Norwich Western Link

Environmental Statement

Chapter 13: Geology & Soils

Appendix 13.3: Ground Contamination Interpretive Report Part 1 of 3

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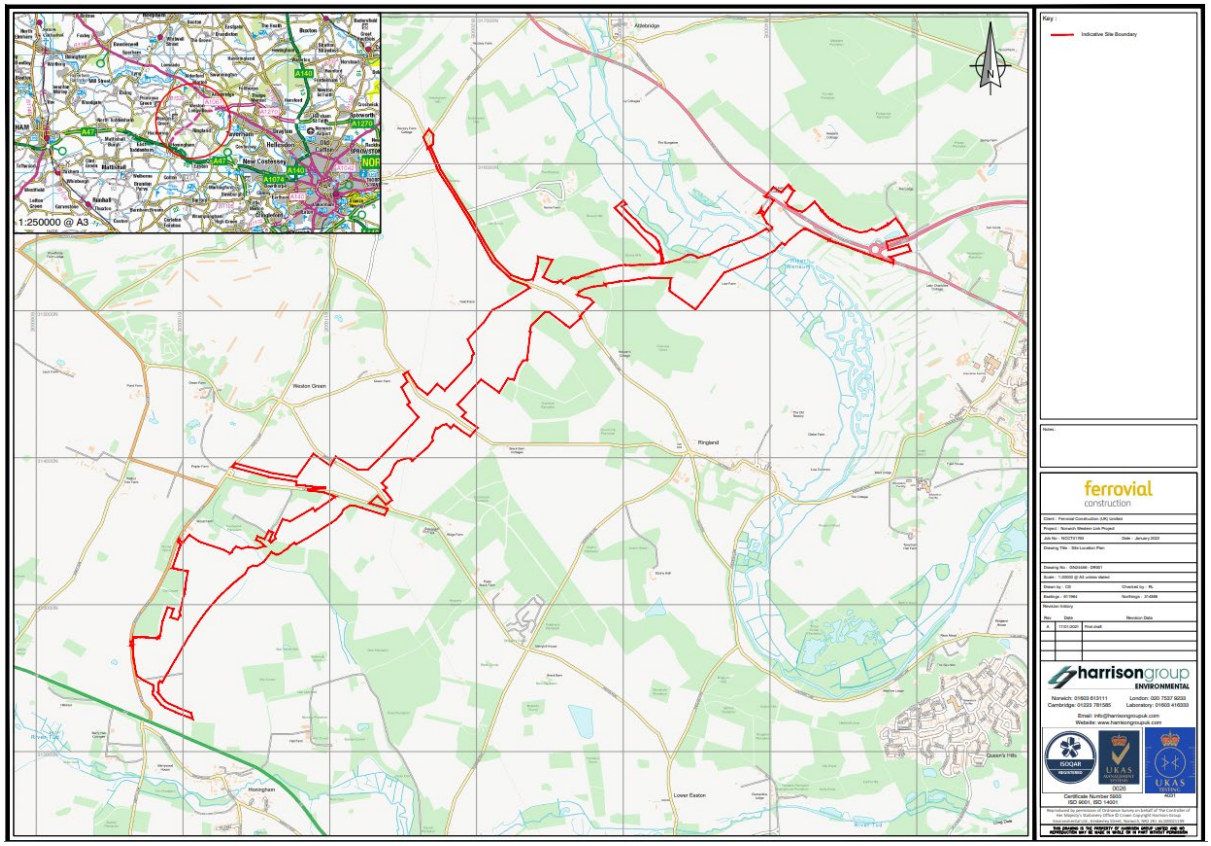
Executive Summary

Ramboll UK Limited have prepared a Ground Contamination Interpretative Report for the Proposed Scheme. The Proposed Scheme comprises a new section of dual carriageway linking the A47 to the A1067 to the north-east of Norwich. This assessment has been undertaken assuming the area within the site boundary will be redeveloped for an end-use comprising the Proposed Scheme. A Site Location Plan with the site boundary in red is provided in Figure 1 and is shown below. A borehole location plan is included in Figure 2 of this report.

Figure 1: Site Location Plan



This Ground Contamination Interpretative Report includes the objectives and reasons for undertaking a generic quantitative risk assessment (GQRA), provides a summary of relevant background information, details how a ground investigation was designed and findings of that investigation, specifies how relevant generic assessment criteria (GAC) were selected, provides a quantitative risk assessment and conceptual site model and identifies data gaps and further actions which are required.

Potential contaminant linkages (PCLs) were identified at Preliminary Risk Assessment (PRA) stage through development of a preliminary conceptual site model (CSM) by WSP (as detailed in their Interpretative Environmental Desk Study Report, document reference 3.13.01. Ramboll designed the ground investigation, and included locations targeting historical potentially contaminated land uses, as highlighted by the WSP report.

The River Wensum, River Tud and their tributaries run through the Proposed Scheme and its surroundings. The groundwater in the chalk beneath the Proposed Scheme is a principal aquifer and the entire site is also within a Source Protection Zone 3 and as such the groundwater and surface water are classed as sensitive receptors.

The ground conditions within the Site Boundary were identified through the ground investigation to comprise topsoil (approximately 0.2-0.5 m thick) over superficial deposits (up to 34 m thick). The superficial deposits comprise Alluvium, Head Deposits, River Terrace Deposits, the Lowestoft Formation and the Sheringham Cliff Formation. The individual superficial deposits are present in distinct areas of the site and as such, it is unlikely that a continuous cohesive layer is present above the bedrock. Localised areas of Made Ground were noted during the investigation, with average thicknesses of 0.4 m. The underlying bedrock is Chalk, which comprises the undifferentiated components of the Lewes Nodular Chalk Formation, the Seaford Chalk Formation, the Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation.

An assessment of groundwater levels shows that the general direction of flow is towards the north-east. This is likely to be in hydraulic continuity with the River Wensum. It is considered likely that groundwater is continuous between the superficial deposits and bedrock strata due to the absence of any aquitards above the chalk aquifer at many locations. However, the absence of groundwater in many of the monitoring wells and the presence of a variety of granular and cohesive materials within the superficial deposits indicates that groundwater is not continuous within the various superficial deposits.

Human Health Assessment

Chemical testing results from a total of 123 soil samples were screened against Norfolk County Council specified GAC for public open space. All concentrations were below Norfolk County Council's GAC with the exception of benzo(a)pyrene which was recorded above the GAC in the pavement cores in ten (10) samples from Fakenham Road, Ringland Lane and Breck Road. The maximum exceedance was recorded in PC-020 between 0.01-0.04 mbgl at 1,400mg/kg. No potential ACMs were identified during the ground investigation and no asbestos fibres were identified in the 123 soil samples screened for asbestos. Pendimethalin (a selective herbicide) was found to be present in five locations at concentrations up to 23 µg/kg but was not deemed as being a significant risk to groundwater and surface water due to its high affinity to bind with soil and sediment.

The risk to the future Proposed Scheme users from contaminants in the soil is considered to be low. Provided that construction workers and future maintenance workers utilise appropriate vigilance and work in accordance with construction health and safety best practice, the risk to them from contaminants in soil within the site boundary is also anticipated to be Low.

Controlled Waters Assessment

Leachate testing has been completed for 34 soil leachate samples and the concentrations have been screened against Drinking Water Standards (DWS) and Environmental Quality Standards (EQS). Exceedances of the EQS were noted for leachable copper, lead, nickel and zinc at several locations. Two locations marginally exceeded the DWS for arsenic. There are exceedances of the EQS and DWS for PAHs. All exceedances of PAHs are from the Pavement Cores. The pavement core samples were collected from the asphalt and macadam from roadways on-site. Given some of the Pavement Cores were found to be hazardous, it is likely these will be removed from within the site boundary unless further assessment is undertaken to identify an appropriate location within the site boundary for re-use. Such assessment would need to include a detailed quantitative risk assessment (DQRA) so that site specific acceptability criteria can be set for these materials. It is noted that a DQRA is currently being

undertaken by Ramboll to inform the re-use of the road planings. Given that the exceedances are marginal and the process of extracting leachate from the soils is not likely to represent conditions within the ground, the risk to controlled waters is considered to be low.

To date, eighteen (18) groundwater samples have been collected during two rounds (February 2022 and February 2023) and were screened against EQS and DWS. One further groundwater sampling visits is planned for March 2023. Interpretation of these results will be undertaken following the issue of the laboratory data.

From the groundwater sampling completed to date concentrations of metals including arsenic, cadmium, copper, lead, mercury, nickel and zinc exceed the EQS. The majority of the exceedances are marginal (i.e less than one order of magnitude), with the exception of mercury and nickel. Only nickel exceeds both the EQS and DWS. The majority of exceedances are noted at BHR35 (in the south-west), which is screened in the superficial deposits and the chalk. Furthermore, the pH of the water in BHR35 was recorded to be alkali, outside the acceptable range for both the EQS and DWS.

The elevated metals in groundwater are likely to represent background levels within the site boundary, in both the superficial and the chalk deposits. Most exceedances were recorded in BHR35, screened in the boundary between the superficial and the chalk. The exceedances are localised, and there is no known contamination source from the current or historic land uses within the site boundary. As such, the risk to controlled waters is considered to be low.

Ground Gas Assessment

Four (4) ground gas monitoring rounds have been undertaken between February 2022 and May 2022.

