Norwich Western Link

Environmental Statement

Chapter 13: Geology & Soils

Appendix 13.1: Interpretative Environmental Desk Study Report

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1 Introduction

1.1 Terms of Reference

1.1.1 An Interpretative Environmental Desk Study Report (EDSR) has been undertaken in order to assess the ground conditions and constraints of land for the Norwich Western Link (the Proposed Scheme) road. The Site Location Plan (Figure Appendix A.1) is presented in **Appendix 13.1 Interpretative Environmental Desk Study Report Sub Appendix A - Figures and Drawings** (Document Reference: 3.13.1a). The 'Site Boundary' refers to the areas within the Red Line Boundary which the main engineering/construction works (structures, carriageway, drainage, earthworks etc) would be undertaken.

1.2 Aims

1.2.1 The Interpretative EDSR's aim is to undertake a desk-based assessment of the Site Boundary with respect to ground conditions. The key aims of this assessment are to:

- Develop a preliminary Conceptual Site Model (CSM) to identify potential contamination risks associated with the proposed use of the Site;
- Evaluate the significance of the potential contaminant linkages on the identified receptors to support the planning application for the Proposed Scheme; and
- Highlight environmental considerations (i.e., potential risks and/or constraints with respect to ground, groundwater and ground gas conditions).

1.3 Development Proposal

1.3.1 The Proposed Scheme consists of the construction, operation and maintenance of an approximately 6 kilometre (km) long dual-carriageway road connecting the A1067 Fakenham Road and the A47, with a dualled section of the A1067 to the existing A1270 roundabout.

1.3.2 The works include the design and construction of:

- A dual carriageway of the A1067 Fakenham Road westwards from its existing junction with the A1270 to a new roundabout located approximately 430 metres to the north-west;
- A new three arm roundabout connecting the A1067 and Norwich Western Link.
- A dual carriageway link of approximately 5.6 kilometres from that new roundabout to a new A47 junction developed by Highways England across the new A47 near Honingham in the south-west of the scheme. The detailed tie-in design and construction of this end will need to be coordinated with Highways England for their proposed alignment of the A47.

1.3.3 It should be noted the majority of the scheme will implement earthworks construction along the carriageway through cut and fill activities to form raised embankments and verges. Additionally, there are several drainage basins (in the southwest, north, and northeast), green bridges (at the crossing with The Broadway and Ringland Lane) and a viaduct crossing in the northeast of the scheme over the River Wensum.

1.4 Scope of Works

1.4.1 To assist in meeting the aims as stated in Section 1.2, the scope of this assessment comprised:

- A review of historical maps and Site plans (where available) to identify former land uses and potential contaminative activities on and surrounding the Site;
- A review of relevant regulatory databases and contact with relevant regulatory authorities including Local Council planning website, the Contaminated Land Officer (CLO) and Environment Agency (EA);
- A review of relevant publicly available information and private records relating to hydrological features, hydrogeology, neighbouring land use, ecologically sensitive uses and geology in order to establish the environmental setting of the Site and potential underlying ground conditions;
- Develop a preliminary CSM via the source-pathway-receptor contaminant linkage approach;
- Outline the environmental risks and/or opportunities, with respect to ground, groundwater and ground gas conditions, which may potentially arise as liabilities or constraints associated with future use of the Site; and,
- Preparation of an Interpretative Environmental Desk Study Report.

1.5 Legislative context and guidance

1.5.1 The assessment was undertaken in the legislative context of:

- Part 2A of The Environmental Protection Act (1990); and,
- National Planning Policy Framework (NPPF) (2023).

1.5.2 The following good practice and statutory guidance was considered and the assessment was undertaken in general accordance with:

- Environment Agency 'Land Contamination Risk Management,' LCRM (2021); and

- CIRIA C552 'Contaminated Land Risk Assessment. A guide to good practice' (2001).

1.6 Sources of information

1.6.1 The following relevant sources of information were used in the production of this report:

- Landmark Envirocheck reports, dated 31 January 2019;
- British Geological Survey (BGS) Online Viewer accessed 22 June 2022 (Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html);
- British Geological Survey (BGS) sheet 147 of Aylesham (1:50,000 Bedrock and Superficial Deposits) and sheet 161 of Norwich (1:50,000 Solid and Drift edition).
- Flood Maps for Planning Service accessed 22 June 2022 (Available at: https://flood-map-for-planning.service.gov.uk/);
- DEFRA (Department for Environment, Food and Rural Affairs)Multi-Agency Geographic Information for the Countryside (MAGIC) website accessed 22 June 2022 (Available at: https://magic.defra.gov.uk/MagicMap.aspx);
- Environment Agencies Catchment Data Explorer accessed 22 June 2022 (Available at: https://environment.data.gov.uk/catchment-planning/);
- Norfolk County and Broadland District Council Online Planning Portal, accessed 22 June 2022;
- Zetica UXO Risk Maps accessed 22 June 2022 (Available at: C:\Users\UKKXI322\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\NECL48SM\zeticauxo.com);

- 6 Alpha Associates Preliminary Unexploded Ordnance (UXO) Threat Assessment, dated 22 June 2022; and,
- Detailed UXO Risk Assessment – Peer Review, Norwich Western Link, Fellows International Ltd, dated 2nd March 2022 (NCCT41793-FEL-VGN-FSC-RA-GI-0001).

1.6.2 All information provided by Envirocheck used in the production of this report is included within **Appendix D**.

1.7 Limitations

1.7.1 This report is addressed to, and may be relied upon by, Norfolk County Council (the Applicant) and may not be relied upon or transferred to any other parties without the express written agreement of WSP.

1.7.2 This report should be read and used in full. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party. WSP cannot be held liable for third party information. Full details of the limitations are provided as **Appendix B**.

1.8 Understanding Risk

1.8.1 It is important to understand that any risks identified during a preliminary assessment, such as the one presented in this document, are perceived risks based on the information reviewed. A more detailed assessment of the actual risks can only be assessed following further intrusive investigations. The preliminary assessments presented herein are qualitative based on professional judgements following the review of available data and within the context of the existing/proposed use.

