# A47 Blofield to North Burlingham Dualling

## Scheme Number: TR010040

## Volume 6
## 6.2 Environmental Statement Appendices
Appendix 13.3 – Groundwater Assessment

APFP Regulation 5(2)(a)

Planning Act 2008

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

December 2020

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]

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## ENVIRONMENTAL STATEMENT APPENDICES
## Appendix 13.3 Groundwater Assessment

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# 1. Background and introduction

## 1.1. Introduction

1.1.1. This appendix report supports Chapter 13 Road Drainage and Water Environment (**TR010040/APP/6.1**). It provides a hydrogeological conceptual model for the Scheme and its study area, based on ground investigations undertaken in previous and the current stages of the Proposed Scheme, and the necessary groundwater-specific environmental assessments as described in the Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and the Water Environment (Highways England, 2020). These assessments inform the impact assessment presented in Chapter 13 Road Drainage and the Water Environment (**TR010040/APP/6.1**), which follows the assessment methodology described in LA 104 Environmental Assessment and Monitoring (Highways England, 2019).

1.1.2. The study area must encompass groundwater and surface water features that would potentially be affected by the Proposed Scheme. The study area is based on professional judgement to ensure that effects are sufficiently identified and comprises a 1km corridor surrounding the site. Where appropriate, the study area has been extended to include features further down-gradient that may also be impacted, where a potential pathway or linkage has been identified. The site and groundwater study area are shown in the figures contained in Volume 2, Figure 13.1 to 13.8 (**TR010040/APP/6.3**).

## 1.2. Scheme overview

1.2.1. Chapter 2 of the Environmental Statement (**TR010040/APP/6.1**) provides a description of the Proposed Scheme which includes new structures, new road drainage and a gas main diversion. These structures comprise the Blofield Overbridge (S01) and B1140 Overbridge (S03), as well as the West Retaining Wall (S04). The road drainage is to include soakaways and an infiltration basin discharging to ground.

1.2.2. Key potential construction and operation effects upon the water environment identified in Chapter 13 Road Drainage and the Water Environment (**TR010040/APP/6.1**) include:

- Changes in groundwater levels or flows, leading to a reduction in water supply to groundwater receptors
- Contamination of groundwater by generation of suspended solids, direct contact with construction materials, or polluted construction and/or road drainage runoff

## 1.3. Aims and objectives

1.3.1. The purpose of the groundwater assessment is to:

- present the hydrogeological baseline conditions through consideration of ground investigation results and other freely available sources of information,
- present the following assessments, in line with DMRB LA 104 and LA 113:
  - Groundwater level and flow assessment
  - Routine runoff and groundwater quality assessment
  - Spillage assessment
  - Groundwater dependent terrestrial ecosystems assessment

1.3.2. The above assessments inform groundwater elements of the impact assessment in Chapter 13 Road Drainage and the Water Environment (**TR010040/APP/6.1**).

## 1.4. Assumptions

1.4.1. This assessment has been prepared using information publicly available. The current and historic ground investigations, and subsequent monitoring and sampling have provided comprehensive data relating to the geology and hydrogeology within the site. The Proposed Scheme is linear, however, there is limited pertinent data outside of the site boundary. This has implications with respect to the baseline conceptual hydrogeological model, particularly with respect to local hydraulic gradients.

## 1.5. Data sources

1.5.1. This technical report also takes into consideration the following sources of information:

- British Geological Survey 1:50,000 and 1:625,000 superficial and bedrock geological maps (British Geological Survey, 1991 & 2018)
- DEFRA's 'Magic' interactive map
- Environment Agency (EA) Catchment Data Explorer
- Highways Agency Drainage Data Management System (HADDMS), Drainage Data Management System v5.12.0
- 2020 Ground Investigation Report (GIR; Galliford Try Sweco, 2018)
- 2019 Factual Ground Investigation Report (BWB, 2019)
- 2004 Factual Ground Investigation Report (A F Howland Associates, 2004)
- 1992 Factual Ground Investigation Report (Geotechnics, 1992)

1.5.2. Additional information was requested from the EA for the study area in March 2020 and has also been summarised in the report:

- Licensed groundwater and surface water abstractions
- Consented discharges

1.5.3. The following information was requested from the Broadland District Council in April 2020 and has also been summarised in the report:

- Unlicensed abstractions

### Ground Investigations

1.5.4. The information from the ground investigation undertaken in 1992, 2004 and 2018 has been used in this groundwater assessment to construct an up to date hydrogeological conceptualisation for the Proposed Scheme and the study area. This is detailed in section 2 Hydrogeological baseline conditions.

#### *1992 ground investigation*

1.5.5. An intrusive ground investigation was carried out on the A47 Blofield to Acle Dualling by Geotechnics Ltd between 6 April and 1 May 1992. The investigation was instructed by Norfolk County Council, the Engineer on behalf of the client, the Department of Transport. Geotechnical components of this report were subsequently used to inform the initial proposals for the route layout improvement options in the A47 Blofield-North Burlingham, Preferred Route and Junction Assessments Report (GD00554/RT/004/B), prepared by Hyder Consulting in November 2002 for the Highways Agency.

1.5.6. This initial ground investigation was designed to establish ground conditions at selected locations along the proposed route, and at the location of the structures proposed initially to provide information for use in Phase 1A of the scheme development. The proposed route at the time of the 1992 ground investigation was more aligned with the current A47 route.

1.5.7. The ground investigation comprised exploratory boreholes at proposed junctions, and trial pits and static cone penetration tests at selected locations along the proposed alignment and side roads.

1.5.8. Seven standpipe piezometers were installed for groundwater monitoring, the locations of which are presented on the Mainline Geological Section produced in the 2020 Geotechnical Investigations Report and reproduced within Annex A of this report. Groundwater levels were recorded between April and June 1992. For boreholes constructed towards the end of the period of ground investigation there is very limited groundwater level data available.

### *2004 ground investigation*

1.5.9. A supplementary ground investigation was undertaken between July and September 2004 by A F Howland Associates on the instruction of Edmund Nuttall Ltd and Scott Wilson Kirkpatrick & Co Ltd. This investigation was part of the Value Engineering Process and to inform the preliminary detailed design during Phase 1A of the ECI Contract. The aim was to create a refined ground model for the whole route which extended for approximately 3km from the Blofield Bypass (National Grid Reference (NGR) TG 340 100) in the West to the Acle Bypass in the East (NGR TG 380 099).

1.5.10. 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. As with the 1992 ground investigation, the proposed route at the time of the 2004 ground investigation was more aligned with the current A47 route.

1.5.11. 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

1.5.12. Eight standpipes were installed for groundwater monitoring, the locations of which are presented in the Mainline Geological Section produced in the 2020 GIR and reproduced within Annex A of this report. 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*

1.5.13. The 2018 ground investigation was undertaken between August and September 2018 by BWB Consulting (BWB) on the instruction of Interserve Construction Ltd, (the Principal Contractor) on behalf of Highways England (the Client). This investigation informed the Stage 3 preliminary design of the Proposed Scheme.

1.5.14. The ground investigation comprised:

- 32 machine excavated trial pits
- 17 soakaway tests

- 28 cable percussive boreholes
- 10 variable head tests
- 12 post-investigation monthly groundwater monitoring visits
- Chemical analysis of soils and groundwater

1.5.15. Thirteen standpipes were installed for groundwater monitoring, the locations of which are presented in the Mainline Geological Section produced in the 2020 GIR and reproduced within Annex A of this report. Groundwater levels were recorded monthly between October 2018 and September 2019.

# 2. Hydrogeological baseline conditions

## 2.1. Topography and drainage

2.1.1. The study area is located within an interfluvial area between the South Walsham Broad and the River Bure to the north and east, and the Witton Run and the River Yare to the west and south. The Witton Run, and its tributaries at Braydeston Hall and Red House, is the closest surface watercourse.

2.1.2. The catchment boundary between the surface watercourses to the north and east and those to the west and south is located near Poplar Farm, Lingwood Road, approximately in the centre of the study area[1].

2.1.3. Ground elevations along the proposed route range between 17 mAOD and 27 mAOD. A low point along the current A47 route coincides with the area upstream of the Braydeston Hall tributary located south west of the scheme. In this area the ground level continues to fall away from the A47 towards the south west and the Witton Run. Elsewhere there is very little variation in ground elevations both directly below the Proposed Scheme and in the surrounding study area.

2.1.4. The existing drainage network along the current A47 comprises clusters of soakaway chambers at the eastern extents, East of North Burlingham village, and at the western extents, to the west of High Noon Lane and Hemblington Road, as presented in Volume 2 of the Environmental Statement, Figure 13.3 (Aquifer designations) (**TR010040/APP/6.3**).

## 2.2. Geology

2.2.1. The Proposed Scheme traverses an area where extensive Pleistocene and Pliocene superficial deposits are present overlying the Cretaceous Chalk. Descriptions below are based on the spatial extents shown on the 1:50,000 scale superficial map (British Geological Survey, 2018), which is reproduced in Volume 2 of the Environmental Statement, Figure 13.4 (Ground investigation boreholes) (**TR010040/APP/6.3**).

2.2.2. Superficial deposits generally comprise diamicton of the Lowestoft Till and Happisburgh Glacigenic formations, as well as sand and gravel horizons within the Happisburgh Glacigenic Formation (previously known as the Corton Formation). The Happisburgh Glacigenic Formation is underlain by the Bytham Sand and Gravel Formation (previously referred to as the Kesgrave Formation)

[1] Taken from WFD waterbody catchment areas. Available online at http://environment.data.gov.uk/catchment-planning/WaterBody/GB105034051310 Accessed 8 October 2018.

and the Crag Group. The extents of the Bytham Sand and Gravel Formation is not well understood and BGS mapping does not differentiate it from the underlying Crag in this area (British Geological Survey, 2018). Hence the Bytham Sands and Gravels Formation and the Crag Group are generally discussed together in this report. The Crag is underlain by the Ormesby Clay of the Thanet Formation beneath the eastern half of the Project (British Geological Survey, 1991). Where the Ormesby Clay is absent the Crag directly overlies the Chalk.

2.2.3. Although most of the study area has an extensive cover of Pleistocene superficial geology, at the western extents of the study area the Witton Run surface watercourse and its tributaries at Braydeston Hall and Red House have cut through these to expose the Crag at the surface. Peats of the Holocene Breydon Formation are also present along the route of the Witton Run and directly overlying the Crag. The Happisburgh Glacigenic Formation outcrops upstream of the Braydeston Hall tributary at approximately NGR TG 349 099, and also generally at the eastern extents of the study area.

2.2.4. Lithological descriptions of the bedrock and superficial geology found within the study area, along with confirmed thicknesses, are provided in Table 2.1.

Table 2.1 : Lithological descriptions and thicknesses [2]

| 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.<br>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.<br>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.<br><br>Grey marine deposited cohesive material with shell fragments evident. | ~ 1 - ~ -0.5 | Not confirmed |
| Palaeocene | Thanet Formation – Ormesby Clay | A variably glauconitic, partly calcareous clay, commonly silty at the base, with a basal gravel bed. | Not confirmed | 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 |

[2] Lithological descriptions taken from British Geological Survey Lexicon of Named Rock Units. Available online at https://www.bgs.ac.uk/lexicon/ Accessed 15 April 2020.

### Lowestoft Formation

2.2.5. The Lowestoft Till Formation is encountered below topsoil across the majority of the scheme with the exception of at the topographic low point to the east of Hemblington Road, Blofield (TG 34612 09938 to TG 35489 09987). The formation described in exploratory holes as alternating thick beds of silty sandy clay, clayey sandy silt and loose to medium dense silty clayey sands with some rare flint gravels. These beds often contain lenses and pockets of sands, and fissuring.

### Happisburgh Glacigenic Formation

2.2.6. The Happisburgh Glacigenic Formation is encountered below the Lowestoft Till Formation, except at the topographic low point to the east of Hemblington Road, where it is exposed. The lower boundary of the Happisburgh Glacigenic Formation varies between 9.5m to 10m AOD. The Happisburgh Glacigenic Formation is described in the exploratory holes as slightly gravelly sandy to very sandy clay, gravelly slightly clayey fine to coarse sand with some subangular to subrounded flints.

### Crag Group and Bytham Sand and Gravel Formation

2.2.7. The Bytham Sand and Gravel Formation and Crag Group have been combined in the BGS superficial geology map, where the two geologies are undifferentiated.

2.2.8. This unit is encountered below the Happisburgh Glacigenic Formation Diamicton within the deeper boreholes across the scheme. The formation is described as medium dense to very dense sand and gravel and occasionally encountered as soft to stiff clay. Soft to stiff clay pockets, lenses and fissured bands are often noted.

## 2.3. Aquifer designations

2.3.1. Table 2.2 summarises Environment Agency aquifer designations, along with their approximate extents within the study area. Aquifer designations are presented in Volume 2 of the Environmental Statement, Figure 13.3 (Aquifer designations). Where geological units are not present at surface, assumed aquifer designation or equivalent hydrogeological definitions have been provided.

2.3.2. There are two designations available for the Happisburgh Glacigenic Formation across the Scheme, due to its varying lithology. Their relative extents are provided in Table 2.2.

Table 2.2 : 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 |
| Lowestoft Formation - 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.<br>Outcrops in one small area at chainage TG 346 099. |
| Happisburgh Glacigenic Formation - Diamicton | Unproductive strata | Entire extents of the Proposed Scheme.<br>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)<br>Present at surface along the Witton Run and tributaries. |
| Thanet Formation – Ormesby Clay | Not classified – assumed to be Unproductive strata | From approximate 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) |

2.3.3. Principal aquifers are strata that have high intergranular and/or fracture permeability, and as such usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale[3] .