Monitoring results exceeded both the long and short term WELs for carbon dioxide at all wells during at least one monitoring round. The carbon dioxide concentrations are likely to represent the natural underground conditions given the similarity of the concentrations across the large spatial area. However, the flow rates are consistently low within the site boundary.

The risk to Human Health for the end-use of the Proposed Scheme is low; however, mitigation measures will need to be put in place for construction workers during the construction phase.

Initial Waste Assessment

Based on the results of a preliminary waste assessment, macadam in some of the existing highways within the site boundary has the potential to be classified as hazardous for the purposes of disposal. This material should be stockpiled separately and subjected to chemical testing to confirm waste classification or suitability for re-use on-site as appropriate. Based on the results of the materials assessment, road planings should not be re-used within the Proposed Scheme unless further assessment and DQRA is undertaken to confirm suitable locations for re-use and to determine site specific acceptability criteria. It is noted that this DQRA is currently being undertaken.

Other materials excavated within the site boundary are considered to be chemically suitable for re-use on-site.

Re-Use Summary

Chemical analysis of the soil indicates that all material, with the exception of the road planings, are within the re-use criteria set by Norfolk County Council and the risk to Human Health from the material is classed as low. Additional leachate and groundwater assessment show some metal exceedances of the Norfolk County Council's water criteria; however, these likely relate to background conditions within the site boundary and have been assessed as a low risk to Controlled Waters. Given the results of the assessment, it is likely that the majority of the material excavated during the construction phase may be re-used on the Proposed Scheme provided that:

- Construction and maintenance workers utilise appropriate PPE and health and safety best practices;
- Material is confirmed to be geotechnically suitable for reuse in accordance with an Earthworks Specification (to be prepared separately).

However, it is noted that the Made Ground, road planings and any unexpected contamination identified during the works is chemically tested throughout the construction works to ensure the material is in line with the findings of this investigation.

A DQRA will be undertaken by The Applicant to assess whether the road planings may be re-used in specific areas where the risk to Controlled Waters is Low, and the results of this assessment will be reported separately.

1 Introduction

1.1 Brief

1.1.1 Harrison Group Environmental Ltd (HGE) on behalf of The Applicant has undertaken an intrusive ground investigation required in relation to the design and construction of the Proposed Scheme. The Proposed Scheme comprises the construction of a new section of dual carriage highway linking between the existing A47 road to the south-west to the existing A1067 Fakenham Road to the north-east.

1.1.2 The Site Boundary extends in a north-east to south-west trend with the far north-east situated off the A1067 Fakenham Road roundabout at National Grid Reference (NGR) 614853, 315625 through to the far south-west located north of the A47 at NGR 609696, 312490. The Proposed Scheme Location Plan is provided in Figure 1.

1.1.3 This report presents the objectives, scope, findings and conclusions of an intrusive ground investigation undertaken for the Proposed Scheme with respect to contaminated land within the Site Boundary.

1.2 Objectives and Scope of Report

1.2.1 The objectives of this report are to provide a generic quantitative risk assessment (GQRA) identifying potential risks and constraints associated with ground and groundwater conditions and identifying potential locations of concern within the site boundary with respect to ground and groundwater contamination.

1.2.2 The scope of this report is to:

- Undertake a review of relevant reports pertaining to the Proposed Scheme, where available;
- Document and interpret the environmental ground conditions encountered from an intrusive ground investigation;
- Assess the presence, likely extent and nature of potential contaminants;
- Conduct a contaminated land generic quantitative risk assessment (GQRA) with respect to the proposed land use based on the results of the ground investigation;
- Produce a conceptual site model for the site based on the GQRA and to provide recommendations for future works, where appropriate; and
- Provide a commentary on contaminated land risks under the proposed end use within the site boundary.

1.3 Proposed Development

1.3.1 The Proposed Scheme comprises the construction of a new section of dual carriageway highway linking between the existing A47 road to the south-west to the existing A1067 Fakenham Road to the north-east.

1.3.2 The Proposed Scheme is to comprise a new dual carriageway in a general north-east to south-west orientation that will pass through areas of agricultural land, woodland, and some country roads. There will be sections of cutting and embankment, ranging from cut depths of approximately 8 m to embankment heights of approximately 6 m. The Proposed Scheme will incorporate a number of road overpasses and underpasses, wildlife crossings and pedestrian foot-bridges, the primary structures being the Additional Green Bridge, The Broadway, Foxburrow Plantation Green Bridge and the Tud Tributary Culvert. One key feature of the Proposed Scheme will be the approach to the proposed junction with the A1067, where it is proposed the alignment will cross the River Wensum and associated floodplain by a viaduct. The Proposed Scheme will include the construction of highway drainage and infiltration ponds. The locations of the key features of the Proposed Scheme are shown in the general arrangement drawings, document reference 2.03.00.

1.4 Scope of Ground Investigation Works

1.4.1 The ground investigation undertaken on behalf of The Applicant by Harrison Group Environmental Ltd (HGE) comprised the following works undertaken between 27th September 2021 and 15th December 2021:

- 16 cable percussion boreholes (CP01-CP13A and BHR30-BHR32) drilled between 27th September 2021 and 14th December 2021 to a maximum depth of 40.45m (hand excavated starter pits were completed to a maximum of 1.2m depth for each location prior to drilling);
- Upon completion, a number of cable percussive boreholes were installed with groundwater/gas monitoring standpipes. Boreholes that did not require a monitoring installation were backfilled with bentonite/cement and reinstated accordingly;
- 17 rotary boreholes (BHR12-BHR35) were completed between 27th September 2021 and 6th December 2021 up to a maximum depth of 60.45m. A number of boreholes were installed for monitoring purposes. Cable percussive drilling was used to advance the majority of the boreholes through the superficial deposits and into the surface of the bedrock where the boreholes were then advanced using a rotary rig;

- 37 dynamic continuous sampler (window sampler) boreholes (WS01 to WS41) drilled between 30th September 2021 and 10th December 2021 to a maximum depth of 8m. Hand excavated starter pits were completed to a maximum of 1.2mdepth. WS08, WS09, WS13 and WS14 were not drilled;
- 51 dynamic cone penetrometer tests utilising a TRL-DCP at 49 locations between 30th September 2021 and 10th December 2021;
- 4 cone penetration tests (CPT01, CPT03- CPT05) undertaken on 8th October 2021 and 9th November 2021 to depths between 12.68m and 30.16m. Prior to each CPT, a hand starter pit was completed to 1.2m;
- 55 machine excavated trial pits (TP01-TP54 incl.TP37A) between 27th September 2021 and 2nd November 2021 to a maximum depth of 4.6m. Twelve trial pits were partially back filled (TP04-TP07, TP11-TP14, TP37A-TP38, TP51-TP52) with gravel to maintain stability and temporary monitoring pipe to enable subsequent infiltration testing to BRE DG 365 methodology;
- 19 pavement cores (PC-001-PC-022 excl. PC-005, PC-008, PC-015) between 6th December 2021 and 9th December 2021 using a 150mm coring barrel:
    - PC-001-PC-010, PC-012-PC-014 was undertaken at A1076;
    - PC-015 (soft landscaping only) was taken north of the A1067;
    - PC-011 was completed at NICC Land;
    - PC-016-PC-018 at Ringland Lane;
    - PC-019 at Weston Road;
    - PC-020 at Breck Road;
    - PC-021-PC-022 at The Broadway;
- 29 pressure meter tests were undertaken between 19th October 2021 and 26th November 2021 at the following locations: BHR13-BHR14, BHR17-BHR18, BHR21-BHR22, BHR25, using either a reaming pressure meter (RPM or PIP) or high-pressure dilatometer (HPD);
- All environmental samples were subject to screening of volatile organic compounds (VOC) using a photo ionisation detector (PID);
- In situ and geotechnical/ geo-environmental laboratory testing;
- 3 rounds of groundwater sampling from well installations, where groundwater was encountered;
- 4 rounds of gas monitoring from well installations;

- Submission of selected soil and groundwater samples to an approved MCERTs and UKAS1 accredited laboratory for analysis for a range of determinands relevant to the history of the Proposed Scheme; and
- Production of an interpretative report, to include comparison of the analytical results with the Norfolk County Council specified Generic Assessment Criteria (GAC) and the GAC derived in accordance with UK guidance on risk assessment, a qualitative source-pathway-receptor risk assessment (based on a commercial land use within the site boundary) and production of a conceptual site model.

1.4.2 The scope of works was in general accordance with that initially proposed by Ramboll, with any deviation agreed with the Investigation Supervisor. Works were stopped on the 26th November 2021. As a result, a portion of the proposed investigation locations were either terminated short of their intended depth or not started. Ground investigation data including chemical test results are provided in the Factual Ground Investigation Report. A plan of the exploratory hole locations is presented as Figure 2.

1.4.3 In the preparation of this report Ramboll has made reference to UK regulatory guidance and methodologies, including, but not limited to: Land Contamination: Risk Management (LCRM) 2020; BS5930:2015+A1:2020 Code of Practice for site Investigation; and BS10175:2011 + A2:2017 Code of Practice for the Investigation of Potentially Contaminated sites.

1.5 Contaminated Land Scope of Works

- Ground Investigation – input to scope and ground investigation specification (prepared by Ramboll's geotechnical team), liaison with the ground investigation contractor during the site works and scheduling of laboratory testing, review of the factual report produced by the ground investigation contractor;
- Contaminated land interpretative reporting based on comparison of the soil and groundwater results against The Applicant's generic assessment criteria (GAC) and including a general qualitative risk assessment;
- Initial assessment of the acceptability of the soil to be re-used within the site boundary.

