fix A stage, the drainage design included two attenuation ponds which were proposed to drain via a controlled discharge at Greenfield runoff rates and outfall to new interceptor ditches leading to an outfall which appeared to be a suitable ditch from LIDAR. As Design Fix A progressed to Design Fix B, one of the ponds proposed to the north of the scheme at Chainage (Ch) 1+700 was eliminated to avoid a potential clash with the gas main. This resulted in the joining up of two drainage networks: Network Ch 1+075 – 1+700 and Network Ch 1+700 – 2+470 and combining these leading to one attenuation pond, located to the south of the scheme at Ch 1+100.

5.2.4. An infiltration basin was also included in the earlier drainage design at Ch 2+750.

5.2.5. Further drainage considerations led to drainage accommodation in the design and the design was updated to Design Fix B2. Results were received from the Ground Investigation which also informed the progression of the drainage design. The following design changes were included in the design:

- Drainage of the entrance and car park to the Allotments – It is proposed that the car park facilitating the Allotments will be surface dressed in hard core. The car park will drain ‘over the edge’ to adjacent ground. It appears from information supplied from Norfolk County Council on surface water

pathways, that flows running off from this area will be directed in a southerly direction. The car park is 0.9km from the nearest watercourse, a tributary of Run Dike. The entrance to the car park will receive flows locally from the realigned section of the existing A47 and these flows will be captured in a shallow concrete dished channel which will collect flows across the entrance and redirect these flows back into the proposed new drainage system on that road. The channel will firstly discharge into a catchpit to protect the new drainage system from a build- up of vegetated material and soils falling from trailers entering the car park. The catchpit will require periodic maintenance.

- New footpath along the realigned section of the existing A47 – It was deemed necessary to extend the footpath from the junction with High Noon Lane further along High Noon Lane to facilitate a safe crossing for pedestrians. The road drainage could not then drain to filter drains along this section as the footpath was proposed to be kerbed. This required further gullies along the extended section of footpath on High Noon Lane.
- The new footpath along the existing A47 will require realignment of existing drainage and tie-ins to the new drainage networks.
- Maintenance tracks to ponds required slight movement of catchment interceptor ditches and ditches to be piped across tracks.
- An existing ditch was required to be culverted across the new field entrance opposite The Coach House, off the B1140 roadway.
- The filter drain running along the existing A47 at the eastern tie-in may have to be maintained under the new B1140 road embankment. This is to convey drainage from the North Burlingham Access and the link from the existing A47 which will connect with the B1140 road. This connection can also be used for drainage of the connecting roads here if the infiltration rates for the proposed soakaway outfalls is unsuitable. Infiltration tests were not included in the scope of works for the Ground Investigation to the north of the eastern tie-in, so historical data is being relied upon here for infiltration rates. Infiltration tests are scheduled to be undertaken here in late 2020/early 2021.
- Results of infiltration tests failed at the location of a proposed infiltration basin at Ch 2+750 and this drainage network was then combined with an adjacent network to outfall at the location where infiltration tests had proved satisfactory.
- Following a site walkover it was determined that the potential outfall from the attenuation pond to the west of the scheme was unsuitable and while this was a surface water pathway, no defined ditch existed at this location. Results of Ground Investigations, included in the Ground Investigation Report had found satisfactory infiltration rates, albeit at deep levels at the location of the proposed pond however, and an option for an infiltration basin could be considered as an alternative to the attenuation pond. A possible outlying outfall to a tributary of Run Dike was investigated meanwhile, some 1km downstream of the Proposed Scheme and an outfall modelled to check for suitable levels to reach the outfall. This appeared to

be a feasible option, however a later HEWRAT surface water assessment failed at the outfall location due to a poor Q95 assimilative capacity in the stream/drain which then required a groundwater assessment to be undertaken at this outfall. It was determined that it would be unsuitable to provide a soakaway outfall at this location (1km south of the scheme) given its proximity to a source protection zone SPZ 3. The option for an infiltration basin at source was deemed to be the most feasible option for an outfall and this has been adopted in the current design. Further detail on the suitability of this location for an infiltration basin is provided in Annex E Technical Note on Deep Drainage.

- Online storage in the form of oversized pipes was ruled out for this scheme due to the absence of outfalls.

5.2.6. Further design options to be considered for detailed design is to adopt a spacing of 150m for chambers as this is acceptable by Highways England without a Departure from Standards (DFS) on straight runs without connections. This would reduce the number of chambers overall on the scheme. The local maintenance capability will be investigated before this option is considered to check if rodding and jetting capabilities will be practical at such spacings. Chamber spacing in the central reserve will be largely dictated by the outlet spacings for the concrete channels.

5.2.7. There is currently allowance for a steel barrier in a paved central reserve. If the central reserve changes to grassed, filter drains may be permitted where stone stabilisation techniques are used in accordance with CD 525 Design of combined surface and sub-surface drains and management of stone scatter. This would replace the carrier drain, concrete surface water channel and narrow filter drain combination that is included in the current drainage design in the central reserve.

5.2.8. Locations of soakaways shown on the drawings in Annex B of this report are indicative only. The recommended 10m separation minimum between assets and appropriate offsets from the highway will be provided at detailed design stage. The use of space was restricted by topography, road alignment low points and matching natural surface water pathways. Contours and surface water flow pathways have been shown on the drainage drawings in Annex B of this report which demonstrates some of the constraints on the positioning of soakaways, the aim of which was also to keep these as flat as possible. The soakaway locations and depths are subject to the limits of deviation whereby if subsequent infiltration testing at later stages in the project programme provides satisfactory infiltration at shallower depths in adjacent ground the soakaways will be re-designed to suit. Alternative design options such as geocellular units for the soakaway trenches may also be considered for incorporation at the next stage (detailed design). The merits of using geocellular soakaways with 95% voids will also be examined to further reduce the sizing (and therefore potentially

the depth) of the proposed soakaways. Granular fill material with a pre-determined void space of 40% will also be considered to further reduce the sizing and depth of soakaways. The provision of further infiltration basins in place of soakaways will be considered where appropriate following additional ground investigation which is scheduled for late 2020/early 2021.

6. Proposed design

6.1. Interface with existing drainage system

6.1.1. The drainage design at the interface with the existing drainage system was developed based on data sources available such as HA DDMS and site visits as discussed in Sections 2, 3 and 4.

6.1.2. A CCTV drainage survey of the existing drainage was recently completed and this confirmed some of the routes of drainage systems from HA DDMS records, while providing additional information at the tie-ins.

6.1.3. Detailed information on drainage levels at tie-ins, from the recently received CCTV drainage surveys were not examined at the time of writing this report and this will be incorporated at detailed design stage.

6.1.4. Some sections of existing drainage may be retained subject to a more detailed examination of the interconnecting levels from the recently completed CCTV drainage survey, for example, at the junction on the eastern end.

6.1.5. Where new footways are proposed along the existing A47 and providing links to other areas along the scheme, these will result in further modifications to the existing and proposed drainage design.

6.2. Proposed drainage system

Pavement drainage

6.2.1. The aim of the proposed drainage system is to demonstrate that the proposed drainage will ensure the road remains free from flooding whilst additional runoff is attenuated to greenfield runoff rates and any potential water quality impacts are mitigated, if necessary.

6.2.2. In the development of the road drainage design, the proposed road alignment options were examined as to how these might align with the available outfalls. Overbridge and underpass options for the local Yarmouth Road were examined for the optimum design in terms of drainage. Subsequently, the expected land take required to facilitate treatment and discharge options for the surface water runoff from the road (via soakaways and infiltration basin, storage ponds, outlying outfalls) was determined to inform the red line boundary for the scheme. Further development of the drainage for the scheme for Stage 3 has concluded that all road drainage will drain by infiltration methods due to the absence of streams and drains suitable for outfall on this scheme. Outlying outfalls which were some 1km downstream were deemed unsuitable and inappropriate given that this would transfer surface water discharges closer to areas deemed to be at risk of flooding, as shown in Figure 13.1 (Surface water features, consented

discharges and fluvial flood risk) of the Environmental Statement Volume 2. The existing road drainage outfalls are either at source to small drains or streams with indeterminate outfalls or via soakaways and drainage for this road improvement scheme is proposed to emulate the existing surface water flow regime.

6.2.3. The development of the road drainage examined the developing alignment, proposed cross-falls, grassed or other medians, median barriers, kerbing requirements, footways, cycleways, equestrian routes, utilities (limited to available drawings to date) and all other constraints.

6.2.4. The road drainage network for the scheme has now been designed, see the drainage layout drawings in Annex B. The catchments draining to each soakaway outfall and the infiltration basin are shown on the drawings and the associated contributing areas and the discharge volumes retained by the soakaways and the infiltration basin are set out in Table 6-1.

Table 6-1 : Catchments for road runoff with modelled results of soakaway/infiltration basin performance (See Drainage Drawings in Annex B)

Road Runoff		Modelled storm events including Climate Change (CC) allowance - Discharge Volume						
Catchment	Impermeable Area (ha)	1 in 10 year plus 20% CC (m3)	1 in 100 year plus 20% CC (m3)	1 in 100 year plus 40% CC (m3)	Soakaway / Infiltration Basin ID	Infiltration Rate (m/s)	Half Drain Time (hrs)	Result
1	5.532	1586	2154	4350	PR1	1.20E-05	40	Flows do not exceed ground level in all events modelled (In accordance with CG 501)
2	1.524	617	1007	1230	SR1	1.20E-05	9	
3	1.527	523	950	1108	SR2	4.70E-05	6	
4	1.209	461	587	643	SR3	1.40E-05	21	
12	0.303	129	190	206	SR4	1.40E-05	13	
10	0.385	111	206	241	SR5	8.00E-06	23	
13	0.214	79	101	111	SR6	1.40E-05	22	
7	0.716	247	318	385	SR7	1.20E-05	24	
11	0.15	36	73	85	SR8	1.40E-05	3	
5	Contributing area = 0.9 ha as existing - outfall to existing A47 drainage							
6	Contributing area = 0.6 ha as existing - outfall to existing A47 drainage							
8	Draining area = 0.657 ha (decrease from 1.74 ha) - Outfall to existing ditch which is routed through cleanwater soakaways SC4 and SC5 in series (see Table 6-2)							
9	Draining area = 0.3 ha (no increase from existing) - Outfall to existing ditch which is routed through cleanwater soakaways SC6 and SC7 in series (see Table 6-2)							

6.2.5. The road drainage network includes the following drainage types: filter drains; carrier drains; kerb and gulley; concrete surface water channels (in the median) and combined kerb drains (where continuous drainage is required in flatter gradients and on bridge decks), leading to an infiltration basin or soakaways. The tie-ins on some side roads drain into existing outfalls such as existing ditches or streams or into existing drainage. The design has evolved through the Design Fix stages, followed by the clash detection exercises with the other elements of the design and further adjustments following the receipt of results on infiltration testing from the Ground Investigation. The results of a recently completed CCTV drainage survey at the tie ins on the scheme has highlighted where some modifications will be required to connect back into the existing drainage and where existing drainage will be accommodated in the proposed new drainage system.

6.2.6. Close liaison with the geotechnical team was ongoing through the process, on the suitability of the low points identified as outfalls and the suitability of infiltration systems such as infiltration, basins or soakaway trenches for receiving surface water discharges. The geotechnical team supplied estimated infiltration rates from historical information, to inform the initial estimates for sizing of infiltration systems. Later the results of the infiltration testing from the Ground Investigation was available and the drainage design refined accordingly. The data sources informing the design for infiltration was discussed in more detail in Section 2.2.

6.2.7. Infiltration basins or frequent soakaways are the preferred outfall solution for this scheme. This emulates the existing drainage regime on the existing A47. Appropriate treatment will be provided in the form of filter drains draining the road where possible, and in the soakaways or the infiltration basin.

6.2.8. The treatment of surface water runoff from the road and the attenuation of flows is discussed in Section 7.

Sub-surface drainage

6.2.9. Narrow filter drains are provided where there are carrier drains associated with kerb and gulley or combined kerb drainage. This is predominantly at the junctions and at embankments approaching the overbridges where the road is required to be kerbed and also in the paved median where the road drains towards the median, where concrete surface water channels are provided. Elsewhere the sub-surface drainage will be collected by the combined system in the filter drains.

Natural catchment drainage

6.2.10. Existing surface water pathways for overland flows have been maintained or facilitated through interception using collection ditches and appropriately designed cross-drains.

6.2.11. The management of surface water runoff from exterior catchments is discussed in Section 8 of this report.

6.2.12. Where point flows emerge downstream of the mainline, these are managed in clean water soakaways to dissipate velocities and offer some attenuation of flows, as there is an absence of streams and ditches adjacent to the Proposed Scheme. This will prevent rutting of the ground during extreme events and allow a gentle return to the course of the flows along the existing surface water pathways which remain dry when there is no rainfall.

6.2.13. The clean water soakaways have now been designed, see the drainage layout drawings in Annex B. The catchment areas draining to each soakaway outfall and the associated discharge volumes retained by the soakaways are set out in Table 6-2.

Table 6-2 : Catchments for natural catchment runoff with modelled results of soakaway performance (See Drainage Drawings in Annex B)

Natural Catchment Runoff	Modelled storm events including Climate Change (CC) allowance - Discharge Volume						
Contributing Area (ha)	1 in 10 year plus 20% CC (m3)	1 in 100 year plus 20% CC (m3)	1 in 100 year plus 40% CC (m3)	Clean water Soakaway ID	Infiltration Rate (m/s)	Half Drain Time (hrs)	Result
0.380	29	86	101	SC1	1.10E-05	6.3	Clean water soakaways for dissipation of velocities in overland flows only, serving to maintain flows along existing surface water flowpaths during exceedance events. Flows do not exceed ground level where properties lie in the pathway downstream (In accordance with CD 530).
5.000	457	877	971	SC2	1.40E-05	29.4	
5.000	457	763	811	SC3	1.40E-05	28.3	
45.000	4186	10745	12357	SC4 SC5	1.90E-05	9.1	
46.000	4186	10744	12536	SC6 SC7	1.90E-05	9.8	
43.600	4005	10280	11993	SC8	1.90E-05	9	

Pre-earthworks drainage

6.2.14. Toe drains, where required, draining embankments greater than 1m, have been included in the catchment interceptor drainage design for the exterior catchments. These toe drains will drain via ditches to soakaways or along existing surface water pathways.

6.2.15. Some of the larger embankments drain directly into the infiltration basin where the runoff from these areas will be attenuated along with the road runoff.

6.3. Infiltration potential

6.3.1. In the earlier stages of the development of the drainage design, the design of soakaways and the infiltration basin had to rely on historical data for infiltration rates and infiltration coefficients. It was concluded however, for the initial assessment on infiltration potential, that although infiltration rates were poor, they were an acceptable option for drainage of the scheme route. The amount of historical data recorded was limited but no other sources were available until results became available from the ground investigation. The tests undertaken as part of the ground investigation were undertaken to the method outlined in BRE Digest 365 at the locations of proposed outfalls along the scheme. The results for infiltration rates and infiltration coefficients were available from the Ground Investigation Report and these results were examined further in relation to the proposed infiltration basins and soakaway trenches locations in Annex D Technical Note on Deep Drainage. Further investigations will be required where infiltration testing was not carried out at the exact locations of a small number of the outfalls due to access restrictions. These further investigations are scheduled for Q4 2020/Q1 2021. Infiltration tests were conducted on horizons that were considered to have a successful result (i.e. granular horizons). Table 6-3 gives an overview of the comparison of infiltration rates interpreted from historical data and infiltration rates from the test results from the Ground Investigation. This table also gives an indication of the model changes that were required for the drainage design following receipt of the results from the Ground Investigation.

Table 6-3 : Comparison of Infiltration Rates interpreted from Historical Data and Infiltration Rates from Initial test results from the Ground Investigation

Infiltration Test I.D. (from Geotechnical Ground Investigation Survey Scope)	Initial G.I. Results - Infiltration Rate (m/s)	Infiltration Rates interpreted from Historical Data	Changes Undertaken to Drainage Design*
INF19	8.7×10^{-6}	1.5×10^{-5}	Soakaway upsized
INF18	Failed	1.5×10^{-5}	Assumed local result and outfall from the clean water drainage network can find a suitable location for a soakaway in the vicinity of the test taken at INF15
INF15	1.4×10^{-5}	1.5×10^{-5}	No change
INF14	4.7×10^{-5}	1.5×10^{-5}	Soakaway downsized
INF13	1.2×10^{-5}	1.5×10^{-5}	Soakaway upsized and now also taking additional road drainage due to INF12 test failing.
INF12	Failed	1.5×10^{-5}	Infiltration Basin removed as not feasible at this location. Road drainage connected to soakaway further up chainage. Rework of modelled road drainage undertaken.
INF11	Failed	1.5×10^{-5}	Soakaway removed. Ditch network extended to connect with ditch network further up chainage. Rework of modelled catchment interceptor drainage undertaken.
INF10	1.1×10^{-5}	1.6×10^{-5}	Soakaway upsized
INF07	Failed	-	This location no longer required as an outfall
INF05a (taken adjacent to INF05)	1.9×10^{-5}	1.6×10^{-5}	Feasible option here for an Infiltration Basin (the previously proposed outfall from an Attenuation Pond proved unsatisfactory here – see Section 5 for detail on this design change)
INF05	Failed	1.6×10^{-5}	Assumed local result with INF05a adjacent providing adequate infiltration.
INF04	1.2×10^{-5}	1.6×10^{-5}	Soakaway upsized
INF02	Failed	1.6×10^{-5}	Rework of modelled road drainage undertaken to connect to network up chainage leading to infiltration basin.

Infiltration Test I.D. (from Geotechnical Ground Investigation Survey Scope)	Initial G.I. Results - Infiltration Rate (m/s)	Infiltration Rates interpreted from Historical Data	Changes Undertaken to Drainage Design*
INF01	Failed	1.6×10^{-5}	Rework of modelled road drainage required to connect to network up chainage leading to infiltration basin.

*Further changes were made to soakaway sizes following the Geotechnical Review of Infiltration Coefficients for the sides and base of soakaways as determined from Ground Investigation results.

6.3.2. Deep soakaway designs have been considered necessary on this 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. It should be noted that the road drainage network inlets to soakaways are already at least 2.0 m below ground as this scheme is very flat and it is required to allow for cover to the pipework in the road and fields before discharge to the soakaway. The effective depth in the soakaway is below the inlet, leading to depth requirements greater than 3 to 4m in mostly all of the soakaways.

6.3.3. It is noted that design depths of no more than 3 to 4 m are recommended to optimise the opportunity for maximum attenuation of pollutants in the unsaturated zone (Ref. DMRB CD530 Design of Soakaways, Clause 3.19), however the Environment Agency have expressed that soakaways at depths greater than 2m would be their least preferred method of drainage. Data was available from groundwater monitoring which has indicated deep groundwater levels and this would provide a more than satisfactory depth of unsaturated zone for the attenuation of pollutants. The Technical Note on Deep Drainage in Annex D provides further detail on groundwater levels.

6.3.4. The proposed depths of soakaways and the infiltration basin, at the different locations are set out in Table 6-4. The design depths are based on the volume of storage required within the area available and on the results of infiltration testing. At all locations the unsaturated zone thickness is greater than the minimum design standard (1.2m; Ref. DMRB CD530 Design of Soakaways, Clause 2.6) between the base of the infiltration feature and peak seasonal groundwater levels, as recorded from the groundwater monitoring results, which are set out in Annex D Technical Note on Deep Drainage.

6.3.5. There are no streams or drains along or adjacent to the Proposed Scheme which might have otherwise provided suitable outfalls and the existing A47 drains predominantly to soakaways or ditches with no apparent outfalls.

Table 6-4 : Proposed design and half drain times of soakaways and the infiltration basin

Road Drainage - Locations	Length (m)	Width (m)	Designed Soakaway Depths (m)	Half drain time (hours)	Soakaway/Basin ID on Drainage Drawings
Mainline MC10 – Ch 3040	132	10	3.1	9	SR1
Mainline MC10 – Ch 3560	100	10	4.5	6	SR2
Mainline MC10 – Ch 3950	120	10	3.8	21	SR3
MC40 – Ch 16	40	7	4.2	13	SR4
MC40 – Ch 465	70	10	3.7	23	SR5
MC50 – Ch 400	30	7	3.7	22	SR6
MC00 – Ch 378	75	10	4.4	24	SR7
MC90 – Ch 120	52.5	7.5	3.4	3	SR8
Infiltration Basin - Location					
Ch 1207	Plan area 4961m2		3.2	40	PR1
Clean Water - Locations					
HML Ch 2300	15	7	2.7	22	SC1
HML Ch 3928	100	10	3.4	23	SC2
HSR MC50 Ch 450 – 515 & MC40 Ch 15 – 48	100	10	2.8	15	SC3
HSR MC00 – Ch 480	SC4:100 x 10; SC5: 100 x 10		4.5m reducing to 2.5m for SC5	9	SC4 & SC5
HML Ch 1126	SC6: 100 x 10; SC7: 75 x 10		4.5 (TBC)	9	SC6 & SC7
HML Ch 1500	175	10	4.5 (TBC)	10	SC8

7. Treatment of discharges

7.1. Proposed surface water treatment

7.1.1. The surface water from the road drainage will follow a treatment train as recommended in SuDS guidance (CIRIA C753 SuDS Manual). The initial treatment for the surface water will be provided in the filter drains, where these are provided. The catchpits 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 and by detention of the discharges to greenfield runoff rates offering further opportunities to filter out sediment.

7.1.2. The new guidance for drainage design *CG 501 Design of highway drainage systems (Clause 8.7)* no longer permits oil separators as part of the drainage design.

7.1.3. Access by maintenance vehicles to the soakaways or infiltration basin via the driveable swale is anticipated on a monthly basis. These vehicles will be well maintained and the driveable swales will not be accessible to the public. The very low traffic flows and the low risk of vehicles acting as a pollution source will subsequently result in the low potential for accumulation of pollutants in the driveable swale. Filtration is expected to occur in the grassed swales which would treat the likely low pollutant concentrations in the surface water runoff leading to the soakaways.

7.2. Attenuation

7.2.1. Attenuation will be provided in soakaway trenches and in the proposed infiltration basin. In all cases there is a substantial unsaturated zone available which will allow the maximum attenuation of pollutants.

7.3. Spillage containment

7.3.1. A penstock 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 proposed location of the penstocks is shown in the drainage drawings in Annex B. This will provide further protection to the groundwater. The requirements for additional spillage containment at the outfalls was determined in accordance with LA 113 Road drainage and the water environment and the assessment is included as part of the Groundwater Assessment (Appendix 13.3 of Volume 3). The results of the spillage

assessment have not required the inclusion of dedicated offline spillage containment tanks at drainage outfalls.

7.3.2. The infiltration basin will include a shallow lined settlement basin/forebay at the inlet to the infiltration basin to capture 1st flush discharges. Catch pits are provided as shown at the outfalls, upstream of the soakaways.

7.4. Mitigation and interrelation with other disciplines

7.4.1. Environmental constraints have been accounted for in the drainage design, with proposed drainage infrastructure being moved or re-orientated where possible at off-road locations, to facilitate the proposed Environmental Masterplan. In addition, inter-disciplinary workshops, continuous liaison with the environment team and the other disciplines throughout the Design Fix stages and following the clash detection runs, has allowed a sustainable and robust drainage design to develop.

7.4.2. Further mitigation has been outlined in the groundwater assessment included in Appendix 13.3 of Chapter 13 Road Drainage and Water Environment and in the technical note on catchment hydrology included in Annex E.

7.4.3. Any correspondence with the local authorities and the Environment Agency, including the Scoping Opinion provided in their responses to the Proposed Scheme, where this pertained to drainage is included in Annex C.

8. Natural catchment drainage

8.1. Overland flow pathways

8.1.1. The patterns of surface water runoff from natural catchment drainage crossing the Proposed Scheme was examined using LiDAR data. Contributing areas to low points crossing the Proposed Scheme were derived using LiDAR. Norfolk County Council also provided a sketch of overland pathways as part of the consultation process, indicating that these pathways should be considered in the drainage design for the A47 Blofield to North Burlingham scheme. A natural catchment drainage assessment was undertaken and this is included in Annex E of this report. The contributing areas to the dry culverts at each of the low points or 'pour points' are indicated on Figure 8-1 and Figure 8-2. This is where the surface water flow pathways meet the proposed road. Peak flow rates for a 1 in 100 year event, including a 65% allowance for climate change, were derived at these low points using Flood Estimation Handbook methods. This is in line with the advice provided by Norfolk County Council regarding the provision of 'dry culverts'. Further details of the natural catchment derivation and estimation of peak flow rates at key points crossing the Proposed Scheme are provided in Annex E.

8.1.2. In the development of the catchment interceptor drainage design, the overland flow routes impacted were identified and a high-level collection system determined. This, in turn, identified the key outfall locations or low points in the terrain. The necessary crossings of the road were identified also, where overland flow needed to be conveyed across the road, as the road improvement scheme now creates an obstruction to some of these flows. The low points identified were compared with available suitable outfalls such as drains, streams or ponds or natural valleys and depressions which slope southwards. Where it was not possible to connect directly with existing surface water pathways, locations for proposed infiltration via clean water soakaways were identified. The feasibility of these locations was initially examined in the context of historical data on infiltration testing and later confirmed from the infiltration test results from the Ground Investigation. This is discussed further in Section 6.3.

8.1.3. The catchment interceptor drainage network for the scheme has now been designed and modelled, see drainage layout drawings in Annex B. The catchment interceptor drainage includes the following drainage types: ditches; filter drains (to be confirmed if these will be required to replace ditches at detailed design stage where space restrictions may occur with utilities running alongside); cross-drains (dry culverts) across the mainline and side roads and driveable swales in a few locations where drainage is to be collected alongside the route of a maintenance track.

8.1.4. The design has evolved through the Design Fix stages outlined in paragraph 5.2.1, including the clash detection exercises with the other elements of the design and further adjustments following the receipt of results on infiltration testing from the Ground Investigation Report.

8.1.5. A detailed topographic survey will be undertaken at detail design stage to inform the accurate placement of all drainage including natural catchment interceptor drainage.

8.1.6. Any consent applications necessary will be applied for as appropriate.

Figure 8-1 : Dry culvert catchment areas – Catchments 1-3

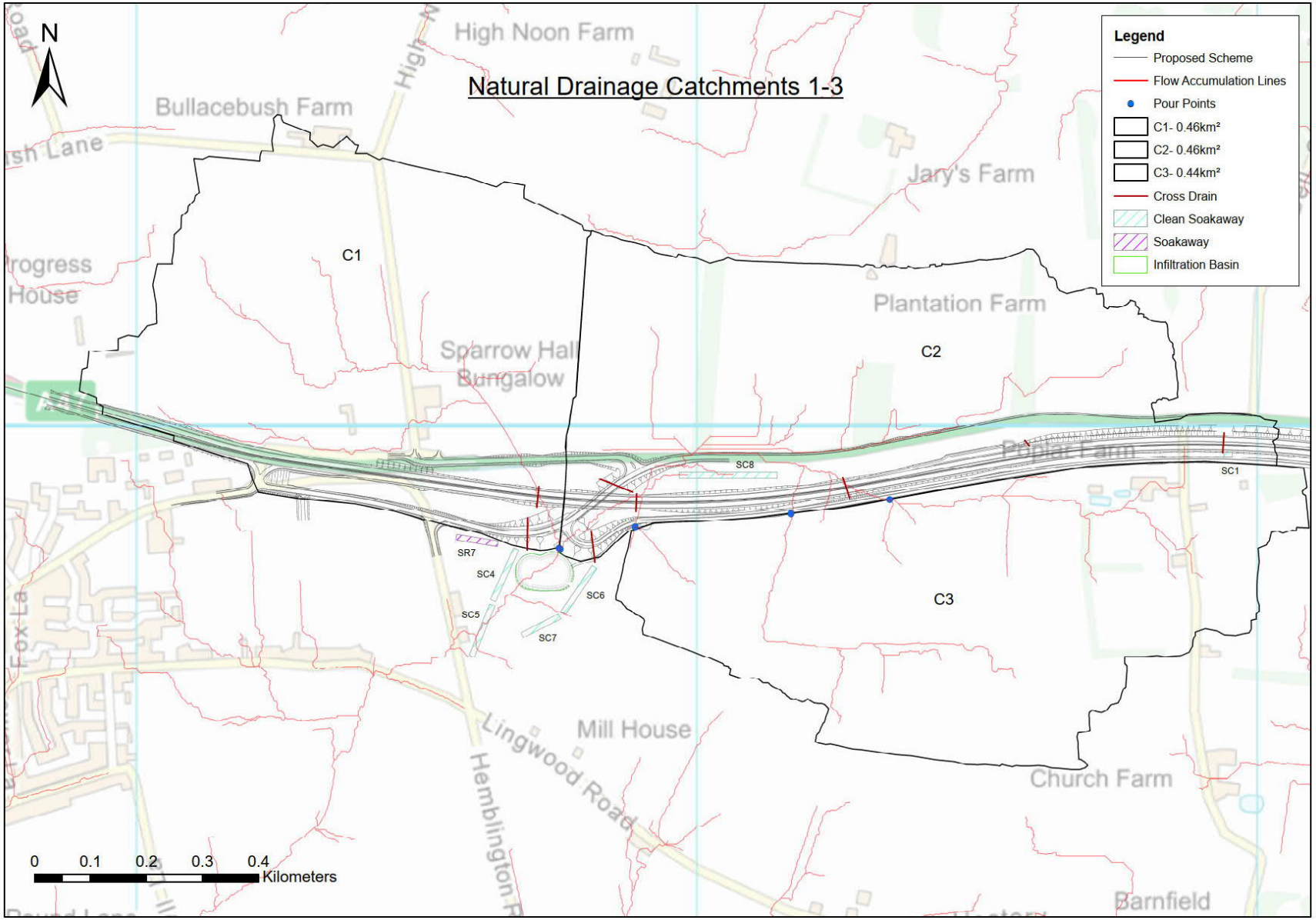
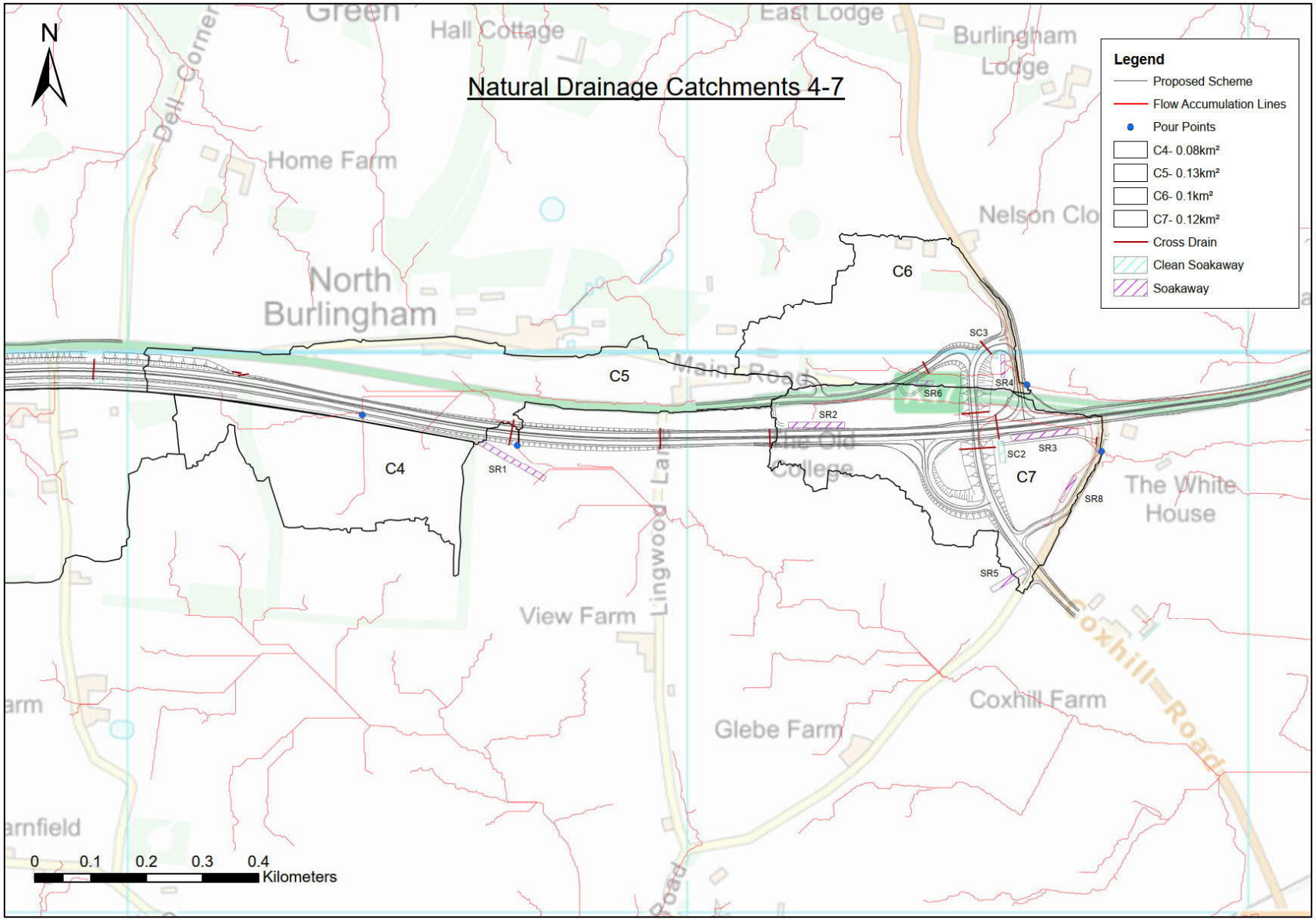


Figure 8-2 : Dry culvert catchment areas – Catchments 4-7



9. Design methodology

9.1. Design criteria

9.1.1. The design storm events and requirements for drainage pipework, in accordance with CG 501 Design of highway drainage systems are as follows:

- 1 year storm – no surcharge
- 5 year storm – no flooding
- 10 year storm – no flooding of critical areas
- 50 year storm - no flooding at sags, adjacent to structures or at road crossings. Ensure flood flow pathways exist for any local flooding in these areas.
- 100 year storm - highway surface water flooding does not extend beyond the highway boundary up to the 1 in 100 year rainfall event including an allowance for climate change
- A sensitivity check for exceedance was undertaken to ensure there were no adverse impacts from highway surface water flooding.