2.3.4. Secondary A aquifers are permeable layers capable of supporting water supplied at a local, rather than strategic scale, and in some cases, form an important source of baseflow to rivers.

2.3.5. Secondary (undifferentiated) aquifers are classified as such due to the formation previously having been designated as both a minor aquifer and non-aquifer (now defined as Secondary A and Secondary B respectively) in different locations, due to variable characteristics of the rock type. As such Secondary (undifferentiated) aquifers are likely to contain lower permeability layers and perched aquifers.

[3] Definitions for aquifer designations available online at: http://apps.environment-agency.gov.uk/wiyby/117020.aspx Accessed 29 July 2020

2.3.6. Unproductive strata are strata with low permeability that have negligible significance for water supply or river base flow.

2.3.7. The bedrock and superficial aquifers have a combined groundwater vulnerability classification of medium to high risk with a small area of low risk in the West. The higher groundwater vulnerability is associated with areas where the superficial Lowestoft Formation and the Happisburgh Glacigenic Formation sands outcrop at surface. The area of low risk correlates with areas where the superficial Happisburgh Glacigenic Formation Diamicton outcrops at surface. Where the Crag is outcropping in the south west of the study area and where the scoping boundary crosses Hemblington Road, the groundwater vulnerability is medium to low.

## 2.4. Groundwater levels and flows

### Monitoring installations and results

*2018 ground investigation*

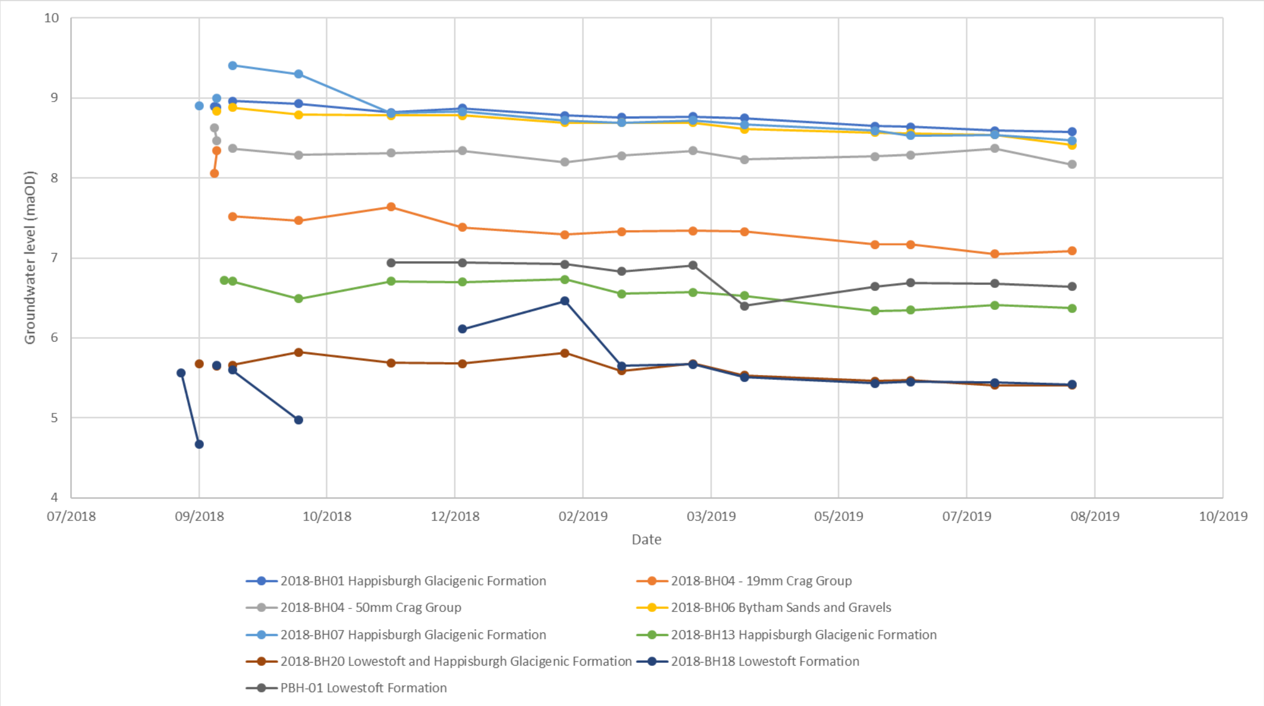
2.4.1. The 2018 installations were constructed to monitor individual horizons covering the Lowestoft Formation, the Happisburgh Glacigenic Formation, the Bytham Sands and Gravels Formation, and the Crag Group, as shown on the mainline geological section provided in the 2020 GIR (Annex A) and Volume 2 of the Environmental Statement, Figure 13.4 (Ground investigation boreholes) (**TR010040/APP/6.3**). Groundwater level data was collected over 11 months between October 2018 and September 2019. Out of thirteen boreholes monitored in monthly dip visits, seven were installed with groundwater level data loggers which recorded groundwater levels four times per day. However due to significant drifting in logger data only the manual dip data is presented below in Table 2.3 and Figure 2.1.

Table 2.3 : Groundwater level monitoring summary (October 2018 - 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 |
|---|---|---|---|---|---|---|---|---|---|
| 2018 - BH01 | 15.97 | 7 – 10 | Happisburgh Glacigenic Formation | 7.39 | 8.58 | 14/08/19 | 7.01 | 8.96 | 20/09/18 |
| 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 Formation | 6.36 | 8.41 | 14/08/19 | 5.89 | 8.88 | 20/09/18 |
| 2018 - BH07 | 15.83 | 7 – 10 | Happisburgh Glacigenic Formation | 7.36 | 8.47 | 14/08/19 | 6.42 | 9.41 | 20/09/18 |
| 2018 - BH08 | 20.96 | 5 – 6 | Happisburgh Glacigenic Formation | - | DRY | - | - | DRY | - |
| 2018 - BH10 | 26.48 | 7 – 10 | Happisburgh Glacigenic Formation | - | DRY | - | - | DRY | - |
| 2018 - BH13 | 26.33 | 18 – 25 | Happisburgh Glacigenic Formation | 19.99 | 6.34 | 29/05/19 | 19.60 | 6.73 | 28/01/19 |
| 2018 - BH15 | 25.64 | 7 - 9 | Lowestoft Formation | - | DRY | - | - | DRY | - |
| 2018 - BH18 (19mm) | 25.50 | 19 - 22 | Happisburgh Glacigenic Formation | 20.83 | 4.67 | 07/09/19 | 19.04 | 6.46 | 28/01/19 |
| 2018 - BH20 | 25.64 | 18 - 28 | Happisburgh Glacigenic Formation | - | N/A | - | - | N/A | - |
| 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 | - |

2.4.2. Groundwater level dips, as shown on Figure 2.1 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 (Standardized Precipitation Index; CEH, 2020), which characterises meteorological drought related to soil moisture or groundwater and reservoir storage, 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 2.1.

Figure 2.1 : Groundwater level hydrograph




### *2004 and 1992 ground investigations*

2.4.3. The 2004 ground investigation boreholes were constructed to monitor the entire thickness of superficial deposits to depths of either 15 or 20m below ground level. These therefore encounter a range of horizons from the Lowestoft Till Formation through to the Bytham Sands and Gravels Formation and Crag Group.

2.4.4. Groundwater levels were monitored on a maximum of three occasions between 24 August and 25 October 2004 and therefore the data cannot be used to comment on seasonal variation in groundwater levels.

2.4.5. The 1992 installations were generally constructed to monitor either the Happisburgh Glacigenic Formation or the Bytham Sands and Gravels Formation and the Crag Group. The Lowestoft Till Formation was either thin (and therefore cased out) or absent in all locations monitoring the upper Pleistocene superficial geology. BH04/92 monitors both the Happisburgh Glacigenic Formation and the Bytham Sands and Gravels Formation and Crag Group.

2.4.6. Groundwater levels were monitored on a number of occasions between 10 April and 12 June 1992. Groundwater levels within each monitoring installation were relatively stable, and no indication of seasonal variation can be observed over this short time period.

2.4.7. Details of all the borehole monitoring horizons and average water levels are presented in Table 2.4. Further details are included within the 2020 GIR Mainline Geological Section (Annex A).

Table 2.4 : 1992 and 2004 ground investigation monitoring installations

| Borehole Reference Number | Ground Elevation (mAOD) | Response Zone Depths (mbDAT) | Monitoring Horizon | Average Water Level (mbDAT) | Average Water Level (mAOD) | Dates of monitoring |
|---|---|---|---|---|---|---|
| BH04/92 | 26.046 | 2 – 15 | Happisburgh Glacigenic Formation (2 – 8.75m)<br>Bytham Sands and Gravels / Crag (8.75 – 15m) | 7.37 | 10.67 | May – Jun 1992 |
| BH08/92 | 26.645 | 26 – 30 | Bytham Sands and Gravels / Crag | 5.70 | 11.73 | Apr – Jun 1992 |
| BH18/92 | 24.554 | 2 – 8.6 | Happisburgh Glacigenic Formation | Dry | Dry | Apr – Jun 1992 |
| BH21/92 | 24.591 | 21 – 30 | Bytham Sands and Gravels / Crag | 5.21 | 20.84 | Apr – Jun 1992 |
| BH29/92 | 17.980 | 21 – 30 | Bytham Sands and Gravels / Crag | 5.32 | 21.33 | Apr – Jun 1992 |
| BH42/92 | 17.420 | 2 – 14 | Happisburgh Glacigenic Formation | Dry | Dry | Apr – Jun 1992 |
| BH43/92 | 23.030 | 16 – 28 | Bytham Sands and Gravels / Crag | 4.45 | 20.15 | Apr – Jun 1992 |
| BH01/04 | 26.590 | 2 – 20 | Happisburgh Glacigenic Formation (2 – 9.5m)<br>Bytham Sands and Gravels / Crag (9.5 – 20m) | 8.8 | 9.15 | Aug – Oct 2004 |
| BH02/04 | 28.580 | 1 – 15 | Happisburgh Glacigenic Formation (1 – 9.2m)<br>Bytham Sands and Gravels / Crag (9.2 – 15m) | 8.5 | 8.92 | Aug – Oct 2004 |
| BH03/04 | 26.430 | 1 – 15 | Lowestoft Till Formation (1 – 4m)<br>Happisburgh Glacigenic Formation (4 – 15m) | 14.3 | 8.74 | Aug – Oct 2004 |
| BH04/04 | 24.170 | 1 – 15 | Happisburgh Glacigenic Formation | Dry | Dry | Aug – Oct 2004 |
| BH05/04 | 24.980 | 1 – 15 | Lowestoft Till Formation (1 – 4m)<br>Happisburgh Glacigenic Formation (4 – 15m) | Dry | Dry | Aug – Oct 2004 |

| Borehole Reference Number | Ground Elevation (mAOD) | Response Zone Depths (mbDAT) | Monitoring Horizon | Average Water Level (mbDAT) | Average Water Level (mAOD) | Dates of monitoring |
|---|---|---|---|---|---|---|
| BH08/04 | 26.046 | 1 – 20 | Lowestoft Till Formation (1 – 8m)<br>Happisburgh Glacigenic Formation (8 – 20m) | 19.1 | 7.36 | Aug – Oct 2004 |
| **BH09/04** | 26.645 | 1 – 19 | Lowestoft Till Formation (1 – 4m)<br>Happisburgh Glacigenic Formation (4 – 18m)<br>Bytham Sands and Gravels / Crag (18 – 19m) | 18.48 | 5.69 | Aug – Oct 2004 |
| **BH10/04** | 24.554 | 1 – 20 | Lowestoft Till Formation (1 – 5.3m)<br>Happisburgh Glacigenic Formation (5.3 – 17.3m)<br>Bytham Sands and Gravels / Crag (17.3 – 20m) | Dry | Dry | Oct 2004 |

### *EA groundwater level monitoring*

2.4.8. The nearest EA groundwater level monitoring boreholes are located approximately 2.7km to the south west of the study area at Strumpshaw. These monitor the Chalk, the Crag and presumably shallow superficial deposits. Data has been provided by the EA for between January 2010 and October 2017. Details of the monitoring boreholes and a summary of water levels is provided in Table 2.5.

Table 2.5 : Environment Agency groundwater monitoring boreholes

| Borehole Reference Number | Borehole Name | NGR | Monitoring Horizon | 2010 – 2017 Water levels (mbDAT) | | |
|---|---|---|---|---|---|---|
| | | | | Minimum | Average | Maximum |
| TG30/376c | RSPB 'B4', Strumpshaw | 633587 307146 | Not known (assumed shallow superficial deposits) | 0.26 | 0.69 | 0.96 |
| TG30/376d | PHD Crag BH, Strumpshaw | 633600 307157 | Crag | 0.68 | 1.02 | 1.26 |
| TG30/376b | RSPB Chalk BH, Strumpshaw | 633607 307336 | Chalk | 0.54 | 0.75 | 1.26 |

2.4.9. Boreholes logs (including datum details) were not provided by the EA, but it is assumed that the RSPB Chalk BH relates to the Marsh Support observation borehole TG30NW30[4]. Using an assumed datum elevation of 1.65maOD (the datum elevation of the adjacent RSPB marsh support borehole; TG30NW29),

[4] Borehole logs available from the British Geological Survey onshore geoindex: http://scans.bgs.ac.uk/sobi_scans/boreholes/517700/images/12115231.html Accessed 27 July 2020.

the groundwater levels in the Chalk ranged between 0.39 and 1.11mAOD between 2010 and 2017.