[1] Monitoring Emissions to Air, Land and Water (MCERTs) and United Kingdom Accreditation Services (UKAS)

1.6 Previous Relevant Reports

WSP Interpretative Environmental Desk Study Report

1.6.1 A preliminary interpretative environmental study report was produced by WSP in June 2020. WSP were instructed by Norfolk County Council to undertake an Interpretative Environmental Desk Study Report, document reference 3.13.01, to assess the ground conditions and constraints of land for the Proposed Scheme. The purpose of this phase of work was to assess the ground conditions of land for the Proposed Scheme highlighting environmental considerations which will be used to assist with its design. Although direct access to the WSP report was not given, Ramboll has gathered information from this report as an additional source of data.

1.6.2 Within the previous report, WSP stated that the potential risk pathways to sensitive receptors that warranted further assessment were as follows:

- Due to the nature of the Proposed Scheme, exposure of future site users and workers to potentially contaminated soils and groundwater is likely to be in localised areas within the site boundary i.e. only in public bridges/walkways. The risk to future users is considered to be Low.
- 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.
- It is considered likely that Made Ground deposits will be present within the site boundary especially in the north. However, given the nature of the Proposed Scheme the risk from ground gas is considered to be Low.
- The River Wensum and associated floodplain crosses the Proposed Scheme 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 boundary to enter these water courses. It is considered likely that the Proposed Scheme 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 this information, the risk to surface water receptors is considered to be Low-Moderate.
- The extent of the Site Boundary 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.

- There is potential for dust and asbestos fibres to be blown from surrounding areas on the extent of the Site Boundary. However, given the limited historical development of the area surrounding the Proposed Shceme and the nature of it, the risk from windblown dust and fibres is considered to be Low.
- Ground gas generated by Made Ground in the north and infilled Marl Pit/Clay Pits in the surrounding area may migrate laterally within the subsurface and accumulate in enclosed spaces, posing a risk of explosion. However, within the Site Boundary, it is not considered likely that there will be many areas where ground gas could accumulate. 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. The risk from ground gas to the Proposed Scheme from the surrounding area is considered to be Low.
- The migration of contaminants from surrounding area shallow soils into the superficial and bedrock aquifers has the potential to occur given the lack of hardstanding on-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.
- Given the limited historical development of the area surrounding the extent of the site boundary and nature of the Proposed Scheme, the risk to future infrastructure and services is considered to be Low.
- The report included numerous historical borehole logs accessed from the British Geological Survey (BGS) for historical boreholes present within the site boundary and in the surrounding area (see Section 3.1.6 for review of selected borehole logs that are publicly available).

1.6.3 WSP noted that based on the basis of the findings of the Conceptual Site Model discussed in the Interpretative Environmental Desk Study, it was recommended that an intrusive ground investigation should be undertaken to provide detailed information regarding the underlying ground profile and allow for the identification of contamination in ground and groundwater. This was required to facilitate the further assessment of the plausible pollutant linkages identified in the Conceptual Site Model (CSM).

WSP Geotechnical Desk Study Report

1.6.4 A Geotechnical Desk Study was published by WSP in 2019[2]. The report presented the findings of a geotechnical desk study undertaken to identify potential

[2] WSP (2019) Norwich Western Link Geotechnical Desk Study. Ref: NCCT41361-04-B-02-01

geotechnical constraints and risks associated with the Proposed Scheme. This included the collation and review of available existing historical geotechnical information within the study area, review and assessment of the anticipated geology and ground conditions, a preliminary engineering assessment and recommendations for design, and a summary of geotechnical risk and recommendations.

1.6.5 The report reviewed four different options for the alignment of the road, and gave detailed information about the geology of the area. The report considered ground stability design implications of the various strata identified from the desk study.

1.6.6 The recommendations included a project specific ground investigation for the selected alignment is required to establish detailed ground conditions. It was recommended by WSP that piled foundations should be used for sensitive structures traversing the river valleys, to achieve sufficient bearing capacity and to mitigate the effects of settlement. The outcomes of the report also highlighted the possibility of chalk mining, sinkholes and dissolution features being present and presenting a general risk to the Proposed Development, and these shall require consideration and mitigation measures included in the design.

WSP Ground Investigation Report

1.6.7 WSP carried out a ground investigation following the recommendations of the Interpretative Environmental Desk Study (Reference 3.13.01) and the Geotechnical Desk Study Reports. This report has not been reviewed by Ramboll.

1.7 Constraints and Limitations

1.7.1 This report has been prepared by Ramboll exclusively for the intended use by The Applicant, defining, among others, the purpose, the scope and the terms and conditions for the services. No other warranty, expressed or implied, is made as to the professional advice included in this report or in respect of any matters outside the agreed scope of the services or the purpose for which the report and the associated agreed scope were intended, or any other services provided by Ramboll.

1.7.2 Confirmation of Harrison Group's appointment on the project was initiated on the 13th August 2021 with final agreement of the contract documentation settled on 29th September 2021.

1.7.3 In preparation of the report and performance of any other services, Ramboll has relied upon publicly available information, information provided by The Applicant and information provided by third parties. Accordingly, the conclusions in

this report are valid only to the extent that the information provided to Ramboll was accurate, complete and available to Ramboll within the reporting schedule.

1.7.4 Ramboll's services are not intended as legal advice, nor an exhaustive review of conditions within the Site Boundary and/ or compliance. This report and accompanying documents are initial and intended solely for the use and benefit of The Applicant for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts any duty to any third party, unless formally agreed by Ramboll through that party entering into, at Ramboll's sole discretion, a written reliance agreement.

1.7.5 The ground investigation works were undertaken during a discrete period of time. The findings and conclusions presented in this report are accordingly factually limited by these circumstances and, unless stated otherwise in the report, are preliminary. The field investigations were restricted to a level of detail necessary to meet the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant period of time has elapsed since the sampling took place. The interpretation of the geological and environmental quality conditions is based on extrapolation from point-source data in a heterogeneous environment. Accordingly, more detailed investigation may be appropriate dependent upon The Applicant’s objectives.

1.7.6 Six (6) groundwater monitoring rounds and four (4) ground gas monitoring rounds were scheduled to take place in 2022 (starting in February). Currently, eight (8) groundwater and four (4) ground gas monitoring rounds have been undertaken, with two supplementary groundwater monitoring rounds undertaken in February and March 2023. To date three (3) groundwater sampling rounds have been undertaken, in February 2022, February 2023 and March 2023. The chemical testing laboratory certificates are presented in the Harrison Group Environmental Ltd Factual Ground Investigation Report[1].

2 Site Setting

2.0.1 The Proposed Scheme location and details of the site setting are provided in Table 2.1 and a Proposed Scheme location plan is provided as Figure 1.

Table 2.1: Site Setting Details

Parameter	Details
Site Location	Area extends in a north-east to south-west trend with the far north-east of the site situated off the A1067 Fakenham Road roundabout (NGR 614853, 315625) through to the far south-west of the site located north of Weston Road (NGR 612032, 314583).
General setting	Area extends between the existing A47 road to the south-west to the existing A1067 Fakenham Road to the north-east.
Current site use	At the time of investigation, the area within the Site Boundary comprised individual parcels of agricultural farmland, sections of woodland, and the Wensum Valley floodplain.
Current regulated activities on-site	None present.
Topography	Towards the south-east there are areas of steepened hill slopes along tributaries of the River Tud. Within the north-east of the Site Boundary lies the River Wensum with a wide floodplain area at the base of the valley. There is an incline towards Morton on the Hill and Royal Hill further to the east.
Land bounding site – use NORTH	The Proposed Scheme is largely surrounded by agricultural farmland and the villages of Attlebridge (1.5km) and Felthorpe (c.3km)
Land bounding site – use SOUTH	The Proposed Scheme is largely surrounded by agricultural farmland, the River Tud and the villages of Honingham (c.1km) and East Tuddenham (c.2km)
Land bounding site – use EAST	The Proposed Scheme is largely surrounded by agricultural farmland with the village of Ringland c.1.5km distant.
Land bounding site – use WEST	The Proposed Scheme is largely surrounded by agricultural farmland with the village of Weston Longfield c.1km distant.

3 Desk Study Summary

3.0.1 The information presented in Section 3.1 describes the site setting based on desk-based information and provides a preliminary CSM, which is a simplified representation of the environmental conditions within the Site Boundary and surrounding area. The CSM is used to initially identify potentially sensitive receptors

and potential pollutant linkages. Information obtained during the environmental site investigation, described in the following sections of this report, is then used to refine and update this preliminary conceptual model in Section 8.

3.0.2 The information in Section 3 has been collected from publicly available sources and a summary of the information from WSP's Interpretative Environmental Desk Study (Reference 3.13.01) and Geotechnical Desk Study is provided at the end in Section 3.5 and 3.6.

3.1 Anticipated Geology and Hydrology

3.1.1 The geological information provided within this section is based primarily on information from the following sources which were accessed in February 2022:

- British Geological Survey (BGS): Aylsham (Sheet 147 Bedrock and Superficial Deposits) and Norwich (Sheet 161 Solid and Drift Edition) [Accessed 22 February 2022];
- Review of publicly available historical BGS borehole logs within the Site Boundary or in the vicinity;
- Regulatory authority websites including the Environment Agency (EA); and
- Websites including the UK Government's 'MAGIC' maps.

3.1.2 A summary of the anticipated natural geology identified from publicly available information is provided in Table 3.1.