9.1.2. A climate change allowance of 20% was included for all of the design storm events modelled. An allowance for climate change of 20% was used for all drainage design, with an assessment for 40% as a sensitivity check to ensure any flood flow pathways, if found, are away from sensitive areas (residential properties etc) and if not, it is required to provide safe pathways away from these areas – acquiring sacrificial land, or upsizing pipes. The results of the sensitivity tests will then be presented to the Highways England Project Manager and the Highways England Drainage Specialist for acceptance at detailed design stage. The following storm events were also modelled for the proposed road drainage to inform the drainage impact assessment. This will enable a risk assessment to be undertaken for extreme events and will satisfy the consideration for climate change prediction as is required for this scheme:

- 100 year storm with 20% allowance for climate change
- 100 year storm with 40% allowance for climate change

9.1.3. The design storm event for the infiltration basin and soakaway design for highway surface water is as follows:

- 100 year storm with 20% allowance for climate change
- check for flooding in a 1 in 100 year storm with 40% allowance for climate change
- where infiltration facilities are deep these facilities to be approved by Environment Agency and Norfolk County Council as appropriate

9.1.4. The design storm event for the clean water soakaway design for natural catchment runoff is as follows:

- 10 year storm with 20% allowance for climate change
- check for flooding in a 1 in 100 year storm with 20% and 40% allowance for climate Change in accordance with CD 530 Design of Soakaways, to ensure that any overflows for exceedance events would be captured along controlled pathways which are existing surface water flow pathways (Note that the greenfield runoff on this site 'clean water', flows overland along surface water pathways and these are shown in the drainage drawings in Annex B of this report).
- Where a property lies downstream of a clean water soakaway (SC2), this soakaway will fully attenuate the extreme events: 1 in 100 year storm with 20% and 40% allowance for climate change.
- where infiltration facilities are deep these facilities to be approved by Environment Agency and Norfolk County Council as appropriate

9.2. Drainage systems

9.2.1. Sustainable Drainage Systems (SUDS) elements which are included in the drainage design are as follows:

- filter drains
- soakaways
- infiltration basin
- ditches
- driveable swale

9.2.2. Pollution control devices used to provide protection from a spillage:

- catchpits providing settlement of sediment
- penstocks to provide a shut-off facility at each outfall upstream of the infiltration basin and the soakaways

9.2.3. Further control measures as follows were considered:

- vortex separators - The HEWRAT assessment (for routine road runoff) found the infiltration basin and soakaway trenches to be low risk and therefore do not require any further mitigation for settlement of suspended solids (i.e. Vortex Separators).
- dedicated spillage containment tanks - Spillage assessments are included in the Groundwater Assessment included in Appendix 13.3 of Chapter 13 Road Drainage and Water Environment. The assessments found the annual probability of spillage risk to be significantly lower than the

maximum tolerable limit and as such dedicated spillage containment is not required.

9.3. Drainage parameters

9.3.1. The drainage parameters included the following:

- Flood Studies Report rainfall methodology is used as this supports sub-hourly rainfall for storm durations less than 30 minutes.
- All pipes to achieve a minimum velocity of 1.0m/s and a maximum velocity of 2.5m/s at full bore.
- Roughness co-efficient (ks value) for carrier pipes to be 0.6mm and for filter drains to be 1.5mm.
- Maximum of 100m spacings between carrier drain chambers and filter drain catchpits.
- Average of 100m spacings for outlets from open channel into carrier drain, that is, every chamber is an inline outlet. See HCD F22 for details.
- Minimum pipe diameter for drainage networks is 225mm diameter, except for gulley connections which shall be 150mm diameter Type Z. Maximum connection length to be 16m generally, up to 20m absolute maximum.
- Minimum depth to soffit to allow for easy access to chamber shall be 1.2m. Where the minimum depth is less than 1.2m, a concrete surround will be provided.

9.3.2. Permitted drainage types:

- filter drains to be installed as follows:
  - at the toe of road cuttings
  - in road verges where embankments are not greater than 1.5m
  - at the base of all embankments greater than 1m high or alternatively ditches may be used here
  - at the base of all embankments where the existing ground falls towards the highway boundary or alternatively ditches may be used here
  - at the top of a cutting where the existing ground falls towards the highway boundary or alternatively ditches may be used here
- filter drains to outfall via a carrier drain system to an infiltration basin or a soakaway
- all catchpits shall be 1050mm diameter pre-cast concrete
- subsurface drainage in accordance with HCD drawings F18. F19 & F20. All subsurface drains are to be 1 - 2m deep

- kerb and gulley drainage, combined kerb drainage or concrete channels (where longitudinal gradient shallower than 1:200), discharging to carrier drains or filter drains

9.4. Guidance and policy

Design codes and standards used

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

- CD 521 Hydraulic design of road edge surface water channels and outlets
- CD 522 Drainage of runoff from natural catchments
- CD 523 Determination of pipe roughness and assessment of sediment deposition to aid pipeline design
- CD 524 Edge of pavement details
- CD 525 Design of combined surface and sub-surface drains and management of stone scatter
- CD 526 Spacing of road gullies
- CD 527 Sumpless gullies
- CD 528 Vortex separators for use with road drainage systems
- CD 529 Design of outfall and culvert details
- CD 530 Design of soakaways
- CD 532 Vegetated drainage systems for highway runoff
- CD 533 Determination of pipe and bedding combinations for drainage works
- CD 534 Chamber tops and gully tops for road drainage and services
- CD 535 Drainage asset data and risk management
- CG 501 Design of highway drainage systems
- National Planning Policy Framework
- Flood risk and coastal change, Ministry of Housing, Communities & Local Government, March 2014.
- Sewers for Adoption (8th Edition).
- CIRIA: The SUDS manual (C753).
- Highways England Manual of Contract Documents for Highway Works (MCHW) Volume 1 (Series 500) and Volume 3, Section 1, Highway Construction Details (HCD) B & F Series. Specific list of HCD's to be referred to:
  - Section F – Drainage

- Surface Water Drains – Trench and Bedding Details F1
- Filter Drains – Trench and Bedding Details F2
- Type 2 Chamber – (Precast Concrete Manhole) F4
- Type 3 Chamber – (Precast Concrete Manhole) F5
- Type 4 Chamber – (Precast Concrete Manhole) F6
- Type 7 Chamber – (1050 Catchpit) F11
- Precast and In Situ Cast Gullies F13
- Edge of Pavement Drains – Fin Drains & Narrow Filter Drains F18
- Edge of Pavement Drains – Installation of Fin Drains F19
- Edge of Pavement Drains – Installation of Narrow Filter Drains F20
- Edge of Pavement Drains – Under Channel Drainage Layers F21
- In-line Outlet triangular Surface Water Channel F22
- Weir Outlet to Surface Water Channel F24
- Type 11 Chamber – (Precast Concrete Deep Inspection Chamber) F27
- Gully Frame - BSEN124, Group3, D400, Ductile Iron.
- Manhole cover - BSEN124, D400, 600x600, Ductile Iron.
- Filter drains - HCD F2, Type H, K or I, minimum 225mm dia. Minimum depth to soffit 900mm in verge, 600mm in fields.

Planning policy

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

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

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

9.4.4. The Broadland District Council Development Management Development Planning Document (DPD):

- Policy EN4 – Pollution. Development must include an assessment of potential pollution and provide mitigation, where required. Development will only be permitted where there will be no significant impact upon amenity, human health or the natural environment.

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

9.4.5. Norfolk County Council also provide guidance to developers on their role as Lead Local Flood Authority and the information required from developers as part of planning applications (Norfolk County Council, 2020)

9.5. Hydraulic modelling software

9.5.1. The following software is utilised for the preliminary design of the drainage system:

- XP MICRODRAINAGE Version 2019.1 for drainage design of pipework, drainage ditches, kerb-side channels, infiltration basin, soakaways. Rainfall information shall be obtained from MICRODRAINAGE programme which uses the Wallingford Procedure with associated maps.

9.6. Departures from DMRB standards

9.6.1. None currently identified.

9.7. Design assumptions

9.7.1. The following design assumptions have been made:

- Detailed information on drainage levels at tie-ins, from recently received CCTV drainage surveys was not examined at the time of writing this report. The design is based on earlier data sources available such as HA DDMS as discussed in Section 2 and 3.
- No detail on flooding incident hotspots recorded by HA DDMS other than the events listed in Section 2.2 has been provided - The scope for this element of work is unknown. Refer to the Flood Risk Assessment (Volume 3, Appendix 13.1) for further information on off-site flooding.
- No allowance has been made for third party drainage connections (e.g. field drain connections).
- No allowance has been made for third party drainage issues.
- Discharge via soakaways is not permissible for carrier drain networks. Drainage in the central reserve is served by concrete channels draining into carrier drains. Shut off facilities will be provided at the end of the median runs.

- Existing direct discharges to watercourses will remain where no increase in impermeable area is introduced into the drainage.
- No remedial works are required to drainage systems that are remaining in place, where no works are required.
- Where it is proposed to utilise existing drainage, remedial works may be required, which could include flushing and minor repairs/replacement of existing pipes and chambers. This will be informed from a condition survey/CCTV to be undertaken prior to handover.
- It is assumed that separately from the Proposed Scheme, Highways England will investigate 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.
- No connections from new impermeable areas are currently foreseen to existing networks, except for the North Burlingham Link Access which is a realignment of an existing section of approximately 50 m of roadway.
- Soakaways will be maintained by Norfolk County Council and Highways England where relevant and this has yet to be agreed between the two authorities.
- It is understood from consultation with Environment Agency on the design depth of soakaways to a maximum depth of 4.5 m that these are acceptable, given the demonstration that the conditions set by the Environment Agency have been met in this report and in Annex D Technical Note on Deep Drainage. A copy of the correspondence with the Environment Agency is available in Annex C of this report.

10. Opportunities for environmental enhancement

10.1.1. Environmental enhancement will be included in the drainage design by introducing appropriate vegetation in the infiltration basin. This can be achieved by allowing varied forms of vegetation using appropriate local species 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 coupled with the significant depth of unsaturated zone that is available below the infiltration basin and above the aquifer. It will be necessary to allow easy access for removal and replacement of the filter material in the floor of the basin for maintenance intervals or following an accidental spillage. Therefore, this would preclude any deep-rooted planting on the basin floor.

10.1.2. The cross-drains conveying natural catchment flows (‘dry culverts’) could double as points to allow wildlife to cross the scheme and the details of this will be examined at detailed design stage.

11. Stakeholders and consultation

11.1.1. The following have been identified as drainage related statutory consultees and lead authorities for the scheme:

- Environment Agency
  - The Environment Agency highlighted in their scoping opinion on the Environmental Statement that the maximum acceptable depth for infiltration SUDS is 2.0m bGL. Following a review of the catchment and results of the ground investigation, it became apparent that there were no other options than deep infiltration features. The Environment Agency were consulted to demonstrate that the conditions stipulated for deep drainage have been met by the drainage design, as presented in Annex D Technical Note on Deep Drainage. Subsequent correspondence is presented in Annex C.
- Norfolk County Council as Lead Local Flood Authority
  - As Lead Local Flood Authority, Norfolk County Council were consulted to provide information on any known sources of flooding. A figure was provided by Norfolk County Council of surface water pathways in the Scoping Opinion (Annex C). All sources of flooding were examined to inform the development of the drainage design. Norfolk County Council required the provision of surface water modelling of overland flow routes to include dry culverts sized for the 1 in 100 year plus climate change allowance. Their correspondence is included in Annex C. The natural catchment hydrology assessment is included in Annex E.
  - A previous version of the draft Drainage Strategy (P01) has been issued to Norfolk County Council for comment and a response received on 6 August 2020. A meeting was held on 24 September to discuss Norfolk County Council's comments and this version has been updated to address those comments. The Drainage Strategy will be issued to Norfolk County Council for further comment and as such, consultation with Norfolk County Council is ongoing.
  - In a letter of 7 October 2020 (FW2020_0786) following previous discussions on embankment drainage at the meeting of 24 September, Norfolk County Council requested that the embankment runoff should be attenuated. The DMRB CG501 Rev 2, paragraph 2.1, 4) requires that the drainage design manages water flows from earthworks and structures associated with the roads; 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. To satisfy the request from Norfolk County Council , the design was examined retrospectively. The Proposed 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 had already been taken into account in the design and is shown as part of the relevant drainage catchment in the drainage drawings in Annex B. 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.

- Broads Internal Drainage Board
  - The Proposed Scheme is not within the Broads Internal Drainage Board area. The Broads Internal Drainage Board have confirmed that as proposed drainage will drain to ground they do not have any concerns.
- Anglian Water
  - Anglian Water were consulted on the location of their assets to inform the requirement for any potential connections to or from those assets.

11.1.2. The above stakeholders were consulted during the scoping for the Environmental Assessment and PEIR review and some recent consultations are ongoing as mentioned above. Their concerns were considered and a response provided from the drainage designer on issues raised. Some of the concerns raised by the lead authorities have been included in Annex C.

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

12. Residual risks

12.1. Risks identified

12.1.1. The following risks have been identified and the proposed management of these risks outlined where appropriate:

- Non-approval of departures for the road design may result in an updated design which may in turn limit the achievement of the environmental mitigation proposed;
- Changes made to future developments could have an impact on the traffic movements and highway capacity and this would ultimately require a further upgrade of the scheme and associated drainage design;
- Removal of earthworks to facilitate drainage could contain invasive species. The removal of any earthworks containing invasive species will be carefully managed.
- We are not aware of any existing drainage issues that third parties are experiencing on their properties downstream of proposed outfalls on the scheme, however all surface water runoff from road runoff will be attenuated to greenfield rates at source using soakaway trenches or an infiltration basin therefore the risk of increasing any existing drainage issues is low.
- Uncharted connections into the existing network drainage system that were not picked up by HAD DMS or in the CCTV drainage survey may require a modification to the drainage design at construction stage.
- A re-work of drainage designs would be required if assumed levels at outfalls do not meet the levels determined from the CCTV drainage survey.
- Further infiltration testing is required to confirm satisfactory infiltration rates where access had not been permitted during the Ground Investigation (at the eastern end of the scheme). These further investigations are scheduled for Q4 2020/Q1 2021. Should these locations prove unsatisfactory when the further testing has been completed, some of the proposed new drainage may be directed via the existing drainage system to alternative outfalls. These outfalls will be either to suitable soakaways or to the existing system where there is no increase in the area from the contributing road runoff. From an examination of the CCTV drainage survey it would appear that the utilisation of existing drainage at the eastern end of the scheme at the link roads would be a suitable alternative to use to convey the drainage to outfalls, where existing contributing areas from road runoff will not be exceeded. There is a risk that existing drainage will be severed by the Proposed Scheme proving difficult to retain existing networks and some additional connection pipework may be required to link the new with the existing drainage.

12.2. Residual risk from flooding exceedance

12.2.1. Consideration of Flood Incident Hotspots. Flooding hotspots due to existing drainage, as identified in the HA DDMS information supplied by Highways England and the flood records included in Section 2.2 where relevant are expected to improve with the proposed positive drainage from these areas. Separately Highways England are investigating recent flood events of October 2019 and may propose remedial measures which may have to be considered in the detailed design for the Proposed Scheme. The proposed new drainage design includes the improvement of falls in the road and a positive drainage system collecting drainage and modelled for extreme events in accordance with CG 501. It is expected that any Flood Incident Hotspots identified on the existing A47, where proposed improvements will be undertaken will have a reduced risk of recurrence.

12.2.2. The design of the infiltration facilities has been checked for exceedance events (1 in 100 year with a 40% allowance for climate change) as outlined in Section 9.1. Any discharge for exceedance events shall be routed safely to avoid flooding the road and minimise impact upon adjacent land in accordance with CD 530 Design of Soakaways. The infiltration facilities will avoid the surcharge of groundwater leading to harmful water logging or exacerbated groundwater flooding. Therefore, a residual flood risk from exceedance events is not anticipated.

12.2.3. Refer to the Flood Risk Assessment in Appendix 13.1 of Chapter 13 Road Drainage and Water Environment for further detail on residual flood risk.

12.3. Residual risk from utility diversions

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

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

12.4. Residual risk from unexploded ordnance

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

12.4.2. This residual risk has been noted on the design drawings for this scheme.

13. Maintenance

13.1. Limits of responsibility

13.1.1. The proposed responsibility of the drainage assets will be that of Highways England and Norfolk County Council. Allocation of assets between the 2 bodies is subject to agreement at this time.

13.1.2. 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.

13.1.3. 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.

13.2. Maintenance provision

13.2.1. A four metre swathe is proposed adjacent to all proposed soakaway trenches and the infiltration basin, allowing suitable access for maintenance.

13.2.2. Access tracks for maintenance of the infiltration basin and the soakaway trenches will be provided and will utilise existing agricultural pathways where possible. Driveable swales are used where overland flow paths are intercepted and the access to these will be gated. No access points are necessary from the back of the proposed A47 verge, meaning that interaction between maintenance vehicles and high-speed traffic is avoided. Laybys will also act as maintenance laybys for soakaways within the vicinity.

13.2.3. Fencing and lifebuoy protection will be provided at the infiltration basin.

13.2.4. It is necessary to allow for replacement and/or cleaning of existing pipework following the results of a CCTV drainage survey where any existing drainage will be re-used.

13.3. Sustainable Drainage Systems

13.3.1. The proposed maintenance regime, in accordance with the CIRIA SuDS Manual 2015, is depicted below. The regime for the infiltration basin, soakaway trenches, filter drains, ditches and driveable swales are set out respectively in Table 13-1 to 13-5.

Table 13-1 : Required maintenance for infiltration basin

Required action	Typical frequency
Remove litter and debris	Monthly (or as required)
Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
Inspect inlets, banksides, structures, pipework etc for evidence of blockage and / or physical damage	Monthly
Inspect water bodies downstream for signs of poor water quality	Monthly (May – October)
Inspect silt accumulation rates at the inlet and in main body of the basin and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
Check any mechanical devices, for example penstocks	Half yearly
Mow grasses covering base of basin	Monthly during the growing season (or as required)
Hand cut denser growth/shrubs at inlet to basin	Monthly during the growing season (or as required)
Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
Remove sediment accumulation at inlet	Every 1–5 years, or as required

Table 13-2 : Required maintenance for soakaway trenches

Required action	Typical frequency
Remove litter and debris	Monthly (or as required)
Inspect inlets, inspection chambers, structures, pipework etc for evidence of blockage and / or physical damage	Monthly
Inspect water bodies downstream for signs of poor water quality	Monthly (May – October)
Inspect silt accumulation rates in the upstream catchpits and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
Check any mechanical devices, for example penstocks in the upstream chamber	Half yearly

Required action	Typical frequency
The proposed soakaways vary in depth between 2m and 5m deep. In the unlikely event of an emergency pollution incident requiring complete emptying of a soakaway, battering and shoring of the soakaway trench sides will be required and only authorised maintenance crew will be allowed to replace the stone and distribution pipe work.	As required
Mow grasses covering surface of soakaway	Monthly during the growing season (or as required)
Hand cut denser growth/shrubs at surface of soakaway	Monthly during the growing season (or as required)
Tidy all dead growth (scrub clearance) before start of growing season (Note: tree maintenance is usually part of overall landscape management contract)	Annually
Check soakaway to ensure emptying is occurring	Annually
Remove sediment accumulation at inlet	Every 1–5 years, or as required

Table 13-3 : Required maintenance for filter drains

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

Table 13-4 : Required maintenance for ditches

Required action	Typical frequency
Remove litter and debris	Monthly, or as required
Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
Manage other vegetation and remove nuisance plants	Monthly at start, then as required
Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then
Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Repair erosion or other damage by re-turfing or reseeding	As required
Relevel uneven surfaces and reinstate design levels	As required
Inspect overflows and outlets from existing drains connecting to the new ditches	Monthly, or as required

Table 13-5 : Required maintenance for driveable swales

Required action	Typical frequency
Remove litter and debris	Monthly, or as required
Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
Manage other vegetation and remove nuisance plants	Monthly at start, then as required
Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then
Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Repair erosion or other damage by re-turfing or reseeding	As required
Relevel uneven surfaces and reinstate design levels	As required
Examine grass reinforcement mat in driveable swale for any rutting or tearing and replace or reset	As required

14. Construction Phasing

14.1. Temporary mitigation for drainage

14.1.1. The general requirements for temporary mitigation for drainage are included in ES Chapter 13 and the detailed mitigation will be outlined in the water monitoring and management plan as part of the Environmental Management Plan (EMP) **(TR010040/APP/7.7).**

14.2. Construction of permanent drainage

14.2.1. The drainage outfalls for A47 Blofield to North Burlingham Dualling Scheme are all to infiltration systems. These include trench soakaways and an infiltration basin. These infiltration systems will be constructed in advance of the works so that all phases of construction will have an operational system in place for drainage.

14.2.2. The detail on construction phasing for the permanent drainage is included in the EMP (**TR010040/APP/7.7**).

15. Summary

15.1.1. The scheme is to provide a continuous dual carriageway on the A47 linking Blofield to North Burlingham Bypass while maintaining strategic links to local areas utilising 'left-in', 'left-out' junctions and overbridges.

15.1.2. There is an absence of streams and watercourses across the Proposed Scheme length which runs just to the south of the existing road. The drainage on the existing A47 utilises filter drains discharging to soakaways and over the edge drainage to ditches. It is proposed to adopt a similar drainage regime for the Proposed Scheme, utilising SuDS drainage systems where possible.

15.1.3. The suitability for drainage outfalls by infiltration was informed by infiltration testing undertaken during the ground investigation. As the site is quite flat throughout, leading to outfalls being buried underground, deep soakaways and a deep infiltration basin were subsequently required to attain a suitable depth for effective infiltration. The consequences of deep drainage were examined in a technical note included as an annex in this drainage strategy report and this note assessed the deep drainage as having no significant negative impacts on groundwater.

15.1.4. Natural catchment drainage was intercepted in ditches and cross-drains provided across the scheme to sustain the existing surface water pathways. The cross-drains (dry culverts) were assessed for their capacity to convey a 1 in 100 year storm event with a climate change allowance of 65%, in line with the advice provided by Norfolk County Council regarding the provision of 'dry culverts'. The technical note on catchment hydrology is included as an annex in this report.

15.1.5. The road drainage design was checked for the 1% Annual Exceedance Probability (AEP) (1 in 100 year event), including a 40% climate change allowance which is in line with the Environment Agency's upper estimates for the 2080s.

15.1.6. Natural catchment drainage draining to clean water soakaways was checked for exceedance events to ensure that overland flows would not present a risk to properties downstream.

15.1.7. The risk of an increase in flood risk for surface water, groundwater and fluvial flooding in exceedance events was assessed and no increase in flood risk is anticipated as a result of the proposed drainage for this scheme when compared to an undeveloped site.

15.1.8. The drainage strategy has been developed in collaboration with statutory consultees and consultation is still ongoing. The proposed philosophy is to replicate, as far as reasonably practicable, an un-developed site response to

rainfall; limiting both the rate and volume of surface water runoff from 100% of the proposed catchment.

15.1.9. The outfalls have been located to mirror the existing outfall locations where soakaways were provided along the existing A47.

15.1.10. In addition to the infiltration basin and soakaways, further Sustainable Drainage Systems (SuDS) in the form of filter drains have been included within the design providing benefits in water quantity and water quality.

15.1.11. Access has been provided to features remote to the highway, such as soakaways and the infiltration basin.

15.1.12. It is recommended a full condition and validation assessment is undertaken for the existing system where the system is to be retained at the tie-ins.

15.1.13. Construction phasing of drainage including temporary mitigation and permanent drainage is outlined in the EMP (**TR010040/APP/7.7**).