2.4.10. Although the PHD Crag borehole is located at a short distance from the Marsh Support borehole, assuming a similar datum elevation would give an approximate range of Crag water levels of between around 0.4 and 1mAOD.

### Discussion of groundwater levels and flows

*Lowestoft Till and Happisburgh Glacigenic formations*

2.4.11. Installations from the 2018 ground investigation monitoring the Lowestoft Formation are either dry (2018-BH15) or have groundwater levels near the base of the borehole (2018-BH18a). Groundwater level data from groundwater quality probes (2018-PBH01 and 2018-PBH02) within the Lowestoft Formation were at the base of installation (PBH01) and dry (PBH02). A similar pattern of groundwater levels being dry, or levels close to the base of borehole, was noted within boreholes monitoring the Lowestoft Till and Happisburgh Glacigenic formations in the 1992 and 2004 investigations; either dry (BH42/92, BH04/04 and BH05/04) or have groundwater levels recorded near the base of the borehole (BH03/04 and BH08/04).

2.4.12. Boreholes that do not penetrate the entire thickness of the Happisburgh Glacigenic Formation are reported to be dry. Where groundwater levels have been recorded, the entire thickness of the Happisburgh Glacigenic Formation is generally considered to be monitored.

2.4.13. A number of boreholes also monitor the Bytham Sands and Gravels Formation (BH04/92, BH01/04, BH02/04, BH09/04). Groundwater levels in these boreholes also tend to coincide with the base of the Happisburgh Glacigenic Formation.

2.4.14. It is therefore likely that any groundwater levels observed within the base of the Happisburgh Glacigenic Formation are in hydraulic continuity with the Bytham Sands and Gravels Formation.

*Bytham Sands and Gravels Formation and Crag Group*

2.4.15. Groundwater levels within the 2018 installations in the Bytham Sands and Gravels Formation (2018-BH06) are broadly comparable to those in the Crag Group (2018-BH04 50mm and 2018-BH04 19mm) and shallow groundwater levels in the Happisburgh Glacigenic Formation. It is likely that these formations are in hydraulic continuity with each other. This was also reflected by boreholes from the 1992 and 2004 investigations that monitoring the Bytham Sands and Gravels Formation.

2.4.16. Groundwater levels within the Bytham Sands and Gravels Formation and Crag Group are at around 10mAOD at the western extent of the scheme (2018-BH01 and 2018-BH06), 5 – 6maOD in the centre of the Scheme (2018-BH13 and BH29/92) and between 4 – 5mAOD to the eastern end of the Scheme (2018-BH18, 2018-BH20, and BH43/92). This is shown on the Mainline Geological Section in Annex A. They are confined or semi-confined by the overlying Lowestoft Till Formation and clay-rich horizons within the Happisburgh Glacigenic Formation.

2.4.17. Groundwater level monitoring indicates that groundwater flow direction is principally to the east. However, there is likely to be a local influence from the River Yare and Witton Run watercourses at the western extent of the scheme, where groundwater likely flows southwards towards the watercourses where it discharges. This is interpreted from groundwater levels monitored within the Chalk, overlain by the Crag, at Strumpshaw, which are around 1maOD. This suggests that locally, groundwater flows away from the study area (and the interfluvial area where the Crag is overlain by the Lowestoft Till and Happisburgh Glacigenic formations), and towards the Witton Run and River Yare.

2.4.18. Seasonal groundwater level fluctuations within the Crag across the East Anglian region are generally less than 1m due to the high storage coefficient of the aquifer. Where the Crag is underlain by the Ormesby Clay, such as in the eastern half of the study area, groundwater contours generally reflect topography (Ander *et al*, 2006) and the Crag is considered to discharge to surface water either directly or via springs.

2.4.19. Where the Crag directly overlies the Upper Chalk, such as in the western half of the study area, the regional potentiometric surface in the Chalk is generally lower than that of the Crag. This suggests that the Crag is a source of recharge to the Chalk.

### *Cretaceous Chalk*

2.4.20. No ground investigation boreholes monitored groundwater within the Chalk.

2.4.21. The Chalk groundwater levels recorded by the EA at Strumpshaw are lower than all groundwater levels in the superficial deposits recorded in the study area. However, ground elevations are much lower at this location and the Chalk groundwater levels are within 2m of ground level. Away from the River Yare, and in interfluvial areas such as at the study area, Chalk groundwater levels would be expected to be much higher than those observed at Strumpshaw.

## 2.5. Aquifer properties

2.5.1. Falling head permeability tests undertaken as part of the 2004 ground investigation focussed on the Lowestoft Formation diamicton and interbedded sand and clay horizons of the Happisburgh Glacigenic Formation. Permeability results are summarised in Table 2.6. The range of values obtained for the upper sand horizon of the Happisburgh Glacigenic Formation is representative of silty sands, whereas values obtained for the Lowestoft Formation and diamicton or interbedded sands and clays of the Happisburgh Glacigenic Formation are representative of glacial tills.

2.5.2. Variable head permeability testing was undertaken in boreholes drilled as part of the 2018 GI works and are summarised in Table 2.6. Testing was completed in superficial geology in both sandy clays and clayey sands. Permeabilities obtained were in the range of $6.6 \times 10^{-7}$ to $1.5 \times 10^{-6}$ m/s which are typical of silty sands (Freeze and Cherry, 1979). The Lowestoft Formation has a similar permeability to that of the Bytham Sands and Gravels, which may be due to pockets of clay present in the test sections of the Bytham Sands and Gravels, or conversely, sand pockets within the Lowestoft Formation.

2.5.3. Infiltration tests within the Lowestoft Formation and the granular layers Happisburgh Glacigenic Formation passed. However, infiltration testing within the cohesive layers of the Happisburgh Glacigenic Formation failed as the water did not infiltrate. Results from the infiltration tests are summarised in Table 2.6.

Table 2.6 : Infiltration and permeability values

| Geological Unit | Range of Infiltration / Permeability Values (m/s) | | |
|---|---|---|---|
| | 2018 Infiltration tests[1] | 2018 borehole falling head tests[2] | 2004 falling head tests[3] |
| Lowestoft Formation | $8.7 \times 10^{-6} – 1.1 \times 10^{-5}$ | $1.5 \times 10^{-6} – 5.4 \times 10^{-6}$ | - |
| Happisburgh Glacigenic Formation – granular | $1.2 \times 10^{-5} – 4.7 \times 10^{-5}$ | - | - |
| Happisburgh Glacigenic Formation – cohesive | Failed | $2.0 \times 10^{-7} – 2.4 \times 10^{-7}$ | $7 \times 10^{-9} – 2 \times 10^{-7}$ |
| Bytham Sand and Gravel Formation | - | $6.6 \times 10^{-7} – 1.5 \times 10^{-6}$ | - |

[1] based on tests undertaken at various depths in trial pits INF01, INF01a, INF02, INF04, INF05, INF05a, INF07, INF10, INF11, INF12, INF13, INF14, INF15, INF18 and INF19.

[2] based on tests undertaken at various depths in boreholes 2018-BH01, 2018-BH02, 2018-BH04, 2018-BH05, 2018-BH06, 2018-BH08, 2018-BH09, 2018-BH20, 2018-BH21 and 2018-BH26.

[3] based on tests undertaken at various depths in boreholes BH01/04, BH02/04, BH03/04, BH04/04, BH05/04 and BH08/04

## 2.6. Groundwater quality

### Ground investigations

2.6.1. Soil and groundwater quality sampling were carried out as part of the 2018 GI and is presented in Appendix E (Summary of Soil Contamination) of the 2020 GIR. A total of 10 water samples were analysed. Analyses included general inorganics, total phenols, speciated polycyclic aromatic hydrocarbons (PAHs), total PAH, heavy metals, metalloids and petroleum hydrocarbons. There were no noticeable signs of contamination.

2.6.2. No groundwater quality data was collected as part of either the 1992 or 2004 ground investigations.

### Environment Agency monitoring

2.6.3. There are no EA groundwater quality network monitoring points within the study area. The closest Environment Agency groundwater level monitoring borehole is south west of the study area at Strumpshaw. This is discussed above in Section 2.4.

## 2.7. Groundwater resources

### Groundwater abstractions

2.7.1. There are no groundwater abstractions from the central section of the study area. The extents of the SPZ3 and locations of the abstractions are presented in Volume 2 of the Environmental Statement, Figure 13.6 (Groundwater abstractions and source protection zones) (**TR010040/APP/6.3**).

2.7.2. A source protection zone (SPZ) 3 (Total Catchment) crosses the site at its western extent for approximately 500m. This is associated with groundwater abstractions at Postwick, approximately 4.5km to the west of the Project.

2.7.3. There are five licensed groundwater abstractions and eight abstractions of less than 20 $m^3$/day (i.e. exempt from licensing) within the study area. Abstractions are generally clustered at the eastern and western extents of the study area, around Blofield and to the east of North Burlingham. Of the licensed abstractions the majority abstract from the Chalk, although one abstraction to the east of North Burlingham abstracts from sands and gravels. It is assumed that this abstraction relates to the Bytham Sands and Gravels Formation and Crag Group. All licensed abstractions are used for spray irrigation purposes. Out of the eight unlicensed abstractions six are borehole abstractions (four domestic use and two commercial use) and the other two are wells (for domestic use). It is not known whether the unlicensed abstractions take water from the Chalk or overlying superficial deposits.

### Consented discharges to groundwater

2.7.4. There are three consented discharges to land and groundwater within the study area (Volume 2, Figure 13.1 (Surface water features, consented discharges and fluvial flood risk) (**TR010040/APP/6.3**)). These comprise:

- two discharges of biologically treated sewage effluent to soakaways at NGR TG 3569 1085 and TG 3638 1084
- one discharge of untreated domestic sewage effluent via a trench arch system at NGR TG 36531 10118

2.7.5. There have been no unconsented discharges identified from consultation.

## 2.8. Designations

### Water Framework Directive

2.8.1. The study area is located within the Broadland Rivers Chalk and Crag groundwater body (GB40501G400300), which is part of the Broadland Rivers Chalk and Crag Operational Catchment and the Anglian GW Management Catchment. Details of the groundwater body are summarised in Table 2.7.

2.8.2. The Broadland Rivers Chalk and Crag groundwater body has 'Poor' Chemical and Quantitative status from 2016 cycle 2 assessment. The Quantitative status is limited by the Groundwater Dependent Terrestrial Ecosystems (GWDTE) test which scored poorly due to agricultural abstractions lowering the natural flow and levels of the groundwater. The objective is to achieve 'Good' Quantitative status by 2021. The Chemical status is limited by the Chemical Drinking Water Protected Area criteria, which scored poorly although data is reportedly suspect. Objectives are to achieve 'Good Chemical Status by 2027 by natural recovery.

Table 2.7 : Summary of WFD groundwater bodies within the study area

| Category | Details |
|---|---|
| Water body ID | GB40501G400300 |
| Water body Name | Broadland Rivers Chalk and Crag groundwater body |
| Operational Catchment | Broadland Rivers Chalk and Crag Operational Catchment |
| Management Catchment | Anglian GW Management Catchment |
| River Basin District | Anglian |
| Overall Classification (Cycle 2 – 2016) | Poor |
| Current Quantitative status (Cycle 2 – 2016) | Poor |
| Current Chemical Quality (Cycle 2 – 2016) | Poor |
| Chemical Objective | Good (by 2027) |
| Protected Area | Yes, Nitrates Directive and Drinking Water Protected Area |

### Other designations

2.8.3. Within the 1km study area there are no Ramsar sites, Special Areas of Conservation (SAC), Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA), Local Nature Reserves or National Nature Reserves (NNR). Designated sites outside of the 1km study area with a potential hydrogeological link have been identified due to the local south easterly groundwater flow direction controlled by the River Yare, as discussed in Section 2.4. These include the Yare Broads and Marshes SSSI, the Broadland Ramsar site and the Mid Yare Valley NNR (National Nature Reserve), situated approximately 1.6km to the southwest of the western extents of the study area, and Damgate Marshes SSSI and Decoy Carr SSSI, situated approximately 3km to the east of the study area.

## 2.9. Groundwater flooding

2.9.1. The 1km study area includes areas that have limited potential for groundwater flooding to occur. However, there are three small areas at the eastern and western extents of the study area, and to the south of the scheme respectively, where there is potential for groundwater flooding of property situated below ground level (see Volume 2 of the Environmental Statement, Figure 13.8 (Susceptibility to Groundwater Flooding) (**TR010040/APP/6.3**)). The groundwater susceptibility dataset is only available for a 500m corridor around the existing road, and as such there is no information available for the areas to the south of the Proposed Scheme that may be required for the drainage regime.

## 2.10. Summary of findings

2.10.1. This section provides a summary of findings in the form of a conceptual hydrogeological model, and highlights uncertainties relating to the datasets considered.

### Hydrogeological conceptual model

2.10.2. The default study area comprises a 1km buffer zone of the Scheme, however this assessment considers features further south and east, extending to the River Yare and Decoy Carr respectively, based on professional judgement of the groundwater flow pathways controlled by groundwater supply to the river.