1.8.2 Those risk categories presented (very low, low, low to moderate, moderate, high and very high) follow guidance presented in CIRIA Publication C552, Contaminated Land Risk Assessment – A Guide to Good Practice. CIRIA states that the risk levels should be based on an understanding of both the probability (likelihood) of a risk occurring and the magnitude of the potential

consequence (severity) of a risk. CIRIA defines four levels of probability and four levels of severity with relation to contaminated land, as presented in **Appendix C**.

2 Summary of the Site and Surrounding Area

2.1.1 The focus of this study is the north-west area of Norwich, known as the Norwich Western Quadrant (NWQ)**.** The broad Study Area includes the key radial routes of the A47 trunk road, the A1074 (Dereham Road), and the A1067 (Drayton High Road / Fakenham Road).

2.1.2 The Study Area encompasses the western fringe of Norwich and settlements, from Lyng, North Tuddenham and Hockering in the west to Horsford, Drayton, Costessey and Bawburgh in the east and all the settlements in between.

2.1.3 The Site Location Plan for the proposed alignment (Figure A.1) is presented in **Appendix A**.

2.2 Site Description and Current Use

2.2.1 The Site Boundary comprises a new dual carriageway route between the A47 at Wood Lane to the A1067 at a new junction running roughly north-east to south-west. The wider Red Line Boundary also contains multiple areas of main/office compounds adjacent to the road, proposed reservoir and ponds, a satellite compound, possible wildlife / road crossing bridges and multiple areas of temporary access. Due to the large area covered by the Proposed Scheme, for the purposes of the Interpretive Environmental Desk Study Report the Site Boundary has been divided into three sections. No Site walkover has been conducted during preparation of this report.

2.2.2 The three areas are:

- **Chainage -172 – Chainage 550**: The area contains, the proposed viaduct that crosses the River Wensum flood plain and joins the A1067 at a new junction. The area also contains the upgraded section of the A1067 and a possible pond.

- **Chainage 550 – Chainage 3200**: Proposed section of road that continues from the east of Weston Green village to south of an ancient woodland adjacent to the west of the River Wensum flood plains. The area also includes a possible pond and two road crossing bridges.
- **Chainage 3200 – Chainage 5580**: Proposed section of road that runs from the A47 at Wood Lane to the east of Weston Green village. The area also includes two existing possible ponds and a road crossing bridge.

2.3 Surrounding Area

2.3.1 The surrounding area is predominantly agricultural or wooded land with occasional residential properties and farm buildings. Multiple villages are also present within the vicinity of the Site: Attlebridge to the north; Ringland to the east; Honingham to the south; and Weston Green and Weston Longville to the west. The Weston Green solar farm also lies to the west. The River Wensum and associated flood plain roughly runs from north-west to south-east crossing the Site in the northern section (at Chainage 172 – Chainage 550). Further afield to the east lie more densely populated residential areas on the western fringe of Norwich.

2.3.2 A Site Location Plan (Figure Appendix A.1) is presented in **Appendix 13.1 Interpretative Environmental Desk Study Report Sub Appendix A - Figures and Drawings** (Document Reference: 3.13.1a)

3 Historical Land Use

3.1 Historical Maps

3.1.1 Historical maps were obtained as part of the Envirocheck reports (**Appendix D**) and were reviewed to identify potentially contaminative former land uses on Site and within a 250 metre radius of the Site Boundary. In order to present the on-Site and off-Site history, the Site has been divided into three sections as indicated on **Figure 1**. A summary of the on-Site and off-Site features are

presented in **Tables 3-1 to 3-3**. Only pertinent features in relation to potential contaminating land uses/sources have been included in the summary tables.

Table 3-1 Summary of Historical Land Uses in Chainage 3200 – Chainage 5580

Historical Map (Date and Scale)	On-Site Feature	Off-Site Feature
1883-1885 (1:10,560) 1883-1884 (1:10,560) 1882 (1:2,500) 1906 (1:2,500) 1907 (1:10,560)	The Site Boundarygenerally comprises multiple undeveloped fields. In the north, the Foxburrow Plantation with an associated track transects the Site Boundary.	An unnamed road runs approximately 60m to the south of Site running in a north-west to south-east orientation. An unnamed road connecting to the unnamed road to the south runs approximately 30m to the west of Site. An Old Marl Pit is located 185m north-west of Site. An Old Clay Pit is located 193m north-west of Site. There are multiple ponds located within 250m of Site in all directions.
1952 (1:10,560) 1957 – 1959 (1:10,000)	No significant change.	The Old Marl and Clay Pits are now unnamed and covered in vegetation.

Historical Map (Date and Scale)	On-Site Feature	Off-Site Feature
1971 (1:2,500) 1971 – 1981 (1:2,500) 1976 (1:10,000) 1982 (1:10,000)	A junction, which now crosses the Site Boundary in the south, has been altered connecting Wood Lane to the west with the A47 to the south.	Old Marl Pit is no longer shown, presumed infilled. Old Clay Pit is no longer shown, presumed infilled. Buildings (including Berry Hall Cottages and Merrywood House) associated with Honingham are located approximately 250m to the south-west of the Site Boundary.
1994 (1:2,500) 1999 (1:2,500) 2000 (1:10,000) 2006 (1:10,000) 2019 (1:10,000)	'Robin's Nursery' extends over the Site Boundary in the northern section, making up part of the Foxburrow Plantation. Unnamed stream present in Foxburrow Plantation and indicated to flow in a south-easterly direction.	No significant change.
2023 (Google Earth Review)	No significant change.	No significant change.