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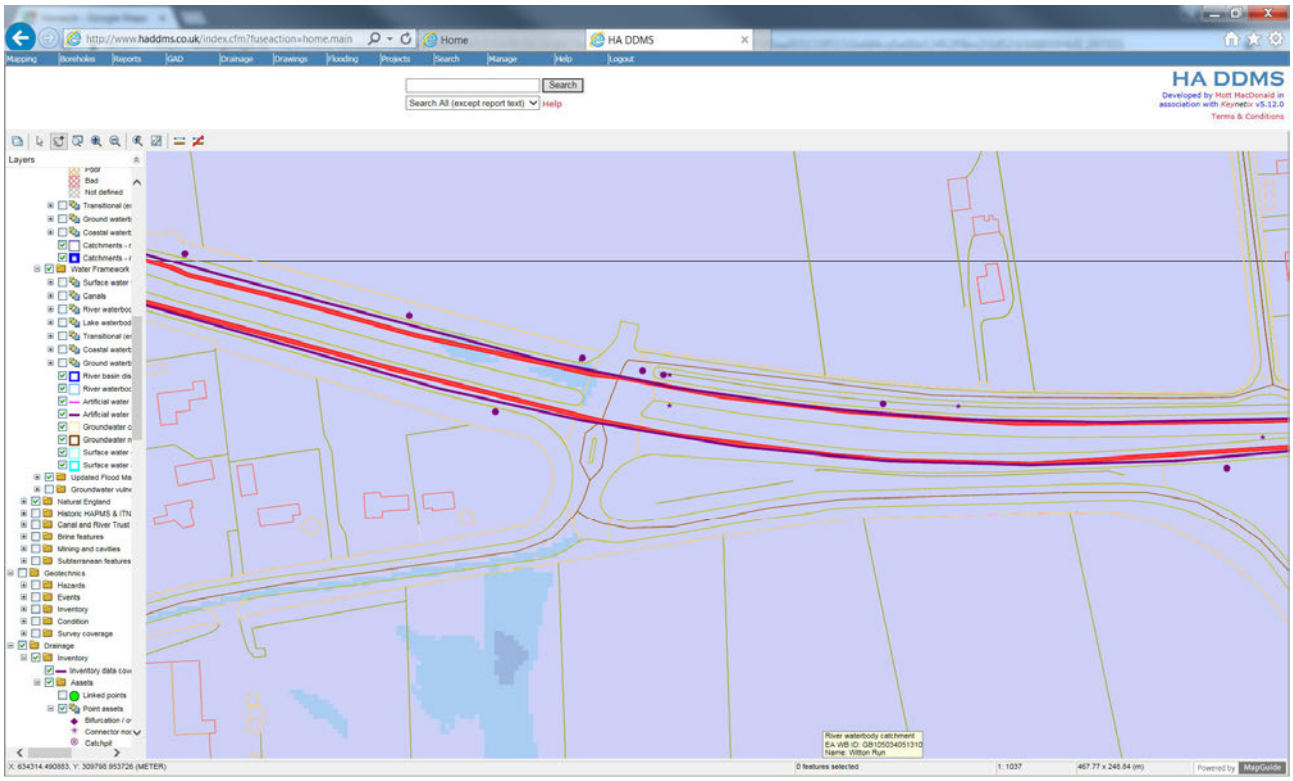
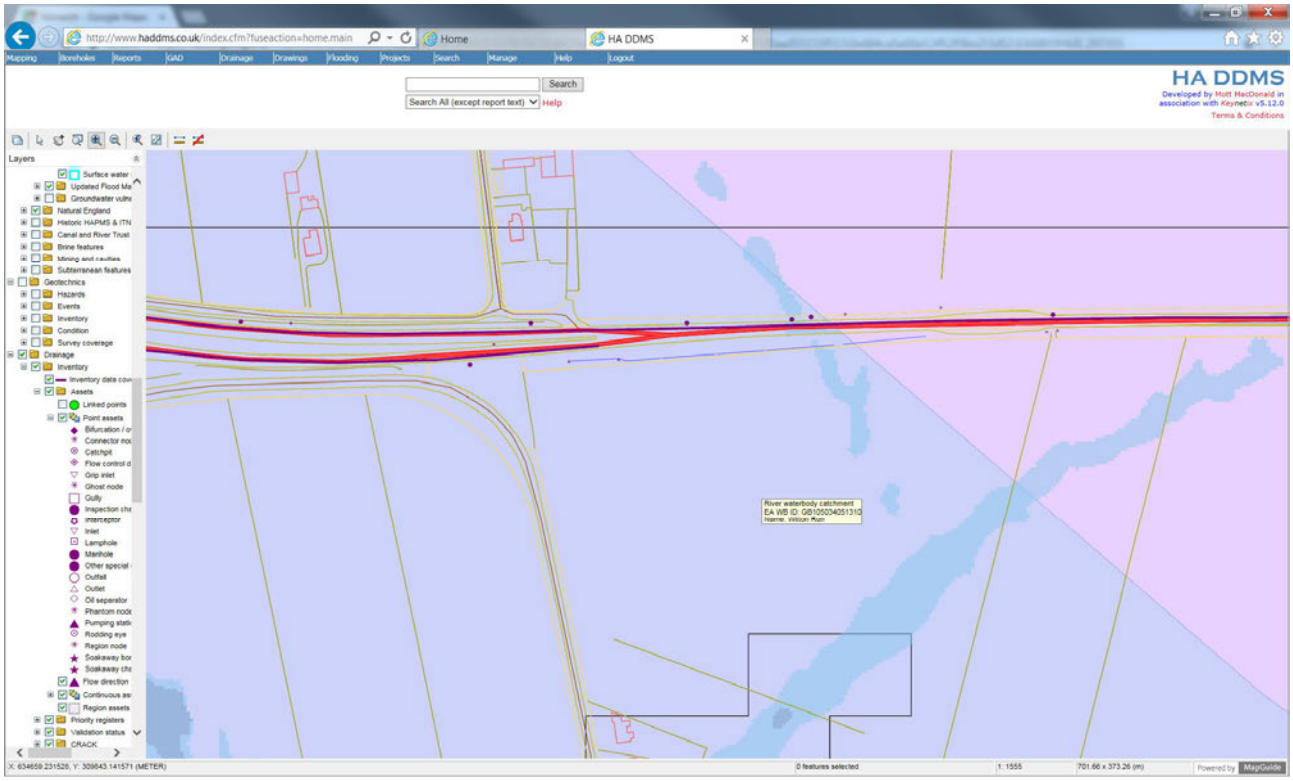
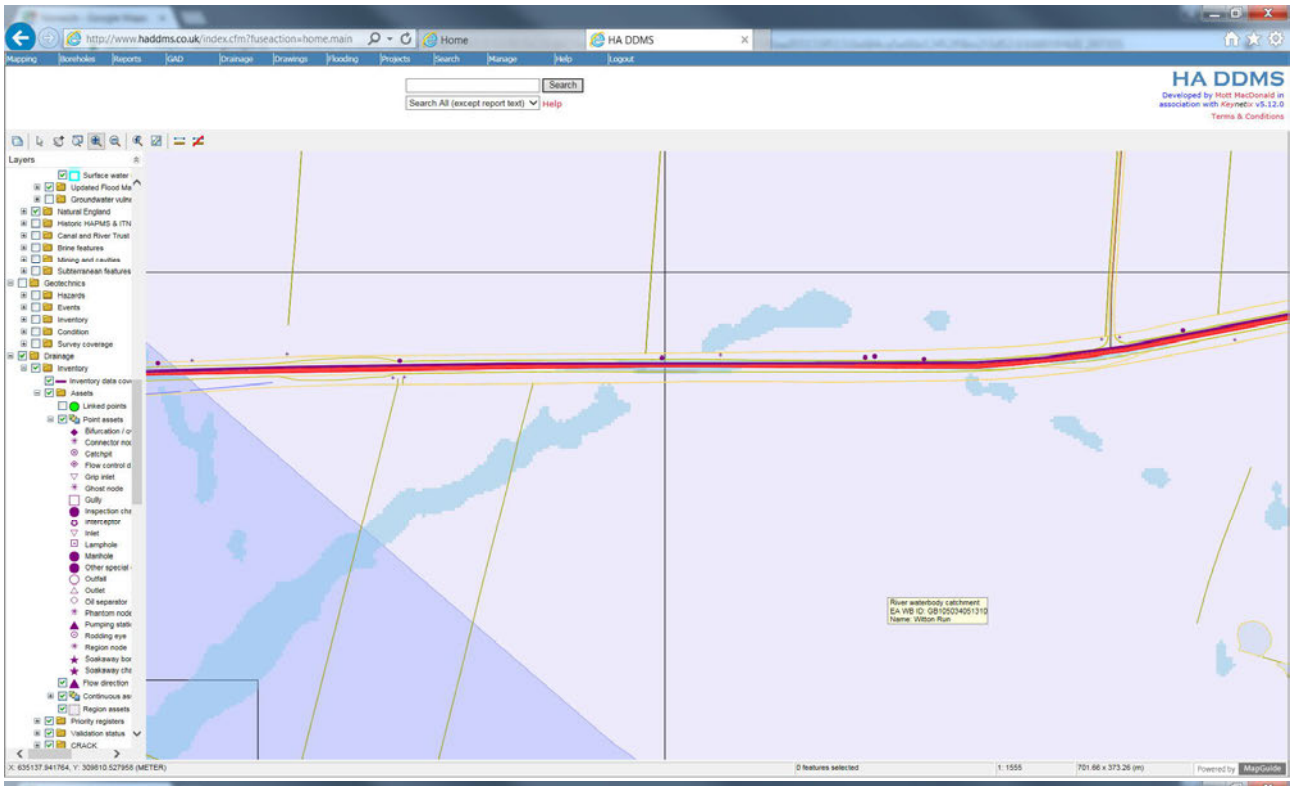
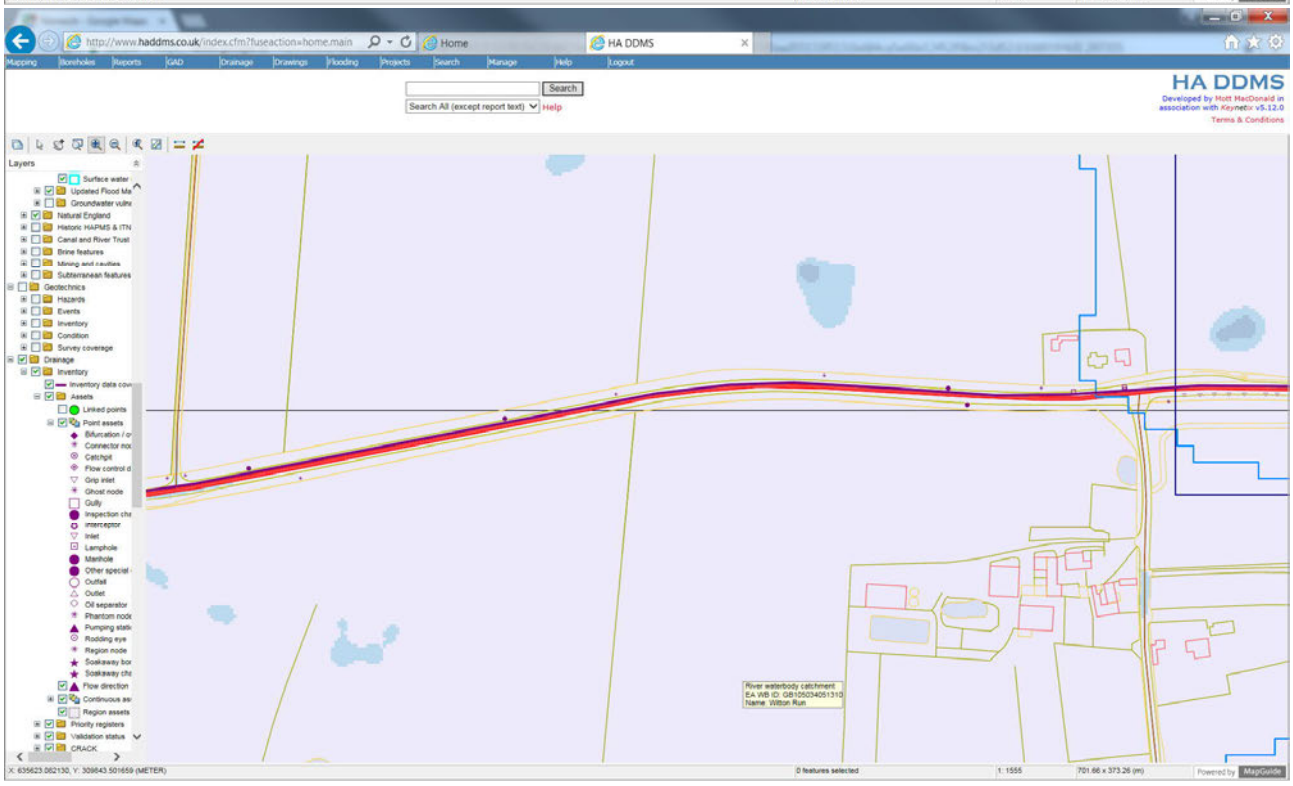
Annex A. HADDMS Records

Screenshots from HADDMS Web Portal covering the extent of the proposed A47 Blofield to North Burlingham Scheme






HA DDMS
Developed by Mott MacDonald in association with Keynetix v5.12.0
Terms & Conditions
River waterbody catchment
EA WB ID: GB105034051310
Name: Witton Run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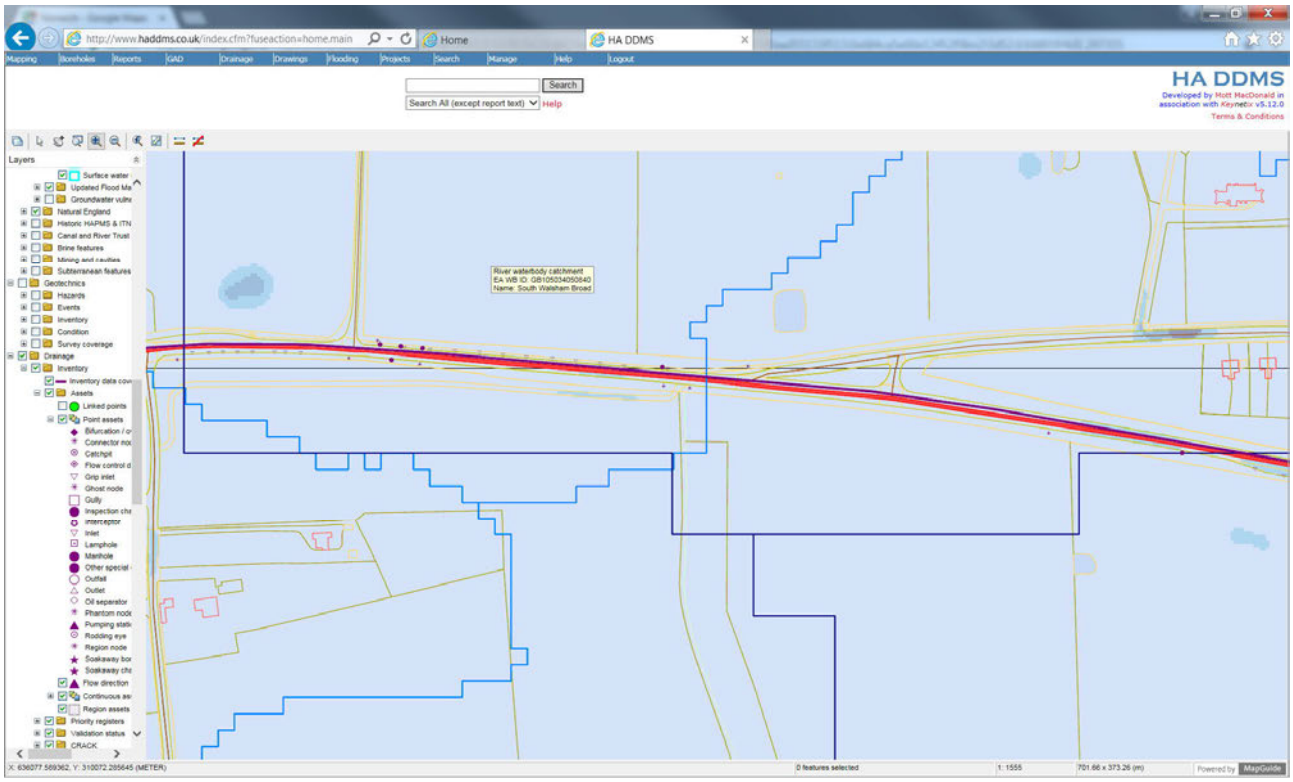
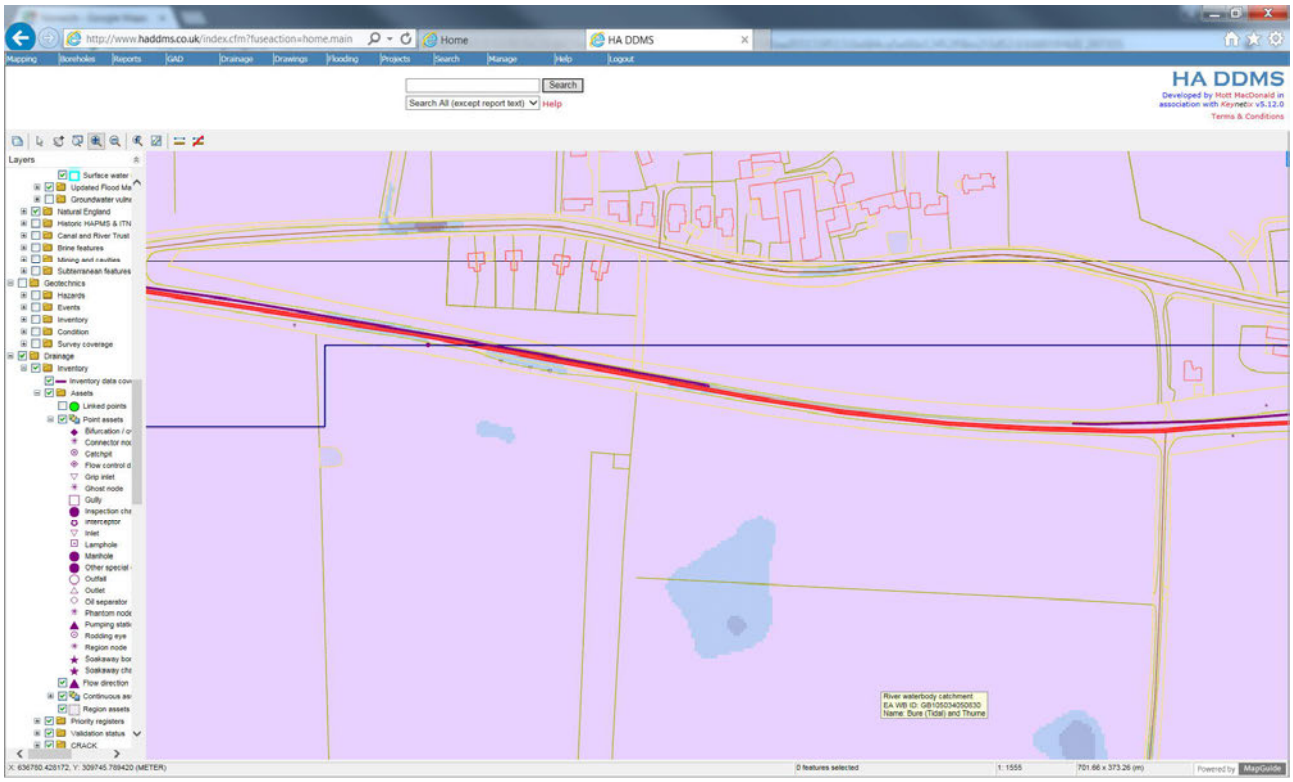
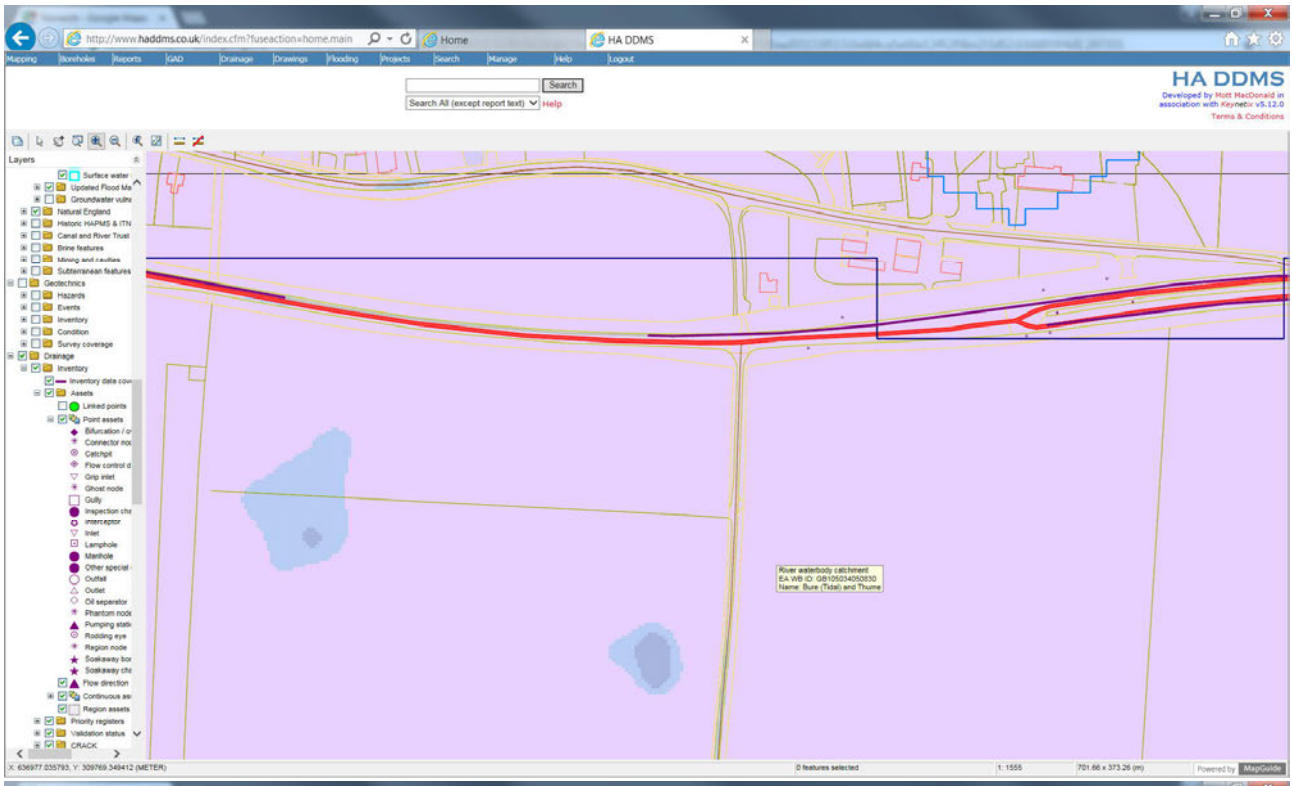
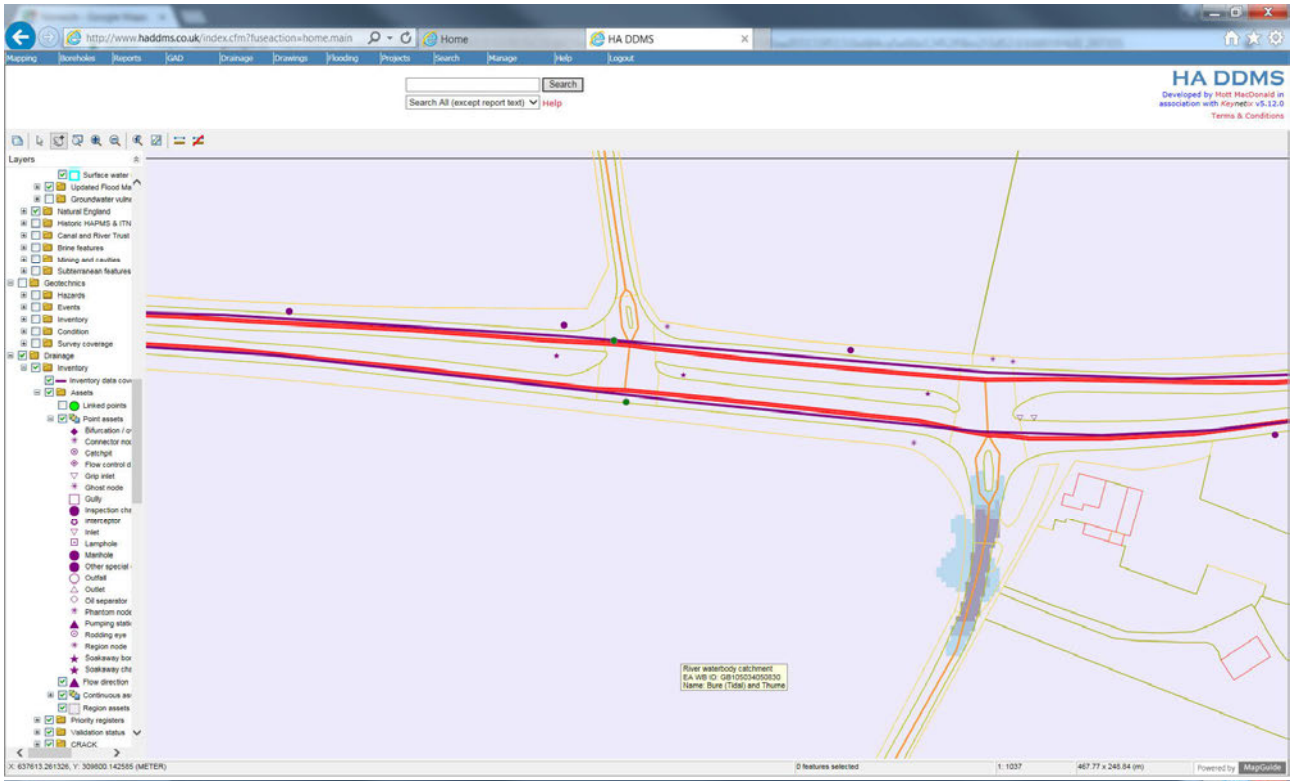
EA WB ID: GB105034051310
Name: Witton Run


HA DDMS
River waterbody catchment
EA WB ID: GB105034050940
Name: South Walsham Broad


HA DDMS
River waterbody catchment
EA WB ID: GB105034050930
Name: Bure (Tidal) and Thurne


HA DDMS
Developed by Mott MacDonald in association with Keynetix v5.12.0
Terms & Conditions
River waterbody catchment
EA WB ID: GB105034050830
Name: Bure (Tidal) and Thume


HA DDMS
Developed by Mott MacDonald in association with Keynetix v5.12.0
Terms & Conditions
River waterbody catchment
EA WB ID: GB105034050830
Name: Bure (Tidal) and Thume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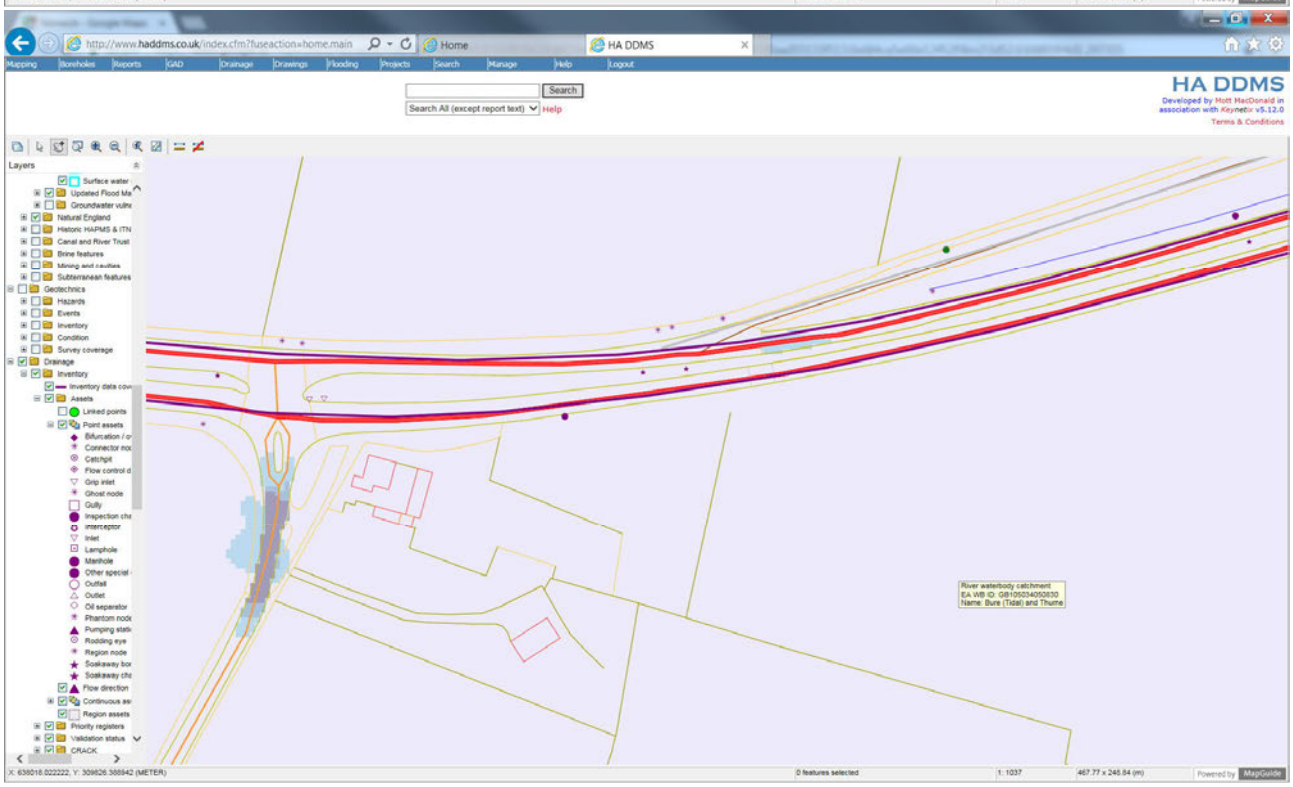
River waterbody catchment
EA WB ID: GB105034050830
Name: Bure (Tidal) and Thurne


HA DDMS
River waterbody catchment
EA WB ID: GB105034050830
Name: Bure (Tidal) and Thurne

Annex B. Drainage Drawings

A47 Blofield~North Burlingham Soakaway Depths

ID	Length (m)	Width (m)	Depth (m)
SR1	132	10	3.1
SR2	100	10	4.5
SR3	120	10	3.8
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SC8 *	175	10	4.5

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Catchment colour code
1
7

STRUCTURE S04 WILL INCLUDE DRAIN TO COLLECT SUB-SURFACE FLOWS

ALLOTMENT CAR PARK, SURFACE DRESSED WITH HARDCORE TO DRAIN 'OVER THE EDGE'

CONCRETE DISHED CHANNEL TO BE PROVIDED ACROSS ENTRANCE TO CAR PARK, WITH SUMP AND OUTLET TO MH 5

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

1:1250 0 62.5m 125m

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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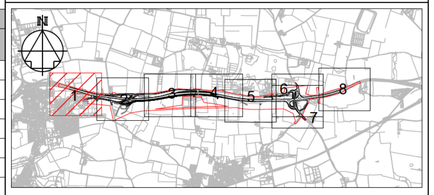
5	Standing water in Infiltration Basin and open soakaway trenches

NOTES



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KEY TO SYMBOLS

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- TOE DRAIN
- DRIVEABLE SWALE
- DRY CULVERT
- INFILTRATION BASIN
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- CATCHPIT
- MANHOLE
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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 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

N

Catchment colour code

1
7
8
9

A47 Blofield~North Burlingham Soakaway Depths

ID	Length (m)	Width (m)	Depth (m)
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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

SC8

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

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

PENSTOCK AND CATCHPIT CHAMBER

SR7

5,6

CLEAN WATER TO OUTFALL TO SOAKAWAYS

SC4

5,6

PENSTOCK AND CATCHPIT CHAMBER

Pond

PR1

5,6

SC6

SC7

SC5

5,6

DRIVEABLE SWALE FOR ACCESS TO INFILTRATION BASIN

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

Sparrow Hall

Sunny Acres

Sparrow Hall Bungalow

Brienz

Kyrenia

Willow Cottage

21.0m

20.8m

13.6m

14.6m

1:1250 0 62.5m 125m

IMPORTANT

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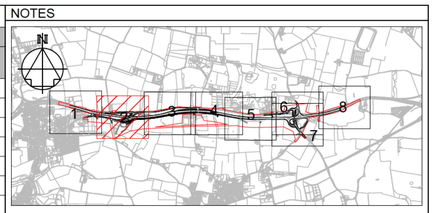

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DESIGNER: SWECO

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

A47 Blofield~North Burlingham Soakaway Depths			
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Catchment colour code
1

SC8

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

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

IMPORTANT

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1:1250 0 62.5m 125m

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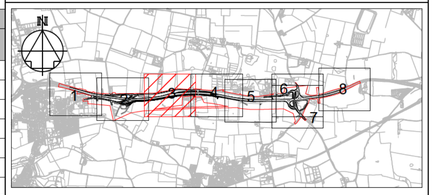

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DESIGNER
SWECO

CONTRACTOR
GallifordTry

CLIENT
highways england

PROJECT TITLE
A47 BLOFIELD TO NORTH BURLINGHAM DUALLING

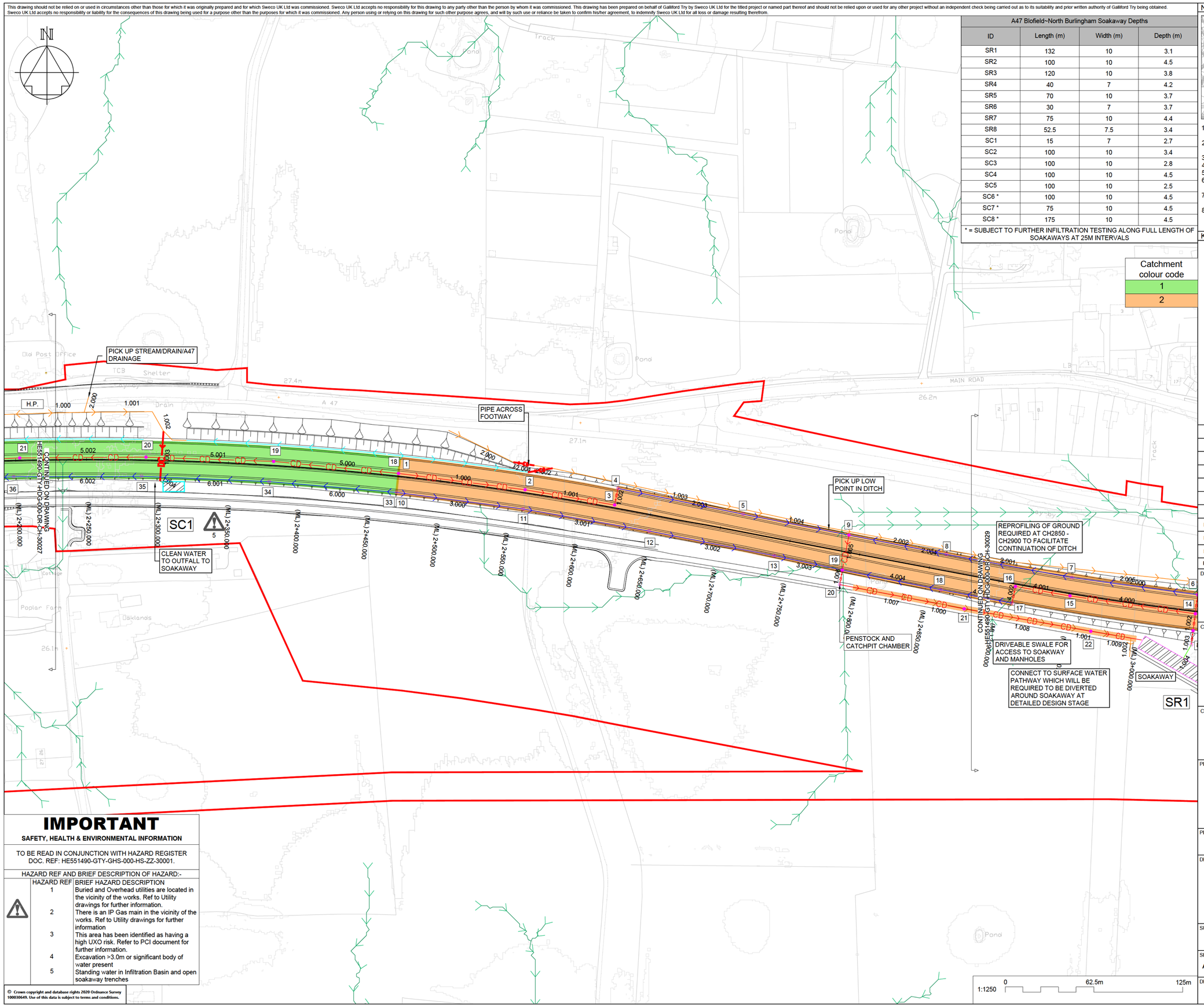
PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
DRAINAGE LAYOUT PLANS
TO SUPPORT DRAINAGE STRATEGY REPORT
SHEET 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