2.10.3. The aquifer units in the study area are the Bytham Sands and Gravels Formation, the Crag and the Chalk. Permeability of the Bytham Sands and Gravels Formation ranges between $6.6 \times 10^{-7} – 1.5 \times 10^{-6}$ m/s. No permeability testing was undertaken within the Crag or the Chalk. The overlying Lowestoft Till and Happisburgh Glacigenic formations are predominantly clay-rich and locally semi-confine the Bytham Sands and Gravels Formation and the Crag aquifers.

Sand and gravel horizons within the Lowestoft Till Formation and upper layers of the Happisburgh Glacigenic Formation are considered to be permeable, although have been found to be dry in the study area. This is likely due to the study area being situated in an interfluvial setting.

2.10.4. Local hydraulic gradients within the Bytham Sands and Gravels Formation and Crag Group are primarily to the east, however, there is an assumed local control towards the Witton Run and the River Yare, to the south of the study area, where groundwater from the Crag likely discharges to surface watercourses. This is interpreted from groundwater level monitoring at Strumpshaw.

2.10.5. Upstream of the Braydeston Hall tributary, at the western extents of the study area, the Lowestoft Till and upper sandy horizons of the Happisburgh Glacigenic Formation have been eroded away to expose its lower horizons. As in other locations, the Lowestoft Till and Happisburgh Glacigenic formations are largely dry here, with groundwater associated with the Bytham Sands and Gravels Formation and Crag Group aquifers.

2.10.6. Aquifer units underlying the scheme are within Broadland Rivers Chalk and Crag groundwater body, which has a poor overall status due to quantitative and chemical assessments. Groundwater sampling from the site during the 2018 ground investigation showed no signs of contamination.

2.10.7. There are five licensed abstractions and in the study area generally abstract from the Chalk, although one abstraction to the east of North Burlingham abstracts from sands and gravels. It is assumed that this abstraction relates to the Bytham Sands and Gravels Formation and Crag Group.

2.10.8. Groundwater-fed surface water features within the study area are limited to the tributaries of the Witton Run at Braydeston Hall and Red House. These are likely to receive groundwater from the Bytham Sands and Gravels Formation and the Crag Group where these formations outcrop within the valleys to the north and east of Braydeston Hall.

2.10.9. There are a number of designated sites located outside the 1km study area. These are associated with groundwater dependent terrestrial ecosystems and likely receive groundwater from the Bytham Sands and Gravels Formation and the Crag Group/Chalk.

### Uncertainty

2.10.10. Groundwater monitoring, comprising monthly dip readings undertaken over an 11-month period following the 2018 ground investigation, gives an indication of the seasonal variation of the groundwater levels. However, the seasonal maximum and minimum groundwater levels may not have been recorded, especially considering the apparent rainfall deficiency over the monitoring period.

2.10.11. Groundwater flow direction within the study area is interpreted to be primarily to the east. However, groundwater monitoring at Strumpshaw, south of the site, indicates that groundwater flows may also be towards the south, towards the River Yare. The location of the groundwater flow divide is not known.

2.10.12. Chalk groundwater levels directly below the study area are not known, and therefore it is not possible to fully determine the hydraulic relationship between the superficial deposits, the Crag and the Chalk.

2.10.13. Aquifer properties of the Crag and the Chalk within the study area have not been confirmed during the 2018 ground investigation.

# 3. Groundwater assessments

## 3.1. Groundwater levels and flows assessment

3.1.1. The baseline assessment and hydrogeological conceptual model outlined in Section 2 informs the groundwater level and flows assessment as per Appendix A of the LA 113 guidance document. The findings show that, in summary:

- The main direct groundwater receptors within the Study Area are as follows:
    - Aquifer units of the Broadland Rivers Chalk and Crag groundwater body (GB40501G400300), comprising:
        - Bytham Sands and Gravels Formation
        - Crag Group
- The main indirect groundwater receptors within the Study area are as follows:
    - Five licensed groundwater abstractions and eight unlicensed groundwater abstractions, although it is noted that only one abstracts water from the sand and gravels. All other abstractions take water from the underlying chalk aquifer.
    - Designated sites associated with groundwater dependent terrestrial ecosystems, including the Yare Broads and Marshes SSSI, the Broadland Ramsar site and the Mid Yare Valley NNR.

3.1.2. The designated sites are considered further in Section 3.4, and all direct and indirect receptors listed above are considered further in the impact assessment presented in Chapter 13 Road Drainage and the Water Environment (**TR010040/APP/6.1**).

## 3.2. Groundwater quality and runoff

3.2.1. Groundwater quality and runoff risk assessments were completed to assess the risk of impact upon groundwater quality from routine runoff based on the 'source-pathway-receptor' model, as per Appendix C of the DMRB LA 113 guidance.

3.2.2. The drainage design includes the use of infiltration basins and trenches that are deeper than 2m and considered by the Environment Agency as deep drainage. As deep drainage to groundwater is less preferable to the Environment Agency than shallow drainage, further consultation has been undertaken.

3.2.3. 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.

3.2.4. The Drainage Strategy (Volume 3, Appendix 13.2 (**TR010040/APP/6.2**)) demonstrates that there are no other feasible options and 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. The Drainage Strategy also highlights the pollution control measures that have been included and demonstrates that these compensate for the increased risk arising from the deep infiltration system.

3.2.5. A Technical Note (Volume 3, Appendix 13.2, Annex D (**TR010040/APP/6.2**)) was also produced specifically to address the Environment Agency's concerns. This presents detailed information on the infiltration capacities for both the Lowestoft Formation and the Happisburgh Glacigenic Formation (as summarised in Section 2.5), confirms that discharges to groundwater are indirect, and presents risk assessments to confirm that no unacceptable discharge to groundwater will take place. Details of the risk assessments are also presented below.

3.2.6. Risk assessments for one infiltration basin, eight road drainage soakaway trenches and three combined road drainage and clean water soakaway trenches have been completed. All scored < 150, which categorises them as low risk.

3.2.7. Input parameters were derived from ground investigation data and publicly available information. These are in line with the conceptualisation outlined above in Section 2.10 and are summarised below in Table 3.1. Results are summarised below in Table 3.2. The full results of the groundwater quality and runoff risk assessments are provided in Annex B. Further details of the drainage design, including drainage feature locations, are provided in the Drainage Strategy (Volume 3, Appendix 13.2 (**TR010040/APP/6.3**)).

Table 3.1 : Summary of HEWRAT risk assessment input parameters

| Input parameter | Detail |
|---|---|
| Traffic flow | AADT model data. |
| Rainfall depth (annual averages) | Average based on warm/dry climatic region from nearest UK rainfall monitoring site (Ipswich). |
| Drainage area ratio | Determined as 'drainage area of road'/'active surface area of infiltration device', where the surface area is that part of the device through which most downward discharge will occur. |
| 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 was based on groundwater monitoring data available for the monitoring boreholes from the 2018 ground investigation. |
| 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 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 | TOC results from boreholes BH7, BH8, BH15 and BH22 and trial pit TP28. Sample results ranged between 0.3 and 1.0%. |
| 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 mbGL. The result was selected for each infiltration feature, based on the nearest adjacent borehole and sample depth. |

Table 3.2 : Summary of groundwater quality impacts from routine runoff

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

## 3.3. Spillage assessment

3.3.1. The risk to groundwater quality from spillage during operation of the Proposed Scheme was assessed using the methodology outlined in Appendix D of the DMRB LA 113 guidance document. Results from the spillage assessment are in Annex C of this report.

3.3.2. Spillage assessments were carried out for 22 existing drainage features and 13 designed drainage features, no annual probability was greater than 0.0096%.

3.3.3. No further action is required, as this is lower than the maximum tolerable annual probability risk of 1%, or 0.5% where a spillage has the potential to affect a:

- SSSI;
- SPZ;
- Protected area;
- Drinking water supply; or
- Commercial activity abstraction from the watercourse.

3.3.4. It is noted that the Proposed Scheme reduces the number of junctions (including at-grade junctions) compared to the existing A47 between Blofield and North Burlingham. This reduces collision risk and therefore reduces spillage risk as per the assessment matrix included in Appendix D of the DMRB LA 113 guidance document.

## 3.4. Groundwater dependent terrestrial ecosystems

3.4.1. Identified groundwater dependent terrestrial ecosystems (GWDTE) have been assessed to determine hydrogeological links with the Proposed Scheme, the importance of each GWDTE, the magnitude of any potential impact on the GWDTE and thereby the overall significance of risk to the GWDTE.

3.4.2. Designated sites outside of the 1km study area with a potential hydrogeological link to the study area have been identified. These include the Yare Broads and Marshes SSSI, the Broadland Ramsar site and the Mid Yare Valley NNR, situated approximately 1.6km to the southwest of the western extents of the study area; and Damgate Marshes SSSI and Decoy Carr SSSI, situated approximately 3km to the east of the study area.

### Potential hydrogeological link between the Scheme and GWDTE

3.4.3. Groundwater flow within the study area in primarily east, as shown on the Mainline Geological Section within Annex A of this report. However, as discussed in Section 2, hydraulic gradients in the area may also be controlled by the River Yare south of the Scheme. This is interpreted from regional groundwater monitoring at Strumpshaw. Local hydraulic gradients within the Bytham Sands and Gravels Formation and Crag Group in the western extent of the study area are likely to be towards the Witton Run and the River Yare. Here, groundwater from the Crag possibly discharges to surface watercourses and to the Yare Broads and Marshes SSSI, Broadland RAMSAR and Mid Yare Valley NNR. Towards the east of the study area, local hydraulic gradients within the Bytham Sands and Gravels Formation and Crag Group are also likely to supply the Damgate Marshes SSSI and Decoy Carr SSSI.

### Assessment of GWDTE importance

3.4.4. Table 3.3 presents the overall importance for the GWDTEs. This is taken as highest of the 'flora and fauna' and 'habitat' receptors, based on SSSI citations (Natural England, 1985, 1988, 1993) and UKTAG guidance for national vegetation classification (UKTAG, 2009).

Table 3.3 : Summary of GWDTE classification and importance based on flora and fauna, and habitat receptors

| GDTWE | Flora and fauna receptor | Flora and fauna importance | Habitat receptor | Habitat importance | Overall importance |
|---|---|---|---|---|---|
| Yare Broads and Marshes SSSI/<br>Broadland RAMSAR/<br>Mid Yare Valley NNR | M22 - Juncus subnodulosus<br>M24 - Molinia caerulea<br>S24 - Phragmites australis<br>NVC dependency on groundwater – level 2 | Moderate | SSSI | High | High |
| Damgate Marshes SSSI/<br>Decoy Carr SSSI | M24 - Molinia caerulea<br>S24 - Phragmites australis<br>NVC dependency on groundwater – level 2 | Moderate | SSSI | High | High |

### Assessment of potential impacts

3.4.5. Potential impacts to GWDTEs from construction and operation of the scheme are described in detail in Chapter 13 Road Drainage and the Water Environment (**TR010040/APP/6.1**).

3.4.6. Possible groundwater quantity impacts are limited to the potential for piled foundations for overbridge structures to act as a barrier to groundwater flow. There are no anticipated dewatering activities as part of construction. Considering the extents of the Bytham Sands and Gravels Formation and Crag Group aquifer, however, and the relative distance between the structures and the GWDTEs, the pile foundations are not likely to act as a significant barrier to groundwater flow, and the magnitude of any change in groundwater flow or flux is considered to be negligible.

3.4.7. Possible groundwater quality impacts on the GWDTEs relate to possible metalloid and organic compounds discharging to groundwater from the proposed road drainage, which discharges exclusively to groundwater. HEWRAT assessments for the soakaways are all categorised as low risk, however, and the annual probability of spillage has been assessed as being well below the tolerable limit of 1%. Furthermore, the drainage design includes penstocks to allow outfalls to the infiltration basin and soakaway trenches to be shut off manually in the event of a spillage. The magnitude of any changes to groundwater quality are therefore considered to be negligible.

3.4.8. As the overall risk to GWDTEs is assessed as being negligible, no further assessment is required.

# 4. Conclusions

4.1.1. This appendix report summarises baseline hydrogeological conditions from ground investigations completed in 1992, 2004 and 2018, and from publicly available information. These details have been used to create a hydrogeological conceptual model of the Proposed Scheme and study area, and to inform assessments of potential impacts to the groundwater environment during construction and operation, as per the DMRB LA 113 guidance documents.

4.1.2. The groundwater levels and flows assessment identified the following receptors for consideration in the impact assessment:

- The main direct groundwater receptors within the Study Area are as follows:
  - Aquifer units of the Broadland Rivers Chalk and Crag groundwater body (GB40501G400300), comprising:
    - Bytham Sands and Gravels Formation
    - Crag Group
- The main indirect groundwater receptors within the Study area are as follows:
  - Five licensed groundwater abstractions and eight unlicensed groundwater abstractions, although it is noted that only one abstracts water from the sand and gravels. All other abstractions take water from the underlying chalk aquifer.
  - Designated sites associated with groundwater dependent terrestrial ecosystems, including the Yare Broads and Marshes SSSI, the Broadland Ramsar site and the Mid Yare Valley NNR.

4.1.3. The groundwater quality and runoff assessment considered the infiltration basin and road drainage soakaway trenches, all of which were assessed to be low risk.

4.1.4. The spillage assessment considered existing and new drainage features and found the annual probability of spillage risk to be significantly lower than the maximum tolerable limit.

4.1.5. The GWDTE assessment considered potential hydraulic links between the scheme and designated sites to the south and east of the scheme. The assessment concluded that there is negligible risk to the sites in terms of groundwater quality and quantity.