Table 3-2 Summary of Historical Land Uses in Chainage 550 – Chainage 3200

Historical Map (Date and Scale)	On-Site Feature	Off-Site Feature
1883 – 1884 (1:10,560) 1882 (1:2,500) 1905 – 1906 (1:2,500) 1906 (1:2,500) 1907 – 1908 (1:10,560)	Site generally comprises multiple undeveloped fields. Transecting the Site is the Gravelpit plantation with a track running from north to south, the Primrose plantation with associated tracks, the Long plantation in the east. Longrow Lane and an additional unnamed road cross the Site both running from north-west to south-east. The north-easternmost section of Site lies to the south of Rose Carr in the flood plains of the River Wensum.	Low farm is located approximately 100m south. A Marl Pit is situated 234m north of the Site Boundary. An unnamed pond is located approximately 150m north-west of the south-western area of Chainage 550 – Chainage 3200. The River Wensum is situated approximately 220m east of the north-eastern section of Chainage 550 – Chainage 3200.
1938 (1:10,560) 1938-1952 (1:10,560) 1957 (1:10,560) 1957 – 1959 (1:10,560)	No significant change.	Marl Pit is now unnamed and covered in vegetation.

Historical Map (Date and Scale)	On-Site Feature	Off-Site Feature
1970 – 1971 (1:2,500) 1971 (1:2,500) 1974 – 1975 (1:2,500) 1973 – 1976 (1:10,560) 1975 – 1976 (1:10,560)	Longrow Lane has been changed to Ringland Lane.	Gravelpit plantation adjacent to the central section of Site has reduced in size. A pond associated with the Rose Carr plantation is situated 170m north of Site. Marl Pit is no longer shown, presumed infilled.
1994 (1:2,500) 1999 Aerial Photography (1:2,500) 2000 (1:10,000) 2006 (1:10,000) 2019 (1:10,000)	No significant change.	The pond associated with the Rose Carr plantation has reduced in size.
2022 (Google Earth Review)	No significant change.	No significant change.

Table 3-3 Summary of Historical Land Uses in Chainage -172 – Chainage 550

Historical Map (Date and Scale)	On-Site Feature	Off-Site Feature
1882 (1:2,500) 1883 – 1884 (1:10,560) 1906 (1:2,500) 1907 – 1908 (1:10,560)	The Site generally made up of the flood plains of the River Wensum. The River Wensum also transects Site, running in an approximate north-west to south-east orientation. A track is present running in an approximate north-west to south-east orientation. Crooked Oaks plantation with an associated track is also situated in the eastern tip of Site. A Marl Pit extends on to the northern part of the Site Boundary.	An unnamed road runs from north-west to south-east adjacent to the south of Site. Attlebridge Hall is located adjacent to the River Wensum, and adjacent to the north-western boundary of the Site. The Attlebridge Hills plantation is located approximately 25m north of the Site Boundary.
1938 (1:10,560) 1957 (1:10,000)	The Marl Pit is noted on the northern boundary and encroaching on to the Site, is unnamed and covered in vegetation.	No significant change
1970 (1:2,500) 1975 (1:10,000) 1975 – 1976 (1:10,000)	The layout of the track is detailed as the A1067.	No significant change
1994 (1:2,500) 1999 Aerial Photography (1:2,500) 2000 (1:10,000) 2006 (1:10,000)	A1067 which crosses part of the Site and runs adjacent to the south of Site is now detailed as Fakenham Road.	From the 2000 map edition, a refuse/slag heap and a shooting range was noted approximately 200m to the north-west and north-east

Historical Map (Date and Scale)	On-Site Feature	Off-Site Feature
2019 (1:10,000)	No significant change.	A roundabout has been constructed on A1067 to the east of Chainage -172 – Chainage 550 connecting to the Broadland Northway to the east of Site. Attlebridge Hall to the north of Site is now renamed as Old Hall Cottages. The former refuse/slag heap and shooting range was relabelled as Attlebridge Landfill Site and was disused. The eastern boundary of the Wensum Valley Hotel Golf and Country Club is located adjacent and south-east of Site.
2022 (Google Earth Review)	The former Marl Pit is noted on the northern boundary of the red line boundary.	No significant change.

4 Environmental Setting

4.1 Geology

4.1.1 The British Geological Survey (BGS) 'Geology of Britain' online viewer and BGS maps of Aylsham (Sheet 147 Bedrock and Superficial Deposits) and Norwich (Sheet 161 Solid and Drift Edition) were reviewed. The geology underlying within the Site Boundary is summarised in **Table 4-1**.

Table 4-1 Summary of Geology

Superficial or Bedrock	Strata	Distribution Across the Site	Aquifer Designation
Superficial	Alluvium	This unit is present in a band in the north of the Site Boundary in the vicinity of the A1067	Secondary B Aquifer
Superficial	Head Deposits	This unit is present to the south of the alluvium deposits in the north of the Site Boundary.	Secondary B Aquifer
Superficial	River Terrace Deposits	This unit is present to the north of the alluvium deposits in the north of the Site Boundary.	Secondary A Aquifer
Superficial	Sheringham Cliffs Formation	Dominates the superficial deposits for the majority of the Site Boundary.	Secondary A Aquifer

Superficial or Bedrock	Strata	Distribution Across the Site	Aquifer Designation
Superficial	Lowestoft Formation	The unit is present only at the very south of the Site Boundary in the vicinity of the A47.	Secondary Undifferentiated Aquifer
Superficial	Happisburgh Glacigenic Formation	Potentially present in localised areas across the Site Boundary.	Secondary Undifferentiated Aquifer
Bedrock	Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (Undifferentiated)	The unit underlies the entire Site Boundary.	Principal Aquifer

4.1.2 The aquifer designations defined by the EA are presented below:

- Secondary A Aquifer – permeable layers that can support local water supplies and may form an important source of base flow to rivers.
- Secondary B Aquifer – lower permeability layers that may store and yield limited amounts of groundwater through characteristics like fissures and openings or eroded layers.
- Secondary Undifferentiated Aquifers – where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value.

- Principal Aquifers – provide significant quantities of drinking water, and water for business needs. They may also support rivers, lakes and wetlands.

4.1.3 Four publicly available borehole logs within the vicinity of the Site were reviewed. Of the reviewed logs, TG11SW3 was located in the south of Site, TG11SW11 in the centre south, TG11SW16 in the centre north and TG11NW99 in the north. The logs are presented in **Appendix E** and a summary of the logs is presented in **Table 4-2**.