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Catchment colour code
1
2

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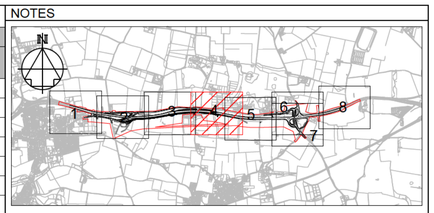

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DESIGNER: SWECO

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 4 OF 8

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
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DRAWING NUMBER: HE551490-GTY-HDG-000-DR-CD-30028

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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

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

CONNECT TO SURFACE WATER PATHWAY

SOAKAWAY

SR1

SR2

RELIEF PIPE AT NATURAL CATCHMENT LOW POINT

PENSTOCK AND CATCHPIT CHAMBER

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

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

IMPORTANT

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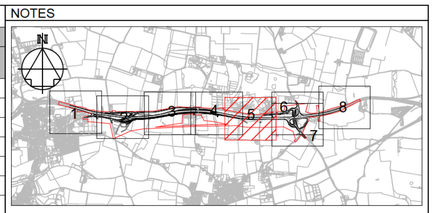

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KEY TO SYMBOLS

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- 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	CHKD	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 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

ID	Length (m)	Width (m)	Depth (m)
SR1	132	10	3.1
SR2	100	10	4.5
SR3	120	10	3.8
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Catchment colour code
3
4
5
6
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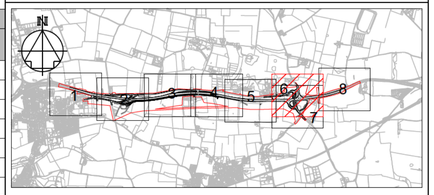
11
12
13

NOTES



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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

IMPORTANT

SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

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

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

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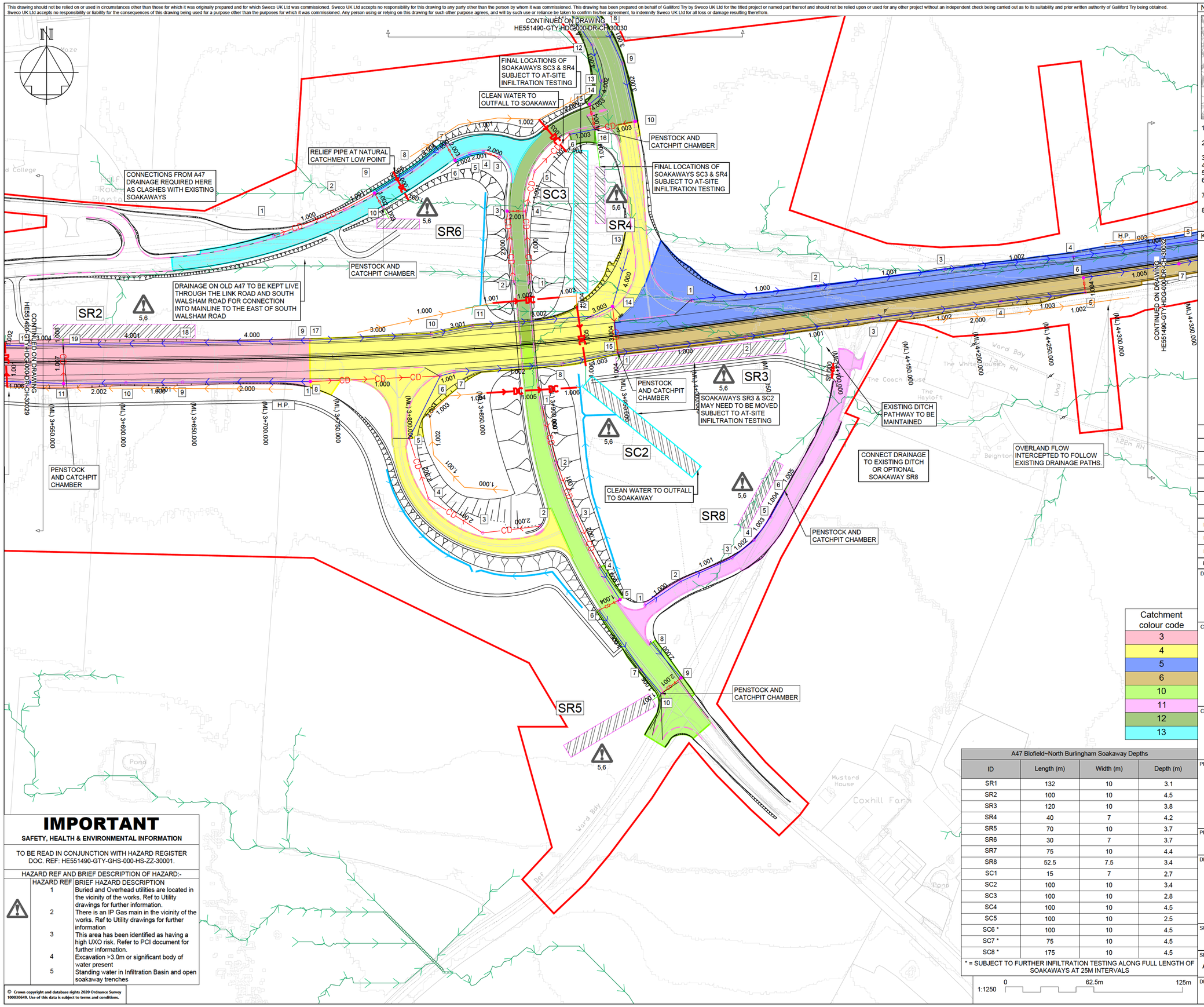
1:1250 0 62.5m 125m



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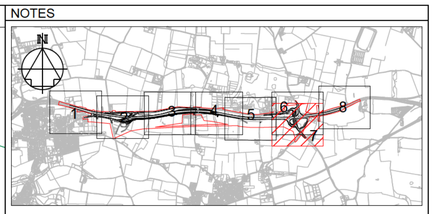

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DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

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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

Catchment colour code
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4
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13

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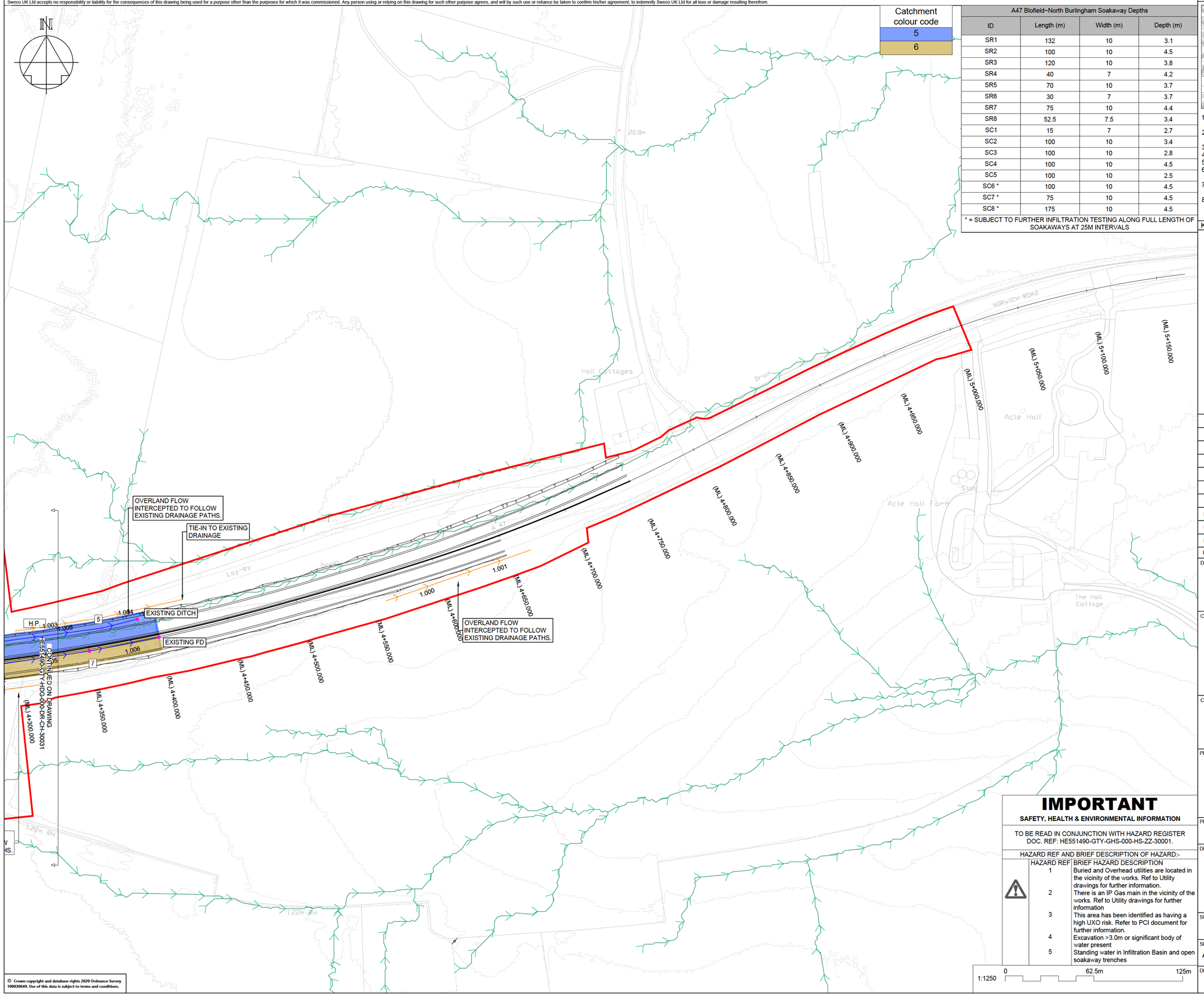

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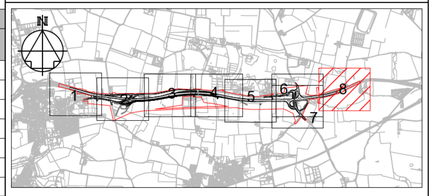

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DESIGNER: SWECO

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 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

IMPORTANT

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1:1250 0 62.5m 125m

Annex C. Correspondence with Lead Agencies

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: Yvonne.Smith@wlma.org.uk | e: planning@wlma.org.uk

Water Management Alliance
Kettlewell House, Austin Fields Industrial Estate, King's Lynn, Norfolk, PE30 1PH, UK
[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

Water Management Alliance

From: Dunton, Karen [mailto:Karen.Dunton@sweco.co.uk]
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
Grove House
Mansion Gate Drive
Leeds, LS7 4DN
+44 113 262 0000
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.

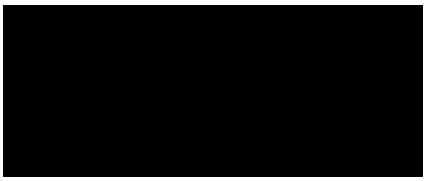
We would also suggest that Table 13.3 should explicitly include changes to groundwater flow.

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
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Record of meeting/discussion

Mott MacDonald Sweco

Project Title	A47 Thickthorn Junction With A11 Improvements A47 Blofield to North Burlingham Dualling	Project No.	HE551492 HE551490
Subject	Groundwater, biodiversity, geomorphology	Date of Meeting	08 June 2018 11:00
Location	Bittern Room, Dragonfly House, Gilders Way, NR3 1UB		
Present	Kate Warwick — Environment Agency (EA) Anna Sharpin — EA Stephen Hughes — Mott Macdonald Sweco (MMS) Caroline Ball — MMS Ishbel Campbell — MMS Diane Wood — MMS		
Apologies	Jose Garvi-Serrano — Highways England (HE) Martin Barrell — EA		

Recorded	Distribution
SH	Attendees Francesca Greene (MMS) Mark Murphy (MMS) Jose Garvi-Serrano (HE) Martin Barrell (EA)

Item		Text	Action on
1.0		**Introductions**	
2.0		**A47/A11 Thickthorn Junction scheme**	
	2.1	SH gave a background to the scheme.	
	2.2	The EA's PINS responses to the Scoping Report were discussed, with the following points raised:	
	2.3	The EA hold no further data on groundwater flooding in the area. AS confirmed the groundwater body is at poor status due to nitrates from agriculture. AS to pass on most up-to-date abstraction data.	AS
	2.4	Lowland Fen Biodiversity Action Plan habitat: any changes to drainage in this location would have to be discussed with Norfolk Wildlife Trust (landowners). Condition assessments and habitat loss compensation would be required. Fen monitoring (groundwater levels) may be required to inform baseline and understand water sources – meeting to be arranged to discuss requirements with Norfolk Wildlife Trust.	SH / CB / DW
	2.5	Dewatering: AS can give advice prior to consultation with permitting team, and to share Hydrogeological Impact Assessment guidance document for dewatering with MMS.	AS
	2.6	Drainage team to produce maintenance management plans for drainage and particularly treatment.	MMS (drainage

Item		Text	Action on
			design)
	2.7	Attenuation pools to include permanent standing water and marginal vegetation to improve biodiversity and treatment, if possible. This would require a larger land take.	MMS (drainage design)
	2.8	The EA's main concerns in terms of groundwater are impacts on abstractions and supporting surface water.	
	2.9	The EA are happy with the proposed amended approach to inclusion of WFD status on estimating magnitude of effects. The proposal was to include an impact of 'Major Adverse' magnitude for deterioration in status of any WFD waterbody and an impact of 'Major Beneficial' for improvement in status of any WFD waterbody. KW indicated that the reasons for failure of WFD waterbodies should be used as a guide for mitigations and enhancements. IC/DW highlighted there are specific mitigation requirements for water vole and otter which are present on Cantley Stream. SH to send link to DMRB HD 45/09 for EA reference.	SH
	2.10	The EA are keen to see biodiversity and geomorphological enhancements where the Cantley Stream is to be diverted (currently heavily modified); i.e. avoidance of trapezoidal catch channels, inclusion of low flows and margins, etc. design to replicate river channel upstream of the heavily modified section. The EA can help with information on flooding, geomorphology, erosion and biodiversity considerations. KW indicated that the EA would be happy to comment on Cantley Stream diversion proposals although such advice would be chargeable. SH to liaise with ecology, geomorphology, structures and design teams.	MMS SH / IC
	2.11	The new river channel would have to be ready to receive water voles Feb/March before road construction (and destruction of old channel) begins. If otters present on site, would have to keep corridor open during construction.	
3.0		**A47 Blofield to North Burlingham scheme**	
	3.1	SH gave a background to the scheme.	
	3.2	The EA's PINS responses to the Scoping Report were discussed, with the following points raised:	
	3.3	Landscape enhancement required to compensation for ponds to be infilled. Mitigation should include for creation of at least double the number of ponds infilled.	
	3.4	SPZ updates: AS confirmed that the AWS Strumpshaw licence has been revoked, although there are still other abstractions in this area. The Strumpshaw licence has been replaced by abstractions at Postwick. AS to send updates SPZ data, when available.	AS
	3.5	Climate change considerations: EA confirmed that a simple qualitative assessment in line with assumptions made for flood risk is acceptable. AS commented that in the Anglian region, projections suggest that annual recharge remained the same, but with different timing.	

Project No. Date of Meeting

Item		Text	Action on
	3.6	EA requested that the GI groundwater monitoring is extended to observe maximum groundwater levels in spring.	MMS
	3.7	Treatment mitigation will be required for soakaways.	
	3.8	KW asked what will be happening to the land left between the existing A47 and proposed duelling, and whether this could be utilised for replacement priority habitat. MMS to confirm.	MMS (DW)
4.0		**Any Other Business**	
	4.1	Postponement of East Tuddenham scheme briefly discussed. AS stated that large scale pumping tests would unlikely be approved due to existing licensed abstractions (and new abstractions about to become licensed) in the area.	

Ball, Caroline

From:	Hesp, Elizabeth [redacted]
Sent:	27 April 2020 10:22
To:	Ball, Caroline
Cc:	Sharpin, Anna; Barrell, Martin
Subject:	A47 Blofield to North Burlingham - Deep Drainage

Hi Caroline

Thank you for your email regarding the proposal to use deep drainage for the Blofield to North Burlingham section of the A47. Drainage to depths greater than 2mbgl are our least preferred method, because the system by-passes the soil zone and increases the potential for pollution of groundwater to occur. Before we can assess the proposal we require some additional information.

Please refer to our Groundwater Position Statements G1, G9-13 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/692989/Envirnment-Agency-approach-to-groundwater-protection.pdf

The Environment Agency will only agree to the use of deep infiltration systems for surface water drainage if the developer can show that all the below apply:

- There are no other feasible options – we would expect the developer to investigate the potential for all other disposal options including shallow infiltration and discharge to watercourse before deep drainage can be considered. Further consideration of the infiltration capacity of the Lowestoft Formation needs to be made. This deposit tends to be variable with bands of sands and gravels often evident. It is possible these could be utilised for shallow infiltration.
- The discharge to groundwater is indirect see G1 (with the exception of clean uncontaminated roof water- See G12). The information you have provided appears to indicate that this may be achieved. Seasonal variation should also be considered.
- The system is no deeper than is required to obtain sufficient soakage in order to maximise attenuation in the unsaturated zone.
- Acceptable pollution control measures are in place.
- A risk assessment demonstrates that no unacceptable discharge to groundwater will take place- the discharge of hazardous substances will be prevented.
- There are sufficient mitigating measures to compensate for the increased risk arising from the use of a deep infiltration system. A SuDS management train to ensure the removal of hazardous substances prior to discharge to the boreholes will be required.

Deep infiltration SuDS for anything other than clean roof drainage (see G12) in a SPZ1 would not be acceptable.

We look forward to receiving the additional information.

Kind regards

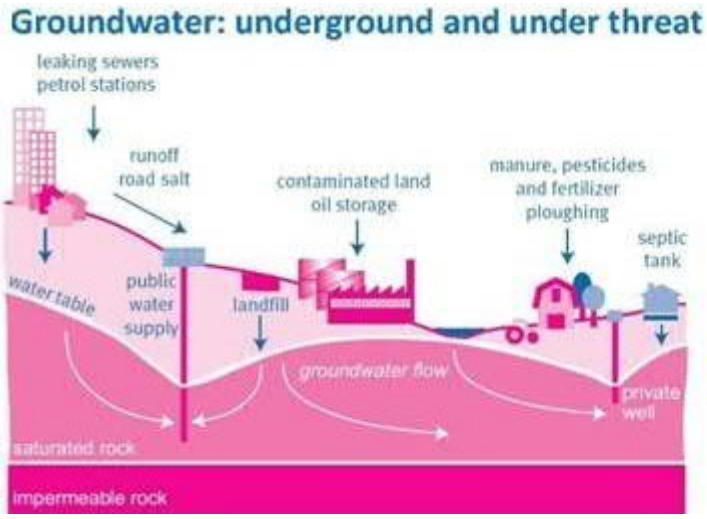
Liz

Elizabeth Hesp BSc MSc FGS
Technical Officer - Groundwater and Contaminated Land
East Anglia Area (formerly C&B/ ENS Areas)

[redacted]

Please note my usual working days are Monday, Tuesday and Wednesday morning.

Our 2017 Groundwater Protection Position Statements are now available online:
https://www.gov.uk/government/publications/groundwater-protection-position-statements



www.gov.uk/environment-agency

Environment Agency

Ms. Caroline Ball - Principal Hydrogeologist
SWECO

Via email only:
Caroline.Ball@sweco.co.uk

Our ref: AE/2020/125317/01-L01
Your ref: HE551490-GTY-HDG-000-RP-CD

Date: 14 August 2020

Dear Caroline

A47 BLOFIELD TO NORTH BURLINGHAM DUALLING
DRAINAGE STRATEGY REPORT

We have reviewed the Highways England A47 Blofield to North Burlingham Dualling Drainage Strategy Report of 14 July 2020 (ref: HE551490-GTY-HDG-000-RP-CD-30001 | P01) – DRAFT, as well as associated annexes. Comments on this report are made below:

The plans in Annex B do not show location of penstocks, or apparent arrangement between infiltration basins, attenuation basins, and soakaways. It has been confirmed in writing within the report that they are to be in place before any infiltration system, but will the positioning of penstocks or other shut off systems be put into plans once a more detailed design is finalised?

We would ask why no additional treatment steps other than filter drains have been proposed? Is there scope for shallow settlement/detention basins before every infiltration device?

Are all the filter drains permeable at their base or lined, and therefore only for conveyance? If they are permeable, could measures be put in place to help encourage limited shallow infiltration, such as shallow steps along its route or sections of flat/very low gradient, for lower flow conditions? We would like to discourage as much as possible the amount being discharged to the deep infiltration features as they have bypassed the soil zone. It is noted that the soakaway tests have failed but given the variability in the glacial deposits, there may be some localised infiltration, with the soakaways being utilised in higher flow conditions where runoff is more dilute?

We understand the reasons for selecting depths greater than 2m due to low infiltration potential in the shallow glacial deposits, however, have any other options been explored for reducing the depth of the base of the soakaway? Whilst it has

been shown that there is a relatively acceptable depth to the unsaturated zone, the depth still misses natural degradation that would occur in the soil zone. An example of how to reduce the depth could be that the soakaway itself is raised but the low permeability glacial deposits are removed and replaced with a more permeable material. Therefore the soakaway would be underlain by an artificial mix of moderate to high permeability material, such as a mix of granular material of the same or slightly better permeable rate than the underlying soils. This could be possible as particle size distribution curves have been collected for each location. Has this approach been considered?

The 'clean water' soakaways are to receive overland flows only. Has there been any modelling carried out to determine if there is any possibility of the road scheme overflowing into these soakaways? As they do not have any isolation devices or treatment train associated with them, they are therefore at an elevated vulnerability.

In section 13 References, point 1 refers to 'What's In Your Back Yard'. This website has been superseded and therefore the reference should be updated. Mapped information and other data is now available via Magic Maps, DATA.GOV.UK, from the BGS or via a specific information request to us.

The HEWRAT Risk Assessment selected the infiltration method as "continuous", shallow linear (e.g. unlined ditch, swale, grassed channel) for all locations. Is there a more appropriate selection if the infiltration point is via a point source of a soakaway or an infiltration basin? The trenches have been shown to be used primarily (or entirely) for conveyance so would not be the parameter to select.

We hope that these comments are useful and look forward to hearing from you on the points raised

Yours sincerely

MR MARTIN BARRELL
Sustainable Places - Planning Specialist

[redacted]

Ball, Caroline

From: Ball, Caroline
Sent: 23 September 2020 11:34
To: [redacted]
Subject: RE: A47 Blofield to North Burlingham - Deep Drainage
Attachments: A47 Blo - EA Designer Response_21Sept20.xlsx

Follow Up Flag: Follow up
Flag Status: Flagged

Hi Martin,

Many thanks for your response to the drainage strategy document. Please find attached our response log, addressing each one of the comments raised in your letter. I hope that these comments sufficiently demonstrate that the design takes into account all the requirements that were originally set out in your email of 27th April, essentially demonstrating that all efforts have been made to minimise the depths of the infiltration basin and soakaway trenches, within the constraints of the Proposed Scheme setting, and that the treatment included in the design is acceptable for the protection of groundwater.

I would be very grateful if you can confirm that you are happy with our approach, and that the drainage design is acceptable to the Environment Agency.

In addition to this, in our email on 16 July 2020 we queried the requirement for surface water monitoring before, during and after the construction of the scheme considering the proposed drainage design does not discharge to a surface watercourse, and there will be no works within 8m of a watercourse or within the floodplain. I would be very grateful if you could confirm the Environment Agency's monitoring requirements for the Proposed Scheme.

Kind regards,

Caroline Ball
[redacted]

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SWECO

A47 Blofield to North Burlingham		
EA Letter dated 14/08/2020 - Comments on Drainage Strategy Report (DSR)		
Item	**EA Comment**	**Designer Response**
1	The plans in Annex B do not show location of penstocks, or apparent arrangement between infiltration basins, attenuation basins, and soakaways. It has been confirmed in writing within the report that they are to be in place before any infiltration system, but will the positioning of penstocks or other shut off systems be put into plans once a more detailed design is finalised?	Location of penstocks in the outfall manhole upstream of all discrete networks will be shown on the updated drainage drawings in the DSR
2	We would ask why no additional treatment steps other than filter drains have been proposed? Is there scope for shallow settlement/detention basins before every infiltration device?	The outfalls passed the HEWRAT assessments as designed. A shallow lined settlement basin/forebay will be incorporated at the inlet to the infiltration basin to capture 1st flush discharges. For other soakaways the space is too limited to provide such settlement areas. Catchpits are provided as shown at the outfalls, upstream of the soakaways.
3	Are all the filter drains permeable at their base or lined, and therefore only for conveyance? If they are permeable, could measures be put in place to help encourage limited shallow infiltration, such as shallow steps along its route or sections of flat/very low gradient, for lower flow conditions? We would like to discourage as much as possible the amount being discharged to the deep infiltration features as they have bypassed the soil zone. It is noted that the soakaway tests have failed but given the variability in the glacial deposits, there may be some localised infiltration, with the soakaways being utilised in higher flow conditions where runoff is more dilute?	The filter drains are not permeable at their base but they are not lined. Alteration to gradients would inhibit self-cleansing velocities and the capacity of the filter drains. Much of the area along the middle section of the scheme is unsuitable for shallow infiltration of any magnitude - we would not therefore be encouraging shallow infiltration along any areas that are unsuitable. A considerable depth of unsaturated zone is available below all of the infiltration features.
4	We understand the reasons for selecting depths greater than 2m due to low infiltration potential in the shallow glacial deposits, however, have any other options been explored for reducing the depth of the base of the soakaway? Whilst it has been shown that there is a relatively acceptable depth to the unsaturated zone, the depth still misses natural degradation that would occur in the soil zone. An example of how to reduce the depth could be that the soakaway itself is raised but the low permeability glacial deposits are removed and replaced with a more permeable material. Therefore the soakaway would be underlain by an artificial mix of moderate to high permeability material, such as a mix of granular material of the same or slightly better permeable rate than the underlying soils. This could be possible as particle size distribution curves have been collected for each location. Has this approach been considered?	The depths greater than 2m are led firstly by the very flat alignment of the scheme, with pipes greater than 450mm in diameter leading to the outfall with a cover depth to soffit of 1.2m. This means that the invert into the soakaway is greater than 1.7m to begin with. This is followed by a requirement for at least 1.5m effective storage depth below the invert. Other constraints are the maximum allowable width of the trench and the storage volume required. It is not envisaged that the methods suggested would result in raising the soakaways to any extent as we could no longer include infiltration through the sides of the soakaway along with the above constraints. The soakaway locations and depths are subject to the limits of deviation whereby if subsequent infiltration testing at later stages in the project programme provides satisfactory infiltration at shallower depths in adjacent ground the soakaways will be re-designed to suit. Alternative design options such as geocellular

		units for the soakaway trenches may also be considered for incorporation at the next stage (detailed design). The merits of using geocellular soakaways with 95% voids will also be examined to further reduce the sizing (and therefore potentially the depth) of the proposed soakaways.
5	The 'clean water' soakaways are to receive overland flows only. Has there been any modelling carried out to determine if there is any possibility of the road scheme overflowing into these soakaways?	Modelling of the road scheme run-off for exceedance events was undertaken and only neglible flooding was observed in one soakaway only (SR7) which will be designed out at detailed design stage or the exceedance flows directed into the infiltration basin.
6	In section 13 References, point 1 refers to 'What's In Your Back Yard'. This website has been superseded and therefore the reference should be updated. Mapped information and other data is now available via Magic Maps, DATA.GOV.UK, from the BGS or via a specific information request to us.	The Magic maps were used. This was an older reference at inception of the scheme and it will be removed from the DSR and replaced with the correct reference to the Magic maps.
7	The HEWRAT Risk Assessment selected the infiltration method as "continuous", shallow linear (e.g. unlined ditch, swale, grassed channel) for all locations. Is there a more appropriate selection if the infiltration point is via a point source of a soakaway or an infiltration basin? The trenches have been shown to be used primarily (or entirely) for conveyance so would not be the parameter to select.	LA113 Road drainage and the water environment, Section C2.1.2 on Infiltration Method states that "*The terms 'continuous', 'region' and 'point' are specific asset definitions from CD 535". CD535 (Drainage asset data and risk management) was consulted for completion of the assessment, and in particular* Table 2.13 which includes Soakaway Trenches as 'Continuous' assets and Infiltration Basins as 'region' assets (see also Table A.6 and Table A.10). Note that a 'continuous' infiltration method has been selected for all soakaway trenches, but a 'region' infiltration method has been selected for the infiltration basin.

Environment Agency

Ms Caroline Ball - Principal Hydrogeologist
SWECO

Via email only:
caroline.ball@sweco.co.uk

Our ref: AE/2020/125317/02-L01
Your ref: HE551490-GTY-HDG-000-RP-CD

Date: 12 October 2020

Dear Caroline

A47 BLOFIELD TO NORTH BURLINGHAM DUALLING
DRAINAGE STRATEGY REPORT

Thank you for providing a detailed response to the points raised in our previous letter dated 14 August 2020 (ref: AE/2020/125317/01-L01). Please find our further comments below:

1. Thank you for confirming that penstocks will be included and that they will be shown in plans in the DSR.

2. Thank you for confirming that catch pits are present ahead of all soakaways. This was not clear from the plans provided. Please could plans be updated with this information?

3. No further comments, thank you for the clarification.

4. Thank you for this detail and that further design will be carried out at detailed design stage. Consider also if more, shallower soakaways are feasible to further reduce depth if possible.

5. Thank you for confirming that this will be designed out at detailed design stage.

6. Thank you for the assurance that this reference will be corrected.

7. Thank you for providing a reference. In the interests of transparency, as document CD535 is not accessible without a subscription, please could you provide the full extract(s) from this document that were referenced in the response.

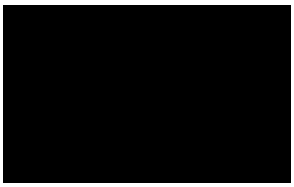
Regarding your further question in respect of requirements for surface water monitoring. The draft Drainage Strategy Report (17/07/20) makes reference (at paragraph 1.9.4), to Policy EN4 of the Broadland DC Development Management DPD. This states that: “Development must include an assessment of potential pollution and provide mitigation”.

When considering the potential for surface water pollution from the proposed scheme, the Report highlights that there is an absence of streams along the route. We would agree with that, there are no WFD rivers or detailed river network in the vicinity

The strategy says that surface water drains etc. are largely dry and that drainage goes to soakaways. The only feature that looks to potentially be affected is a pond adjacent to Lingwood Road. It is mentioned that this receives some road drainage from a ditch at the junction with the existing A47.

We would recommend that the ditch and pond are assessed and monitored if they are considered to be at potential risk. Mitigation may need to be provided. Risk will be reduced if, for example, there are no or low flows, and if there is no potential pollution pathway while construction takes place.