4.1.6. The results of these individual assessments are included in the impact assessment presented in Chapter 13 Road Drainage and the Water Environment.

# 5. References

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# Annex A. 2020 GIR mainline geological 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

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 |
|---|---|
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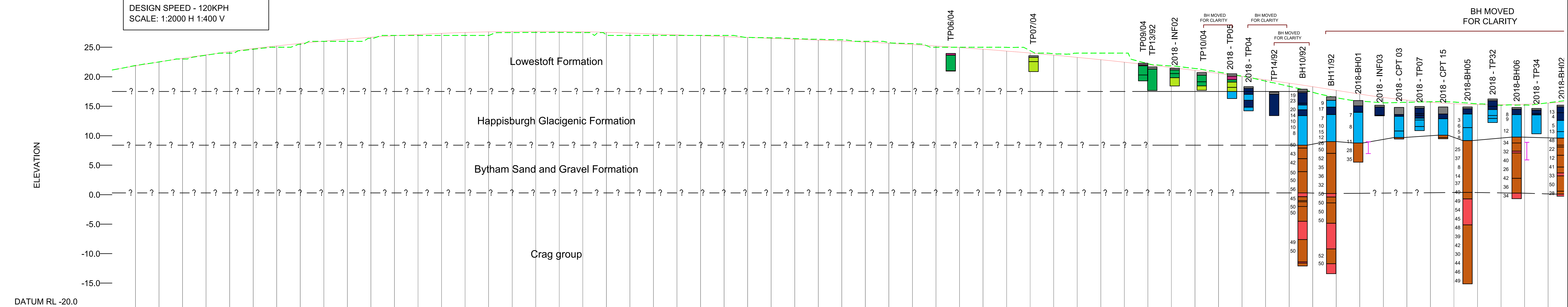
| G2 | There is an IP Gas main in the vicinity of the works. Ref to "Cadent Gas Pipeline Survey" Report UX85585 ICL-DJ-001 (Interserve, 2018) for pipe location as identified during SI. |


PLAN 1
Scale: 1:2000

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



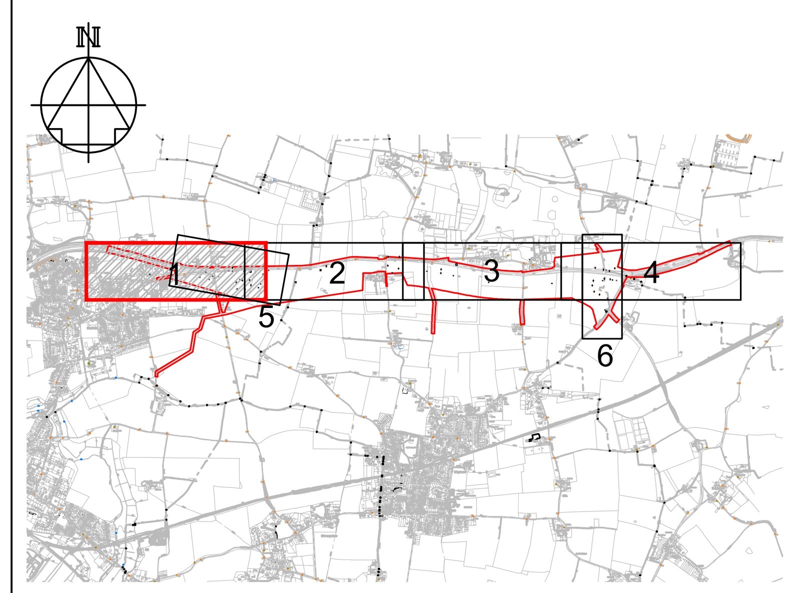

| CHAINAGE | DESIGN LEVELS | EXISTING LEVELS |
|---|---|---|
| 0 | 21.149 | 21.142 |
| 20 | 21.843 | 21.908 |
| 40 | 22.508 | 22.508 |
| 60 | 23.132 | 23.000 |
| 80 | 23.717 | 23.659 |
| 100 | 24.261 | 24.000 |
| 120 | 24.766 | 24.665 |
| 140 | 25.231 | 25.000 |
| 160 | 25.655 | 25.505 |
| 180 | 26.040 | 26.000 |
| 200 | 26.384 | 26.000 |
| 220 | 26.689 | 26.501 |
| 240 | 26.953 | 27.000 |
| 260 | 27.178 | 27.000 |
| 280 | 27.362 | 27.000 |
| 300 | 27.507 | 27.000 |
| 320 | 27.612 | 27.000 |
| 340 | 27.676 | 27.497 |
| 360 | 27.701 | 27.511 |
| 380 | 27.685 | 27.508 |
| 400 | 27.630 | 27.495 |
| 420 | 27.534 | 27.100 |
| 440 | 27.399 | 27.000 |
| 460 | 27.251 | 27.000 |
| 480 | 27.103 | 27.000 |
| 500 | 26.955 | 27.000 |
| 520 | 26.807 | 27.000 |
| 540 | 26.659 | 26.663 |
| 560 | 26.511 | 26.595 |
| 580 | 26.363 | 26.471 |
| 600 | 26.214 | 26.344 |
| 620 | 26.058 | 26.260 |
| 640 | 25.879 | 26.000 |
| 660 | 25.679 | 25.799 |
| 680 | 25.457 | 25.623 |
| 700 | 25.212 | 25.000 |
| 720 | 24.946 | 25.000 |
| 740 | 24.658 | 25.000 |
| 760 | 24.347 | 24.979 |
| 780 | 24.015 | 24.422 |
| 800 | 23.661 | 23.916 |
| 820 | 23.285 | 24.000 |
| 840 | 22.887 | 24.000 |
| 860 | 22.466 | 24.000 |
| 880 | 22.024 | 22.219 |
| 900 | 21.560 | 21.835 |
| 920 | 21.074 | 21.404 |
| 940 | 20.566 | 20.792 |
| 960 | 20.036 | 20.100 |
| 980 | 19.484 | 19.254 |
| 1000 | 18.910 | 18.372 |
| 1020 | 18.314 | 17.367 |
| 1040 | 17.696 | 16.453 |
| 1060 | 17.059 | 15.878 |
| 1080 | 16.487 | 15.575 |
| 1100 | 16.024 | 15.659 |
| 1120 | 15.669 | 15.756 |
| 1140 | 15.423 | 15.707 |
| 1160 | 15.284 | 15.400 |
| 1180 | 15.253 | 15.157 |
| 1200 | 15.331 | 15.196 |
| 1220 | 15.516 | 15.584 |

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

1:2000 0 100m 200m



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 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

- 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

SPT - N VALUE

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:
CERTAIN
UNCERTAIN
POSSIBLE

## IMPORTANT

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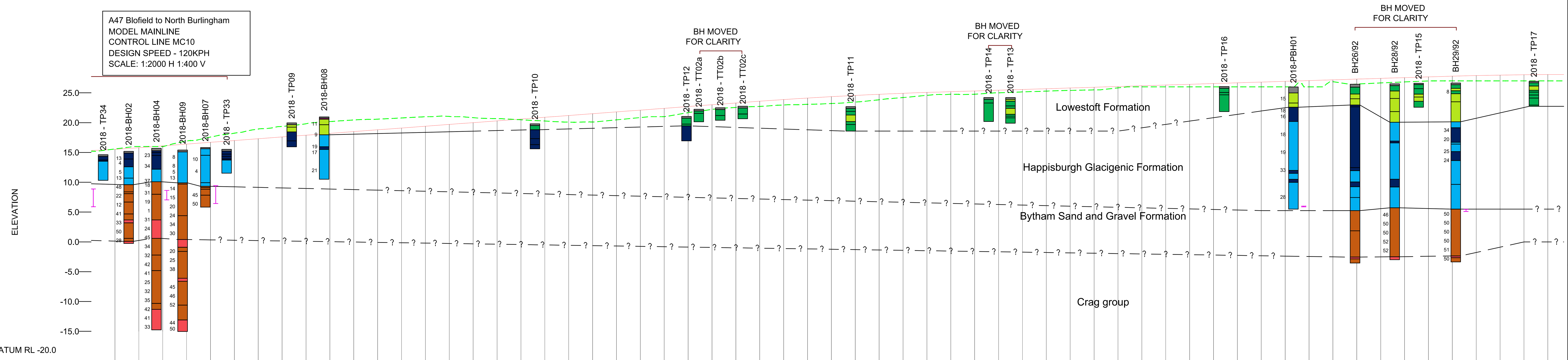
PLAN 2
Scale: 1:2000

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



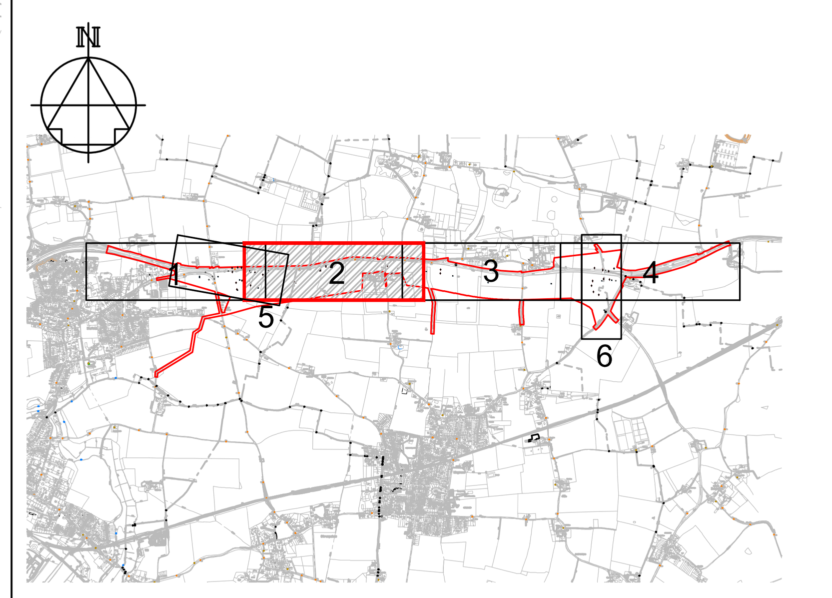

| CHAINAGE | DESIGN LEVELS | EXISTING LEVELS |
|---|---|---|
| 1200 | 15.331 | 15.196 |
| 1220 | 15.516 | 15.584 |
| 1240 | 15.799 | 16.000 |
| 1260 | 16.099 | 16.000 |
| 1280 | 16.399 | 16.922 |
| 1300 | 16.699 | 17.578 |
| 1320 | 16.999 | 18.230 |
| 1340 | 17.299 | 18.929 |
| 1360 | 17.599 | 19.369 |
| 1380 | 17.899 | 19.813 |
| 1400 | 18.199 | 20.186 |
| 1420 | 18.499 | 20.451 |
| 1440 | 18.799 | 20.582 |
| 1460 | 19.099 | 20.781 |
| 1480 | 19.399 | 20.996 |
| 1500 | 19.698 | 21.035 |
| 1520 | 19.998 | 20.834 |
| 1540 | 20.298 | 20.669 |
| 1560 | 20.598 | 20.475 |
| 1580 | 20.898 | 20.277 |
| 1600 | 21.198 | 20.086 |
| 1620 | 21.498 | 20.106 |
| 1640 | 21.798 | 20.468 |
| 1660 | 22.098 | 20.853 |
| 1680 | 22.398 | 21.000 |
| 1700 | 22.698 | 21.675 |
| 1720 | 22.998 | 22.232 |
| 1740 | 23.298 | 22.558 |
| 1760 | 23.594 | 22.725 |
| 1780 | 23.870 | 22.958 |
| 1800 | 24.124 | 23.073 |
| 1820 | 24.356 | 23.209 |
| 1840 | 24.566 | 23.453 |
| 1860 | 24.755 | 23.840 |
| 1880 | 24.921 | 24.211 |
| 1900 | 25.065 | 24.581 |
| 1920 | 25.191 | 24.774 |
| 1940 | 25.315 | 24.771 |
| 1960 | 25.440 | 25.000 |
| 1980 | 25.564 | 25.153 |
| 2000 | 25.688 | 25.293 |
| 2020 | 25.812 | 25.400 |
| 2040 | 25.936 | 25.490 |
| 2060 | 26.061 | 25.829 |
| 2080 | 26.185 | 26.000 |
| 2100 | 26.309 | 26.000 |
| 2120 | 26.433 | 26.000 |
| 2140 | 26.558 | 26.000 |
| 2160 | 26.682 | 26.000 |
| 2180 | 26.806 | 26.000 |
| 2200 | 26.930 | 26.000 |
| 2220 | 27.055 | 26.000 |
| 2240 | 27.179 | 26.871 |
| 2260 | 27.303 | 26.470 |
| 2280 | 27.427 | 26.659 |
| 2300 | 27.552 | 26.827 |
| 2320 | 27.676 | 26.990 |
| 2340 | 27.796 | 27.000 |
| 2360 | 27.895 | 27.000 |
| 2380 | 27.972 | 27.000 |
| 2400 | 28.027 | 27.000 |
| 2420 | 28.060 | 27.000 |

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



1:2000 0 100m 200m

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)

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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 2 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-30002

## 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

SPT - N VALUE

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:
CERTAIN
UNCERTAIN
POSSIBLE