Table 4-2 Summary of Publicly Available Borehole Logs

Stratum	Base of Stratum (m bgl)	Thickness of Stratum (m)	Typical Description	BGS Boreholes
Topsoil (in south of the Red Line Boundary)	0.20 – 0.30	0.20 – 0.30	Topsoil.	TG11SW3 TG11SW11 TG11SW16
Made Ground (in north of the Red Line Boundary)	1.20	1.20	Orange silty fine sand with some fine and medium flint gravel.	TG11NW99
Clay (in south and centre of the Red Line Boundary)	17.70 – 18.20	0.90 – 17.64	Brown and Grey clay Brown / Grey sandy / stoney clay. Grey chalky clay.	TG11SW3 TG11SW11 TG11SW16

Stratum	Base of Stratum (m bgl)	Thickness of Stratum (m)	Typical Description	BGS Boreholes
Sand (in south and north of the Red Line Boundary)	8.00 – 19.50	1.80 – 14.60	Gravelly sand. Sand is fine to medium. Gravel is fine to coarse, subangular flint. Orangey brown silty fine sand with laminae of grey sandy silt. Brown clayey silty fine sand with much fine and medium flint gravel.	TG11NW99 TG11SW3 TG11SW11 TG11SW16
Silt (in north of the Red Line Boundary)	1.20 – 5.60	0.80 – 2.00	Brown very clayey very sandy silt with some fine and medium flint gravel. Laminated grey very clayey sandy silt.	TG11NW99
Chalk (in north and south of the Red Line Boundary)	20.45 (Full extent not proven)	12.45 (base unproven)	Off white silty sized comminuted chalk with a little fine intact chalk.	TG11NW99 TG11SW3 TG11SW11 TG11SW16

4.2 Hydrogeology and Hydrology

4.2.1 Aquifer designations of the superficial and bedrock geology are presented in Section 4.1 above.

4.2.2 The Site Boundary is located within a Source Protection Zone 3 (SPZ) for total catchment. The closest groundwater abstraction is recorded on Site (and is located to the south of the A1067) and operated by J B Piper for the abstraction of water from the Chalk aquifer for general farming and domestic use.

4.2.3 The River Wensum and associated flood plains cross the Site in the northern section. There are also multiple small unnamed inland surface water drains on Site. The River Tud runs approximately 400 metres south of the Site with an orientation of east to west.

4.2.4 There are no records of surface water abstractions occurring on the Site. However, there are nine records of surface water abstractions within 250 metres of the Site Boundary. The closest surface water abstraction is from the River Wensum at Ringland within the north-west boundary of Site. This extraction was used for general agriculture for direct and storage of spray irrigation.

4.3 Environmentally Sensitive Sites

4.3.1 The entire Site is located within a surface water and groundwater Nitrate Vulnerable Zone (NVZ) and is associated with the Crag Formation, Chalk and the River Tud here is a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC) on Site. Both the SSSI and SAC, are related to the River Wensum.

4.4 Flooding

4.4.1 A large proportion of the north of the Site, adjacent to the River Wensum, and a small section of the south are located within Flood Zone 3, indicating a high probability of flooding. Land classified as Flood Zone 3 is defined as having a

1 in 100 or greater annual probability of river flooding, or land having a 1 in 200 or greater annual probability of sea flooding.

4.4.2 Small sections of land south of the River Wensum are located in a Flood Zone 2, which is defined as land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding and between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

4.5 Radon

4.5.1 The entire Site is in a lower probability radon area where less than 1% of homes are estimated to be at or above the Action Level, therefore no protective measures are necessary.

4.6 Mining and Ground Stability

4.6.1 There were 12 No. BGS recorded mineral sites within 250 metres. The closest mineral site was the Attlebridge Hall Marl Pit adjacent to the north-west of the site which was an opencast chalk pit with a Ceased Status

4.6.2 A review of the Envirocheck reports indicate that the site is located within an area which may not be affected by coal mining.

4.7 Preliminary Hydrogeological Model

4.7.1 Made Ground is likely to be present in the north of Site Boundary due to historical development, however the thickness and composition are likely to be highly variable. Groundwater may be present as perched water within the Made Ground, associated with lenses of permeable material which are recharged by surface water infiltration.

4.7.2 The underlying chalk bedrock has been classified as a Principal Aquifer. Groundwater is anticipated to present within the Chalk, at approximately 14.60 metres to 15.50 metres below ground level, based on information recorded on historical borehole logs. Within historic borehole logs, groundwater was not encountered within the superficial deposits. However, should groundwater be present within superficial deposits, it is likely that it will be in hydraulic continuity with groundwater within the Chalk aquifer.

5 Regulatory Information and Consultation

5.1 Regulatory Database

5.1.1 The Envirocheck report includes information and data collected from several organisations including the Environment Agency (EA), the Broadland District Council, the British Geological Survey (BGS), Department for Environment, Food & Rural Affairs (Defra) and Health & Safety Executive (HSE).

5.1.2 It is considered that the information listed in **Table 5-1** represents those of potential concern in relation of contamination at the Site.

Table 5-1 Summary of Database Searches in respect of potentially contaminative land uses or features (All Distances are Approximate)

Descriptor	On-Site	0-250 m	251-500 m	Details
Discharge Consents	0	1	1	Closest located 51m north-east of Site Boundary, at BDR Grain Store on Stony Lane, entailing a discharge onto land, which was issued in January 1989 and revoked October 1996.