Table 3.1: Anticipated Natural Geology

Superficial or Bedrock	Stratum	Distribution Across the Site Boundary	Description	Estimated Average Thickness (m)	EA Aquifer Designation	Hydrogeological Significance
Superficial	Alluvium	This unit is present in a band within the north of the Site Boundary, in the vicinity of the A1067	Silt, sand, peat and basal gravel	Variable, up to 10 m	Secondary B	Lower permeability formations with potential to support small abstractions.
Superficial	Head Deposits	This unit is present to the south of the Alluvium deposits within the north of the Site Boundary.	Clay, gravel and sand	Variable, up to 20m	Secondary B	Lower permeability formations with potential to support small abstractions.
Superficial	River Terrace Deposits	This unit is present to the north of the Alluvium deposits within the north of the Site Boundary/River Wensum valley floodplain.	Sand and gravel	Unknown	Secondary A	Permeable formations with potential to support localised abstractions.
Superficial	Sheringham Cliff Formation	Dominates the superficial deposits for the majority of the northern section within the Site Boundary	Sand and gravel	Variable, up to 40m	Secondary A	Permeable formations with potential to support localised abstractions.

Superficial or Bedrock	Stratum	Distribution Across the Site Boundary	Description	Estimated Average Thickness (m)	EA Aquifer Designation	Hydrogeological Significance
Bedrock	Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation	This unit is present only within the very south of the Site Boundary in the vicinity of the A47.	Chalky boulder clay	Variable, up to 60m	Secondary Undifferentiated	Variable permeability formation with potential to support small or localised abstractions.

3.1.3 The Catchment Data Explorer indicates that groundwater beneath the Proposed Scheme is part of the Wensum Up Stream Norwich groundwater body. The EA has not classified the ecological or chemical status for the groundwater body. The ecological status for the surface water is classed as 'moderate' and the chemical status as 'fail' under the Water Framework Directive (WFD) Scheme as of 2019.

3.1.4 The Proposed Scheme is located within a Source Protection Zone (SPZ) 1-3.

3.1.5 There are no groundwater abstractions within the Site Boundary, however, two (2) lie within 250m of the mainline. The nearest of these is located approximately 15m east of the Site Boundary operated by J B Piper for the abstraction of water from the chalk aquifer for general farming and domestic use.

3.1.6 A number of publicly available borehole logs were identified within the vicinity of the Proposed Scheme. A borehole log (Ref, TG11NW15, 1244 1550) near Morton Hall 300m north of Ringland Lane identified that the underlying geology was comprised of:

- Glacial Sand (a) and Gravel to 11.3 metres below ground level (mbgl); underlain by
- Boulder Clay to 14.6 mbgl; further underlain by
- Glacial Sand (b) and Gravel to 19.8 mbgl; underlain by
- Upper Chalk to 20.7 mbgl (end of borehole).

3.1.7 A borehole log (Ref.TG11NW14, 1278, 1674) at Morton Bridge located adjacent south of Fakenham Road identified the underlying geology comprised of:

- Topsoil to 0.6 mbgl; underlain by,
- Sub alluvium Gravel, 'clayey' from 7.0 to 7.9m; underlain by

- Gravel: fine to coarse, subangular to subrounded, brown and black flint, some subangular white flint and fine subrounded quartz with traces of quartz and quartzite cobbles in lower half of deposit; underlain by
- Sand: medium with coarse, subrounded quartz, with subangular to sub-rounded flint: brown to grey to 9.5 mbgl; underlain by
- Upper Chalk to 10.4 mbgl (end of borehole).

3.1.8 A borehole log (Ref. TG11NW9, 1143, 1650) at Morton Lane 600m north of Weston Longville identified the underlying geology comprised of:

- Topsoil to 0.3m bgl; underlain by
- Glacial Sand and Gravel; Clayey pebbly sand. Gravel mainly in upper half of deposit. 'Clayey' mainly in upper 5.5m and lower 3.7m. Traces of hard chalk pebbles. Gravel is coarse, subangular to angular flint. Sand is fine with medium, subangular; brown to 15.8 mbgl; underlain by
- Boulder Clay; silty fine sand with traces of clay. Brown chalk clay to 24.4m bgl (end of borehole).

3.2 Ecology

3.2.1 There is a Site of Scientific Interest (SSSI) and a Special Area of Conservation (SAC) within the Site Boundary. This is for the River Wensum. A Designated Ancient Woodland named the Mileplain Plantation is 740m north of the Site Boundary.

3.3 Surface Water

3.3.1 The River Wensum (the nearest WFD-classified surface water course) crosses the northern section of the Proposed Scheme, running from north west to south east with several small unnamed inland rivers within the vicinity of the Site Boundary. The EA currently classifies the River Wensum as being of 'moderate' ecological quality and 'failing' chemical quality under the WFD classification scheme as of 2019.

3.3.2 The River Tud is located approximately 400m south of the Site Boundary running in an east to west orientation. The EA currently classifies the River Tud as being of 'moderate' ecological quality and 'failing' chemical quality under the WFD classification scheme as of 2019.

3.3.3 There are no licensed surface water abstractions within 2km of the Site Boundary.

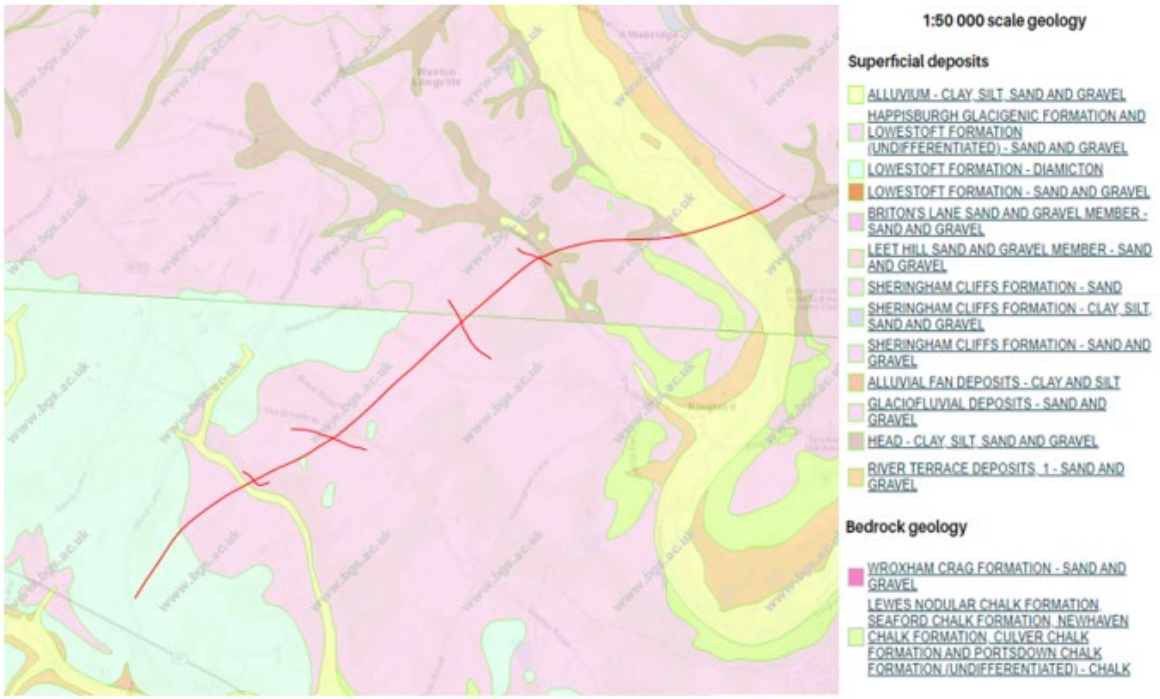
3.4 WSP Geotechnical Desk Study

3.4.1 WSP's Geotechnical Desk Study reports information on the ground conditions of the area within the Site Boundary that are in general accordance with the publicly available information reported above. The Geotechnical Desk Study Report recreated the BGS Geology map for the area and overlaid the road alignment, as shown in Figure 3.1.

3.4.2 The following geological sequence was anticipated along the route of the road:

- Made Ground;
- Head Deposit;
- Alluvium;
- River Terrace Deposits;
- Sheringham Cliff Formation;
- Lowestoft Formation; and
- Chalk.

Figure 3.1-BGS Geology of Britain Map



3.5 WSP Interpretative Environmental Desk Study (Reference 3.13.01)

3.5.1 The WSP Interpretative Environmental Desk Study4 reported information in general agreement with the publicly available information reported above. Additional information was provided surrounding a preliminary assessment of unexploded ordnance (UXO) that had been carried out for the Proposed Scheme.