## IMPORTANT

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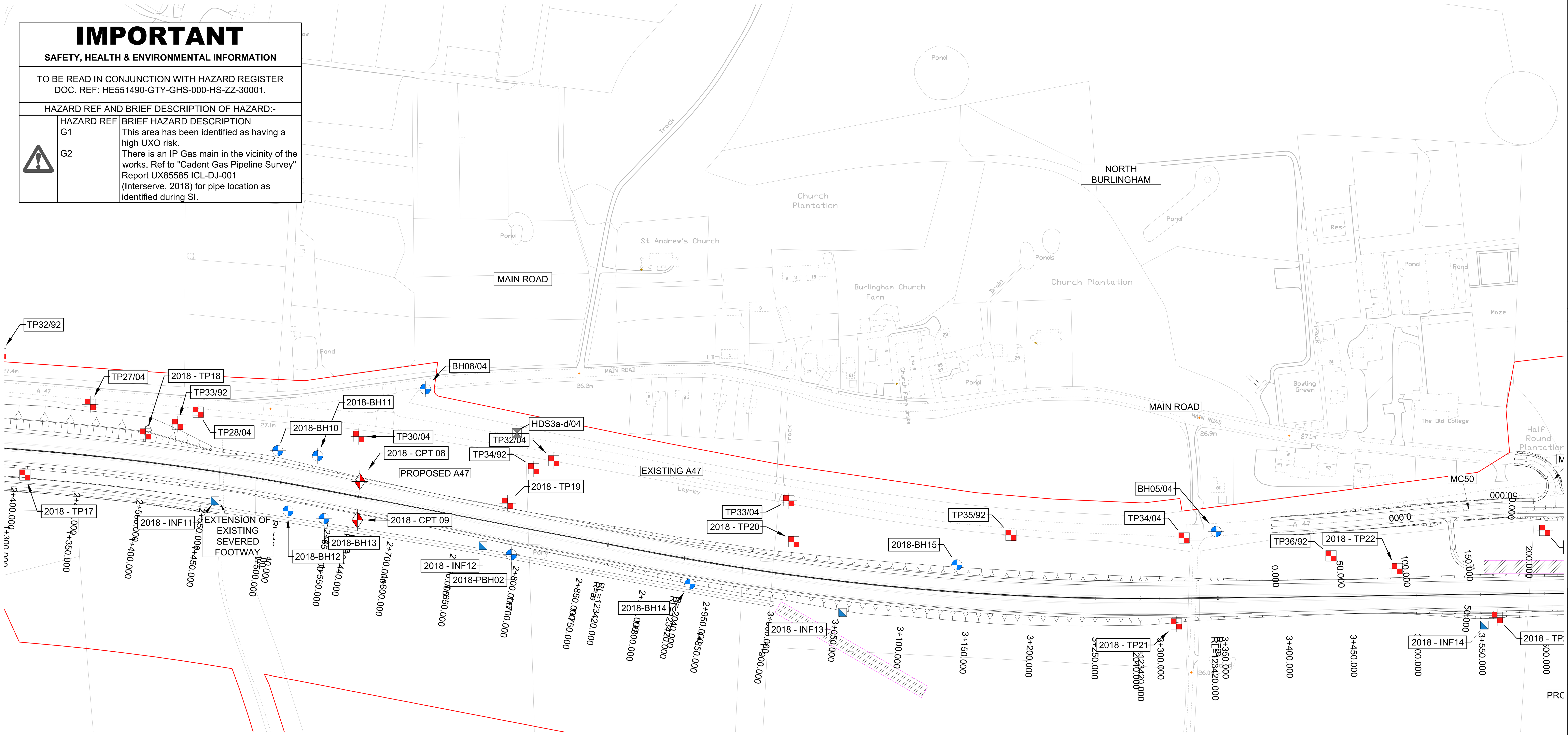
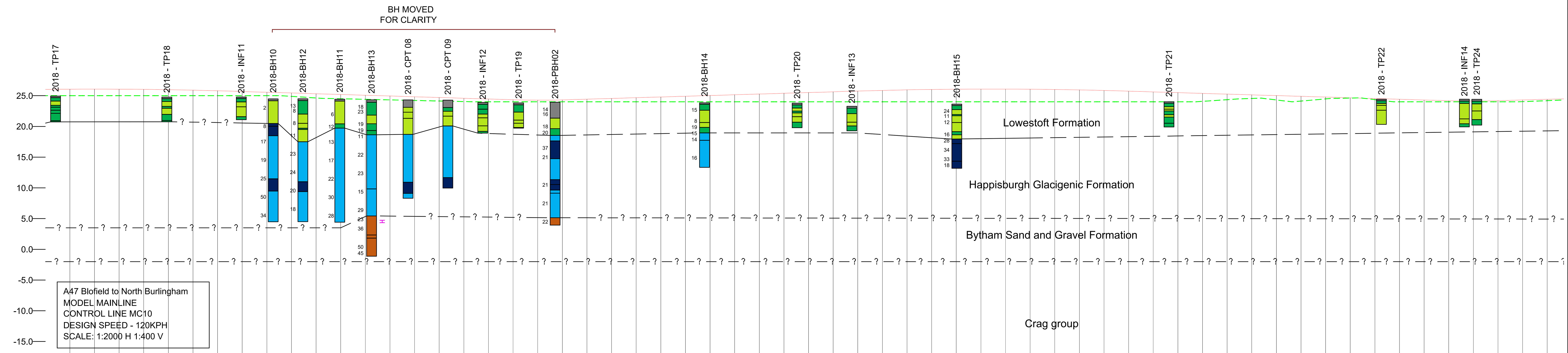



PLAN 3
Scale: 1:2000




DATUM RL -20.0

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN LEVELS | 28.027 | 28.060 | 28.072 | 28.061 | 28.028 | 27.973 | 27.897 | 27.798 | 27.680 | 27.558 | 27.436 | 27.314 | 27.192 | 27.070 | 26.948 | 26.825 |
| EXISTING LEVELS | 27.000 | 27.000 | 27.000 | 27.000 | 27.000 | 27.000 | 27.000 | 27.000 | 27.000 | 27.000 | 26.889 | 26.630 | 26.497 | 26.406 | 26.315 | 26.224 |
| CHAINAGE | 2400 | 2420 | 2440 | 2460 | 2480 | 2500 | 2520 | 2540 | 2560 | 2580 | 2600 | 2620 | 2640 | 2660 | 2680 | 2700 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN LEVELS | 26.703 | 26.581 | 26.459 | 26.337 | 26.271 | 26.312 | 26.430 | 26.550 | 26.670 | 26.790 | 26.910 | 27.030 | 27.150 | 27.270 | 27.390 | 27.510 |
| EXISTING LEVELS | 26.133 | 26.042 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 |
| CHAINAGE | 2720 | 2740 | 2760 | 2780 | 2800 | 2820 | 2840 | 2860 | 2880 | 2900 | 2920 | 2940 | 2960 | 2980 | 3000 | 3020 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN LEVELS | 27.630 | 27.750 | 27.858 | 27.945 | 28.009 | 28.052 | 28.073 | 28.071 | 28.048 | 28.003 | 27.935 | 27.846 | 27.735 | 27.615 | 27.495 | 27.375 |
| EXISTING LEVELS | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.074 |
| CHAINAGE | 3040 | 3060 | 3080 | 3100 | 3120 | 3140 | 3160 | 3180 | 3200 | 3220 | 3240 | 3260 | 3280 | 3300 | 3320 | 3340 |

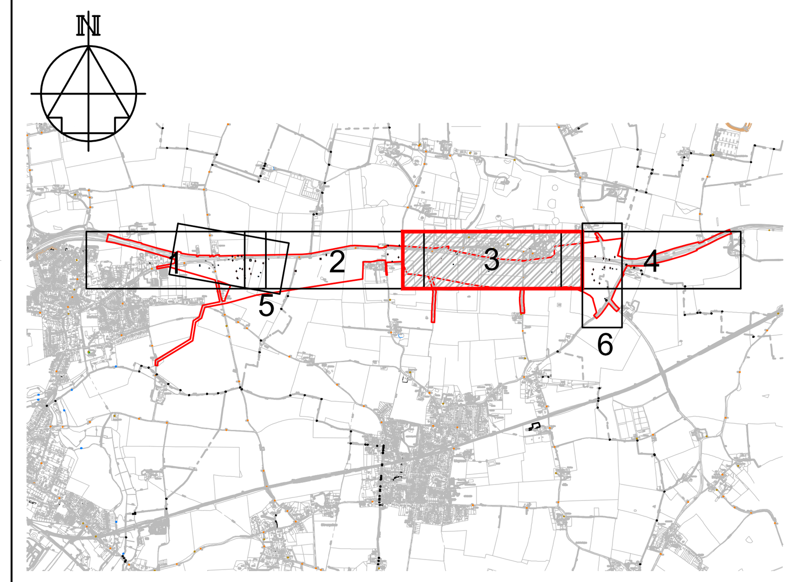
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN LEVELS | 27.255 | 27.135 | 27.015 | 26.895 | 26.775 | 26.655 | 26.535 | 26.415 | 26.295 | 26.176 | 26.122 | 26.176 | 26.303 | 26.417 |
| EXISTING LEVELS | 26.346 | 26.554 | 26.306 | 26.125 | 26.474 | 26.612 | 26.365 | 26.000 | 26.000 | 26.000 | 26.000 | 26.000 | 26.031 | 26.191 |
| CHAINAGE | 3360 | 3380 | 3400 | 3420 | 3440 | 3460 | 3480 | 3500 | 3520 | 3540 | 3560 | 3580 | 3600 | 3620 |

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



1:2000 0 100m 200m

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)
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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
MAINLINE GEOLOGICAL LONG SECTION
SHEET 3 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-30003

## LEGEND

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

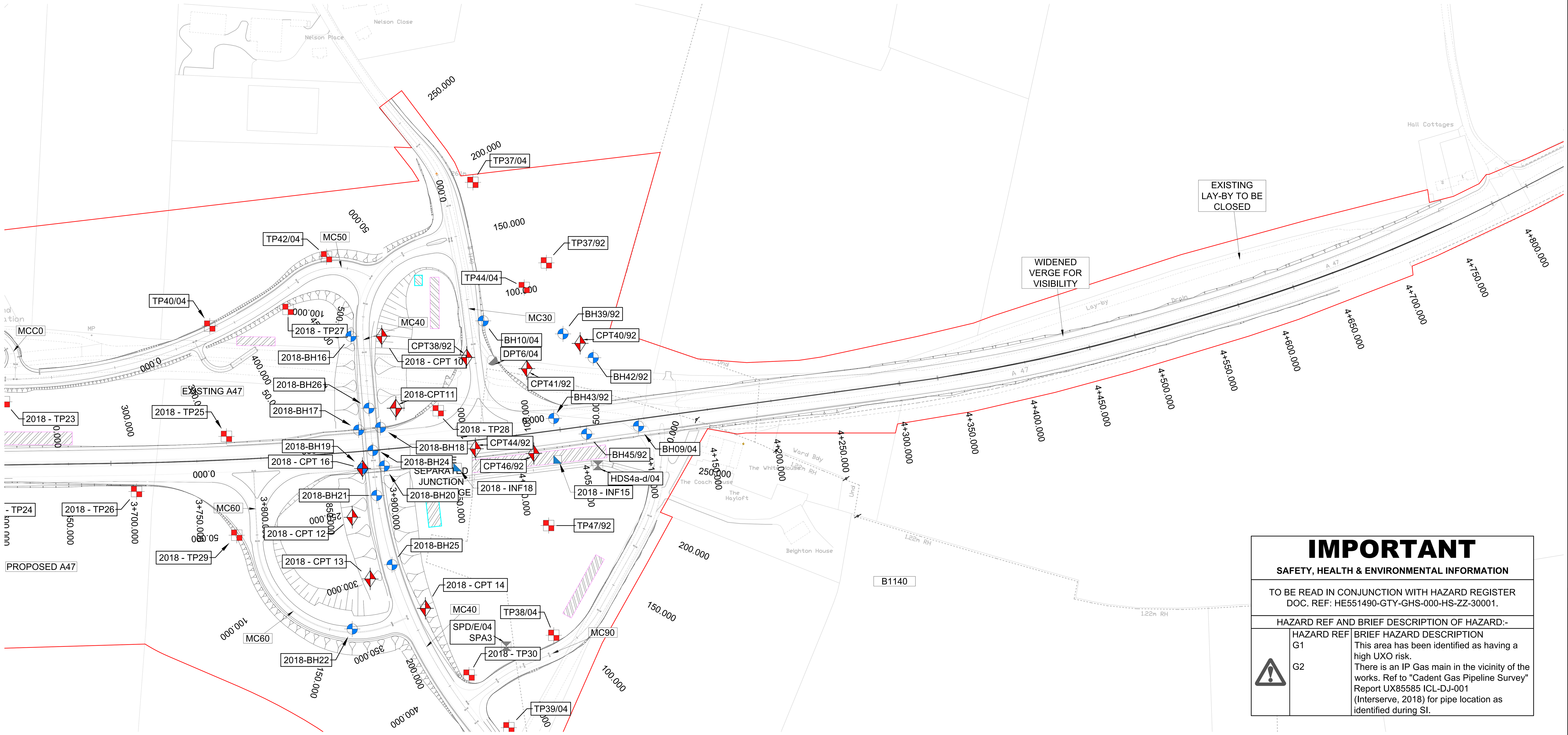
BOREHOLE LOCATION
DATES AS FOLLOWS:
2018-XXXX = 2018
XXXX/04 = 2004
XXXX/92 = 1992

2018-BH01

SPT - N VALUE

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:

- CERTAIN
- UNCERTAIN
- POSSIBLE




## PLAN 4
Scale: 1:2000

## IMPORTANT

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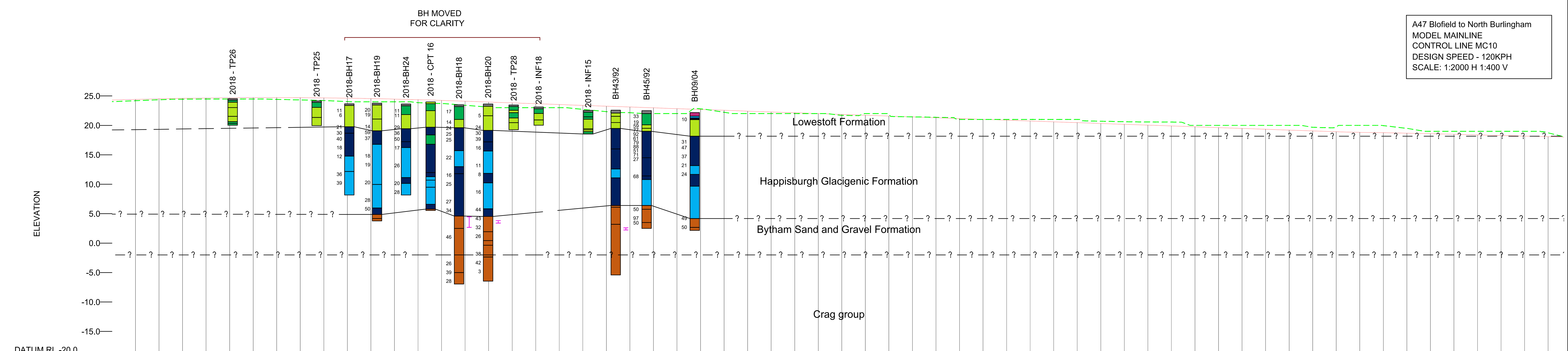
A47 Blofield to North Burlingham
MODEL MAINLINE
CONTROL LINE MC10
DESIGN SPEED - 120KPH
SCALE: 1:2000 H 1:400 V



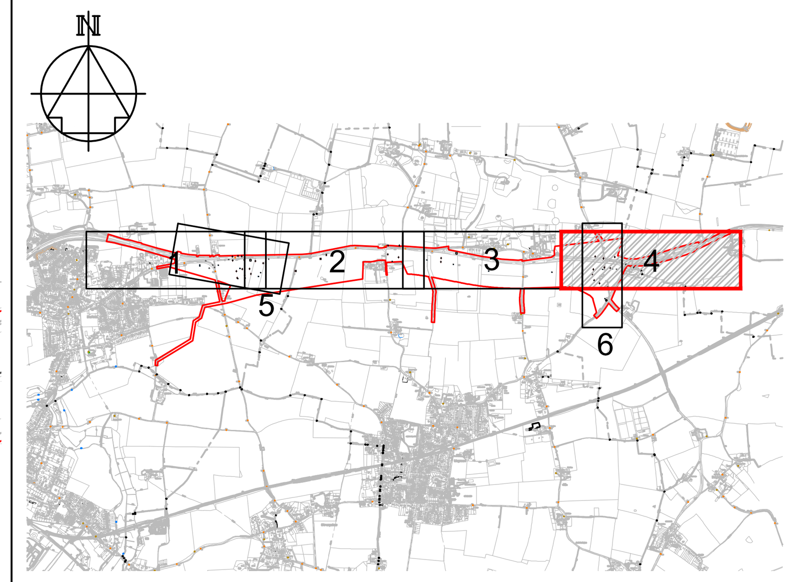

| CHAINAGE | DESIGN LEVELS | EXISTING LEVELS |
|---|---|---|
| 3600 | 26.303 | 26.051 |
| 3620 | 26.417 | 26.191 |
| 3640 | 26.512 | 26.350 |
| 3660 | 26.590 | 26.450 |
| 3680 | 26.649 | 26.477 |
| 3700 | 26.690 | 26.484 |
| 3720 | 26.712 | 26.480 |
| 3740 | 26.717 | 26.417 |
| 3760 | 26.703 | 26.319 |
| 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

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 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

SPT - N VALUE

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:
CERTAIN
UNCERTAIN
POSSIBLE

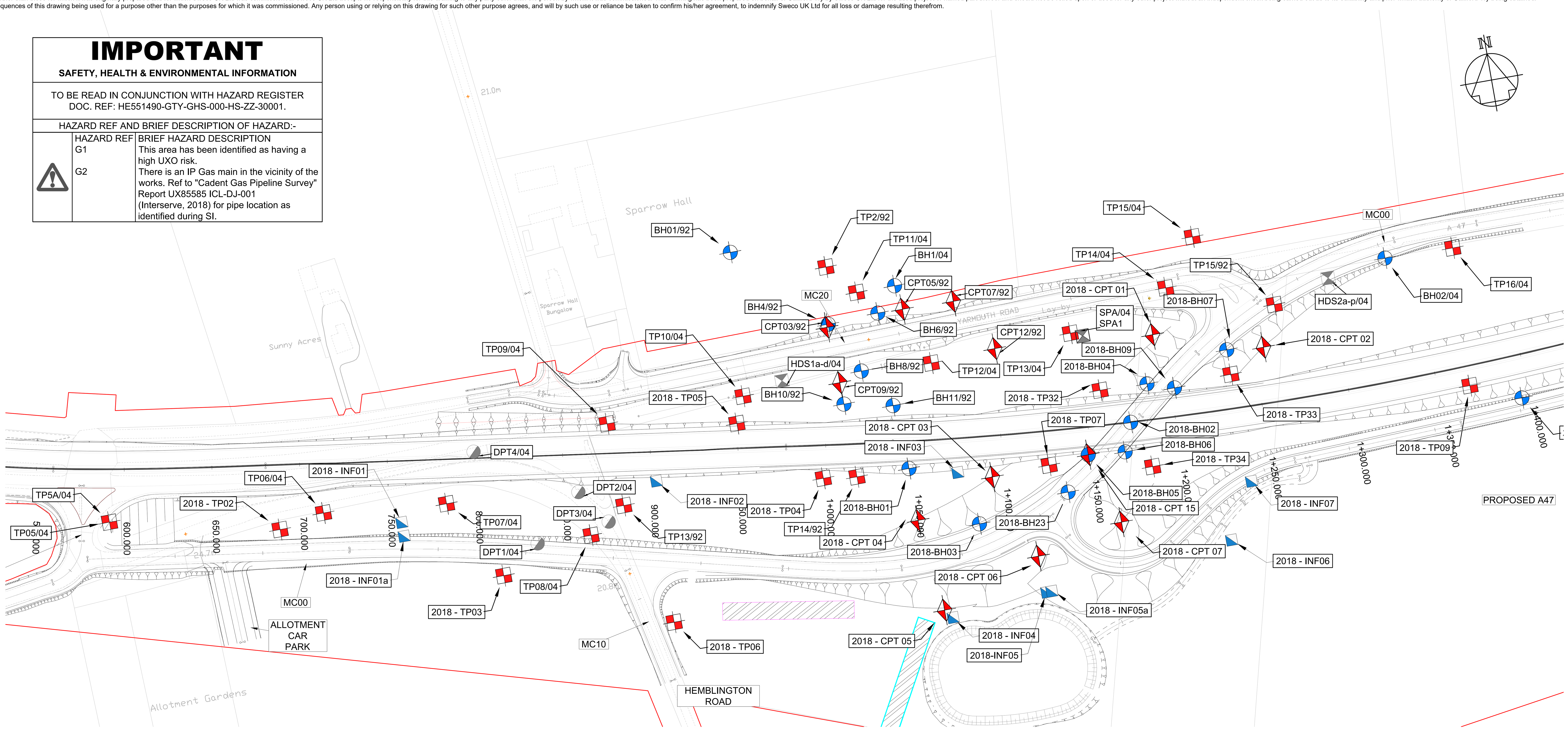
## IMPORTANT

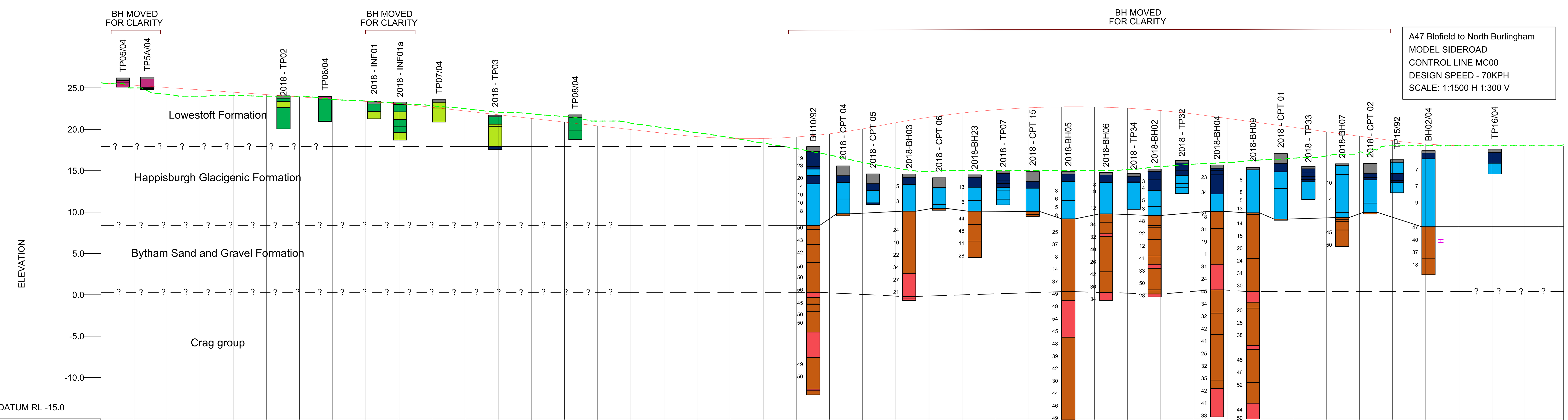
SAFETY, HEALTH & ENVIRONMENTAL INFORMATION

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. |



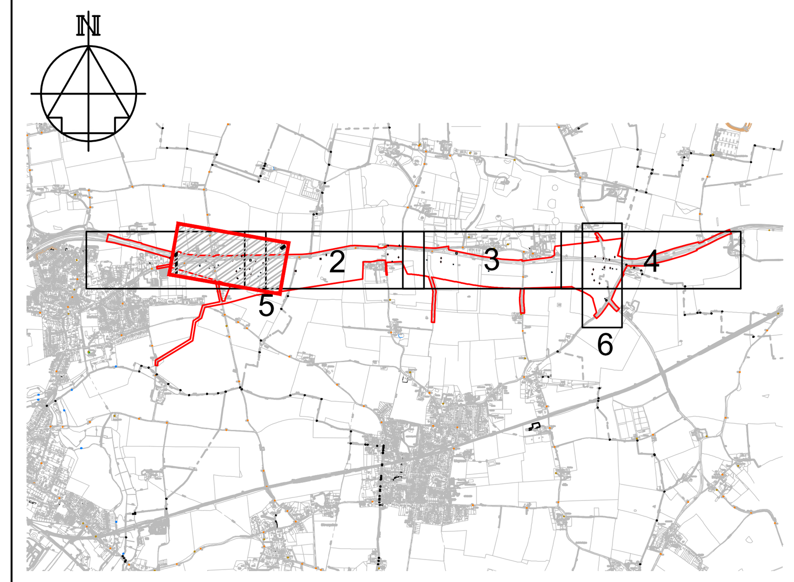

A47 Blofield to North Burlingham
MODEL SIDEROAD
CONTROL LINE MC00
DESIGN SPEED - 70KPH
SCALE: 1:1500 H 1:300 V

| CHAINAGE | DESIGN LEVELS | EXISTING LEVELS |
|---|---|---|
| 0 | 25.603 | 25.602 |
| 20 | 25.322 | 25.000 |
| 40 | 25.041 | 24.240 |
| 60 | 24.760 | 24.000 |
| 80 | 24.479 | 24.104 |
| 100 | 24.197 | 24.000 |
| 120 | 23.916 | 24.000 |
| 140 | 23.635 | 23.619 |
| 160 | 23.354 | 23.408 |
| 180 | 23.069 | 23.130 |
| 200 | 22.655 | 22.848 |
| 220 | 22.207 | 22.481 |
| 240 | 21.759 | 22.023 |
| 260 | 21.311 | 21.865 |
| 280 | 20.863 | 21.574 |
| 300 | 20.415 | 21.000 |
| 320 | 19.967 | 20.747 |
| 340 | 19.519 | 20.180 |
| 360 | 19.117 | 19.585 |
| 380 | 18.904 | 19.000 |
| 400 | 18.892 | 18.326 |
| 420 | 19.079 | 17.662 |
| 440 | 19.466 | 16.905 |
| 460 | 20.053 | 16.000 |
| 480 | 20.797 | 15.316 |
| 500 | 21.447 | 14.912 |
| 520 | 21.963 | 15.000 |
| 540 | 22.347 | 15.000 |
| 560 | 22.597 | 15.000 |
| 580 | 22.713 | 15.000 |
| 600 | 22.696 | 15.000 |
| 620 | 22.546 | 15.127 |
| 640 | 22.263 | 15.526 |
| 660 | 21.846 | 15.790 |
| 680 | 21.319 | 15.985 |
| 700 | 20.781 | 16.290 |
| 720 | 20.243 | 16.509 |
| 740 | 19.705 | 16.782 |
| 760 | 19.167 | 17.266 |
| 780 | 18.632 | 18.000 |
| 800 | 18.229 | 18.000 |
| 820 | 18.026 | 18.000 |
| 840 | 18.000 | 18.000 |
| 860 | 18.000 | 18.000 |
| 880 | 18.000 | 18.000 |