Descriptor	On-Site	0-250 m	251-500 m	Details
Integrated Pollution Prevention and Control	0	0	1	One record relating to Biffa Waste Services Ltd located 455m north-east of the Site Boundary. The status is 'superseded by variation.'
Pollution Incidents to Controlled Waters	1	5	1	One record located on the northern part of the Site Boundary relating to the release of an unknown pollutant to a freshwater stream/river in December 1993. There are five off-site records which include the release of pollutants including oil and organic wastes: cattle manure (solid).
Licensed Waste Management Facilities (Landfill Boundaries)	0	0	2	Two records 233m north-east and 301m east (of the northern part of the Site Boundary), both relating to the Attlebridge Landfill.
Licensed Waste Management Facilities (Locations)	0	0	2	Two records 301m east and 398m north-east (of the northern part of the Site Boundary) both relating to land/premises at Reepham Road.

Descriptor	On-Site	0-250 m	251-500 m	Details
Potentially Infilled Land (non-water)	1	4	4	One record located on the northern part of the Site Boundary recorded as unknown filled ground (pit, quarry etc). The 1884 map indicated this was a Marl Pit and labelled as an area of scrubland from the 1975 map edition.
Historical Landfill Sites	0	0	1	Deighton Hills landfill 300m east of the Site Boundary and received deposited waste including inert waste between December 1980 and December 1985.

Descriptor	On-Site	0-250 m	251-500 m	Details
Registered Landfill Sites	0	0	2	Two records within 500m of the Site Boundary. Deighton Hills is located 331m east which accepted construction and demolition waste, the record is noted to be superseded. The other record is also from Deighton Hills and located 349m east and accepted wastes including concrete waste and hardcore and rubble. The record is noted to be lapsed or cancelled.

5.2 Local Authority

5.2.1 Broadland District Council was contacted via email on 6 November 2019 regarding environmentally pertinent information relating to the Site. A response was received from the council's Environmental Management Officer on the 13 May 2020, the response is presented as **Appendix F**. A summary of the environmentally pertinent information is presented below:

- The council identified six areas of possible filled ground concentrated around the A47 in the south of Site. One of which is located within the Site Boundary and the others are in close vicinity to the Site which may relate to the area of potentially infilled land which encroaches on the northern Site Boundary.
- The council informed of no knowledge of any past industrial/commercial uses on or close to the Site other than agriculture.

- The council has not declared any Sites as contaminated within the Site boundary as defined under the regulations.
- The council informed of the Attlebridge Landfill Site within 500 metres of the Site Boundary, as previously discussed.

5.2.2 Norfolk County Council (County Planning Authority) contacted the Applicant regarding a 'spray disposal area' which would need to be considered as part of the EIA for the site. It is understood that a spray disposal area is an area where surplus pesticide is placed once pesticides have been applied to crops. The area is licensed by the Environment Agency. It is noted that the 'spray disposal area' is in the centre of the Proposed Scheme.

5.3 Environment Agency

5.3.1 The EA was contacted via email on 6 November 2019 regarding environmentally pertinent information relating to the Site. WSP received a response on the 28 November 2019; the response is presented as Appendix G. A summary of the environmentally pertinent information is presented below:

- The EA suggested that the proposed route does not cross any Environmental Permitting Regulations (EPR) / Waste Management Licences (WML) / historic landfill sites. However, noted that the Attlebridge landfill was close to the Site Boundary. They noted that the Site had ceased accepting waste.
- The EA were unaware of any remedial works carried out at the Site or within 500 metres.

5.4 Planning History

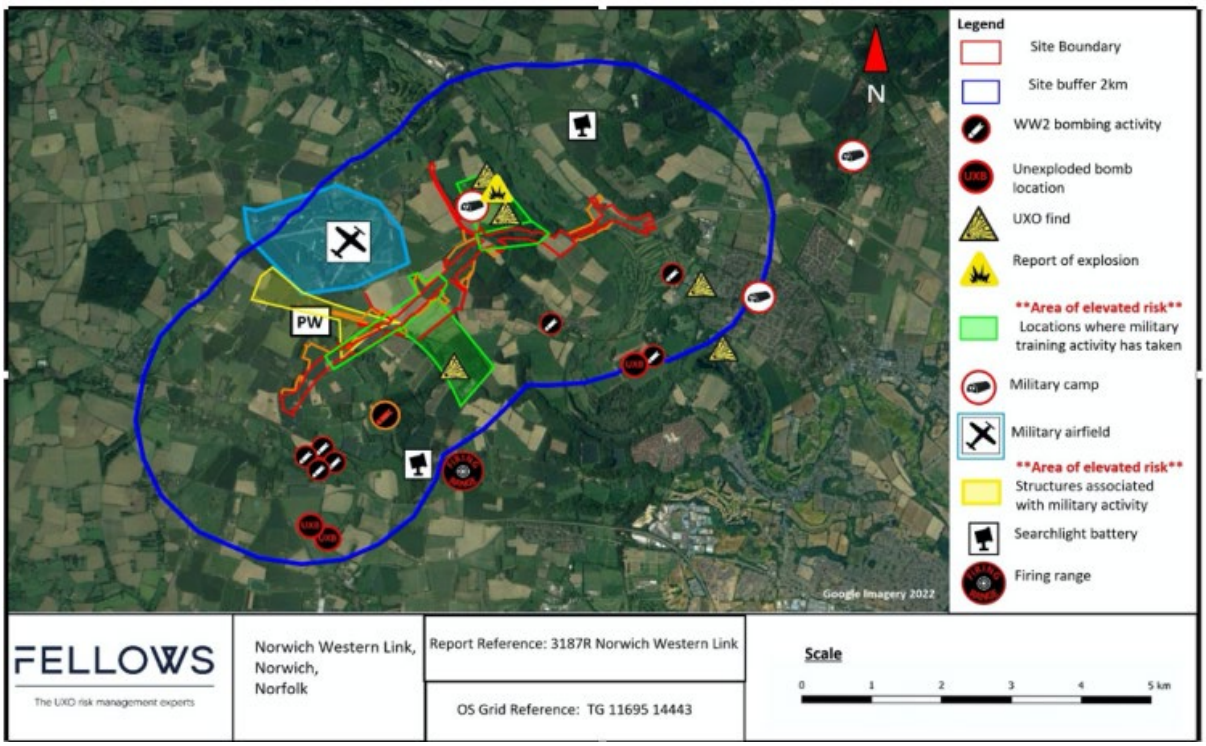
5.4.1 The Norfolk County Council (County Planning Authority) and Broadland District Council Online Planning Portals were accessed on 09 February 2024, no environmentally pertinent information was determined.