Yours sincerely



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

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

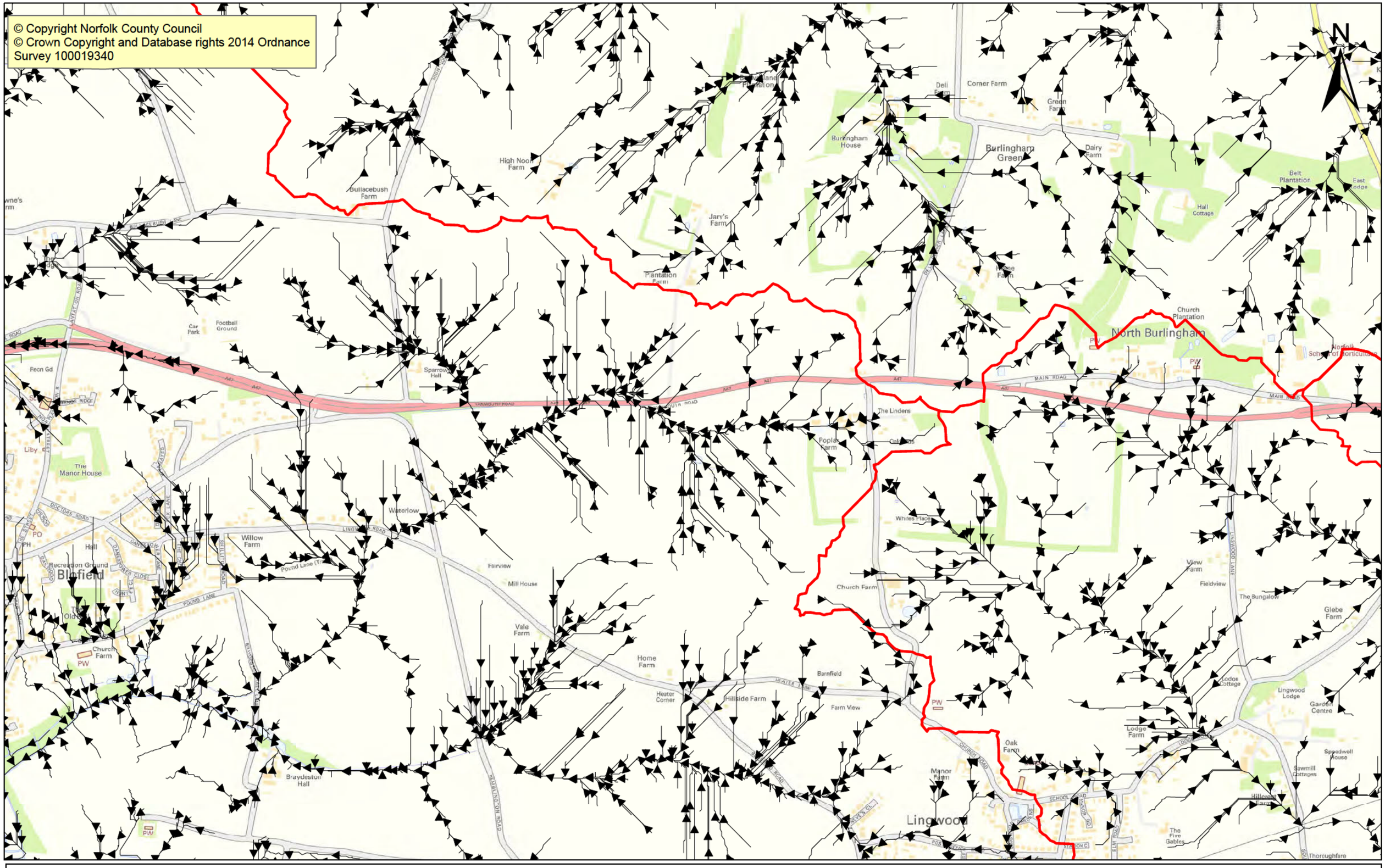
7.1. The Planning Policy context in the Scoping report only details the national planning policy context. Therefore the Scoping Report has not referred to Policy CS16 of the adopted Norfolk Core Strategy and Minerals and Waste Development Management Policies DPD (the 'Norfolk Minerals and Waste Core 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
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:	06/08/2020	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.

Thank you for the providing the drainage strategy for initial review provided on your email on 16 July 2020.

The Drainage Strategy states in section 1.4.3 that the drainage strategy should be read in conjunction with the documents identified in Table 1.1. These documents are the;

- Flood Risk Assessment;
- Groundwater Assessment;
- Technical Note on Deep Drainage; and
- Technical Note on Catchment Hydrology.

Of these documents, the Flood Risk Assessment and Groundwater Assessment were not provided in accordance with the drainage strategy's suggested approach. Therefore, the comments provided by the LLFA on the drainage strategy are limited by the information supplied. It is noted that the drainage strategy would benefit from having key information that is relied upon from each of these and other documents within it rather than cross referenced to other documents that are not available.

The DMRB document *CG 501 – Design of Highway Drainage Systems* has been used in the drainage strategy. This document has been updated to follow NPPF and SuDS National Technical Standards. Section 5.3 states that

> *"All drainage systems shall be designed so that highway surface water flooding does not extend beyond the highway boundary up to the 1 in 100 year rainfall event including an allowance for climate change."*

While section 5.4 confirms that the risks of exceedance of the drainage system should also be checked to ensure that there are no adverse impacts.

At present, 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 that 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. Section 3.4 of the DMRB guidance for soakaway design (530) states

> *"the soakaway drainage system shall be designed to manage surface water runoff from the 1:10 year storm return period, or greater."*

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. It is noted that while the drawings provide the sizing of the soakaways and the report discusses the infiltration testing, no half drain times are made available at present. Please could the half drain times be provided on the included drawings.

With further regard to the design of the soakaways, the infiltration basin is close to some of the soakaways as shown in drawing HE551490-GTY-HDG-000-DR-CD-30002. One of the soakaways beside the infiltration basin appears to be very close to the edge of the basin. The LLFA is concerned the performance of the soakaway and the basin could be reduced due to the close proximity. However, some of the soakaways are located behind residential properties 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 could you clarify the use of space and whether the distances between the soakaways, the basin and the properties are appropriate?

The use of swales as vehicle access ways is unusual due to pollution control issues 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. Please can you provide information regarding the maximum depth of water expected and the supporting environment assessment for the swale at each location.

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 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. Please can you clarify what the constraints are and the options that have been discounted for managing the runoff from the footpaths.

The drainage strategy has indicated that

> *"where existing direct discharges to existing streams or ditches are not taking any increased road runoff from the proposed improvements scheme, these outfalls will remain in place."*

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 may not be increasing as the drainage area is considered to remain unchanged, the drainage strategy has inferred there is an increase in traffic at present and that is expected on the road in the future. Therefore, these road improvements would involve an increase in the future pollution and contaminates in the surface water runoff. Please could you confirm whether an assessment of the water quality on these retained drainage areas has been undertake and whether they resulted in any additional water treatment measures being included?

Some reference to the surface water flow paths has been given in the drainage strategy and its appendices. 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. Please can these plans be prepared as part of the drainage strategy?

In addition, where surface water is being redirected along existing flow pathways, the LLFA would seek confirmation that the redirected flow does not increase the on-site and off-site flood risk. Therefore, the further information the LLFA would seek is to address our 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.

While the drainage strategy acknowledges that it is not aware of any off-site flooding issues, it is not clear whether a consultation exercise with properties owners has been undertaken.

Within the drainage strategy, there has been minimal mention about any required remedial works within existing unchanged systems. Please could the Highways England confirm if any potential remedial works are considered necessary and whether they will be undertaking them within the project area should they be necessary.

In addition, the potential culverting of watercourses and flow paths and the potential pond infilling are noted. The LLFA confirms the need for culverting to be minimised. Furthermore, ordinary watercourse consent applications are likely to be required. Therefore, design information including location, type, size, justification for its need and any appropriate environmental assessments will be required to support any ordinary watercourse consent applications. It will also be necessary for the contractor to obtain appropriate consents from the LLFA prior to undertaking work on the site. Further information can be found on the Norfolk County Council Flood and Water Management website at: https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-homeowners/consent-for-work-on-ordinary-watercourses

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. Please could this be clarified in the report.

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. Please could the drainage strategy contain information about the construction phase drainage works 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: 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.

MEETING MINUTES

Contract:	Regional Delivery Partnership – *A47 Blofield to North Burlingham*		
Weekly Meeting No:			
Venue:	Microsoft Teams		
Date:	24/09/2020	**Time:**	13:00 – 14:30
Meeting:	A47 Blofield – Norfolk County Council comments on the Drainage Strategy		
Attendees:	Sarah Luff, Lead Local Flood Authority, Norfolk County Council (SL) Mary Creedon, Drainage Lead, Sweco (MC) Mark Murphy, EIA Coordinator, Sweco (MM) Jason Ball, Water Environment Lead (JB)		
Apologies:	Sophie May, Acting Project Manager, Sweco		
Distribution:	Attendees		

Item	Discussion	Action
0.0	**Introductions**	
0.1	This meeting discusses the comments raised by Norfolk County Council (NCC) in the letter dated 6th August 2020 following the review of the Drainage Strategy (DS) for the A47 Blofield scheme. Sweco compiled a response to these comments and issued them to NCC on 23rd September 2020; the response is presented in the table below and should be read in conjunction with the meeting minutes. The DS has been updated in light of NCC's comments but has not been re-issued as yet. The agenda of the meeting follows the item numbers as described in Sweco's response.	
1.0	**Flood Risk Assessment and Groundwater Assessment reports**	
	SL noted that FRA comments had been initially sent to Stephen Hughes [post meeting note: 14/08/2020]; SL to resend.	SL (Complete)
2, 3 and 4	**Drainage Strategy and Design Standards**	
	MC described the approach and design standards for the highway drainage and the natural catchment runoff.	
	SL accepted that highway drainage would be appropriately attenuated to the 100 year event plus 40% climate change. SL accepted the approach to the management of intercepted surface water flow pathways where no embankment drainage was included. However, SL noted that embankment drainage should be considered as part of the proposed development and should be attenuated to pre-development runoff rates up to a 100 year event including climate change along with highway drainage.	
	MC noted that DMRB standards had been followed and they didn't require embankment drainage to be attenuated. SL noted that embankments are unlikely to be as permeable as pre-development ground due to compaction.	
	SL was in favour of the design proposals as shown if justification \ evidence that options to include embankment drainage within the highway drainage system were not possible	
	SL requested additional information be provided to clarify including: - drainage catchment area plan showing what areas (e.g. highway and embankments) drain to what attenuation features - calculation of catchment areas (pre and post development) - calculation of runoff rates (pre and post development) for 1 in 10 year and 1 in 100 year flows. - Implications of any differences	MC/JB
	SL noted that the A47 link is a mass evacuation route for Great Yarmouth.	

MEETING MINUTES

5	**Infiltration – half drain times**	
	See table below - MC noted that half drain times have been provided in the updated DS.	
6	**Soakaway placement**	
	See table below - Latest drainage layout drawings provided showing greater spacing between soakaways. MC noted that the placement of soakaways and the infiltration basin is indicative until detailed design. SL asked if there was 10m spacing between the top of the infiltration embankment and the soakaway – MC confirmed there was. SL asked if a note could be inserted on the drainage layout drawings.	MC
	ES Chapter and standalone appendices	
	MM mentioned he had to leave the meeting and asked if there were any questions. SL noted there were references to the main ES chapter and other appendices in the documents and noted that appendices should be standalone documents. SL noted that the ES chapter had not been provided and in particular the local water course network map. JB to provide figure. MM left the meeting.	JB
7	**Driveable swale**	
	See table below – MC noted additional detail provided in the updated DS. MC clarified that the track was used for maintenance vehicle access only and would be gated to prevent public access (and not used in a flood situation). MC noted that the swale does not provide a pollution control function (it acts as a surface water pathway) but SL stated that consideration of environmental impact must be given. DS needs to be clear that pollution is very low risk (no. of visits by maintenance vehicle, maintenance vehicles are maintained). SL stated that as this is a non-standard solution, it needs to be clear that all aspects are considered. DS to be updated.	MC
8	**Use of vortex separators and spillage containment**	
	See table below. HEWRAT assessment confirms this mitigation not required. DS has been updated.	
9	**Footpaths and the use of SUDs**	
	See table below. MC clarified that it is the footpath structures themselves that prevent the use of filter drains in certain locations	
10	**Water quality treatment on retained existing roads**	
	See table below. MC clarified that parts of existing A47 would be retained as a local access road and would experience significantly reduced traffic flows when compared to the road as it is now.	
11	**Surface water pathways on drainage layout drawings**	
	Drainage layout drawings now contain surface water flow pathways and contours and were provided on 23/9/20	
12	**On-site and off-site flood risk from redirecting surface water pathways**	
	See table below. It is noted the flow would remain in existing catchments; clean water soakaways would provide additional attenuation	
13	**Consultation with property owners on flood risk**	
	See table below. SL noted that NCC hold information on historic flood events. JB noted this information had been provided by NCC following recent request. DS needs to reflect this information.	MC
14	**Remedial works on existing unchanged systems**	
	See table below.	
15	**Culverting of watercourses and consenting**	
	See table below – JB confirmed that a walkover was undertaken and confirmed the surface water features in the area were all disconnected. SL noted she had not seen the drawing with the locations of the surveyed watercourses. JB to provide ES Chapter figure.	JB
16	**Further ground investigation**	
	See table below	

MEETING MINUTES

17	**Responsibility of future maintenance between Highways England and Norfolk County Council**	
	See table below.	
18	**Construction phase drainage works**	
	See table below. MC confirmed the details of the construction phase drainage works (for example, the temporary drainage strategy) are not provided in the DS. JB noted that outline construction phasing details are provided as part of DCO submission (*post meeting note: details of the construction works phasing is provided in Chapter 2 of the Environmental Statement*). JB noted that mitigation of increased flood risk etc during construction is discussed in the water ES chapter.	

A47 Blofield to North Burlingham		
Norfolk County Council - Lead Local Flood Authority Letter dated 06/08/2020 - Comments on Drainage Strategy Report (DSR)		
Item	NCC - LLFA Comment	Designer Response
1	FRA and Groundwater Assessment not provided	FRA sent by return on 06/08/20. GW Assessment provided on 22/09/20.
2	The DMRB document CG 501 – Design of Highway Drainage Systems has been used in the drainage strategy. This document has been updated to follow NPPF and SuDS National Technical Standards. Section 5.3 states that "All drainage systems shall be designed so that highway surface water flooding does not extend beyond the highway boundary up to the 1 in 100 year rainfall event including an allowance for climate change." At present, 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 that the 1% AEP storm with climate change allowance would be used to assess the risk.	Revised DSR includes: 100 year storm - highway surface water flooding does not extend beyond the highway boundary up to the 1 in 100 year rainfall event including an allowance for climate change
3	While section 5.4 confirms that the risks of exceedance of the drainage system should also be checked to ensure that there are no adverse impacts.	Revised DSR includes: A sensitivity check for exceedance was undertaken to ensure there were no adverse impacts from highway surface water flooding.
4	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. Section 3.4 of the DMRB guidance for soakaway design (530) states "the soakaway drainage system shall be designed to manage surface water runoff from the 1:10 year storm return period, or greater." 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.	Revised DSR includes: 1.7.3.The design storm event for the infiltration basin and soakaway design for highway surface water is as follows: •100 year storm with 20% allowance for climate change •check for flooding in a 1 in 100 year storm with 40% allowance for climate Change •where infiltration facilities are deep these facilities to be approved by Environment Agency as appropriate 1.7.4.The design storm event for the clean water soakaway design for natural catchment run-off is as follows: •10 year storm with 20% allowance for climate change •check for flooding in a 1 in 100 year storm with 20% and 40% allowance for climate Change in accordance with CD 530 Design of Soakaways, to ensure that any overflows for exceedance events would be captured along controlled pathways which are existing surface water flow pathways (Note that the greenfield runoff on this site 'clean water', flows overland along surface water pathways). •where infiltration facilities are deep these facilities to be approved by Environment Agency as appropriate
5	It is noted that while the drawings provide the sizing of the soakaways and the report discusses the infiltration testing, no half drain times are made available at present. Please could the half drain times be provided on the included drawings.	Half drain times will be provided in Table 2-2 of the updated DSR
6	With further regard to the design of the soakaways, the infiltration basin is close to some of the soakaways as shown in drawing HE551490-GTY-HDG-000-DR-CD-30002. One of the soakaways beside the infiltration basin appears to be very close to the edge of the basin. The LLFA is concerned the performance of the soakaway and the basin could be reduced due to the close proximity. However, some of the soakaways are located behind residential properties 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 could you clarify the use of space and whether the distances between the soakaways, the basin and the properties are appropriate?	Locations of soakaways shown are indicative only. The recommended 10m separation minimum between assets and appropriate offsets from the highway will be provided at detailed design stage. The use of space was restricted by topography, road alignment low points and matching natural surface water flow pathways. Contours and surface water flow pathways will be added to the updated drainage drawings in the DSR which will demonstrate some of the constraints on the positioning of soakaways, the aim of which was also to keep these as flat as possible. The soakaway next to the infiltration basin now includes a separation distance in the updated DSR drawings. It should be noted that the boundary behind the residential properties in question is a high point.

A47 Blofield to North Burlingham		
Norfolk County Council - Lead Local Flood Authority Letter dated 06/08/2020 - Comments on Drainage Strategy Report (DSR)		
Item	NCC - LLFA Comment	Designer Response
7	The use of swales as vehicle access ways is unusual due to pollution control issues 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. Please can you provide information regarding the maximum depth of water expected and the supporting environment assessment for the swale at each location.	A typical detail will be provided in the updated DSR. Further detail on the expected maximum depth of water in the driveable swale will be included in DSR: Max depth in swale at Access Track Ch 150 = 0.1m and at Ch 2+800 = 0.18m. The width of the driveable swale is 3.85m. The driveable swales will capture a small area of embankment run-off and overland flow while maintaining access to the infiltration basin and a soakaway. They are not being required for any pollution control function therefore a supporting environment assessment is not deemed to be necessary.
8	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.	This is clarified in the updated DSR: 1.7.7.Further control measures as follows were considered: •vortex separators - The HEWRAT assessment (for routine road runoff) found the infiltration basin and soakaway trenches to be low risk and therefore do not require any further mitigation for settlement of suspended solids (i.e. Vortex Separators). •dedicated spillage containment tanks - Spillage assessments are included in the Groundwater Assessment. The assessments found the annual probability of spillage risk to be significantly lower than the maximum tolerable limit and as such dedicated spillage containment is not required.
9	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. Please can you clarify what the constraints are and the options that have been discounted for managing the runoff from the footpaths.	In a small number of areas, the introduction of a requirement for footpaths prevented the use of filter drains (SUDS drainage) at those locations. This was explained in Section 1.6.13 of the DSR: *These footways will present constraints to the drainage design, requiring kerbing and closed systems instead of filter drains.*
10	The drainage strategy has indicated that "where existing direct discharges to existing streams or ditches are not taking any increased road runoff from the proposed improvements scheme, these outfalls will remain in place." 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 may not be increasing as the drainage area is considered to remain unchanged, the drainage strategy has inferred there is an increase in traffic at present and that is expected on the road in the future. Therefore, these road improvements would involve an increase in the future pollution and contaminates in the surface water runoff. Please could you confirm whether an assessment of the water quality on these retained drainage areas has been undertake and whether they resulted in any additional water treatment measures being included?	The road improvements will lead to a decrease in the traffic levels in those areas where direct discharges to existing streams or ditches remains unchanged. This is because the through traffic will be diverted onto the new road to the south of the existing A47. The two way AADT forecasted in these areas for 2025 (109) and 2040 (125) is significantly less than the current traffic levels on the existing A47 (~40,000). Where routine runoff from retained roads is redirected to a new soakaway feature, a HEWRAT assessment has been undertaken. These have all been found to be low risk and therefore no additional water treatment measures were required.
11	Some reference to the surface water flow paths has been given in the drainage strategy and its appendices. 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. Please can these plans be prepared as part of the drainage strategy?	The surface flow pathways will be provided on the updated drainage drawings in the DSR.
12	In addition, where surface water is being redirected along existing flow pathways, the LLFA would seek confirmation that the redirected flow does not increase the on-site and off-site flood risk. Therefore, the further information the LLFA would seek is to address our 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.	Flows will remain in-catchment - this will be made clear from the surface water pathways which are included on the updated drainage drawings in the DSR. Interceptor drains facilitate the conveyance of overland flows, ensuring these are maintained along existing flow pathways. Where there is some minor deviation through the construction footprint of the Scheme, clean water soakaways provided additional attenuation of flows before redirecting towards the existing flow pathways. There is no significant increase in flood risk associated with local properties.
13	While the drainage strategy acknowledges that it is not aware of any off-site flooding issues, it is not clear whether a consultation exercise with properties owners has been undertaken.	Property owners have not been directly consulted. As referred to in the DSR the development of the drainage design examined the locations identified by HADDMS as Hotspots and the EA surface water flood maps to inform the drainage design on this scheme.

A47 Blofield to North Burlingham		
Norfolk County Council - Lead Local Flood Authority Letter dated 06/08/2020 - Comments on Drainage Strategy Report (DSR)		
Item	NCC - LLFA Comment	Designer Response
14	Within the drainage strategy, there has been minimal mention about any required remedial works within existing unchanged systems. Please could the Highways England confirm if any potential remedial works are considered necessary and whether they will be undertaking them within the project area should they be necessary.	Potential remedial works that will be considered are: Flushing and minor repairs/replacement of existing pipes and chambers. This will be informed from a condition survey/CCTV to be undertaken prior to handover. A reference will be made to this in the updated DSR.
15	In addition, the potential culverting of watercourses and flow paths and the potential pond infilling are noted. The LLFA confirms the need for culverting to be minimised. Furthermore, ordinary watercourse consent applications are likely to be required. Therefore, design information including location, type, size, justification for its need and any appropriate environmental assessments will be required to support any ordinary watercourse consent applications. It will also be necessary for the contractor to obtain appropriate consents from the LLFA prior to undertaking work on the site.	There are no watercourses on this scheme; drainage ditches local to the Scheme do not form part of a wider continuous stream network. Any consent applications necessary will be applied for as appropriate.
16	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.	Further ground investigation is currently being programmed. It is expected in late 2020/early 2021 - timescale to be included in the DSR
17	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. Please could this be clarified in the report.	As outlined in Section 11 of the DSR, it is expected that assets relating to side roads would be the responsibility of Norfolk County Council and assets relating to the mainline would be the responsibility of HE. Division of assets is subject to confirmation between Norfolk CC and HE.
18	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. Please could the drainage strategy contain information about the construction phase drainage works and any temporary measures that would be in place.	The detail will be included in the Construction Phase Plan.

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 – Groundwater	My Ref:	FW/2020_0740
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 providing a copy of the draft Groundwater Assessment by email on 24th September 2020. The LLFA has reviewed the report and has the following comments.

Within the report there are a large number of national grid references (NGRs) given. Frequently the NGRs are given alone and without any location description meaning that often the reader is unable to locate the point without having to undertake specific search. It is suggested that a review of these NGR references and the inclusion of location descriptions is undertaken where possible by the design team.

The groundwater assessment is supported by various ground investigations undertaken between 1992 and 2018. The investigations have considered both infiltration and groundwater levels. Relevant infiltration testing results should be provided in the drainage strategy. The infiltration testing results identify that infiltration to ground is plausible in the Lowestoft Formation and Happisburgh Glacigenic – Granular Formation although the drainage potential would be at the low end of the acceptable range. The Happisburgh Glacigenic – Cohesive Formation and the Bytham Sand and Gravel Formation are considered to have a very low drainage potential. The LLFA are yet to receive further details regarding the size and depth of the proposed infiltration structures, although we are aware that this information along with the relevant local infiltration testing results will be provided in the updated draft drainage strategy.

The LLFA has noted that part of the site is within a source protection zone. It is not clear at present either in this Groundwater Assessment or the existing drainage strategy, whether deep bore soakaways are proposed for use on this site. However, the infiltration rates reported in the Happisburgh Glacigenic – Cohesive Formation and the Bytham Sand and Gravel Formation are unlikely to be considered acceptable by the LLFA. Furthermore, should the use of deep bore soakaways be proposed for use on this site, further consultation with both the Environment Agency and the LLFA would be necessary.

Finally, in Table 3.1 a summary of the HEWRAT input parameters is given. The Rainfall depth (annual averages) identifies Ipswich as the closest gauge location which is a significant distance away. Please can you clarify whether there is a gauge in the Norwich area?

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
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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

From: Ball, Caroline
Sent: 08 October 2020 11:35
To: [redacted]
Subject: RE: A47 Blofield Groundwater Assessment
Attachments: HE551490-GTY-EWE-000-DR-GI-30008.pdf

Sarah,

Many thanks for your letter containing comments on the Groundwater Assessment for A47 Blofield. Please see below responses to these comments, for your information.

- Use of location descriptions as well as NGRs will be considered during finalisation of the report.
- Size and depth of infiltration structures to be provided in updated DSR, as discussed.
- The SPZ3 is located at the western extents of the Proposed Scheme where there are no infiltration features planned. I have attached figure 13.6 from the draft Environment Statement showing the extents of the SPZ3 in relation to the Proposed Scheme.
- The drainage design does not include any deep borehole soakaways. However, the infiltration basins and soakaway trenches in the drainage design are generally greater than 3m deep, and because of this consultation is ongoing with the EA. We would be happy to discuss this further with Norfolk CC, if required?
- The rainfall gauge site was selected based on a list of regional data provided in the HEWRAT help guide. In this list Ipswich is the nearest site to Blofield. It should also be noted that the soakaway risk assessment only requires selection of a range of rainfall (<=740mm, >740 & >1060mm, or >=1060mm).

Many thanks

Kind regards,

Caroline Ball
Principal Hydrogeologist
[redacted]

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Leeds, LS7 4DN
+44 113 262 0000
www.sweco.co.uk

From: Lead Local Flood Authority <llfa@norfolk.gov.uk>
Sent: 07 October 2020 11:11
[redacted]
Subject: RE: A47 Blofield Groundwater Assessment

Dear Jason,

Thank you for your request. We have reviewed the A47 Blofield to North Burlingham Groundwater Assessment provided and have prepared the attached response.

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

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
Norfolk County Council

From: Jason Ball <filetransfer@filetransfer.swecogroup.com>

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 – Groundwater	My Ref:	FW/2020_0827
Date:	22 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 email received on 8th October 2020 that provided further comments in response to our comments on the draft Groundwater Assessment. The LLFA has reviewed the information and has the following comments.

The LLFA acknowledge that it is the designer's intention to update the groundwater assessment to contain location descriptions as well as National Grid References (NGRs) rather than only NGRs. In addition, further design information regarding the size and depth of infiltration structures to be provided in updated Drainage Strategy report.

Thank you for confirming that the Source Protection Zone 3 is located at the western extents of the Proposed Scheme where there are no infiltration features planned. It is noted that you have had to include a plan from another document to shown the location of the Source Protection Zone. This should be included in the Groundwater Assessment as an evidence base that supports other documents.

The information provided in response to the groundwater assessment queries indicates that the infiltration basins and soakaway trenches in the drainage design are generally greater than 3m deep. Soakaway structures at a depth greater than 2m below the ground level are considered to be deep infiltration features by the LLFA in accordance with our developer guidance. It is also noted that this is the first indication of the soakaways and infiltration basin depths as previously no sizing information had been provided in the drainage strategy. We have been informed in your response that there is ongoing consultation with the Environment Agency.

However, while the Environment Agency may agree to a deep infiltration soakaway, they no longer have the role to advise the LPA on surface water drainage options. Therefore, the LLFA would still require a clear justification to demonstrate why the SuDS hierarchy cannot be followed as per our guidance. Should there be no other feasible way to discharge surface water and this is acceptable to the EA in groundwater pollution prevention terms, the LLFA would still expect that shallow or surface SuDS components to

have been considered in the drainage scheme prior to the deep soakaway and infiltration basins selected as being the final discharge point. This design process would normally be reported in the drainage strategy.

The LLFA would expect the evidence that the necessary protection to the water environment in the drainage strategy and design that is in line with the SuDS philosophy. The LLFA would also expect the design information and support evidence to demonstrate the viability of the deep infiltration system (such as the ground investigation and infiltration testing undertaken at the proposed depth and location of the soakaway, to be included in the drainage strategy and design reports. Note that the LLFA would expect the worst rate (not the average rate) to be used to define the number and size of soakaways required.

Please note that if multiple soakaways in a localised area are proposed then appropriate space between them should be allowed, so as not to inhibit the infiltration capacity. We are aware that an alteration to the design has been made based on previous feedback relating specifically to the drainage strategy report, although we are yet to review the updated design and reports. Therefore, we will remind you that the drainage strategy will also need to include information regarding the long term maintenance arrangements and requirements, the design life of the soakaways, space and access arrangements to facilitate the maintenance activities.

The Environment Agency should review the design in terms of water quality treatment in terms of groundwater protection prior to discharge of the surface water to the unsaturated zone. The LLFA will expect to have sight of the Environment Agency's formal response on this matter prior to considering whether such an approach is suitable by the LLFA.

The clarification provided regarding the rainfall gauge site selection in the HEWRAT is noted.

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: [redacted]
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
[redacted]

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Ball, Jason

From: Lead Local Flood Authority <llfa@norfolk.gov.uk>
Sent: 30 October 2020 06:49
To: [redacted]
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 D. Technical Note on Deep Drainage

Table of contents

Figures

Tables

1. Introduction

1.1.1. Highways England proposes to upgrade the A47 from a single carriageway to a dual carriageway between Blofield at Yarmouth Road and North Burlingham to the east of the B1140. These scheme extents are presented in Figure 1-1 of the Drainage Strategy Report (DSR; Volume 3, Appendix 13.2 (**TR010040/APP/6.2**)).

1.1.2. As part of the upgrades a new drainage system is required, the design of which is set out in the Drainage Strategy Report (Volume 3, Appendix 13.2 (**TR010040/APP/6.2**)). The drainage design plan is given in Annex B of the DSR (**TR010040/APP/6.2**).

1.1.3. This report supports the DSR in providing additional information to the Environment Agency to demonstrate that the preliminary drainage design will not result in potential pollution of groundwater. As such this report should be read in conjunction with the DSR (**TR010040/APP/6.2**).

1.2. Background

1.2.1. The DSR (**TR010040/APP/6.2**) identifies that deep drainage will have to be utilised for the proposed road drainage on the new A47 dualling at Blofield, due to a lack of nearby watercourses, flat topography and low permeability of near surface deposits.

1.2.2. Initial consultation with the Environment Agency on 27 April 2020 stated that the following conditions must be demonstrated for deep infiltration to be accepted:

- There are no other feasible options.
- Discharge to groundwater is indirect.
- The system is no deeper than is required to obtain sufficient soakage, in order to maximise attenuation in the unsaturated zone.
- Acceptable pollution control measures are in place.
- Risk assessments demonstrate that no unacceptable discharge to groundwater will take place.
- There are sufficient mitigating measures to compensate for the increased risk arising from the use of deep infiltration system.

1.2.3. Furthermore, the Environment Agency highlighted that deep infiltration SuDS for anything other than clean roof drainage in a Source Protection Zone (SPZ) 1 (inner protection zone) would not be acceptable.

1.2.4. The DSR (**TR010040/APP/6.2**) contains details of the development of the drainage design and mitigating measures, including pollution control. This technical note aims to give additional details on the following, with the aim of providing all information required to confirm that the above conditions have been met:

- Details of near surface ground conditions and infiltration testing along the route, focussing on locations of the infiltration trenches and basin
- Groundwater level monitoring
- Soakaway risk assessments
- Extents of SPZs in relation to the Site.

1.3. Sources of information

1.3.1. This report is based on information collected through ground investigations conducted in 2004 and 2018 at Stage 2 and 3 of the Scheme:

- A F Howland Associates (2004) A Report on a Ground Investigation for the Dualling of the A47 – Blofield to North Burlingham (Factual). For Edmund Nuttall Limited. Reference CBW/04.068/Final
- Highways Agency (2005) A47 Blofield to North Burlingham Dualling Geotechnical Report. Report number: D105885/GEO/003.
- BWB Consulting (2018) A47 Blofield, Norwich, Factual Ground Investigation Report (HEBLOFLD-BWB-00-XX-RP-YE-0001-FGIR-P2)
- Sweco UK Ltd. (2018) A47 Blofield to North Burlingham, Ground Investigation Report (HE551490-GTY-HGT-000-RP-CE-3001-P01)

1.3.2. The following is a list of additional sources of information used to support this report:

- Drainage Strategy Report (HE551490-GTY-HDG-000-RP-CD-00001)
- Highways England (2020) LA113 Road drainage and the water environment. Design Manual for roads and Bridges. Available online at: https://www.standardsforhighways.co.uk/prod/attachments/d6388f5f-2694-4986-ac46-b17b62c21727 .