1:1500 0 75m 150m



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

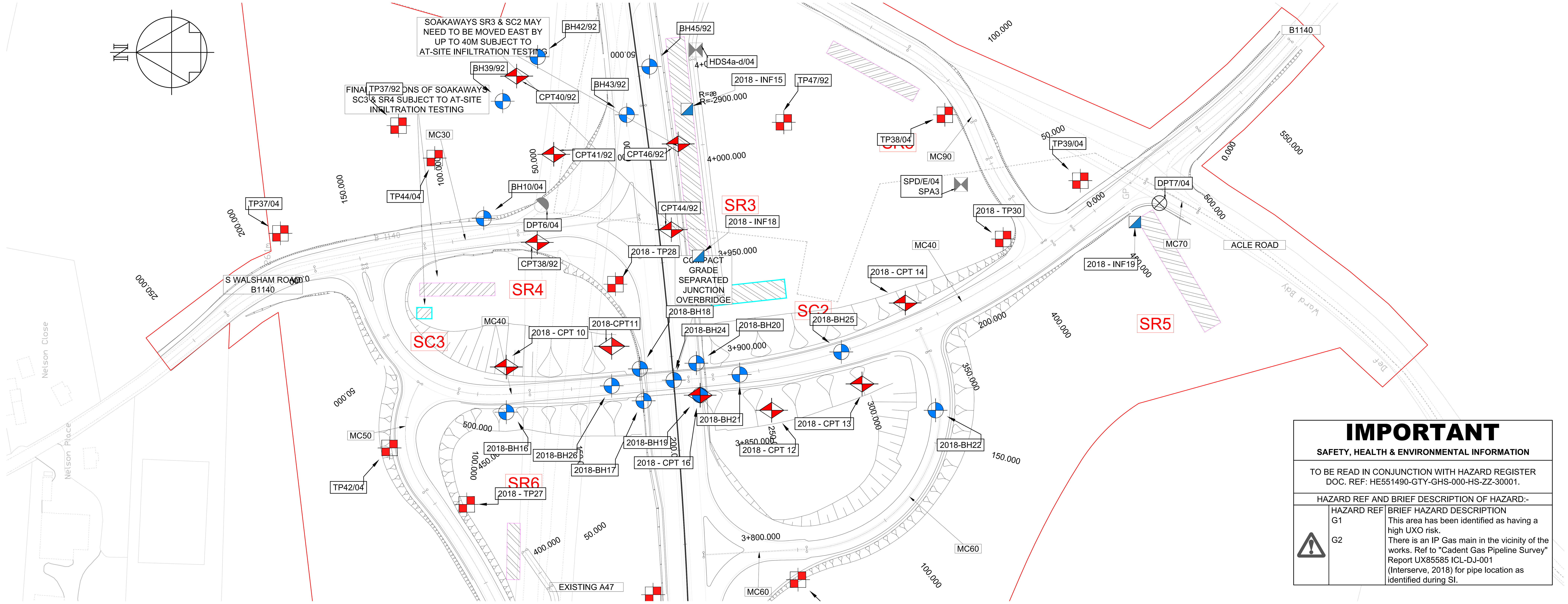
PROJECT STAGE: PCF STAGE 3

DRAWING TITLE: SIDEROAD GEOLOGICAL LONG SECTION SHEET 1 OF 2

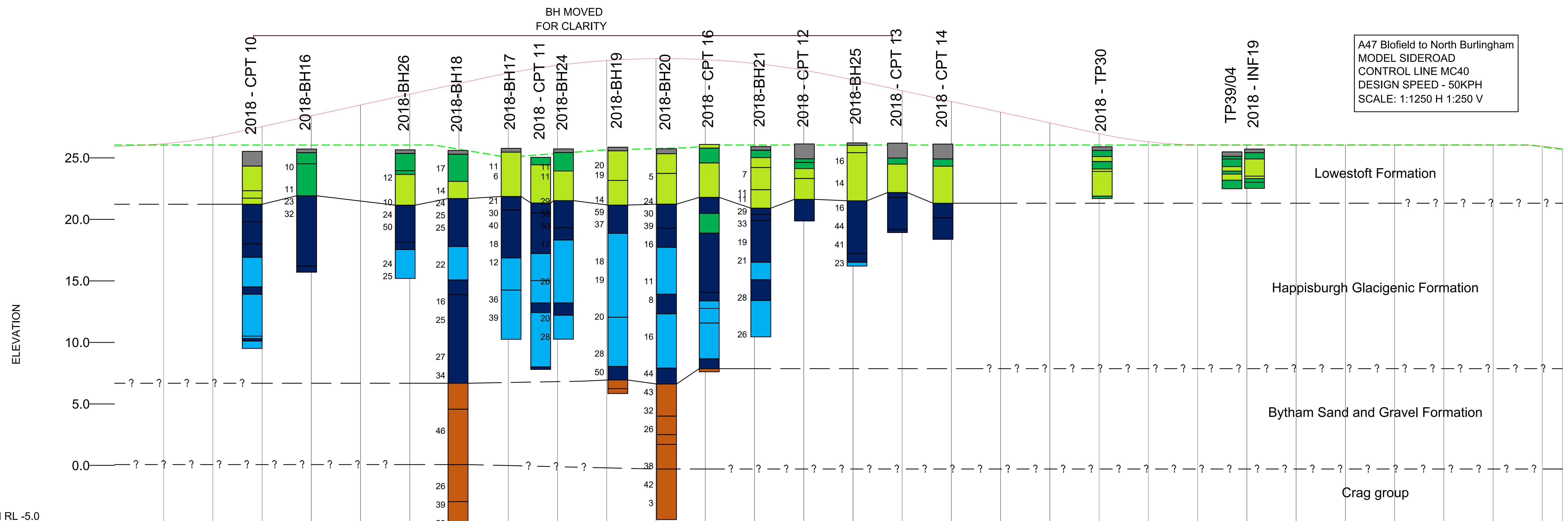
SUITABILITY: SUITABLE FOR REVIEW & COMMENT

| SHEET SIZE | SCALE | STATUS | REVISION |
|---|---|---|---|
| A1 | AS SHOWN | S3 | P02 |

DRAWING NUMBER: HE551490-GTY-VGT-000-DR-VG-30005




PLAN 6
Scale: 1:1250




| CHAINAGE | DESIGN LEVELS | EXISTING LEVELS |
|---|---|---|
| 0 | 25.873 | 26.000 |
| 20 | 26.098 | 26.000 |
| 40 | 26.641 | 26.000 |
| 60 | 27.495 | 26.000 |
| 80 | 28.371 | 26.000 |
| 100 | 29.247 | 26.000 |
| 120 | 30.123 | 26.000 |
| 140 | 30.999 | 25.657 |
| 160 | 31.838 | 25.021 |
| 180 | 32.465 | 25.311 |
| 200 | 32.856 | 25.598 |
| 220 | 33.012 | 25.710 |
| 240 | 32.932 | 25.928 |
| 260 | 32.618 | 26.000 |
| 280 | 32.068 | 26.000 |
| 300 | 31.284 | 26.000 |
| 320 | 30.411 | 26.000 |
| 340 | 29.537 | 26.000 |
| 360 | 28.664 | 26.000 |
| 380 | 27.790 | 26.000 |
| 400 | 26.917 | 26.000 |
| 420 | 26.261 | 26.000 |
| 440 | 26.004 | 26.000 |
| 460 | 26.000 | 26.000 |
| 480 | 26.000 | 26.000 |
| 500 | 26.000 | 26.000 |
| 520 | 26.000 | 26.000 |
| 540 | 26.000 | 26.000 |
| 560 | 26.000 | 26.000 |
| 580 | 25.906 | 25.859 |
| 588 | 25.680 | 25.671 |

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



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.

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. |

## LEGEND

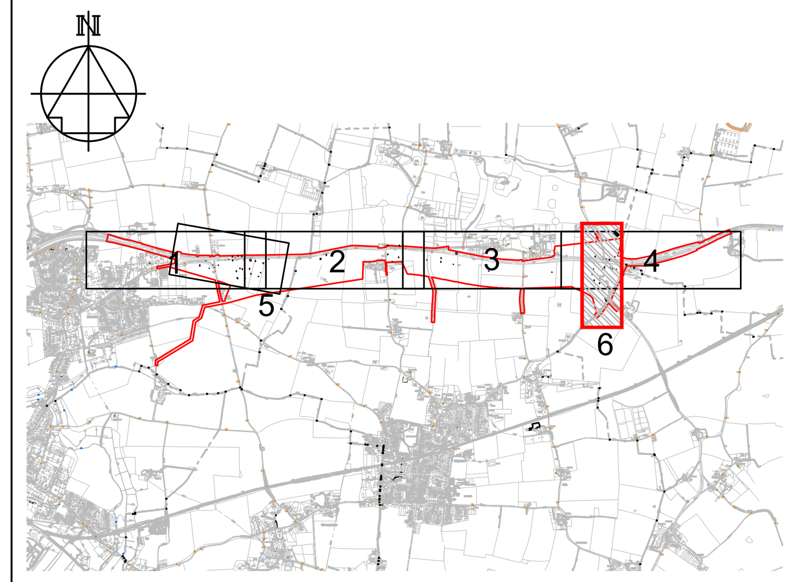
- TOPSOIL
- MADE GROUND
- LOFT GRANULAR
- LOFT COHESIVE
- HPGL GRANULAR
- HPGL COHESIVE
- CRBY GRANULAR
- CRBY COHESIVE

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

SPT - N VALUE

BOUNDARIES BETWEEN GEOLOGICAL LAYERS INDICATED THUS:
CERTAIN
UNCERTAIN
POSSIBLE

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
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

# Annex B. LA 113 Groundwater quality and runoff assessment 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 | <=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 |

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

**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 C. LA 113 Spillage assessment results

PR1

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 2,000 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00064 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00029 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00029 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0003 | 3446 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00029 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0003 | 3446 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00029 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0003 | 3446 |

SR1

## Assessment of Priority Outfalls

| Method D - assessment of risk from accidental spillage | | A (main road) | Additional columns for use if other roads drain to the same outfall B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 600 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | No junction | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.29 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00006 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 36832 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 36832 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 36832 |

SR2

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 250 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | No junction | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/10$^9$ HGVkm/year)* | 0.29 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 88396 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 88396 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 88396 |

SR3

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 300 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00010 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00004 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00004 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 22970 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00004 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 22970 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00004 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 22970 |

SR4

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 100 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 68911 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 68911 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 68911 |

SR5

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A (main road) | B | C | D | E | F | **Totals** | **Return Period (years)** |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 50 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | No junction | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.29 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 441980 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 441980 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 441980 |

SR6

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 500 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00016 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00007 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00007 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 13782 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00007 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 13782 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00007 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 13782 |

SR7

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 600 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00019 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 11485 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 11485 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 11485 |

SR8

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 100 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00003 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 68911 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 68911 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 68911 |

SC1

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | A (main road) | B | C | D | E | F | Totals | Return Period (years) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 200 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | No junction | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.29 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 110495 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 110495 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00001 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 110495 |

SC2

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A (main road) | B | C | D | E | F | **Totals** | **Return Period (years)** |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 120 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/10⁹ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00004 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 57426 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 57426 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 57426 |

SC3

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A (main road) | B | C | D | E | F | **Totals** | **Return Period (years)** |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 120 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00004 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D12 | Is risk greater than 0.01? | **No** | | | | | | | |
| D13 | Return period without pollution reduction measures | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 57426 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 57426 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00002 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0000 | 57426 |

SC4&5

## Assessment of Priority Outfalls

**Method D - assessment of risk from accidental spillage**

| | | | Additional columns for use if other roads drain to the same outfall | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A (main road) | B | C | D | E | F | | |
| D1 | Water body type | Groundwater | | | | | | | |
| D2 | Length of road draining to outfall *(m)* | 600 | | | | | | | |
| D3 | Road Type *(A-road or Motorway)* | A | | | | | | | |
| D4 | If A road, is site urban or rural? | Rural | | | | | | | |
| D5 | Junction type | Side road | | | | | | | |
| D6 | Location (response time for emergency services) | < 20 minutes | | | | | | | |
| D7 | Traffic flow (AADT two way) | 25,000 | | | | | | | |
| D8 | % HGV | 3.8 | | | | | | | |
| D8 | Spillage factor *(no/$10^9$ HGVkm/year)* | 0.93 | | | | | | | |
| D9 | Risk of accidental spillage | 0.00019 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | |
| D10 | Probability factor | 0.45 | | | | | | | |
| D11 | Risk of pollution incident | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | | **Return Period** |
| D12 | Is risk greater than 0.01? | **No** | | | | | | **Totals** | **(years)** |
| D13 | Return period without pollution reduction measures | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 11485 |
| D14 | Existing measures factor | 1 | | | | | | | |
| D15 | Return period with existing pollution reduction measures | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 11485 |
| D16 | Proposed measures factor | 1 | | | | | | | |
| D17 | Residual with proposed Pollution reduction measures | 0.00009 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.0001 | 11485 |