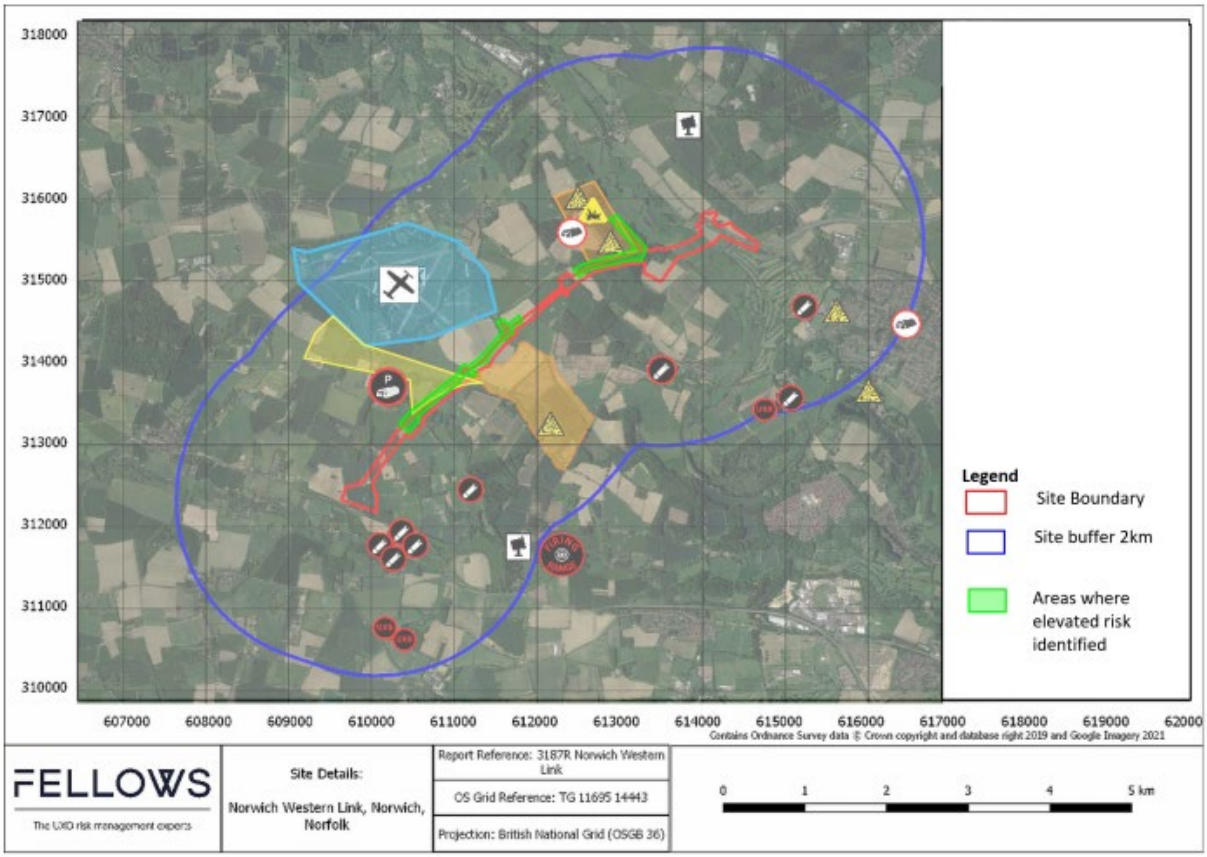
3.5.2 The WSP report states that a preliminary unexploded ordnance (UXO) risk assessment for the Proposed Scheme has been undertaken by Landmark, in association with 6 alpha associates. The findings of the reports show that due to the proximity of the Proposed Scheme to a former airfield (RAF Attlebridge), to the north west of the Site Boundary, a further detailed UXO threat and risk assessment is required. The former airfield has been assessed as being likely to contain WWI and WWII ordnance and required further investigation and assessment to be undertaken. No other areas of potential UXO hazards are identified within the extents of the Site Boundary.

3.6 Additional UXO Risk Assessment

3.6.1 A further UXO risk assessment was carried out by Fellows in August 2019. The assessment identifies a low risk from both German Air Dropped Weapons and British Anti-Aircraft munitions across the Proposed Scheme. There is a medium risk from 'Other Munitions' in two distinct areas within the Site Boundary – the

north western and southern section of the Proposed Scheme, as shown in Figure 3.2.

Figure 3.2: Areas of elevated risk from 'Other Munitions'



3.6.2 The recommended mitigation by Fellows was to have an UXO engineer on site for monitoring of the earthworks and excavations within the areas of elevated risk.

3.7 Historical and Current Site Use

3.7.1 Information summarised from WSP's Interpretative Environmental Desk Study Report4 (Reference 3.13.01) were reviewed and potentially contaminative former land uses on-site and within a 250m radius in the surrounding area were identified. The Envirocheck reports discussed have been categorised into four (4) separate reports to cover the Proposed Scheme. The four (4) reports are titled as 'Lines' to distinguish the large area covered by the Proposed Scheme.

3.7.2 The areas are as follows:

- Line 2: Proposed section of road that runs from the A47 at Wood Lane to the east of Weston Green village.

- Line 3: Proposed section of the road that continues from Line 2 at the east of Weston Green Village to the south of the River Wensum floodplains.
- Line 4/5: The area contains the proposed viaduct that crosses the River Wensum floodplain from Line 3 and joins the A1067 at a new junction.

Line 2

3.7.3 Historically, mapping dated 1882 shows the area within the Site Boundary was generally vacant land. Foxburrow Plantation is shown within part of the Site Boundary with an associated track transecting it. By 1971, a junction crossing the Site Boundary in the south was altered connecting Wood Lane to the west and the A27 to the south. Mapping dated 1994 showed 'Robin's Nursery' extending over the northern section of the Site Boundary, making up part of the Foxburrow Plantation.

Line 3

3.7.4 Historically, mapping dated 1882 showed the majority of the area within the Site Boundary was generally vacant land with a Gravel pit Plantation transecting the Site Boundary, with included a track in a north-south orientation. Primrose Plantation, the Long Plantation and the Rose Carr Plantation/Nursery was present in the east. Longrow Lane and an unnamed road crossed the Site Boundary in a north-west to south-east orientation. River Wensum floodplains were present in the north-eastern section of the Site Boundary. By 1971, Longrow Lane was labelled as Ringland Lane.

Line 4/5

3.7.5 Historically, mapping dated 1882 showed the Site Boundary was occupied by the River Wensum floodplains with the River Wensum transecting the Site Boundary in a north-west to south-east orientation. Crooked Oats Plantation with an associated track was present in the eastern tip of the Site Boundary with a Marl Pit extending to the northern part of the Site Boundary (Line 5). By 1970, the track is depicted as the A1067 and by 1994 was shown to cross the Site Boundary and is shown as Fakenham Road.

Surrounding Area

Line 2

3.7.6 Mapping dated 1883-1885 showed an unnamed road located approximately 60m south of the Site Boundary running in a north-west to south-east orientation. An Old Marl Pit was present 185m north-west and an Old Clay Pit was shown approximately 195m north-west of the Site Boundary (later unnamed and infilled and covered in vegetation in 1952-1959). Buildings associated with Honingham were present 250m south-west of the Site Boundary.

Line 3

3.7.7 Mapping dated 1883-1884 shows that Low farm was located 100m south and a Marl Pit approximately 135m north of the Site Boundary. A pond was shown 150m north-west of the south-western area of Line 3 and the River Wensum was shown 220m east of the north-eastern section of Line 3. Between 1973-1976, the Gravel pit Plantation adjacent to the Site Boundary was smaller in size and a pond was present associated with the Rose Carr Plantation 70m north of the Site Boundary. The Marl Pit was no longer shown.

Line 4/5

3.7.8 Mapping dated 1883-1884 showed an unnamed road present south of the Site Boundary running in a north-west to south-east orientation; a Marl Pit located 20m north of the Site Boundary (no longer shown by 1975-1976) and the Attle-bridge Hall Plantation was located 150m north of the Site Boundary. By 2019, a roundabout was constructed on the A1067 to the east of Line 5 connecting to the Broadland Northway to the east of the Site Boundary. The south-east of the Site Boundary was occupied by Wensum Valley Hotel Golf and Country Club.

3.8 Consultation

3.8.1 Following consultation between The Applicant and the Local Authority, it was brought to attention that a historical waste water treatment plant was located to the west of the site. Aerial imagery shared indicates that the treatment plant was upgradient of the central site area.

3.9 Preliminary Conceptual Site Model

3.9.1 Based upon the current and historical uses within the Site Boundary and its surroundings, potential contaminants, pathways and receptors are summarised in the preliminary CSM. The CSM was developed specifically for this report from the information reported in this Section, following the review of the previous WSP reports4,5 and publicly available information. The CSM has assessed potential ground contamination issues within the Site Boundary, in line with the current UK framework. For a risk of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A contaminant, i.e., a substance that is capable of causing pollution or harm;
- A receptor, i.e., something which could be adversely affected by the contaminant; and
- A pathway, i.e., a route by which the contaminant can reach the receptor.

3.9.2 If one of these elements is absent there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

3.9.3 The potential severity of the risk and the probability of the risk occurring have been combined in accordance with the following matrix in order to give a level of risk for each potential hazard.

Consequence	**Severe**	**Medium**	**Mild**	**Minor**
High Likelihood	Very high	High	Moderate	Low
Likely	High	Moderate	Moderate/Low	Low
Low Likelihood	Moderate	Moderate/ Low	Low	Very low
Unlikely	Moderate/ Low	Low	Very low	Very low

3.9.4 The assessment has been undertaken based on the Proposed Scheme.

3.9.5 A summary of potential sources of contamination, pathways and receptors that may be present on-site and in the immediate surrounding area are included in Table 3.2. The sources of contamination are based on the current and historical uses within the Site Boundary and surrounding area. The pathways and receptors are based on the environmental setting of the Proposed Scheme and surroundings. The preliminary CSM is presented in Table 3.2.