2004 Ground investigation

1.3.3. A ground investigation was undertaken between 26 July and 15 September 2004 by A F Howland Associates on the instruction of Edmund Nuttall Ltd and Scott Wilson Kirkpatrick & Co Ltd as part of the Value Engineering Process and to inform the preliminary detailed design during Phase 1A of the ECI Contract. The purpose of the ground investigation was to create a refined ground model for the

whole route which extended for approximately 3km from the Blofield Bypass (TG 340 100) in the West to the Acle Bypass in the East (TG 380 099).

1.3.4. The ground investigation comprised exploratory boreholes at the location of the proposed overbridge at the White House junction to the east of North Burlingham, trial pits along the proposed alignment and approach roads, groundwater monitoring boreholes and soakaway and infiltration tests for the purposes of the design of the drainage system.

1.3.5. The following information collected as part of the 2004 ground investigation is relevant to the groundwater assessment:

- borehole logs
- water strike information
- infiltration tests and permeability tests
- groundwater level monitoring

1.3.6. Eight standpipes were installed for groundwater monitoring, the locations of which are shown on the mainline geological long sections presented in Appendix A. Groundwater levels were recorded on a very limited number of occasions between August and October 2004, following the construction of the boreholes.

2018 Ground investigation

1.3.7. The 2018 ground investigation was undertaken between 13th August and 20th September 2018 by BWB Consulting (BWB) on the instruction of Interserve Construction Ltd, (the Principal Contractor) on behalf of Highways England (the Client) to inform the preliminary design at Phase 3 of this Scheme.

1.3.8. The ground investigation comprised the following relevant to the drainage design:

- 32 machine excavated trial pits;
- 17 soakaway tests;
- 28 cable percussive boreholes of which seven were supplied with groundwater monitoring installations;
- 10 variable head tests;
- 12 post-investigation monthly groundwater monitoring visits;
- Chemical analysis of soils and groundwater (including soil pH analysis); and
- Geotechnical testing of soil.

2. Drainage design

2.1.1. Details of the infiltrations trenches and basin are provided in Table 2.1. Full details of the drainage design can be found in the DSR (**TR010040/APP/6.2**).

Table 2.1 Proposed design depths of soakaways and the infiltration basin

Drainage feature type	Road Drainage - Locations	Approximate location (grid reference)	Designed Soakaway Depths (m)	Soakaway/Basin ID on Drainage Drawings
Road drainage soakawaytrench	Mainline MC10 – Ch 3040	636651 309873	3.1	SR1
Road drainage soakawaytrench	Mainline MC10 – Ch 3560	637181 309876	4.5	SR2
Road drainage soakawaytrench	Mainline MC10 – Ch 3950	637629 309882	3.8	SR3
Road drainage soakawaytrench	MC40 – Ch 16	637565 309980	4.2	SR4
Road drainage soakawaytrench	MC40 – Ch 465	637571 309610	3.7	SR5
Road drainage soakawaytrench	MC50 – Ch 400	637435 309955	3.7	SR6
Road drainage soakawaytrench	MC00 – Ch 378	634597 309804	4.4	SR7
Road drainage soakawaytrench	MC90 – Ch 120	637624 309689	3.4	SR8
Clean water soakawaytrench	HML Ch 2300	635944 310009	2.7	SC1
Clean water soakawaytrench	HML Ch 3928	637570 309868	3.4	SC2
Clean water soakawaytrench	HSR MC50 Ch 450 – 515 & MC40 Ch 15 – 48	637531 310023	2.8	SC3
Clean water soakawaytrench	HSR MC00 – Ch 480	634627 309670	4.5 reducing to 2.5 for SC5	SC4 & SC5
Clean water soakawaytrench	Mainline MC10 – Ch 1125	634763 309690	4.5 (to be confirmed following further infiltration testing)	SC6 & SC7
Clean water soakawaytrench	Ch1500 heading west	635028 309894	4.5 (to be confirmed following further infiltration testing)	SC8
Infiltration basin	Ch 1207	634746 309747	3.2	PR1

2.1.2. The clean water soakaway trenches drain areas of land to the north and south of the existing A47, that previously drained to roadside ditches. These have been

diverted to soakaway as part of the Scheme. Clean water soakaway trenches SC1, SC4 / SC5 and SC6 / SC7 also take road drainage from sections of the existing A47. Although these sections of road on the existing A47 are included in the scheme extent for modification, they will not contribute to any increase in impermeable area. SC2, SC3 and SC8 are clean water soakaways that only take overland flows and no road drainage. The existing adjacent drainage ditches will remain in place, but overflow to new clean water soakaways, via interceptor ditches. The existing ditches provide some attenuation and pollution control of the surface water run-off from the existing A47 before they are picked up by the new interceptor drainage.

2.2. Drainage design constraints

2.2.1. The design of soakaway features has been based on the volume of storage required within the area available and on the results of infiltration testing. As the inlet pipe from the drainage network can be up to 1.8m below ground level (bGL) as it enters the soakaway due to the relatively flat topography, the depth of the soakaways has to be greater than this depth to provide an effective depth of infiltration. This is discussed in more detail within the DSR (**TR010040/APP/6.2**).

3. Ground Conditions

3.1. Geology

3.1.1. The ground conditions across the site can generally be described as the Lowestoft Formation underlain by the Happisburgh Glacigenic Formation, the Bytham Sand and Gravel and the Crag Group. Geological mapping of the area indicates that the Crag is underlain by the Ormesby Clay of the Thanet Formation beneath the eastern half of the Proposed Scheme[1]. Where the Ormesby Clay is absent the Crag directly overlies the Chalk. Neither the Thanet Formation nor the Cretaceous Chalk were encountered during either the 2005 or 2018 ground investigation.

3.1.2. A summary of superficial and solid geology is detailed in Table 3.1. Descriptions below are based on results from the 2018 ground investigation, which has been supplemented by description from the British Geological Survey (BGS) lexicon[2], and boundary information supplied from the BGS 1:50,000 scale superficial geology map.

[1] British Geological Survey (1991) 1:50,000 series map of Quaternary and Pre-Quaternary Geology, sheet 162 - Great Yarmouth. Available online at: http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001653/ Accessed 04 May 2020

[2] L British Geological Survey Lexicon of Named Rock Units. Available online at https://www.bgs.ac.uk/lexicon/ Accessed 04 May 2020.

Table 3.1 Summary of geological units

Age	Geological Unit	Lithological Description	Elevation at top of strata (m AOD)	Thickness (m)
n/a	Made Ground	Brown sandy gravelly silt/clay with inclusions of concrete, brick, clay pipe, clinker, asphalt, and plastic bags.	26 - 17	0 – 2
Pleistocene	Lowestoft Till Formation	The Lowestoft Till Formation forms an extensive sheet of chalky till, together with outwash sands and gravels, silts and clays. The till is characterised by its chalk and flint content. The carbonate content of the till matrix is about 30%, and tills within the underlying Happisburgh Formation have less than 20%.	28	0 - 7
	Happisburgh Glacigenic Formation – sands and gravels	Formerly known as the Corton Formation. Yellowish-brown loose to medium dense sand and gravel	17 - 22	0 - 10
	Happisburgh Glacigenic Formation - Diamicton	The diamictons of the Happisburgh Glacigenic Formation are typically sandy matrix-supported diamictons that contain a high abundance of flint and quartzose lithologies relative to chalk, distinguishing them from the more chalky tills of the overlying Lowestoft Formation.	14 - 22	4 - 5
	Bytham Sand and Gravel Formation	Formerly known as the Kesgrave Formation. The Bytham Sand and Gravel Formation encompasses fluvial, lacustrine and organic deposits of the Bytham River. Commonly a basal coarse-grained gravel is overlain by red fine- to medium-grained sand. The gravels are composed of Triassic grey and purple quartzite, vein quartz, Jurassic limestone and ironstone, and Carboniferous sandstone and chert. Sedimentary structures imply deposition in a braided river environment. Very low fine content.	5 - 10	~5 - 10m; confirmed at western extents only
Pliocene - Pleistocene	Crag Group	Shallow-water marine and estuarine sands, gravels, silts and clays. The sands are characteristically dark green from glauconite but weather bright orange with haematite 'iron pans'. The gravels in the lower part of the group are almost entirely composed of flint. Those higher in the group include up to 10% of quartzite from the Midlands, igneous rocks from Wales, and chert from the Upper Greensand of south-eastern England. Grey marine deposited cohesive material with shell fragments evident.	~ 1 - ~ -0.5	Not confirmed
Cretaceous	Upper Chalk Formation	White chalks (microporous coccolithic limestone) with beds of flint, nodular chalks, hardgrounds and marl seams.	Not confirmed	Not confirmed

3.1.3. The mainline geological long section presented in Appendix A provides lithological information collected from borehole logs from the 2004 and 2018

ground investigations. This highlights cohesive and granular horizons within the Lowestoft Formation and the Happisburgh Glacigenic Formation and highlights the variability within each.

3.1.4. Across the majority of the scheme the Lowestoft Formation is encountered below topsoil with the exception of the topographic low point to the east of Hemblington Road, Blofield (see Appendix A, chainage Ch1+000m to Ch1+350m). This topographic low exposes the Happisburgh Glacigenic formation at surface, and which is generally granular for a depth of 0 – 3 m bGL moving into more cohesive deposits below this. However, there is considerable variability in the permeability of these deposits as shown on the cross section.

3.2. Hydrogeology

Overview

3.2.1. Table 3.2 summarises Environment Agency aquifer designations, along with their extents within the study area. Where geological units are not present at surface, assumed aquifer designation or equivalent hydrogeological definitions have been provided.

3.2.2. There are two designations available for the Happisburgh Glacigenic Formation across the Scheme, due to its varying lithology. A brief explanation of their relative locations is provided in Table 3.2.

Table 3.2 Aquifer designations

Geological Unit	EA Aquifer Designation	Approximate Extents
Breydon Formation – peat	Unproductive strata	Along route of Witton Run and tributary, to south west of Scheme
Undifferentiated glaciofluvial sands and gravels	Secondary A aquifer	Along route of Witton Run and tributary, to south west of Scheme
Lowestoft Formation - Diamicton	Secondary (undifferentiated) aquifer	Outcrops along majority of the Proposed Scheme. Absent at western extents and at TG 349 099.
Happisburgh Glacigenic Formation - sands	Secondary A aquifer	Present along entire extents of the Proposed Scheme, except between TG 346 099 and TG 350 099. Outcrops in one small area at chainage TG 346 099.
Happisburgh Glacigenic Formation - Diamicton	Unproductive strata	Entire extents of the Proposed Scheme. Outcrops between TG 346 099 and TG 350 099.
Crag group and Bytham Sand and Gravel Formation (undifferentiated)	Secondary A aquifer	Extents of Bytham Sand and Gravel Formation not known.
Crag Group	Principal aquifer	Entire extents of the Proposed Scheme (beneath Lowestoft and Happisburgh Glacigenic formations) Present at surface along the Witton Run and tributaries.
Thanet Formation – Ormesby Clay	Not classified – assumed aquitard	From approximate NGR TG 362 099 to eastern extents
Chalk	Not present at surface – assumed Principal aquifer	Entire extents of the Proposed Scheme (beneath Crag and Thanet Formation)

3.2.3. As mentioned above in Section 3.1.4. the exposure of the Happisburgh Glacigenic Formation at surface occurs in the west of the Scheme and to the east of Hemblington Road, Blofield, in a topographical low area that drains to the south west and towards the Run Dike.

Aquifer parameters

3.2.4. The results of all percolation tests, infiltration tests and permeability (rising and falling head) tests conducted along the route are summarised in Table 3.3, Table 3.4 and Table 3.5.

3.2.5. During the 2004 ground investigation four hand-dug soakaway tests were carried out along the proposed route to a depth of 1.25m. All tests except HDS1 Test A (on the north side of the carriageway and approximately adjacent to the infiltration basin location) failed to drain. Note that although HDS 1 Test A was deemed to be a successful percolation test, subsequent tests on the same trial pit also failed.

3.2.6. The first infiltration tests carried out at shallow depths (INF01 and INF02) during the 2018 ground investigation also failed to drain. Because of this, a decision was made during the ground investigation to carry out subsequent infiltration tests on the shallowest horizon encountered that was considered suitable for a successful infiltration test. Subsequent infiltration tests are therefore all at depths greater than 2m.

Table 3.3 Summary of 2004 ground investigation infiltration testing

Pit Ref	Easting	Northing	Test ref	Depth (m)	Soil infiltration rate (m/s)	Stratigraphy	Nearest drainage feature (m)
HDS 1	634614	309921	Test A	1.25	Average percolation value of Vp (s) = 17.52	Sandy CLAY (TP11/04)	SR7 (~100m south of test)
			Test B		Failed to drain		
			Test C		Failed to drain		
			Test D		Failed to drain		
HDS 2	634944	309929	Test A	1.25	Failed to drain	Slightly sandy CLAY (BH02/04)	n/a (no drainage features close to test)
			Test B		Failed to drain		
			Test C		Failed to drain		
			Test D		Failed to drain		
HDS 3	636426	309978	Test A	1.25	Failed to drain	Sandy CLAY (TP32/04)	SR1
			Test B		Failed to drain		
			Test C		Failed to drain		
			Test D		Failed to drain		
HDS 4	637690	309848	Test A	1.25	Failed to drain	Slightly clayey slightly gravelly SAND*. *Based on nearest log (2018-INF15)	SR3
			Test B		Failed to drain		
			Test C		Failed to drain		
			Test D		Failed to drain		
SPA1	634846	309914	Test 1	2.3	2.20E-05	Sandy CLAY with sandy pockets	PR1, SC6&7 and SC8
			Test 2		1.60E-05		
			Test 3		9.30E-06		
SPA2	636354	310003	Test 1	2.5	9.30E-07	Sandy CLAY with sand pocket	SR1
			Test 2		Failed to drain		
			Test 3		Failed to drain		
SPA3	637626	309718	Test 1	2.9	1.50E-05	Gravelly CLAY	SC3, SR4 and SR6
			Test 2		1.70E-05		
			Test 3		1.80E-05		

Table 3.4 Summary of 2018 ground investigation trial pit soakaway test results

Pit Ref	Easting	Northing	Test ref	Depth (m)	Soil infiltration rate (m/s)	Stratigraphy	Nearest drainage feature (m)	Cohesive or granular?
INF01	634399	309883	Test 1	2.1	Failed	Happisburgh Glacigenic Formation		Cohesive
INF01a	634399	309875	Test 1	4.6	Failed	Happisburgh Glacigenic Formation		Cohesive
INF02	634546	309881	Test 1	3.1	Failed	Happisburgh Glacigenic Formation		Cohesive
INF04	634699	309775	Test 1	4	2.10E-05	Happisburgh Glacigenic Formation	PR1, SC4&5, SC6&7 and SR7	Granular
INF04			Test 2	4	1.40E-05		PR1, SC4&5, SC6&7 and SR7	Granular
INF04			Test 3	4	1.20E-05		PR1, SC4&5, SC6&7 and SR7	Granular
INF05	634754	309780	Test 1	3	Failed	Happisburgh Glacigenic Formation	PR1, SC4&5, SC6&7 and SR7	Cohesive
INF05a	634757	309780	Test 1	3.5	4.70E-05	Happisburgh Glacigenic Formation	PR1, SC4&5, SC6&7 and SR7	Granular
INF05a			Test 2	3.5	2.00E-05		PR1, SC4&5, SC6&7 and SR7	Granular
INF05a			Test 3	3.5	1.90E-05		PR1, SC4&5, SC6&7 and SR7	Granular
INF07	634880	309822	Test 1	4.6	Failed	Happisburgh Glacigenic Formation		Cohesive
INF07			Test 2	4.7	Failed			Cohesive
INF10	635919	309911	Test 1	4.5	1.10E-05	Lowestoft Formation	SC1	Granular
INF11	636191	309922	Test 1	3.6	Failed	Lowestoft Formation		Granular
INF12	636400	309887	Test 1	4.9	Failed	Lowestoft Formation		Granular
INF13	636680	309835	Test 1	4	2.40E-05	Lowestoft Formation	SR1	Granular
INF13			Test 2	4	1.20E-05		SR1	Granular
INF14	637180	309825	Test 1	4.5	6.90E-05	Lowestoft Formation	SR2	Granular
INF14			Test 2	4.5	7.70E-05		SR2	Granular
INF14			Test 3	4.5	4.70E-05		SR2	Granular
INF15	637658	309854	Test 1	4	2.80E-05	Lowestoft Formation	SR3	Granular
INF15			Test 2	4	2.10E-05		SR3	Granular
INF15			Test 3	4	1.40E-05		SR3	Granular
INF18	637580	309848	Test 1	3.1	Failed	Lowestoft Formation	SR3, SC2	Cohesive
INF19	637598	309616	Test 1	3.2	8.70E-06	Lowestoft Formation	SR8	Granular

Table 3.5 Summary of 2018 ground investigation falling head borehole permeability tests

Borehole Ref	Easting	Northing	Base of Standpipe (m)	Resting Water Level (m bd)	Length of Response Zone (m)	K (m/s)	Geology	Unit
2018-BH01	634689	309863	7.5	7.5	6	2.20E-07	Very sandy clay	Happisburgh Glacigenic Fm
2018-BH02	634818	309867	7	7	1	2.10E-06	Clayey sand	Bytham Sand and Gravel Fm
2018-BH04	634831	309887	7	7	1	6.59E-07	Clayey sand	Bytham Sand and Gravel Fm
2018-BH05	634791	309853	6.2	6.2	0.5	1.46E-06	Silty clay	Bytham Sand and Gravel Fm
2018-BH06	634812	309851	5.5	5.5	1	2.04E-07	Slightly clayey sand	Happisburgh Glacigenic Fm/Bytham Sand and Gravel Fm
2018-BH08	635040	309842	3	3	1.5	2.41E-07	clayey sand	Happisburgh Glacigenic Fm
2018-BH09	634846	309882	6.5	6.5	0.5	1.67E-06	clayey sand	Bytham Sand and Gravel Fm
2018-BH20	637523	309849	7	7	1	5.43E-06	Slightly clayey sand	Lowestoft Fm
2018-BH21	637517	309826	3	3	1.5	FAIL	Clayey sand	Lowestoft Fm
2018-BH26	637511	309894	4.9	4.9	0.4	1.50E-06	Slightly clayey sand	Lowestoft Fm

3.2.8. Generally, 2018 infiltration results indicate that there is suitable soil infiltration potential at depths of between 3 and 5 m bGL. Shallow infiltration tests, as outlined in Section 3.2.4, indicate that there is considerably less infiltration potential at depths of less than 2m bGL.

Summary of findings

3.2.9. The results presented above highlight that the infiltration capacity of both the Lowestoft Formation and the Happisburgh Glacigenic Formation is variable. These results were taken into account in the drainage design in identifying locations and depths at which soakaways would be successful.

Groundwater levels and flows

3.2.10. Groundwater level data was collected over 11 months between September 2018 and August 2019 and is presented below in Table 3.6. The range of groundwater levels at individual boreholes is also shown on the cross sections presented in Appendix A, and shows that these generally coincide with the boundary between the Happisburgh Glacigenic Formation and the Bytham Sands and Gravels Formation. In addition, there is a limited amount of groundwater level monitoring available from the 2004 ground investigation (between August and October 2004), which also showed groundwater levels to coincide with the boundary between the two formations.

Table 3.6 Groundwater level monitoring summary (October 2018 to September 2019)

Borehole Reference Number	Ground Elevation (m aOD)	Response Zone Depths (m bDAT)	Monitoring Horizon	Min GW level (m bGL)	Min GW level (m aOD)	Date	Max GW level (m bGL)	Max GW level (m aOD)	Date	Comment
2018 - BH01	15.97	7 – 10	Happisburgh Glacigenic Fm	7.39	8.58	14/08/19	7.01	8.96	20/09/18	Adjacent to PR1, SC4&5, SC6&7 and SR7
2018 - BH04 (50mm)	15.69	15 – 22	Crag Group	7.52	8.17	14/08/19	7.06	8.63	13/09/18	
2018 - BH04 (19mm)	15.69	25 – 30	Crag Group	8.64	7.05	15/07/19	7.35	8.34	14/09/18	
2018 - BH06	14.77	7.5 – 14.5	Bytham Sands and Gravels Fm	6.36	8.41	14/08/19	5.89	8.88	20/09/18	
2018 - BH07	15.83	7 – 10	Happisburgh Glacigenic Fm	7.36	8.47	14/08/19	6.42	9.41	20/09/18	Close to PR1, SC4&5, SC6&7, SC8 and SR7
2018 - BH08	20.96	5 – 6	Happisburgh Glacigenic Fm		DRY			DRY		Close to SC8
2018 - BH10	26.48	7 – 10	Happisburgh Glacigenic Fm		DRY			DRY		
2018 - BH13	26.33	18 – 25	Happisburgh Glacigenic Fm	19.99	6.34	29/05/19	19.60	6.73	28/01/19	Closest to SR1 and SC1
2018 - BH15	25.64	7 - 9	Lowestoft Formation		DRY			DRY		
2018 - BH18 (19mm)	25.50	19 - 22	Happisburgh Glacigenic Fm	20.83	4.67	07/09/19	19.04	6.46	28/01/19	Closest to SR2, SR3, SR4, SR5, SR6, SR8, SC2 and SC3
2018 - BH20	25.64	18 - 28	Happisburgh Glacigenic Fm		N/A			N/A		Erroneous data, possibly due to kink in standpipe
2018 - PBH01	25.99	1 - 20	Lowestoft Formation	19.59	6.4	08/04/19	19.05	6.94	21/11/18	
2018 - PBH02	25.94	4 - 14	Lowestoft Formation		DRY			DRY		Although data was recorded, it is noted in the GIR that PBH02 was dry and has been discounted.

3.2.11. Groundwater levels, as shown on Figure 1 below, show a steadily decreasing groundwater level from the autumn of 2018 through to the summer of 2019. The UK Centre for Ecology and Hydrology UK Droughts: SPI index[3] (Standardised Precipitation Index), which characterises meteorological drought, suggests that the area has experienced a rainfall deficiency over the monitoring period. This would explain the apparent lack of recharge over winter months, as shown on Figure 1. These levels are generally in agreement with average groundwater levels recorded during the 2004 ground investigation, however, which ranged between 8.5 and 14.2m below datum.

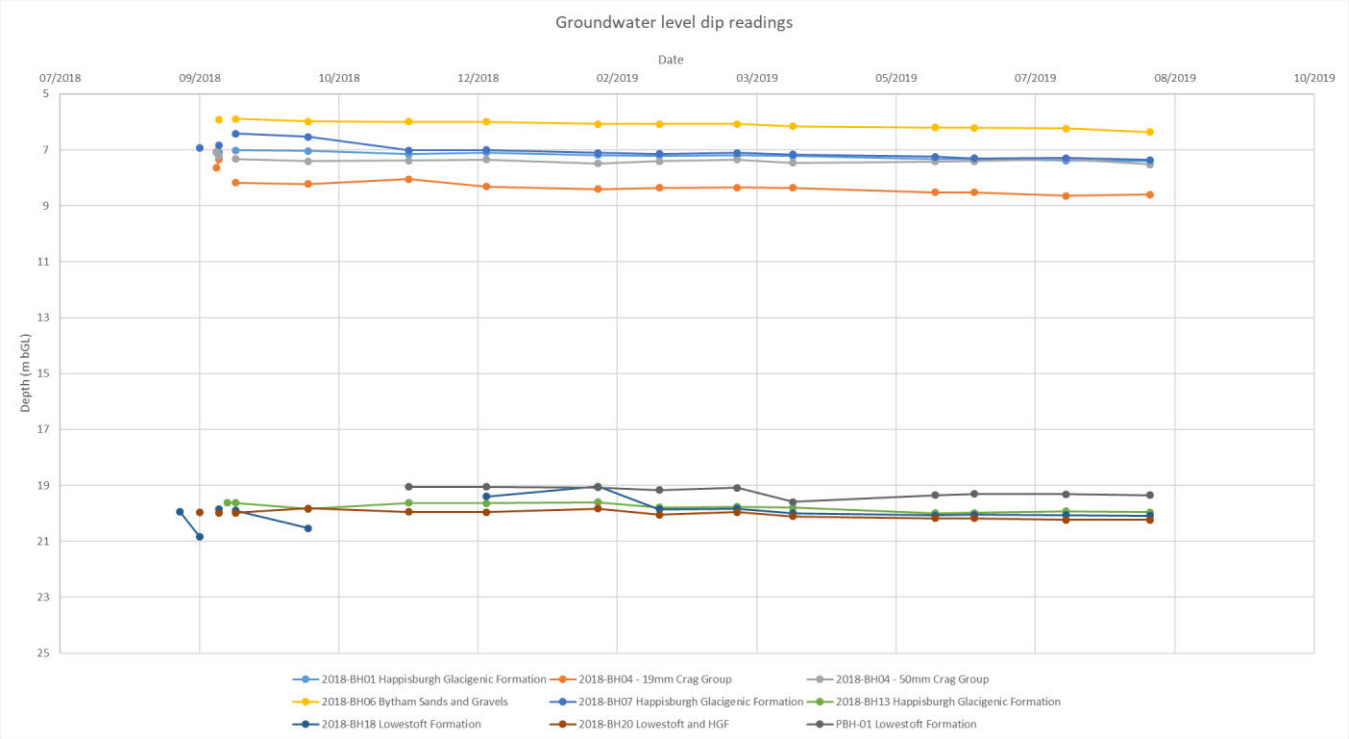


Figure 1 Groundwater level hydrograph, September 2018 to August 2019

Summary of findings

3.2.12. The results of the groundwater monitoring highlight that the unsaturated zone beneath the infiltration trenches and basin is at between 7m and 19m bGL. Eleven months of monitoring data has been reviewed and the seasonal variation has been considered taking into account the effects of mild drought in the area as described above. This confirms however, that discharge to groundwater from these features is indirect and that sufficient attenuation can occur in the unsaturated zone throughout the year.

[3] CEH (2020) UK Droughts: SPI. Available online at: https://eip.ceh.ac.uk/apps/droughts/. Accessed: 07/05/2020.

Source protection zones

3.2.13. Figure 2 presents the extents of SPZs in relation to the Site, and specifically infiltration features. This shows that there is one area of SPZ3 (Total Catchment) at the western extents of the Scheme, which is approximately 0.5km to the west of the nearest infiltration feature in the proposed drainage design.

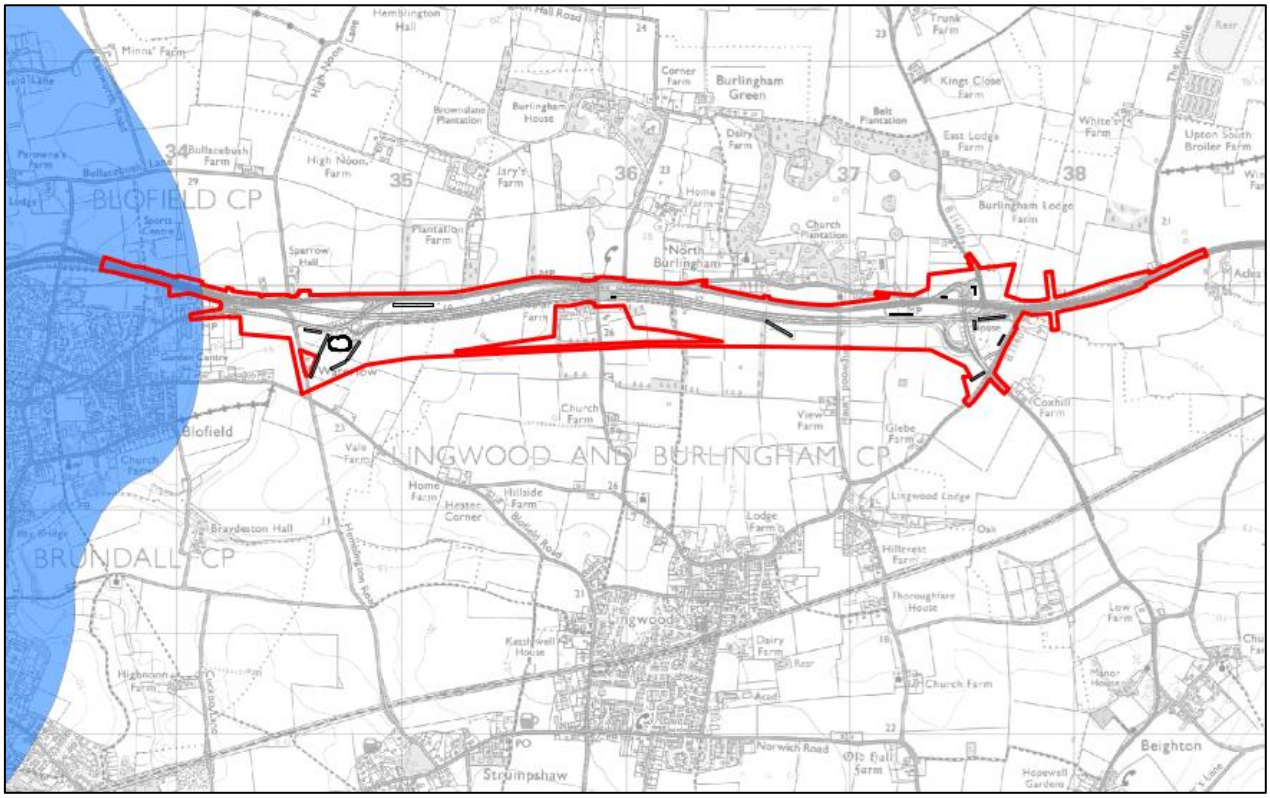


Figure 2 Source Protection Zones (Extents of the SPZ3 are shown in blue, infiltration features are shown in black and the Site is shown in red).

Summary of findings

3.2.14. There are no infiltration features within a SPZ1.

4. Risk Assessments

4.1. Introduction

4.1.1. The risk assessments to demonstrate that no unacceptable discharge to groundwater occurs follow the guidance provided in DMRB LA 113 (Highways England, 2020) and specifically use the Highways England Water Risk Assessment Tool (HEWRAT). Clean water soakaways that do not take any road drainage (SC2, SC3 and SC8) have not been assessed further. These drain areas that previously drained to roadside ditches considered to ultimately discharge to ground, and therefore do not present any change to the current baseline conditions.

4.2. Input parameters

4.2.1. The following is a list of source and pathway input parameters to the HEWRAT groundwater assessment:

- Annual average traffic flow
- Rainfall depth (annual averages)
- Drainage area ratio
- Infiltration method
  - "Region" selected for infiltration basin PR1, and "Continuous" selected for all infiltration trenches.
- Unsaturated zone
  - a conservative estimate of the depth to water table has been based on groundwater monitoring data available for the monitoring boreholes listed in Table 3.6.
- Flow type
  - "Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)" was selected to represent the variability within the Lowestoft and Happisburgh Glacigenic formations.
- Unsaturated zone clay content
  - Particle size distribution results were available for a number of 2018 ground investigation borehole samples across the scheme, and results ranged from 0 to 46% clay content. The most appropriate result was selected for each infiltration feature, based on the nearest adjacent borehole and sample depth below the base of the infiltration feature and within the unsaturated zone.
- Organic carbon

- Total organic carbon results were available for a limited number of 2018 ground investigation samples taken from boreholes BH7, BH8, BH15 and BH22 and trial pit TP28. Sample results ranged between 0.3 and 1.0%. and the most appropriate result was selected for each infiltration feature.

- Unsaturated zone soil pH
  - Soil pH results were available for a number of 2018 ground investigation borehole samples across the scheme. Sample results for approximate depths and within lithologies underlying the soakaway features averaged pH 8.1 to a maximum depth of 4 m bGL. The most appropriate value was selected for each infiltration feature.