5.5 Unexploded Ordnance (UXO)

5.5.1 A detailed unexploded ordnance risk assessment was carried out as part of the Geotechnical desk study by MACC International Limited (Ref. 6021) for the Proposed Scheme and a peer review subsequently undertaken by Fellows International Ltd (NCCT41793-FEL-VGN-FSC-RA-GI-0001). The reports identify numerous historic bombing incidents within proximity of the Site Boundary although none within the Site Boundary. The reports also highlights the risks associated with historic World War Two military training activities at Morton Hall Estate as well as RAF Attlebridge.

5.5.2 The risk associated with German air-dropped weapons and British anti-aircraft munitions was assessed as Low, however the risk from other munitions within zoned areas of the Proposed Scheme as shown on Figure 1 below was assessed as Medium where there is an elevated risk.

Figure 1 Area of elevated Medium risk (in green) along route of Proposed Scheme (taken from Figure 2 from NCCT41793-FEL-VGN-FSC-RA-GI-0001)



6 Preliminary Conceptual Site Model

6.1 Introduction

6.1.1 The preliminary CSM is based upon the environmental conditions present within the Site Boundary as described in the previous sections and was developed in the context of the Proposed Scheme.

6.1.2 The assessment followed a risk-based approach; with the potential environmental risk assessed qualitatively using the 'source-pathway-receptor' contaminant linkage concept introduced in the guidance documents (principally the LCRM 2021) on the practical implementation of the Environmental Protection Act 1990.

6.1.3 Environmental risk can be defined as the combination of the consequence of a harmful effect and the probability of its occurrence. The existence of a contaminant linkage is primarily dependant on historic and current usage and environmental conditions.

6.1.4 The environmental risk assessment has been carried out by identifying and evaluating the significance of the following:

- Potential sources of contamination: these include actual or potentially contaminating materials and activities, located either on or in the vicinity of the Site Boundary;
- Potential receptors of contamination: these include Site users, groundwater and surface waters; and,
- Potential pathways for contamination migration: these are the routes or mechanisms by which contaminants may migrate from the source to the receptor.

6.2 Potential Sources of Contamination

6.2.1 **Table 6-1** provides a summary of the potential sources of contamination that may be present at the Site and in the immediate surrounding area, as well as the likely nature of such sources. This is based on the information obtained from the historical maps, the Envirocheck report and information on likely contaminants associated with the Site's use and history (DoE Industry Profiles).

Table 6-1 Potential Sources of Contamination

Potential Source	Potential Contaminants of Concern	Likely / Anticipated Distribution
On-Site Potential Made Ground	Range of contaminants including metals, inorganics (e.g., cyanide), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), ground gas (methane and carbon dioxide), vapours and asbestos.	In north of Site (Chainage 3200 – Chainage 5580) & where tracks / roads transect the Site.
On-Site Potentially infilled land	Ground gas (carbon dioxide and methane)/vapours, PAHs, heavy metals, petroleum, hydrocarbons and asbestos.	In north of Site (Chainage 3200 – Chainage 5580)
On-Site Alluvium	Ground gas (carbon dioxide and methane)	In north of Site (Chainage 3200 – Chainage 5580)
On-Site Agricultural Practices	Fertilisers and pesticides (including 'spray disposal area')	Site wide.
On-Site Plantations	Fertilisers and pesticides (including 'spray disposal area')	Multiple locations Site wide.

Potential Source	Potential Contaminants of Concern	Likely / Anticipated Distribution
On-Site Historical Sewage Works	Range of contaminants including metals, inorganics (e.g., cyanide), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), ground gas (methane and carbon dioxide), and vapours.	To the north of the western section of the Tributary of the Tud (Foxburrow Stream).
Off-Site Potential Made Ground	Range of contaminants including metals, inorganics (e.g., cyanide), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), ground gas (methane and carbon dioxide) and asbestos.	Predominantly to the north of the Site.
Off-Site Agricultural Practices	Fertilisers and pesticides	All directions.
Off-Site Plantations	Fertilisers and pesticides	Multiple locations Site wide.
Off-Site Historically in-filled Clay and Marl Pits and Attlebridge Landfill	Ground gases, PAHs, heavy metals, petroleum, hydrocarbons and asbestos.	Multiple locations to the north of the Site.

6.3 Potential Receptors

6.3.1 In the context of the Proposed Scheme, the following potential receptors were identified:

Human Health

- Future Site users, adjacent site users and workers – likely to be limited to the areas where the public can access (e.g., pedestrian footpaths) and soft landscaped verges;
- Construction workers; and
- Third party neighbours.

Controlled Waters

- Underlying groundwater within:
    - Secondary A Aquifers, Secondary B Aquifers and Secondary Undifferentiated Aquifers
    - On site and nearby surface Water features including:
- The River Wensum, its associated flood plains located in the north of Site
- Multiple unnamed water features across the Site.

Infrastructure and Services

- Future below ground services/ ground structures.

6.3.2 Based on the nature of the proposed development being a road scheme, current site users have been discounted from the assessment

6.4 Plausible Preliminary Contaminant Linkages

6.4.1 **Table 6-2** provides an evaluation of the potential contaminant linkages that are considered to be plausible on the basis of the information currently available for the Site and the current/proposed end use.