Table 3.2: Preliminary Conceptual Site Model

Source	Pathway	Receptor	Risk of Contaminant Linkage
Potential current and / or historical contamination (on-site). Contaminants include metals, inorganics, TPH, PAH, asbestos, fertilisers and pesticides. The fertilisers and pesticides are associated with the current and historical use within the Site Boundary as agricultural land. Asbestos, metals/inorganics and TPH is associated with the potential made ground beneath or surrounding the on-site public highways, as well as the former airfield (RAF Attlebridge) in the north of the Site Boundary.	Leaching to groundwater	Groundwater in the Chalk Bedrock-Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation	Low. There is a low risk of contamination being present; however, if present, contamination may be able to leach into shallow groundwater in the underlying Principal Aquifer to the north of the Site Boundary (Line 4/5) where tracks/roads transect the Site Boundary. The underlying bedrock in the Principal Aquifer is highly permeable, with significant water storage. Able to support large abstractions in the chalk.

Source	Pathway	Receptor	Risk of Contaminant Linkage
Potential current and / or historical contamination (on-site). Contaminants include metals, inorganics, TPH, PAH, asbestos, fertilisers and pesticides. The fertilisers and pesticides are associated with the current and historical use within the Site Boundary as agricultural land. Asbestos, metals/inorganics and TPH is associated with the potential made ground beneath or surrounding the on-site public highways, as well as the former airfield (RAF Attlebridge) in the north of the Site Boundary.	Direct contact, ingestion and inhalation of dust, gas and/ or vapours	Construction workers	Very Low. Construction workers have the potential to come into contact with soils, dust and ground gas (methane and carbon dioxide) during groundworks. Contamination within the Made Ground may be present and there is also a potential for the generation of Ground Gas in the Made Ground. Given the area within the Site Boundary is currently largely undeveloped agricultural land, with little areas of potential Made Ground, the risk of construction workers coming into contact with Made Ground, and the potential for Ground Gas generation is very low. Potential risk to workers from gas and/ or vapours if confined spaces were to be introduced.

Source	Pathway	Receptor	Risk of Contaminant Linkage
Potential current and / or historical contamination (on-site). Contaminants include metals, inorganics, TPH, PAH, asbestos, fertilisers and pesticides. The fertilisers and pesticides are associated with the current and historical use within the Site Boundary as agricultural land. Asbestos, metals/inorganics and TPH is associated with the potential made ground beneath or surrounding the on-site public highways, as well as the former airfield (RAF Attlebridge) in the north of the Site Boundary.	Direct contact, ingestion and inhalation of dust, gas and/ or vapours	Future Proposed Scheme users	Low. The potential for future users of the road coming into contact with fill materials or areas of contamination is likely to be low due to the presence of hardstanding on the majority of publicly accessible areas. There are no buildings planned for the Proposed Scheme, however it is possible that enclosed spaces will be present in the form of maintenance areas, manholes etc.

Source	Pathway	Receptor	Risk of Contaminant Linkage
Potential current and / or historical contamination (on-site). Contaminants include metals, inorganics, TPH, PAH, asbestos, fertilisers and pesticides. The fertilisers and pesticides are associated with the current and historical use within the Site Boundary as agricultural land. Asbestos, metals/inorganics and TPH is associated with the potential made ground beneath or surrounding the on-site public highways, as well as the former airfield (RAF Attlebridge) in the north of the Site Boundary.	Aggressive ground conditions	Infrastructure/ foundations	Very Low. Below ground concrete and the permeation of contaminants through plastic pipes may have the potential to impact concrete in infrastructure/ foundations, however the presence of contaminants in high enough concentrations to impact infrastructure is unlikely.

Source	Pathway	Receptor	Risk of Contaminant Linkage
Potential current and historical off-site contamination sources in the vicinity of the Proposed Scheme including former airfield (RAF Attlebridge) to the north-west of the Site Boundary. Contaminants may include metals, TPH, PAH and asbestos. Infilled Clay and Marl Pits and Attlebridge Landfill are present in the vicinity of the Site Boundary. Contamination may include TPH, PAH, metals and inorganics.	Lateral migration of contaminants in groundwater.	Groundwater in the Chalk-Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation	Low to Moderate. The underlying superficial deposits are anticipated to include permeable formations with potential to support localised abstractions (Secondary A) and lower permeability formations with potential to support small abstractions (Secondary B) with some potential for migration of contamination.

Source	Pathway	Receptor	Risk of Contaminant Linkage
Potential current and historical off-site contamination sources in the vicinity of the Proposed Scheme including former airfield (RAF Attlebridge) to the north-west of the Site Boundary. Contaminants may include metals, TPH, PAH and asbestos. Infilled Clay and Marl Pits and Attlebridge Landfill are present in the vicinity of the Site Boundary. Contamination may include TPH, PAH, metals and inorganics.	Migration of vapours or ground gases	Construction workers, future Proposed Scheme users	Low. A number of potential vapour and/ or ground gas sources have been identified within the surrounding area, including in potential Made Ground associated with the infilling of the Clay and Marl pits. Given the anticipated lower permeability of the underlying superficial deposits near surface, the potential for migration towards the Proposed Scheme and vertical migration is likely to be low.

The ground investigation strategy was designed to assess the key potential contamination sources and potential pollutant linkages identified in the preliminary conceptual site model. The following sections describe the site investigation strategy, the results of laboratory chemical analysis and a qualitative source-pathway-receptor risk assessment; the revised conceptual model is then presented in Section 8.

4 Ground Investigation Details

4.1 Design

4.1.1 The ground investigation was designed by Ramboll and Ferrovial Construction (UK) Limited (Ferrovial) to investigate the ground, ground gas and groundwater conditions within the Site Boundary. The scope of the ground investigation was prepared by Ramboll and Ferrovial.

4.1.2 The ground investigation was undertaken in order to obtain detailed information on the ground conditions within the Site Boundary. The exploratory locations targeted distinct areas of the Proposed Scheme such as locating deeper bore-holes to inform the piling requirements for the proposed bridge over the River Wensum, targeting road crossing areas, and targeting potential contamination source areas such as infilled ground.

4.1.3 The results from the ground investigation will be incorporated into the Geotechnical Design Documents and aid in refining the Conceptual Site Model for the Proposed Scheme and highlighting any risk to receptors. The scope of the ground investigation is summarised in Section 1.4.

4.2 Ground Investigation Activities

4.2.1 Site works were undertaken from 27th September 2021 to 15th December 2021. The ground investigation was undertaken by Harrison Group Environmental Ltd (HGE) and Ramboll UK Limited (Ramboll) acted as the Investigation Supervisor for the ground investigation works.

4.2.2 The intrusive ground investigation was undertaken in general accordance with:

- BS 5930:2015+A1:2020 Code of Practice for Ground Investigation;
- BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites – Code of Practice; and
- The Ground Investigation Scope Report.

4.2.3 Any deviation from the Ground Investigation Scope Report was agreed with the Investigation Supervisor.

4.2.4 Four (4) ground gas monitoring rounds have been undertaken monthly from February to May 2022 (inclusive). Six (6) groundwater monitoring rounds have been undertaken at monthly intervals from February to May and in July and September 2022. One round of groundwater sampling was conducted in February 2022, with a total of nine (9) groundwater samples obtained. Two (2) further groundwater sampling rounds will take place in December 2022 and February 2023.

4.2.5 Works were stopped on the 26th November 2021. As a result, a portion of the proposed investigation locations within this area were either terminated short of their intended depth or not started.

4.2.6 The Factual Ground Investigation Report including chemical testing laboratory certificates is presented in Harrison Group Environmental's Factual Ground Investigation Report. A plan of exploratory hole locations is presented as Figure 2.

4.2.7 A summary of the scope of the Factual Ground Investigation Report is presented in Table 4.1.

Table 4.1: Summary of Intrusive Works

Item	No.	Comments
Boreholes (cable percussive boreholes)	16	Drilling method: Sixteen (16) percussive boreholes (CP01-CP13A and BHR30-BHR32) were drilled between 27th September 2021 to 14th December 2021 to a maximum depth of 40.45m. Hand excavated starter pits were completed to a maximum of 1.2m depth for each location prior to drilling. Depth range (m): 0.6-60.0 metres The following monitoring wells were installed with 50mm HDPE install; (BHR29-BHR35, CP02-CP03, CP05-CP08 CP011-CP012, WS01, WS03-WS07, WS15-WS24, WS26, WS28-WS31, WS33-34, WS40-WS41). The following monitoring wells were installed with 19mm HDPE install CP01, CP04, CP09-CP10, CP13A, WS02 were installed with 19mm HDPE install. Gas and groundwater monitoring commenced in February 2022 and is ongoing at the time of publication of this report. Wells were of appropriate construction for the ground conditions encountered. The well designs are detailed within borehole logs appended to the factual report (Harrison Group Environmental Limited (2022) for Ferrovial Construction (UK) Limited. Factual Ground Investigation Report.