4.3. Results

4.3.1. A summary of the risk assessments for each infiltration trench / basin from the HEWRAT results is given below in Table 4.1 and screenshots of the full results for these risk assessments is provided in Appendix B. The infiltration basin PR1 is the drainage feature that scored highest in the risk assessment, although this result is <150 which classifies it as low risk. Risk assessments for the linear road drainage and clean water infiltration trenches are all categorised as low risk, despite the varying input parameters for drainage area ratio, unsaturated zone depth or unsaturated zone soil pH.

Table 4.1 Summary of HEWRAT method C risk assessments for infiltration features.

Infiltration feature Ref	Chainage	Risk Assessment Score	Risk Screening Level
PR1	Ch1207 taking road drainage from networks: Ch 415 – 1075 and Ch 1075 – 2470.	145	Low
SR1	Ch300 taking road drainage from networks: Ch 2470 – 3040 and Ch 3170 – 3040.	125	Low
SR2	Ch 3560 taking road drainage from network: Ch 3169 – 3735	110	Low
SR3	Ch 3950 taking road drainage from network: Ch 3734 – 3950	115	Low
SR4	MC40 Ch 16	120	Low
SR5	MC40 Ch 465 taking road drainage from network: Ch 250 - 470	120	Low
SR6	MC50 – Ch 400	120	Low
SR7	MC00 – Ch 378	130	Low
SR8	MC90 – Ch 120	120	Low
SC1	HML Ch 2300	110	Low
SC4 & SC5	HML MC00 – Ch 480	130	Low
SC6 & SC7	Mainline MC10 – Ch 1125	130	Low

Summary of findings

4.3.2. The risk assessments presented above demonstrate that no unacceptable discharge to groundwater will take place.

5. Conclusions

5.1.1. The DSR (**TR010040/APP/6.2**) demonstrates that there are no other feasible options to deep drainage for the A47 Blofield to North Burlingham Scheme.

5.1.2. This technical note highlights that the infiltration capacity of both the Lowestoft Formation and the Happisburgh Glacigenic Formation is variable. Infiltration and permeability testing results were taken into account in the drainage design in identifying locations and depths at which soakaways would be successful.

5.1.3. The groundwater level monitoring presented highlight that the unsaturated zone beneath the infiltration trenches and basin is at around 7 - 19m bGL, allowing for seasonal variation. This confirms that discharge to groundwater from these features is indirect.

5.1.4. The DSR (**TR010040/APP/6.2**) confirms that infiltration features have been designed to keep depths to a minimum in accordance with the guideline CD 530 Design of Soakaways, so that attenuation in the unsaturated zone can be maximised.

5.1.5. The DSR (**TR010040/APP/6.2**) highlights pollution control measures to be included in the preliminary drainage design.

5.1.6. This technical note presents the risk assessments carried out on all infiltration features, and highlights that no unacceptable discharge to groundwater will take place.

5.1.7. The DSR (**TR010040/APP/6.2**) demonstrates that within the confines of the Proposed Scheme, there are sufficient mitigating measures incorporated into the design to compensate for the increased risk arising from the use of deep infiltration system, and as summarised below.

- The first flush of surface water run-off will be treated in the filter drains which drain the majority of the scheme.
- Catchpits will allow for the settlement of silt along the drainage runs.
- The infiltration basin will include a shallow lined settlement basin / forebay at the inlet to the infiltration basin to capture first flush discharges.
- 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 soakaways or the infiltration basin.
- Dedicated offline spillage containment tanks will be provided at the outfalls upstream of the infiltration systems if deemed necessary following the Spillage Containment Assessment.

5.1.8. There are no deep infiltration SuDS features located within a SPZ1.

Appendix A. Mainline Geological Long Sections

LEGEND

- TOPSOIL
- MADE GROUND
- LOFT GRANULAR
- LOFT COHESIVE
- HPGL GRANULAR
- HPGL COHESIVE
- CRBY GRANULAR
- CRBY COHESIVE

BOREHOLE LOCATION DATES AS FOLLOWS:
2018-XXXX = 2018
XXXX/04 = 2004
XXXX/92 = 1992

2018-BH01

SPT - N VALUE → 7 / 8 / 11 / 28 / 35

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:
CERTAIN
UNCERTAIN
POSSIBLE

IMPORTANT

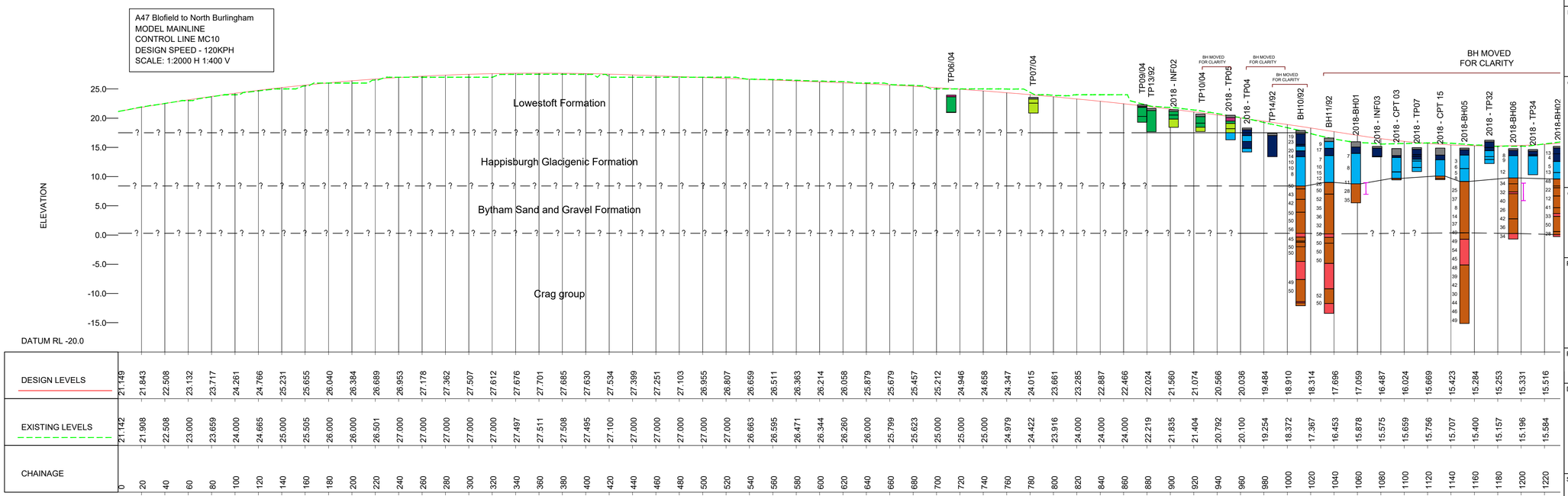
SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

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

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

HAZARD REF	BRIEF HAZARD DESCRIPTION
G1	This area has been identified as having a high UXO risk.
G2	There is an IP Gas main in the vicinity of the works. Ref to "Cadent Gas Pipeline Survey" Report UX85585 ICL-DJ-001 (Interserve, 2018) for pipe location as identified during SI.

PLAN 1
Scale: 1:2000



PROFILE
Scale: 1:2000 H, 1:400 V

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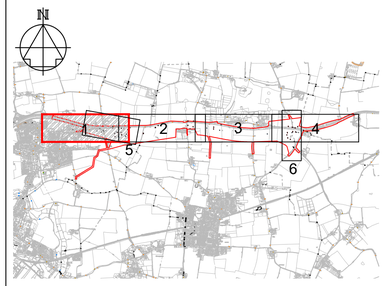
NOTES



KEY TO SYMBOLS

- MAXIMUM AND MINIMUM RECORDED GROUND WATER LEVEL
- BOREHOLE
- CONE PENETRATION TEST
- INFILTRATION PIT
- TRIAL PIT
- TRIAL TRENCH
- DYNAMIC PROBE TEST (DPT)
- HAND DUG SOAKAWAY (HDS)/ SOAKAWAY PIT (SPA)

LOFT - Lowestoft Formation
HPGL - Happisburgh Glacigenic Formation
CRBY - Crag Group And Bytham Sand And Gravel Formation (Undifferentiated)

NOTE: GEOTECHNICAL FENCE DIAGRAMS CREATED USING A 30M OFFSET FROM ROAD CENTRELINE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	17/02/20	FOR INFORMATION	MM	DT	DT
P02	01/04/20	UPDATED TO COMMENTS	MM	MD	MD

DESIGNER
SWECO

CONTRACTOR
GallifordTry

CLIENT
highways england

PROJECT TITLE
A47 BLOFIELD TO NORTH BURLINGHAM

PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
MAINLINE GEOLOGICAL LONG SECTION
SHEET 1 OF 4

SUITABILITY
SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:2000	S3	P02

DRAWING NUMBER
HE551490-GTY-VGT-000-DR-VG-30001

LEGEND

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2018-BH01

SPT - N VALUE

7
8
11
28
35

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:

CERTAIN ——————

UNCERTAIN — — — —

POSSIBLE –?–?–?–?–?–

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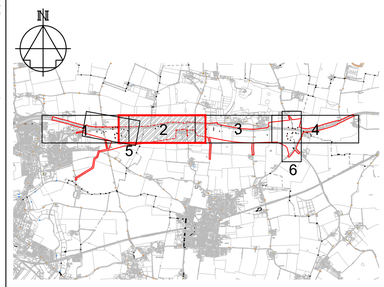
PLAN 2
Scale: 1:2000

NOTES



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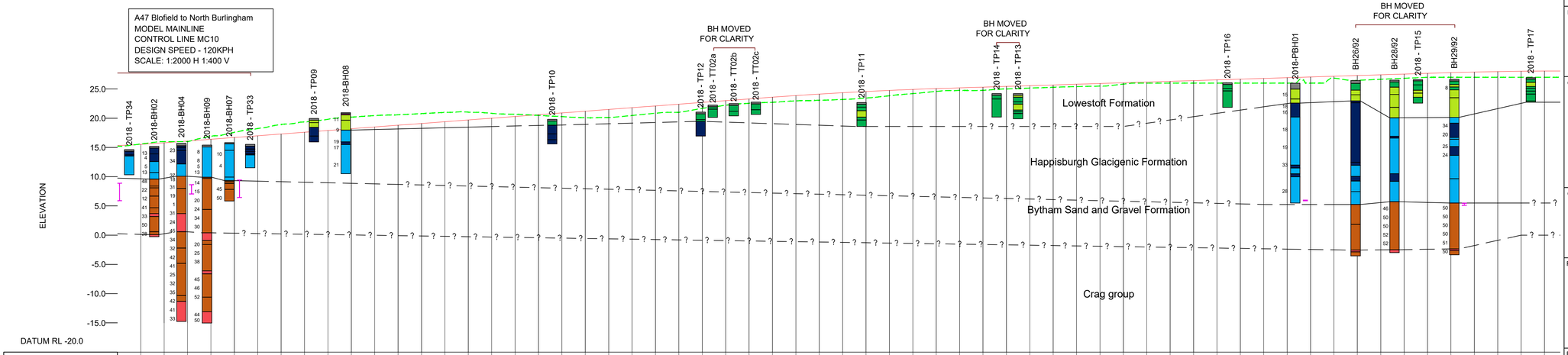

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PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
MAINLINE GEOLOGICAL LONG SECTION
SHEET 2 OF 4

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DRAWING NUMBER
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LEGEND

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- CRBY COHESIVE

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XXXX/92 = 1992

10BH18-102

SPT - N VALUE

7
8
11
28
35

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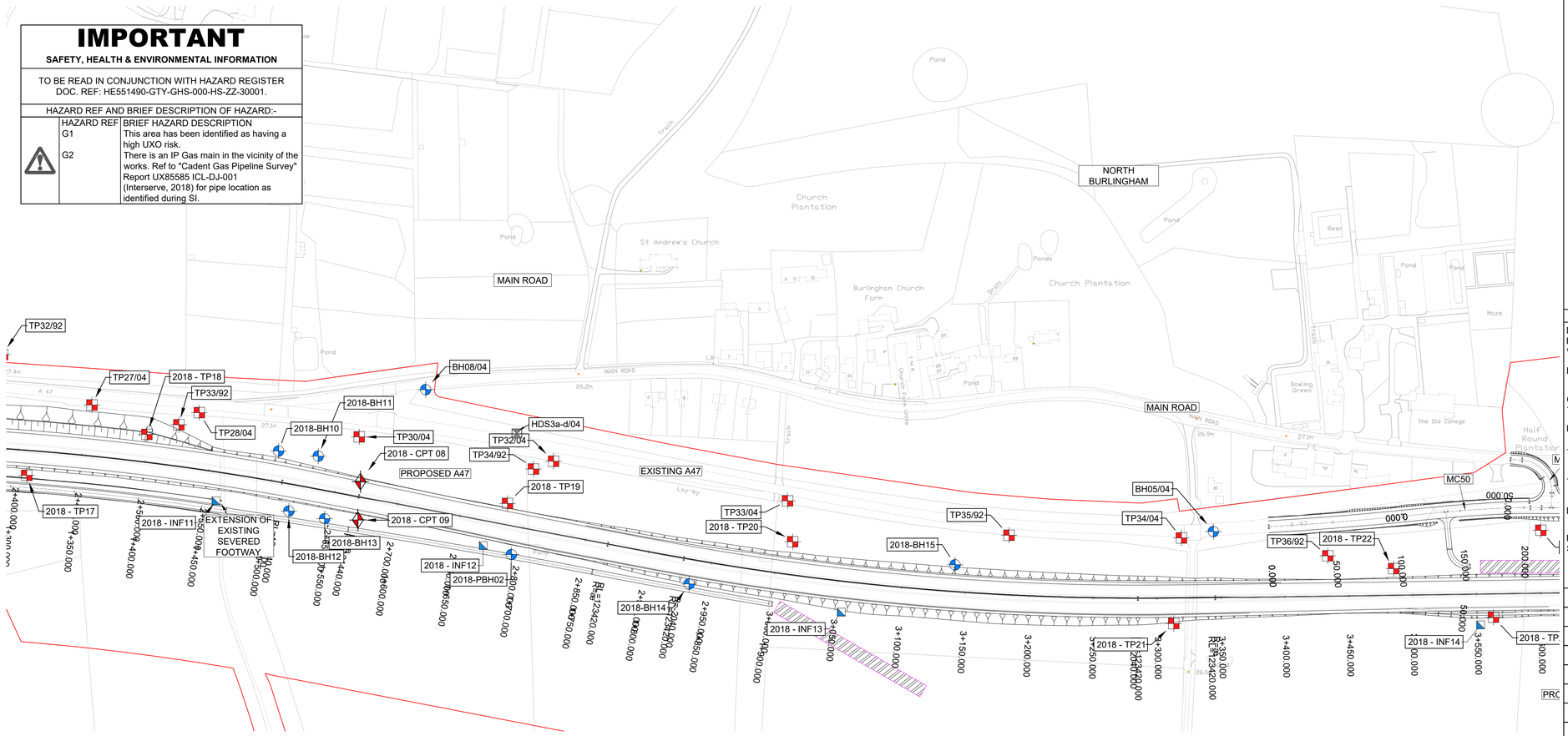

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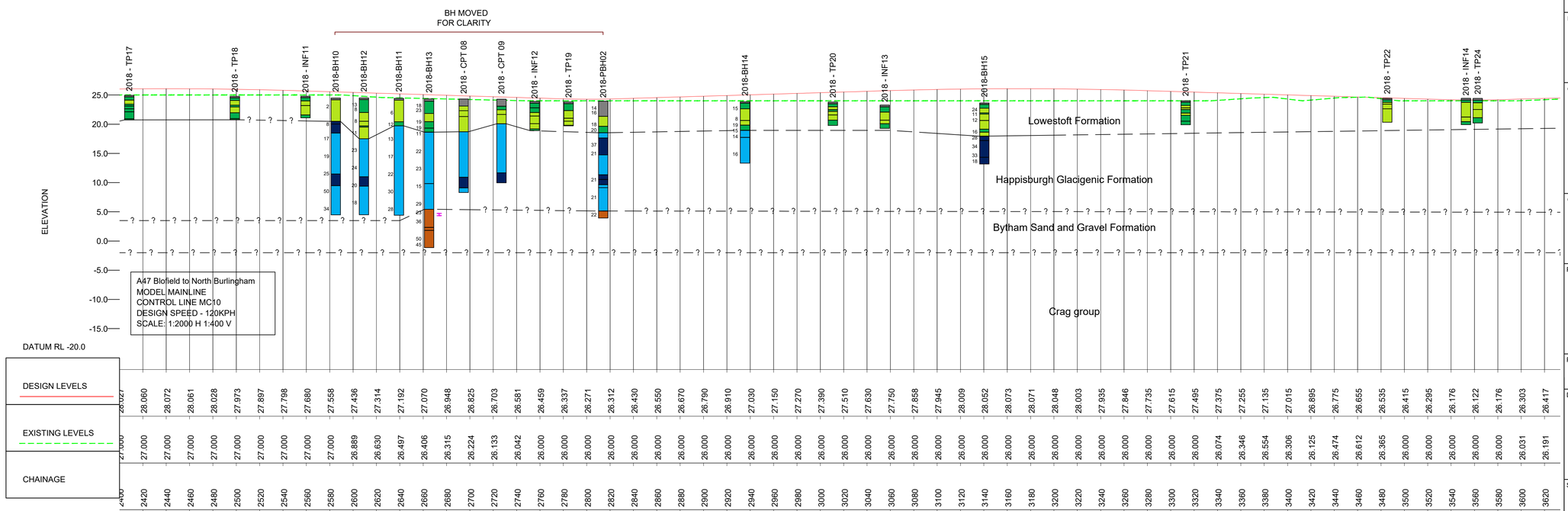

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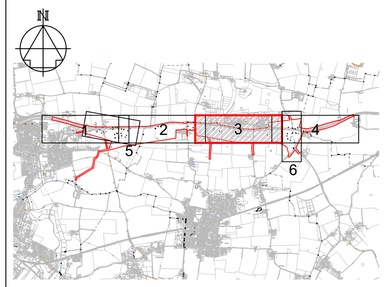
NOTES



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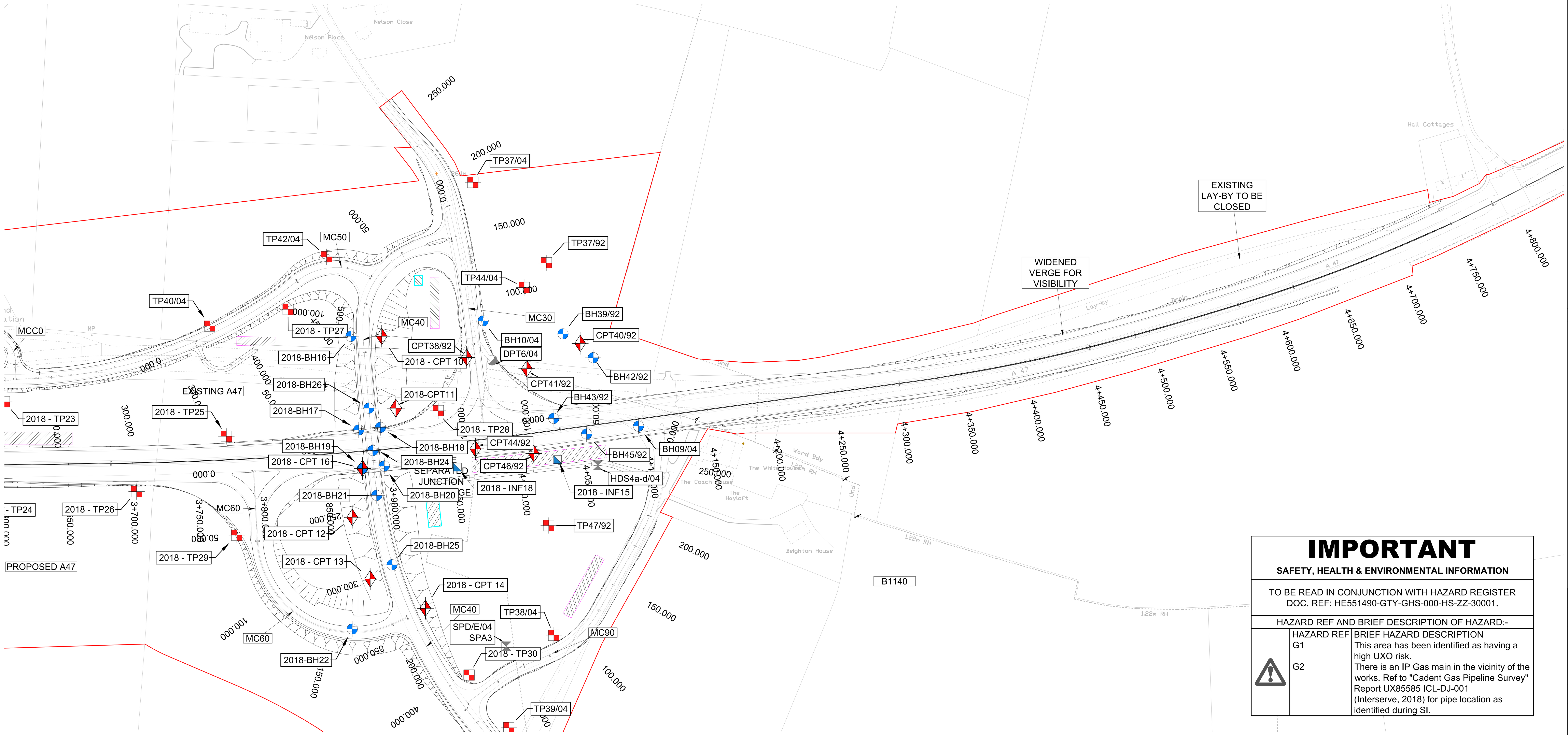
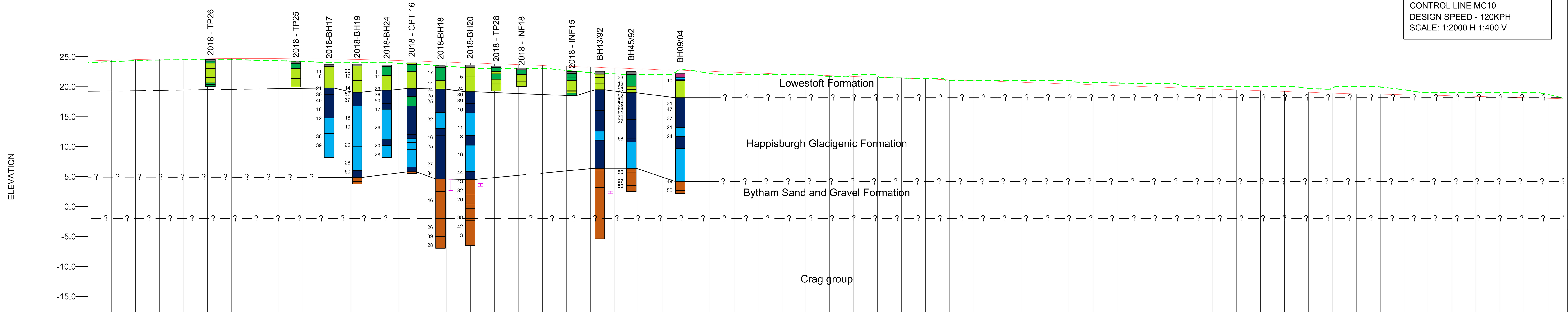
- UNCERTAIN — — —
- POSSIBLE —?—?—?—?—?—



PLAN 4
Scale: 1:2000

BH MOVED FOR CLARITY



A47 Blofield to North Burlingham
MODEL MAINLINE
CONTROL LINE MC10
DESIGN SPEED - 120KPH
SCALE: 1:2000 H 1:400 V

CHAINAGE	DESIGN LEVELS	EXISTING LEVELS
3600	26.303	26.031
3620	26.417	26.191
3640	26.512	26.350
3660	26.590	26.450
3680	26.649	26.477
3700	26.690	26.484
3720	26.712	26.480
3740	26.717	26.417
3760	26.703	26.319
3780	26.671	26.216
3800	26.621	26.031
3820	26.553	26.000
3840	26.466	26.000
3860	26.362	25.852
3880	26.239	25.709
3900	26.101	25.417
3920	25.961	25.096
3940	25.821	25.000
3960	25.681	25.000
3980	25.541	25.000
4000	25.401	24.718
4020	25.261	24.332
4040	25.121	24.152
4060	24.981	24.000
4080	24.841	24.000
4100	24.701	24.807
4120	24.561	24.222
4140	24.421	24.000
4160	24.281	24.000
4180	24.141	24.000
4200	24.001	24.000
4220	23.861	23.708
4240	23.721	24.000
4260	23.581	23.845
4280	23.441	23.446
4300	23.301	23.372
4320	23.161	23.000
4340	23.021	23.000
4360	22.881	23.000
4380	22.741	23.000
4400	22.601	23.000
4420	22.461	23.000
4440	22.321	22.708
4460	22.181	22.635
4480	22.041	22.584
4500	21.901	22.567
4520	21.761	22.000
4540	21.621	22.000
4560	21.481	22.000
4580	21.341	22.000
4600	21.201	22.000
4620	21.061	21.678
4640	20.921	21.781
4660	20.816	22.000
4680	20.758	21.965
4700	20.678	21.489
4720	20.579	21.000
4740	20.479	21.000
4760	20.379	21.000
4780	20.279	21.000
4800	20.179	21.000
4820	20.079	20.736

PROFILE
Scale: 1:2000 H, 1:400 V

1:2000 0 100m 200m

IMPORTANT

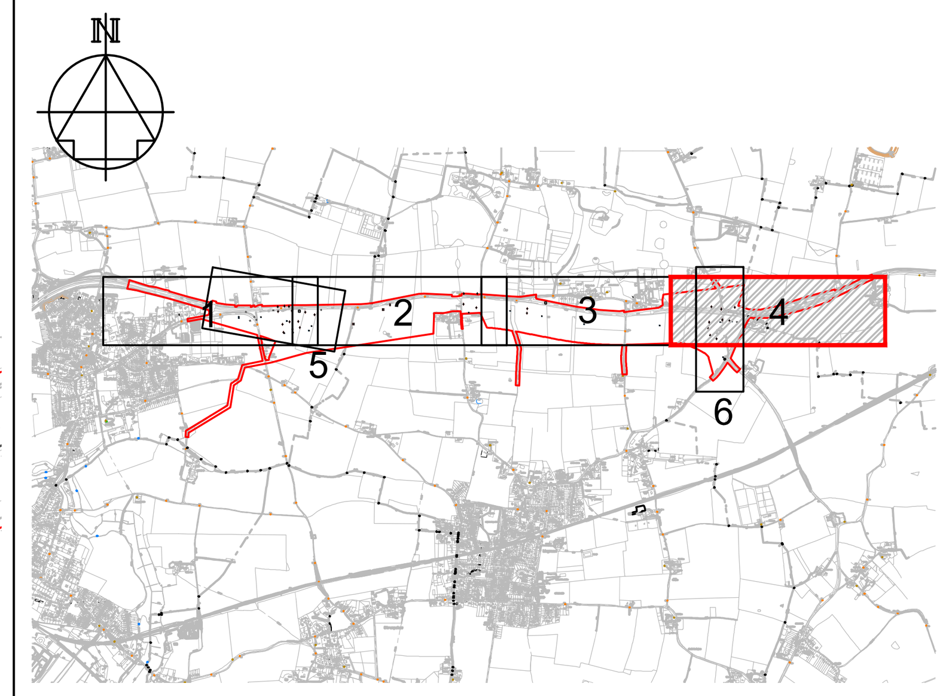
SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

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

HAZARD REF AND BRIEF DESCRIPTION OF HAZARD:-

HAZARD REF	BRIEF HAZARD DESCRIPTION
G1	This area has been identified as having a high UXO risk.
G2	There is an IP Gas main in the vicinity of the works. Ref to "Cadent Gas Pipeline Survey" Report UX85585 ICL-DJ-001 (Interserve, 2018) for pipe location as identified during SI.