Table 6-2 Plausible Contamination Linkages

Potential Contaminant Sources	Receptor	Pathways	Probability	Consequence	Risk	Comments
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Human Health** ▪ Future Site users and workers;	▪ Dermal contact; ▪ Ingestion of impacted soil particles on Site, and windblown to adjacent land-uses; and ▪ Inhalation of dust and asbestos fibres, and windblown to adjacent land-uses.	Low	Mild	**Low**	Due to the nature of the proposed development, exposure of future Site users and workers is likely to be in localised areas of the Site i.e., only in public bridges / walkways. Due to the transient nature of the Site, future site users will experience a limited frequency of exposure to risks posed by contaminated land Therefore, the risk to future Site users is considered to be **Low**.
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Human Health** ▪ Construction workers and future maintenance workers;	▪ Dermal contact; ▪ Ingestion of impacted soil particles on Site, and windblown to adjacent land-uses; ▪ Inhalation of dust and asbestos fibres, and windblown to adjacent land-uses.	Low	Medium	**Low to Moderate**	Construction workers and future maintenance workers may come in contact with asbestos or contaminated soils/groundwater during ground works (e.g., dermal exposure or inhalation of particles, vapours or ground gases), therefore the risk to construction and future maintenance workers is considered to be **Low-Moderate**. However, these risks should be managed with the adherence to Health and Safety protocols during the works.
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Human Health** ▪ Third party neighbours.	▪ Dermal contact; ▪ Ingestion of impacted soil particles on Site, and windblown to adjacent land-uses; ▪ Inhalation of dust and asbestos fibres, and windblown to adjacent land-uses.	Unlikely	Medium	**Low**	There is a chance that windblown impacted soil, dust and asbestos fibres could migrate off-Site causing a risk to third party neighbours. However, given that a large proportion of the Site is surrounded by agricultural land, the risk to these areas is considered to be **Low.**

Potential Contaminant Sources	Receptor	Pathways	Probability	Consequence	Risk	Comments
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Human Health** ▪ Future Site users and workers; ▪ Construction workers and future maintenance workers; and, ▪ Third party neighbours. ▪ Future below ground services/ ground structures.	▪ Migration of ground gas and volatile vapours into buildings or below ground structures/services	Mild	Low	**Low**	It is considered likely that Made Ground and Alluvium deposits will be present at the Site, especially in the north. However, given the nature of the proposed development the risk from ground gas is considered to be **Low**.
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Controlled Waters** ▪ On site and nearby surface water receptors;	▪ Overland flow (surface water runoff) of potential contaminants into surface water; and ▪ Lateral migration from groundwater into surface water via baseflow	Low	Medium	**Low to Moderate**	The River Wensum and associated flood plain crosses the Site in the north. In addition, there are multiple other unnamed water features located on Site. There is a potential for contaminated run off from the Site to enter these water courses. It is considered likely that the proposed development will have a surface water drainage system included within the design, therefore reducing the risk from contaminated run off to surface water courses. Based on the available information in the context of the proposed development, the risk to surface water receptors is considered to be **Low-Moderate.**
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Controlled Waters** ▪ Underlying groundwater within aquifers .	▪ Vertical and lateral leaching from impacted soil; ▪ Lateral migration within groundwater	Low	Medium	**Low to Moderate**	The migration of contaminants vertically from shallow soils in to the superficial Secondary A Aquifers, Secondary Undifferentiated Aquifers and bedrock Principal Aquifer has the potential to occur. The Site is predominantly covered with soft standing and therefore infiltration of rainwater has the potential to cause vertical migration of contaminants. The risk to groundwater is considered to be **Low-Moderate**.

Potential Contaminant Sources	Receptor	Pathways	Probability	Consequence	Risk	Comments
On-site ▪ Potential Made Ground; ▪ Alluvium; ▪ Potentially infilled land; ▪ Agricultural Practices; ▪ Plantations; ▪ Historical Nursery; and ▪ Spray disposal area	**Future Infrastructure and Services** ▪ Future below ground services and structures.	▪ Direct contact via permeation of hydrocarbons though plastic pipes. ▪ Migration of ground gas and volatile vapours into below ground structures/services	Low	Mild	**Low**	There is the potential for chemical attack on below ground concrete and the permeation of contaminants through plastic pipes. Given the nature of the proposed road scheme, the risk to future infrastructure and services is considered to be **Low.**
Off-site ▪ Potential Made Ground; ▪ Agricultural Practices; ▪ Plantations; and, ▪ Historically in-filled Clay and Marl Pits and Attlebridge Landfill.	**Human Health** ▪ Future Site users and workers; and, ▪ Construction workers and future maintenance workers.	▪ Inhalation of windblown dust and asbestos fibres. ▪ Migration of ground gas to Site.	Low	Mild	Low	There is the potential for dust and asbestos fibres to be blown from surrounding areas on to the Site. However, given the limited historical development of the area surrounding the Site and the nature of the proposed road scheme, the risk from windblown dust and fibres is considered to be **Low**. Ground gas generated by Made Ground in the north and infilled marl/clay pits surrounding the Site may migrate laterally within the subsurface and accumulate in enclosed spaces; therefore, posing a risk of explosion or asphyxiation. However, within the proposed development, it is not considered likely that there will be many areas where ground gas could accumulate. Furthermore, the surrounding area is predominantly undeveloped agricultural land and therefore is unlikely to have significant ground gas generation potential. The area in the north, surrounding the A1067 is likely to have Made Ground deposits present. Based on the nature of the proposed improvement works the risk from ground gas to the Site from off-Site sources is considered to be **Low**.
Off-site ▪ Potential Made Ground; ▪ Agricultural Practices; ▪ Plantations; and, ▪ Historically in-filled Clay and Marl Pits and Attlebridge Landfill.	**Controlled Waters** ▪ On site and nearby surface water receptors; ▪ Underlying groundwater within aquifers	▪ Lateral migration of contaminants within groundwater to Site.	Low	Medium	**Low to Moderate**	The migration of contaminants from off-Site shallow soils into the superficial and bedrock aquifers has the potential to occur given the lack of hardstanding on the Site. The lack of hardstanding means that the infiltration of surface water could lead to the leaching of shallow contaminants. The risk is considered to be **Low-Moderate.**