Item	No.	Comments
Boreholes (rotary Boreholes)	17	Drilling method: Seventeen (17) Rotary Boreholes between 27th September 2021 and 6th December 2021 up to a maximum depth of 60.45m. Depth range (m): 22.50-60.45m in BHR12-BHR35 The following monitoring wells were installed with 50mm HDPE install: BHR29, BHR32-BHR35. Cable percussive drilling was used to advance the majority of the boreholes through the superficial deposits and into the surface of the chalk bedrock where the boreholes were then advanced using a rotary rig. The exception was BHR20, BHR21, BHR25 and BHR29 and were instead commenced with a rotary rig using dynamic sampling techniques. Gas and groundwater monitoring commenced in February 2022 and is ongoing at the time of publication of this report. The well designs are detailed within borehole logs appended to the factual report.
Dynamic Continuous Sampling (window sampling boreholes)	37	Drilling Method: 37 window sample boreholes (WS01-WS41, excluding WS08-09 and WS13-14 due to an obstruction) drilled between 30th September 2021 and 10th December 2021. Hand excavated starter pits were completed to a maximum of 1.2 metre (m) depth. All boreholes were installed with 50mm HDPE install with the exception of WS10-WS12, WS17, WS25, WS27, WS32, WS35-39. WS02 was installed with 19mm HDPE install. Depth range (m): 0.53-8.0m

Item	No.	Comments
Dynamic Cone Pene-trometer Tests	51	Method: 51 dynamic cone tests using a TRL-DCP undertaken at 49 locations between 30th September 2021 and 10th December 2021 (DCP01-DCP51 including DCP13A DCP31A and DCP43A) Tests were completed to a depth of 1.5 m below ground level with early termination where 4mm or less penetration was achieved after 40 consecutive blows. Obstructions were encountered at DCP42 and could not be cored out or drilled. DCP13 was undertaken within an area of soft land-scaping however terminated at a depth of 1.05m due to obstruc-tion. The test was instructed to be reattempted (DCP13A) immedi-ately adjacent to the original location however also terminated at a slightly shallower depth of 0.99m due to obstruction. Depth range (m): 0.43m to 1.50m
Cone Penetra-tion Tests	4	Method: CPT was undertaken (CPT01, CPT03- CPT05) between 8th October 2021 and 9th November 201. Depth range (m): 12.68-30.16m
Machine Ex-cavated Trial Pits	55	Method: JCB 3CX machine used to excavate a maximum depth of 4.6m between 27th September 2021 and 2nd November 2021. Twelve trial pits were partially back filled (TP04-TP07, TP11-TP14, TP37A-TP38, TP51-TP52) with gravel to maintain stability and tem-porary monitoring pipe to enable subsequent infiltration testing to BRE DG 365 methodology. Depth range (m): 1.5-4.5m

Item	No.	Comments
Pavement Coring	19	Plant used: Atlas Copco LCD500 Hydraulic Drill between 6th December 2021 and 9th December 2021. Method: Pavement cores using a 150mm coring barrel completed between 6/12/21 and 9/12/21 at specified locations within existing roads (PC-001-PC-022) PC-005, PC-008, PC-015 were not completed.
Pressuremeter Testing	29	Method: 29 pressuremeter tests were undertaken between 19th October 2021 and 26th November 2021 at the following locations (BHR13-BHR14, BHR17-BHR18, BHR21-BHR22, BHR25) using either a reaming pressuremeter (RPM or PIP) or high-pressure dilatometer (HPD).
Soil Sampling and Analysis	123	During the site investigation, soil samples were recovered from each exploratory hole location. All environmental samples were subject to screening for volatile organic compounds (VOC) using a photo ionisation detector (PID) A total of 123 soil samples were scheduled for analysis. Selected soil samples were analysed for a predetermined suite of contaminants a predetermined suite of contaminants (see Section 4.6), selected to be reflective of the area within the Site Boundary's historical and contemporary uses. 34 of the 123 soil samples tested were subjected to further analysis as soil leachate.

Item	No.	Comments
Groundwater Sampling and Analysis	26	Eight (8) rounds of groundwater level monitoring were undertaken on the following dates: 7th to 10th February; 7th to 9th March; 11th to 14th April; 9th to 11th May; 18th to 19th of July; 12th to 13th of September 2022; 13th to 15th February 2023 and 14th to 21st March 2023. A total of nine (9) groundwater samples were obtained during both the monitoring rounds undertaken in February 2022 and February 2023 and eight were sampled in the March 2023 round. All samples were scheduled for analysis for a pre-determined suite of contaminants (see Section 4.6). Resting groundwater levels were monitored using a dip meter and checked for NAPLs (non-aqueous phase liquid using an IP Probe). The groundwater samples were analysed for a suite of contaminants selected to be reflective of the area within the Site Boundary's historic users as shown in Section 4.6.
Ground Gas Monitoring	37	Four (4) rounds of ground gas monitoring were undertaken within the Site Boundary using a GA5000/G504267 analyser on the following dates: 7th to 10th February 2022; 7th to 9th March 2022; 11th to 14th April 2022; and 9th to 11th May 2022.

4.3 Sample Location Rationale

4.3.1 The rationale for positioning the sampling locations is described in Table 4.2.

Table 4.2: Exploratory Hole Geoenvironmental Rationale

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
Boreholes (Rotary Boreholes)	*N/A (Not Applicable)*	*N/A*	*N/A*
BHR02A	Investigate geoenvironmental and geotechnical ground conditions.	0.65	No
BHR03	Investigate geoenvironmental and geotechnical ground conditions.	28.0	No
BHR12	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate	60.45	No
BHR13	Investigate geoenvironmental and geotechnical ground conditions.	55.0	No
BHR14	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate.	60.0	No
BHR15	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate.	60.50	No
BHR16	Investigate geoenvironmental and geotechnical ground conditions.	60.0	No
BHR17	Soil Leachate Investigate geoenvironmental and geotechnical ground conditions for soil leachate.	60.0	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
BHR18	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	60.0	No
BHR19	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate.	60.45	No
BHR20	Investigate geoenvironmental and geotechnical ground conditions.	53.50	No
BHR21	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	60.0	No
BHR22	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	60.0	No
BHR23	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	60.0	No
BHR25	Investigate geoenvironmental and geotechnical ground conditions.	22.50	No
BHR29	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	30.0	Yes
BHR30	Investigate geoenvironmental and geotechnical ground conditions.	40.0	Yes

Exploratory Hole	**Rationale**	**Depth Achieved (mbgl)**	**Installed as Monitoring Well?**
BHR31	Investigate geoenvironmental and geotechnical ground conditions.	40.45	Yes
BHR32	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	34.90	Yes
BHR33	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring.	40.45	Yes
BHR34	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring.	40.50	Yes
BHR35	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	30.45	Yes
Boreholes (Cable Percussion Boreholes)	*N/A*	*N/A*	*N/A*
CP01	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	10.45	Yes

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
CP02	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	10.45	Yes
CP03	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	10.45	Yes
CP04	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling. Insufficient water for sampling.	10.45	Yes
CP05	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	10.50	Yes
CP06	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	10.45	Yes
CP07	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	10.45	Yes

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
CP08	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	40.45	Yes
CP09	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	8.00	Yes
CP10	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	8.00	Yes
CP11	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	12.00	Yes
CP12	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	9.95	Yes
CP13A	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling. Soil Leachate. Insufficient water for sampling.	8.45	No
Window Sampling Boreholes	*N/A*	*N/A*	*N/A*

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
WS01	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	6.00	Yes
WS02	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	5.80	Yes
WS03	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	5.00	Yes
WS04	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	3.00	Yes
WS05	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling. Insufficient water for sampling.	5.00	Yes
WS06	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	5.00	Yes

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
WS07	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	4.00	Yes
WS10	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate.	3.00	No
WS11	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate	1.00	No
WS12	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate.	8.00	No
WS15	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	4.00	Yes
WS16	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling at 0.5m	6.90	Yes
WS18	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	3.00	Yes

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
WS19	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	8.00	Yes
WS20	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	5.00	Yes
WS21	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling.	5.00	Yes
WS22	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	5.00	Yes
WS23	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil and soil leachate sampling	5.00	Yes
WS24	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	5.00	Yes
WS25	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling.	5.00	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
WS26	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	4.00	Yes
WS28	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	5.00	Yes
WS29	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling at and soil leachate	5.00	Yes
WS30	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	5.00	Yes
WS31	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	6.00	Yes
WS33	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	5.00	Yes

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
WS34	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	6.00	Yes
WS35	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	2.00	No
WS37	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	2.00	No
WS38	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	2.00	No
WS39	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	2.00	No
WS40	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and sampling.	6.00	Yes
WS41	Investigate geoenvironmental and geotechnical ground conditions. Groundwater and Gas monitoring and soil sampling	6.00	Yes
Trial Pits	*N/A*	*N/A*	*N/A*