NOTES



KEY TO SYMBOLS

- MAXIMUM AND MINIMUM RECORDED GROUND WATER LEVEL
- BOREHOLE
- CONE PENETRATION TEST
- INFILTRATION PIT
- TRIAL PIT
- TRIAL TRENCH
- DYNAMIC PROBE TEST (DPT)
- HAND DUG SOAKAWAY (HDS)/ SOAKAWAY PIT (SPA)

LOFT - Lowestoft Formation
HPGL - Happisburgh Glacigenic Formation
CRBY - Crag Group And Bytham Sand And Gravel Formation (Undifferentiated)

NOTE: GEOTECHNICAL FENCE DIAGRAMS CREATED USING A 30M OFFSET FROM ROAD CENTRELINE

REV	DATE	REVISION NOTE	ORG	CHK'D	APP'D
P01	17/02/20	FOR INFORMATION	MM	DT	DT
P02	01/04/20	UPDATED TO COMMENTS	MM	MD	MD

DESIGNER: SWECO

CONTRACTOR: Galliford Try

CLIENT: highways england

PROJECT TITLE
A47 BLOFIELD TO NORTH BURLINGHAM

PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
MAINLINE GEOLOGICAL LONG SECTION
SHEET 4 OF 4

SUITABILITY
SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:2000	S3	P02

DRAWING NUMBER
HE551490-GTY-VGT-000-DR-VG-30004

LEGEND

- TOPSOIL
- MADE GROUND
- LOFT GRANULAR
- LOFT COHESIVE
- HPGL GRANULAR
- HPGL COHESIVE
- CRBY GRANULAR
- CRBY COHESIVE

BOREHOLE LOCATION DATES AS FOLLOWS:
2018-XXXX = 2018
XXXX/04 = 2004
XXXX/92 = 1992

2018-BH01

SPT - N VALUE → 7 / 8 / 11 / 28 / 35

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:

CERTAIN ————————

UNCERTAIN — — — —

POSSIBLE —·—·—·—·—

IMPORTANT

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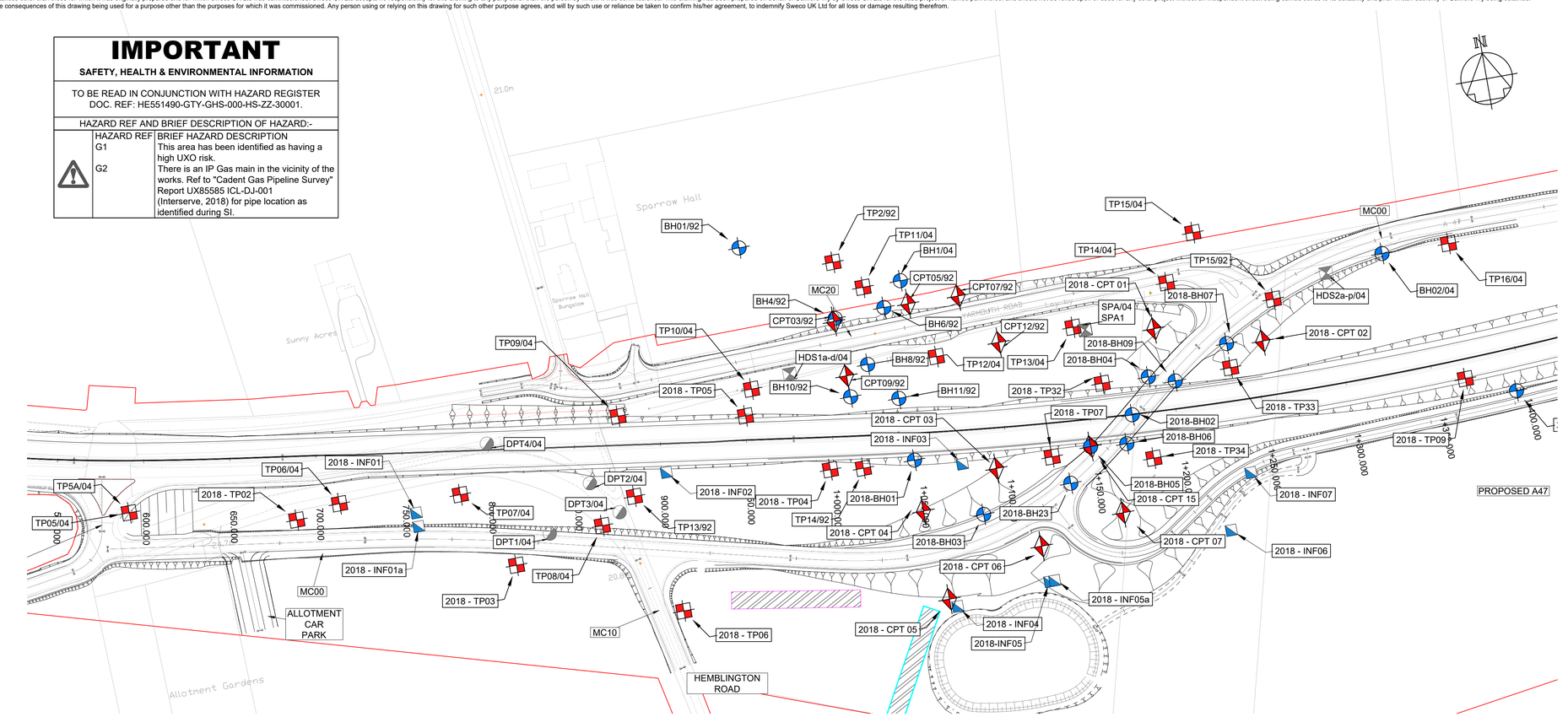

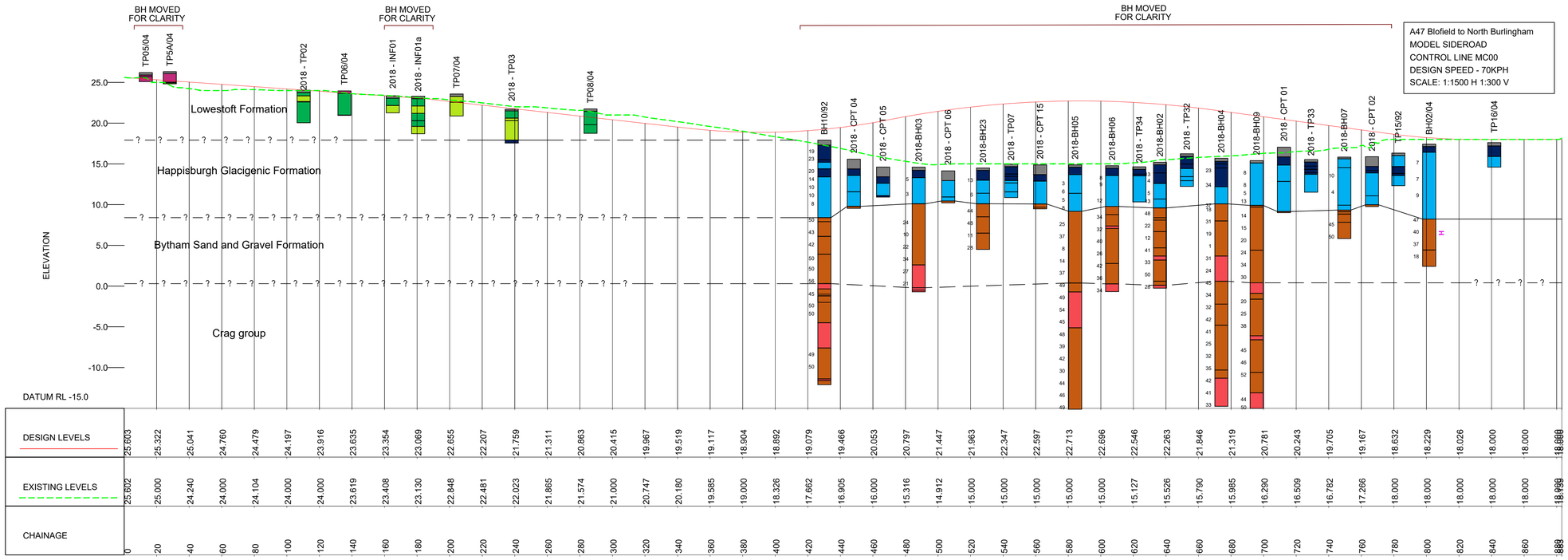

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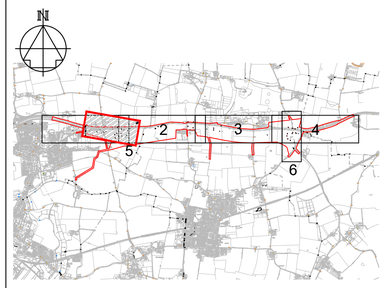

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P01	17/02/20	FOR INFORMATION	MM	DT	DT
P02	01/04/20	UPDATED TO COMMENTS	MM	MD	MD

DESIGNER: SWECO

CONTRACTOR: GallifordTry

CLIENT: highways england

PROJECT TITLE: A47 BLOFIELD TO NORTH BURLINGHAM

PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: SIDEROAD GEOLOGICAL LONG SECTION SHEET 1 OF 2

SUITABILITY: SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
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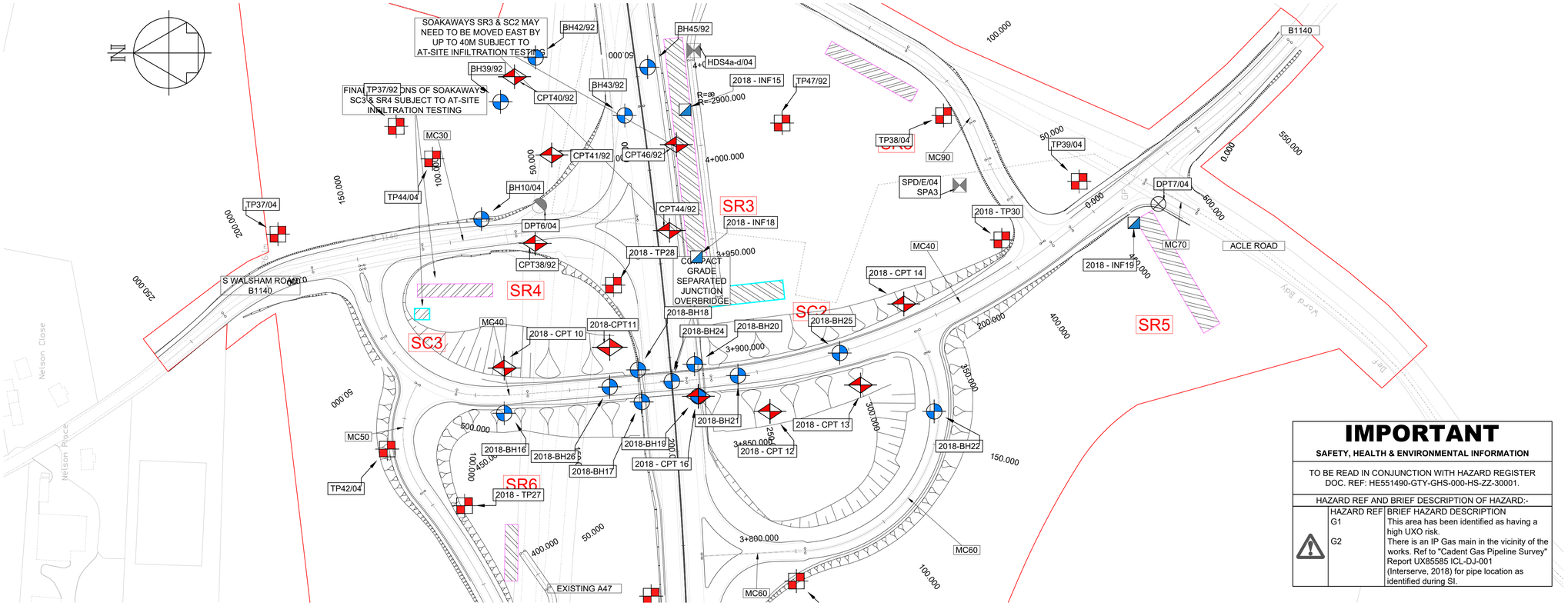
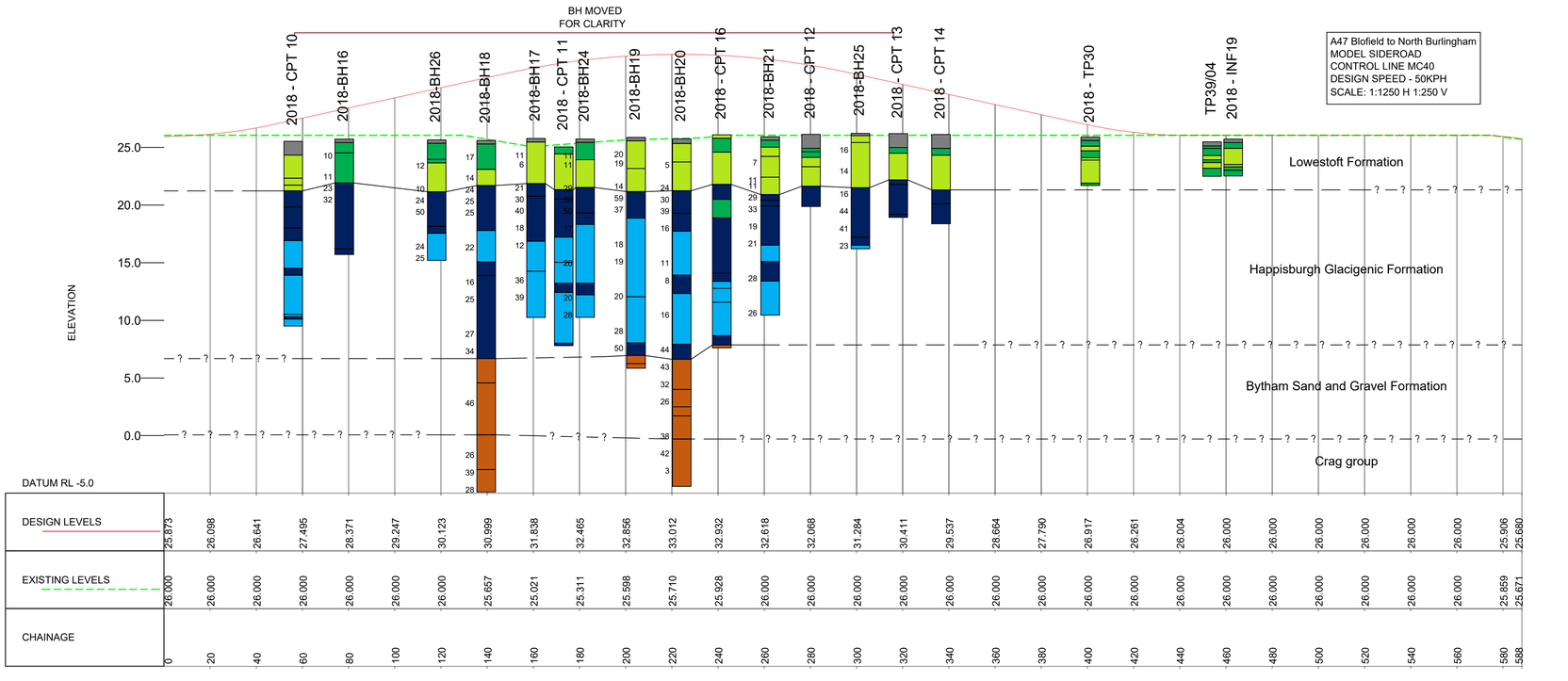
DRAWING NUMBER: HE551490-GTY-VGT-000-DR-VG-30005



PLAN 6
Scale: 1:1250



PROFILE
Scale: 1:1250 H, 1:250 V

IMPORTANT

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2018-BH01

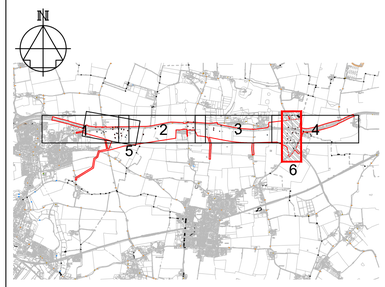
SPT - N VALUE

7
8
11
28
35

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:
CERTAIN
UNCERTAIN
POSSIBLE

1:1250 0 62.5m 125m

NOTES



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P02	01/04/20	UPDATED TO COMMENTS	MM	MD	MD

DESIGNER
SWECO

CONTRACTOR
GallifordTry

CLIENT
highways england

PROJECT TITLE
A47 BLOFIELD TO NORTH BURLINGHAM

PROJECT STAGE
PCF STAGE 3

DRAWING TITLE
SIDEROAD GEOLOGICAL LONG SECTION
SHEET 2 OF 2

SUITABILITY
SUITABLE FOR REVIEW & COMMENT

SHEET SIZE	SCALE	STATUS	REVISION
A1	1:1250	S3	P02

DRAWING NUMBER
HE551490-GTY-VGT-000-DR-VG-30006

Appendix B. HEWRAT Results

PR1

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Region", shallow infiltration systems (e.g. infiltration basin)	2	30
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	145
RISK SCREENING LEVEL	Low

SR1

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<15% to >1% SOM	2	10
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**125**
RISK SCREENING LEVEL	**Low**

SR2

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**110**
RISK SCREENING LEVEL	**Low**

SR3

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<15% to >1% clay minerals	2	10
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**115**
RISK SCREENING LEVEL	**Low**

SR4

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	120
RISK SCREENING LEVEL	Low

SR5

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**120**
RISK SCREENING LEVEL	**Low**

SR6

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	120
RISK SCREENING LEVEL	Low

SR7

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	130
RISK SCREENING LEVEL	Low

SR8

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	<=1% clay minerals	3	15
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**120**
RISK SCREENING LEVEL	**Low**

SC1

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=30,000 AADT	1	10
2		10	Rainfall depth (annual average)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=30	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table >=15 m	1	20
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	**110**
RISK SCREENING LEVEL	**Low**

SC4&5

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	130
RISK SCREENING LEVEL	Low

SC6 & SC7

Groundwater Assessment

Component Number		Weighting Factor	Property or Parameter	Risk Score	Component score	Weighted component score
1	SOURCE	10	Traffic flow	<=50,000 AADT	1	10
2		10	Rainfall depth (annual averages)	<=740 mm rainfall	1	10
3		10	Drainage area ratio	<=50	1	10
4	PATHWAY	15	Infiltration method	"Continuous", shallow linear (e.g. unlined ditch, swale, grassed channel)	1	15
5		20	Unsaturated zone	Depth to water table <15 m to >5 m	2	40
6		20	Flow type (Incorporates flow type an effective grain size)	Dominantly intergranular flow (e.g. non-fractured consolidated deposits or unconsolidated deposits of fine-medium sand or finer)	1	20
7		5	Unsaturated Zone Clay Content	>=15% clay minerals	1	5
8		5	Organic Carbon	<=1% SOM	3	15
9		5	Unsaturated zone soil pH	pH >=8	1	5

TOTAL SCORE	130
RISK SCREENING LEVEL	Low

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

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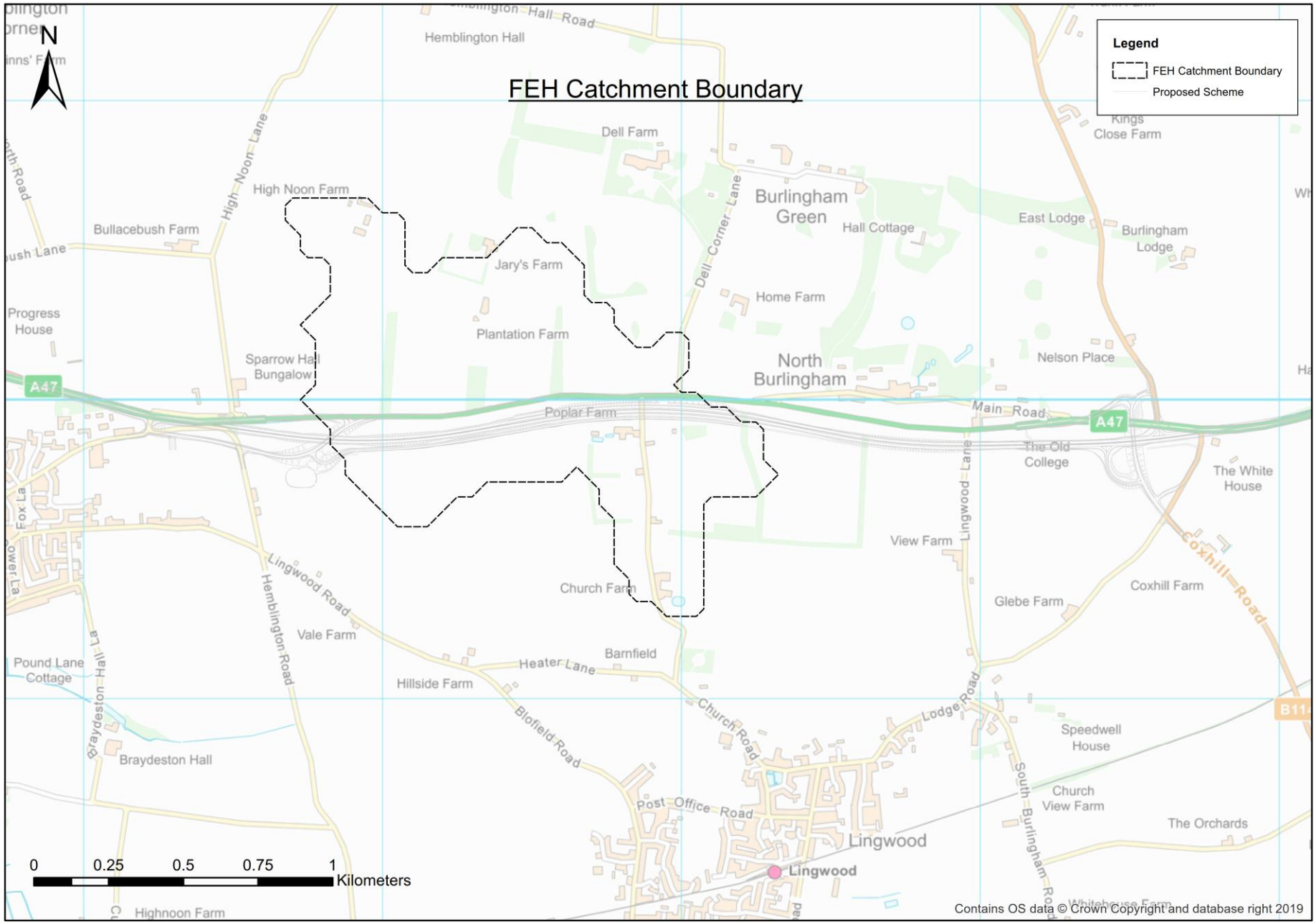
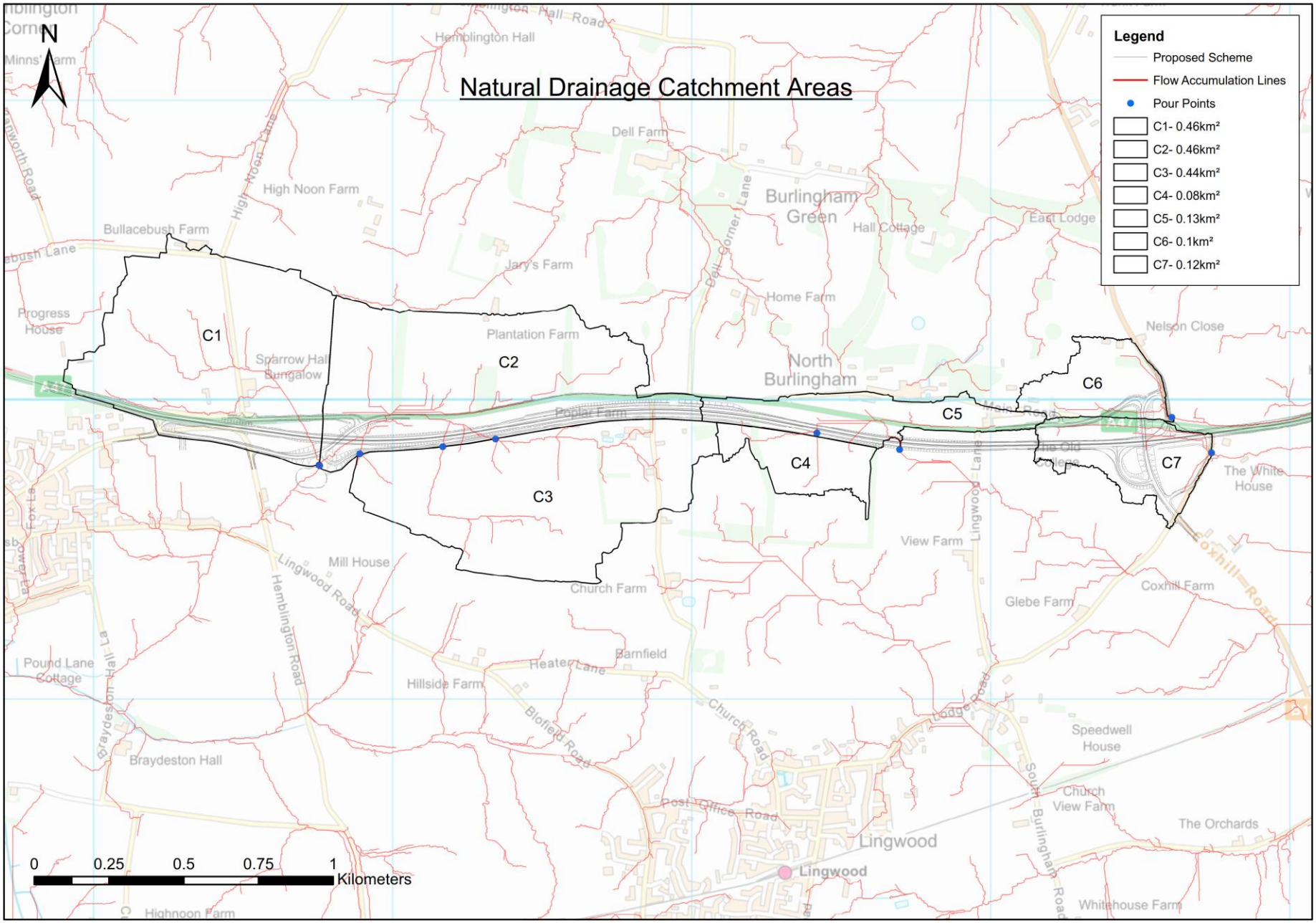
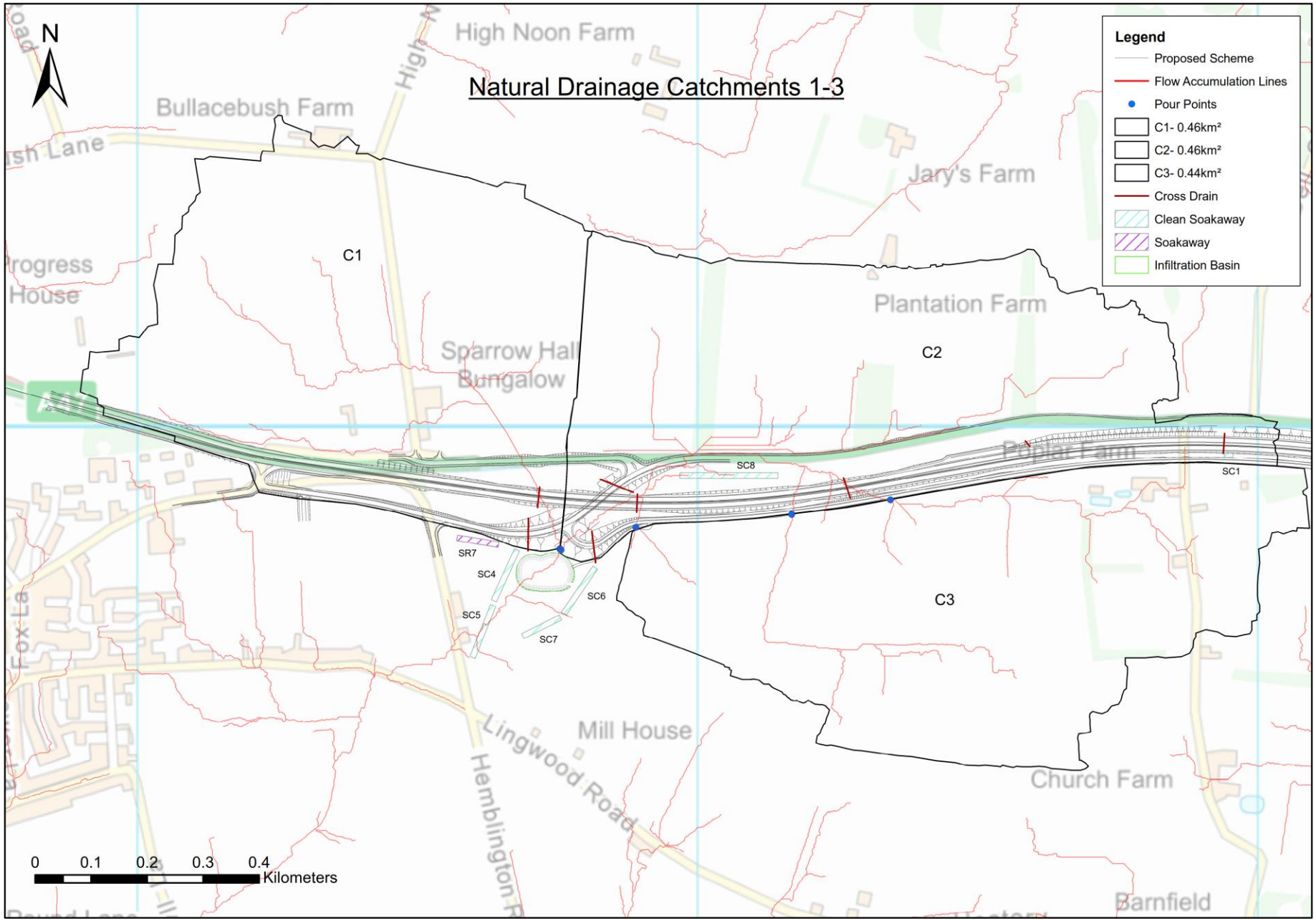
UK Centre for Ecology and Hydrology (2020) Flood Estimation Handbook Web Service. Available online at https://fehweb.ceh.ac.uk/, last accessed June 2020

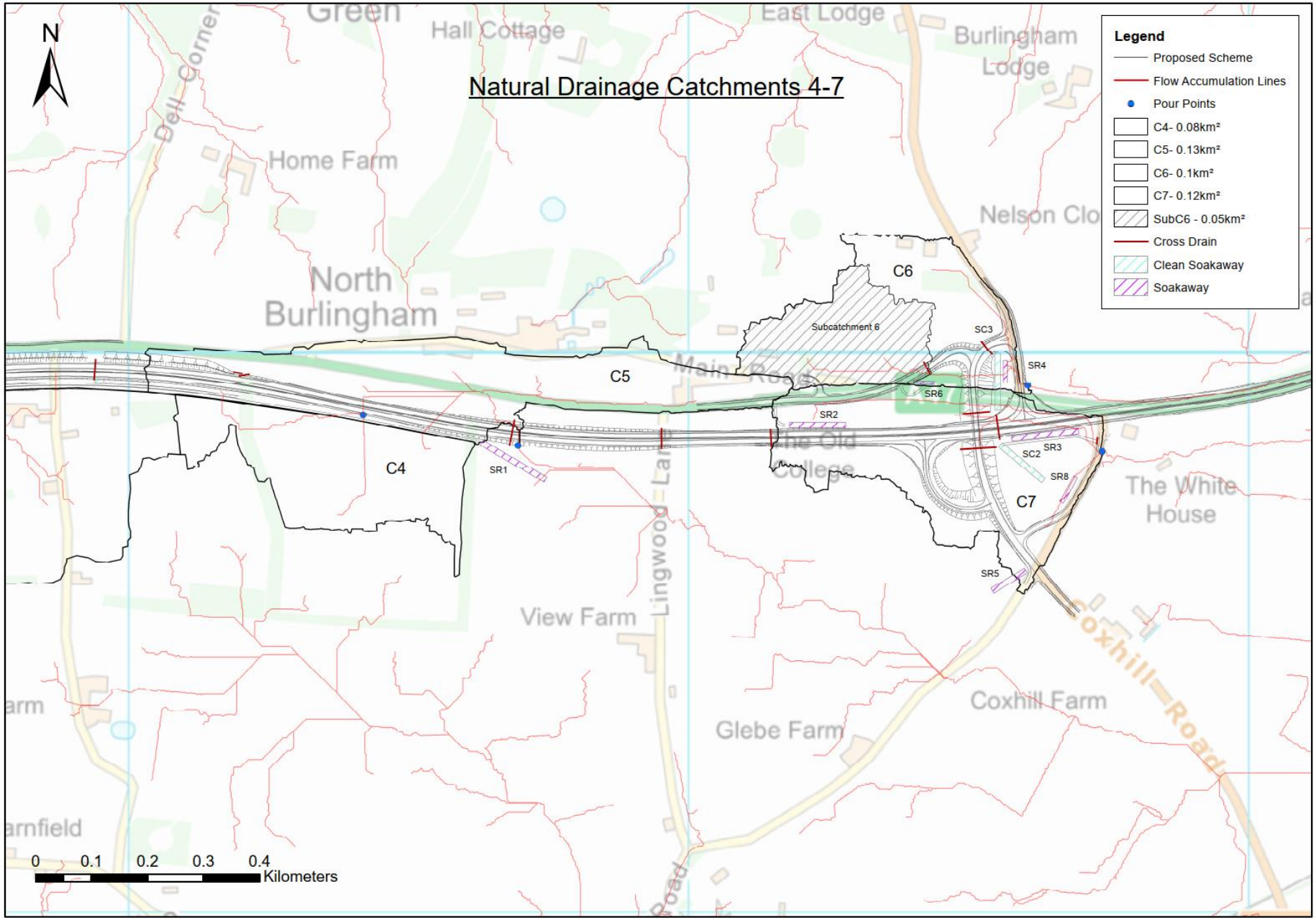
Appendix A. FEH catchment boundary


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
Vale Farm
Barnfield
Heater Lane
Hillside Farm
Pound Lane Cottage
Braydeston Hall
Speedwell House
Church View Farm
The Orchards
Post Office Road
Lingwood
Highnoon Farm
B11
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
Hemblington Hall
Dell Farm
High Noon Farm
Bullacebush Farm
Jary's Farm
Burlingham Green
Hall Cottage
East Lodge
Home Farm
Progress House
Plantation Farm
Sparrow Hall Bungalow
North Burlingham
Nelson Close
Poplar Farm
Mill House
Church Farm
View Farm
Glebe Farm
Coxhill Farm
The White House
Pound Lane Cottage
Barnfield
Hillside Farm
Braydeston Hall
Speedwell House
Church View Farm
The Orchards
Lingwood
Whitehouse Farm
Highnoon Farm
Lingwood Road
Hemblington Road
Heater Lane
Church Road
Post Office Road
Lodge Road
Blofield Road
South Burlingham Road
Coxhill Road
0 0.25 0.5 0.75 1
Kilometers


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
0 0.1 0.2 0.3 0.4
Kilometers


Natural Drainage Catchments 4-7
N
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
SC2
SC3
SR8
Hall Cottage
East Lodge
Burlingham Lodge
Home Farm
Nelson Clo
North Burlingham
Main Road
The Old College
The White House
View Farm
Lingwood Lane
Coxhill Farm
Glebe Farm
Coxhill Road
0 0.1 0.2 0.3 0.4
Kilometers