Potential Contaminant Sources	Receptor	Pathways	Probability	Consequence	Risk	Comments
Off-site ▪ Potential Made Ground; ▪ Agricultural Practices; ▪ Plantations; and, ▪ Historically in-filled Clay and Marl Pits and Attlebridge Landfill.	**Future Infrastructure and Services** ▪ Future below ground services and structures.	▪ Lateral migration of contaminants via impacted groundwater with subsequent direct contact. ▪ Migration of ground gas and volatile vapours into below ground structures/services	Low	Mild	**Low**	Given the limited historical development of the area surrounding the Site and the nature of the proposed road scheme, the risk to future infrastructure and services is considered to be **Low.**

7 Conclusions and Recommendations

7.1 Conclusions

7.1.1 Based on the information presented in this report, the following conclusions have been made for the Proposed Scheme:

- The Proposed Scheme is located in the north-west area of Norwich, known as the Norwich Western Quadrant (NWQ). The area includes the key radial routes of the A47 trunk road, the A1074 (Dereham Road), and the A1067 (Drayton High Road / Fakenham Road). The area also encompasses the western fringe of Norwich including multiple settlements. It is generally made up of agricultural land, with multiple plantations and is crossed by the River Wensum and associated flood plains in the north;
- The earliest available mapping (ca. 1882-1884) shows the Site Boundary be generally made up of multiple agricultural fields and is crossed by multiple plantations and roads/tracks. Throughout the 20th century, the area has stayed relatively unchanged. There are multiple marl and clay pits in close proximity that have been infilled in the 1970s.
- British Geological Survey (BGS) mapping indicates that the superficial geology underlying the majority of the Red Line Boundary generally comprises the Sheringham Cliffs Formation. A band of Alluvium is present in the north of the Site Boundary in the vicinity of the A1067. A band of Head Deposits is present to the south of the Alluvium, and River Terrace Deposits are present to the north of the Alluvium unit. The Lowestoft Formation is present at the southern end of the Site Boundary. The Happisburgh Glacigenic Formation is present in localised areas across the Site Boundary. The bedrock geology underlying the entire Site is the Lewes Nodular, Seaford, Newhaven, Culver and Portsdown Chalk Formations.

- The Sheringham Cliffs and River Terrace Deposits are classified as Secondary A Aquifers. The Alluvium and Head deposits are classified as Secondary B Aquifers and the Lowestoft Formation and Happisburgh Glacigenic Formation are classified as Secondary Undifferentiated Aquifers. The Site Boundary is located within a Source Protection Zone 3 (SPZ) for total catchment. There are no groundwater abstractions location within the Site Boundary, however two lie within 250m of the Site Boundary. The closest abstraction is located 16m east of the Site Boundary for general farming and domestic use and is abstracted from the chalk aquifer.

- The River Wensum and associated flood plains crossing the Proposed Scheme in the northern section (Chainage 3200 – Chainage 5580). There are also multiple small unnamed streams within the Site Boundary. The River Tud runs approximately 400 metres south of the Site Boundary with an orientation of east to west. There are no records of surface water abstractions occurring within the Site Boundary. However, there are nine records of surface water abstractions within 250 metres of the Site Boundary. The closest is from the River Wensum on the north boundary of the Site Boundary, used for general agriculture for direct and storage of spray irrigation.

- A number of potential sources of contamination (both within and outwith the Site Boundary), and potential pathways have been identified within the Conceptual Site Model. Due to the nature of the proposed improvements, future Site users and workers are likely to be in localised areas of the Site Boundary for short periods of time, therefore, the risk to future users is considered to be **Low**.

- The risk to future ground / maintenance workers and construction workers is considered to be **Low-Moderate** due to there being a risk of workers coming in to contact with potential asbestos or contaminated soils. The risks to workers should be managed through health and

safety protocols under the Construction (Design and Management) Regulations 2015.

- It is considered likely that Made Ground deposits will be present at within the Site Boundary, especially in the north. However, given the nature of the proposed development the risk from ground gas is considered to be **Low**.
- The River Wensum and associated flood plains cross the Site Boundary in the north. The overall risk to surface waters is considered to be **Low-Moderate.**
- The overall risk to groundwater within the aquifers underlying the Site Boundary is considered to be **Low-Moderate** given that the areas surrounding the Site Boundary have soft standing, allowing the infiltration of rainwater and the vertical migration of contaminants.
- Within areas determined to be Medium risk within the Detailed UXO Risk Assessment Peer Review, a UXO Engineer should be retained on-site in order to detect for excavations and earthworks and safely manage UXO items, prior to and during construction. The risk from potential UXO contamination sources during ground investigation for Post war worked and unworked ground was considered to be **Low**.

7.2 Recommendations

7.2.1 The following is recommended based on this Environmental Desk Study Report:

- An intrusive ground investigation should be undertaken across the Site Boundary. The ground investigation should be compliant with current UK guidance e.g., BS10175 and include a Generic Quantitative Risk Assessment (GQRA) to allow the assessment of identified plausible contaminant linkages and if remedial measures may be required. Geotechnical testing could also be undertaken to inform foundation design for potential future redevelopment. It is recommended that the

ground investigation is designed based on the following technical objectives:

- Characterisation of the ground and groundwater conditions underlying the Site Boundary;
- Soil and groundwater sampling for contamination and geotechnical testing;
- Groundwater and ground gas monitoring;
- Provision of a GQRA to quantitatively assess risks to human health and controlled waters;
- Refinement of the Preliminary Conceptual Site Model; and

- An assessment of potential foundation design and geotechnical constraints.
- Completion of a detailed UXO assessment report highlighting the potential risk of UXO on the Site and/or employment of a UXO clearance engineer during intrusive works, if required.

7.2.2 Following the desk-based assessment, a ground investigation was carried out on Site from August 2019 – September 2020 order to establish the geotechnical, geo-environmental and hydrogeological conditions on Site. The ground investigation entailed multiple forms of intrusive exploratory holes, with standpipe installations for groundwater/ground gas monitoring along with the collection of geotechnical and geo-environmental samples. A GQRA was undertaken to assess the risk to human health and controlled waters however, due to a change in the alignment as discussed in Section 1.3, a further ground investigation and GQRA will be required in areas not previously investigated.