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
TP01	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	3.00	No
TP02	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.50	No
TP03	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP04	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate	4.00	No
TP05	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP06	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling; soil leachate at 2.0m	4.00	No
TP07	Investigate geoenvironmental and geotechnical ground conditions.	1.60	Yes
TP08	Investigate geoenvironmental and geotechnical ground conditions.	4.00	No
TP09	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
TP10	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP11	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP13	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP14	Investigate geoenvironmental and geotechnical ground conditions.	4.00	Yes
TP15	Investigate geoenvironmental and geotechnical ground conditions.	4.00	No
TP16	Investigate geoenvironmental and geotechnical ground conditions.	4.00	No
TP17	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP18	Investigate geoenvironmental and geotechnical ground conditions.	3.50	No
TP19	Investigate geoenvironmental and geotechnical ground conditions.	4.20	No
TP20	Investigate geoenvironmental and geotechnical ground conditions.	4.00	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
TP21	Investigate geoenvironmental and geotechnical ground conditions.	3.70	No
TP22	Investigate geoenvironmental and geotechnical ground conditions.	3.80	No
TP23	Investigate geoenvironmental and geotechnical ground conditions.	4.00	No
TP24	Investigate geoenvironmental and geotechnical ground conditions.	4.00	No
TP25	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate	4.00	No
TP27	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate	3.50	No
TP31	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
TP33	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	3.50	No
TP37	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	3.00	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
TP42	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	3.50	No
TP43	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate.	3.60	No
TP48	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling.	4.50	No
TP50	Investigate geoenvironmental and geotechnical ground conditions. Soil sampling and soil leachate	4.60	No
TP52	Investigate geoenvironmental and geotechnical ground conditions involving soil sampling	4.00	No
Pavement Cores (see Section 1.4.1 for detail)	*N/A*	*N/A*	*N/A*
PC-001	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.35	No
PC-002	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate	0.43	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
PC-003	Core samples logged by a supervising geotechnical engineer Soil sampling and soil leachate.	0.35	No
PC-004	Core samples logged by a supervising geotechnical engineer involving soil sampling	0.35	No
PC-006	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.32	No
PC-007	Core samples logged by a supervising geotechnical engineer involving soil sampling	0.32	No
PC-009	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.35	No
PC-010	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.35	No
PC-011	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.22	No
PC-012	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate	0.35	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
PC-013	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.57	No
PC-014	Core samples logged by a supervising geotechnical engineer involving soil sampling	0.53	No
PC-016	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.13	No
PC-017	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.20	No
PC-018	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.25	No
PC-019	Core samples logged by a supervising geotechnical engineer. Soil sampling and soil leachate.	0.20	No
PC-020	Core samples logged by a supervising geotechnical engineer involving soil sampling	0.10	No
PC-021	Core samples logged by a supervising geotechnical engineer involving soil sampling	0.20	No

Exploratory Hole	Rationale	Depth Achieved (mbgl)	Installed as Monitoring Well?
PC-022	Core samples logged by a supervising geotechnical engineer involving soil sampling	0.20	No

4.3.2 All exploratory holes reached their target depth, with the exception of the locations summarised in Table 4.3 below.

Table 4.3: On-site constrains affecting target depth

Exploratory Hole	Termination Reason	Depth Achieved (mbgl)	Installed as Monitoring Well?
BHR02	Instruction to stop from Site Engineer	22.50	No
BHR02A	25 mm black plastic pipe encountered	0.65	No
BHR03	Instruction to stop from Site Engineer	28.00	No
BHR32	Unable to advance casing	34.90	Yes
CP12	Instruction to stop from Site Engineer	9.95	Yes
CP13A	Land drain encountered	0.60	No
BHR13	Blown sand trapping barrel	55.00	No
BHR20	Instruction to stop from Site Engineer	53.50	No
BHR25	Instruction to stop from Site Engineer	22.50	No
WS01	Hole Collapsed	6.00	Yes
WS02	Refusal	5.80	Yes
WS03	Hole Collapsed	5.00	Yes
WS04	Refusal	3.00	Yes
WS05	Hole Collapsed	5.00	Yes
WS06	Dense Stratum	5.00	Yes
WS07	Barrel stuck in casing	4.00	Yes
WS10	Barrel stuck in casing	3.00	No
WS11	Groundwater ingress and adverse ground conditions	1.00	No
WS15	Refusal	4.00	Yes
WS16	Casing fault	6.90	Yes

Exploratory Hole	Termination Reason	Depth Achieved (mbgl)	Installed as Monitoring Well?
WS18	Refusal	3.00	Yes
WS26	Refusal	4.00	Yes
WS31	Hole Collapsed	6.00	Yes
WS32	Rig malfunction	3.00	No
WS33	Dense Stratum	5.00	Yes
WS36	Refusal – obstruction	0.53	No

4.4 Sampling and Monitoring

Soil and Leachate Samples

4.4.1 Soil samples were recovered from each of the exploratory locations at changes of strata within the Made Ground, within the first encountered strata of natural ground and wherever contamination was suspected of being present. A total of 121 soil samples were scheduled for analysis. Thirty-four (34) of these soil samples were also scheduled for leachate analysis.

4.4.2 Samples were placed in containers supplied by the laboratory appropriate to the type of analysis being undertaken and stored in cool boxes with ice packs. All samples were dispatched accompanied by chain of custody documentation.

4.4.3 Laboratory test results are presented as part of Harrison Group Environmental's factual report.

Groundwater Monitoring and Sampling

4.4.4 Groundwater level monitoring was undertaken on the following dates: 7th to 10th February; 7th to 9th March; 11th to 14th April; 9th to 11th May; 18th to 19th July; 12th to 13th September 2022; 13th to 15th February 2023 and 14th to 21st March 2023. Three rounds of groundwater sampling were undertaken between 7th to 10th February 2022, 13th to 15th February 2023 and 14th to 21st March 2023. Prior to sampling, the depth to the resting groundwater level (where present) and base of the monitoring wells were measured using an interface probe. The interface probe also detected whether non-aqueous phase liquid (NAPL) was present in the well. Sampling was then undertaken using inertial method within the rotary installed boreholes and submersible high flow sampling method in the window sample boreholes, and an inertial pump in the deeper boreholes.

4.4.5 An initial well development round was completed between 24th January 2022 and 2nd February 2022 with an additional well development round between 6th to 8th February 2023 prior to the 2023 sampling (note: not all original wells were developed during the second development round). Three times the well volume was generally purged from each installation where possible. If water became clear during purging, the sampling began. If the water remained silty, more than three times the well volume was purged until the monitoring of the electrical conductivity measurement became stable. Where groundwater was slow to re-charge, the well was pumped dry and samples were taken once the monitoring well had recharged.

4.4.6 All monitoring wells were installed with 50mm HDPE standpipes with the exception of BHR31, CP01, CP04. CP09-10, CP13A, WS02, which were installed with 19mm HDPE standpipes.

4.4.7 Groundwater samples were collected in accordance with BS 10175:2011+A2:2017 and were stored within appropriate sample containers and stored in cool boxes with ice packs prior to being forwarded to an independent approved MCERTS accredited analytical laboratory (i2 Analytical Ltd) with an accompanying chain of custody form.

4.4.8 A summary of the groundwater level data collected to date is presented in Table 4.4 and a summary of field parameters are presented as part of Harrison Group Environmental's factual report.

Table 4.4: Summary of Groundwater Monitoring Wells

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Water mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
BHR29	1	27.0-30.0	10.38	13.10	29.28	-5.80	Chalk
BHR29	2	N/A (Not Applicable)	10.34	13.14	29.45	-5.97	N/A
BHR29	3	N/A	10.46	13.02	29.45	-5.97	N/A
BHR29	4	N/A	10.64	12.84	29.48	-6.00	N/A
BHR29	5	N/A	11.01	12.47	29.47	-5.99	N/A
BHR29	6	N/A	11.40	12.08	29.38	-5.90	N/A
BHR29	7	N/A	10.60	12.88	29.60	-6.12	N/A
BHR29	8	N/A	10.69	12.79	29.50	-6.02	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Water mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
BHR30	1	4.5-8.0	Dry	N/A	8.28	28.83	Superficial
BHR30	2	N/A	Dry	N/A	8.38	28.73	N/A
BHR30	3	N/A	Dry	N/A	8.34	28.77	N/A
BHR30	4	N/A	Dry	N/A	8.01	29.10	N/A
BHR30	5	N/A	Dry	N/A	8.03	29.08	N/A
BHR30	6	N/A	Dry	N/A	8.02	29.09	N/A
BHR30	7	N/A	Dry	N/A	7.93	29.18	N/A
BHR30	8	N/A	Dry	N/A	8.05	29.06	N/A
BHR31	1	13.5-14.5	Dry	N/A	13.70	18.21	Chalk
BHR31	2	N/A	Dry	N/A	13.69	24.22	N/A
BHR31	3	N/A	Dry	N/A	13.70	24.21	N/A
BHR31	4	N/A	Dry	N/A	19.02	18.89	N/A
BHR31	5	N/A	13.99	23.92	14.02	23.89	N/A
BHR31	6	N/A	Dry	N/A	14.03	23.88	N/A
BHR31	7	N/A	Dry	N/A	13.86	24.05	N/A
BHR31	8	N/A	Dry	N/A	26.15	28.76	N/A
BHR32	1	29.9-34.9	18.51	36.40	27.30	27.61	Superficial
BHR32	2	N/A	18.57	36.64	25.54	29.37	N/A
BHR32	3	N/A	18.60	36.71	26.12	28.91	N/A
BHR32	4	N/A	18.61	36.30	26.22	28.69	N/A
BHR32	5	N/A	18.68	36.23	26.35	28.56	N/A
BHR32	6	N/A	18.80	36.11	26.24	28.67	N/A
BHR32	7	N/A	19.03	35.88	26.15	28.76	N/A
BHR32	8	N/A	18.96	35.95	26.26	28.65	N/A
BHR33	1	38.0-40.0	7.69	36.48	40.05	4.12	Chalk
BHR33	2	N/A	7.67	36.50	40.10	4.07	N/A
BHR33	3	N/A	7.70	36.47	40.13	4.04	N/A
BHR33	4	N/A	7.74	36.43	40.10	4.07	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
BHR33	5	N/A	7.9	36.27	40.29	3.88	N/A
BHR33	6	N/A	8.04	36.13	40.09	4.08	N/A
BHR33	7	N/A	7.80	36.37	39.25	4.92	N/A
BHR33	8	N/A	7.97	36.20	40.02	4.15	N/A
BHR34	1	3.0-5.0	Dry	N/A	5.20	41.20	Superficial
BHR34	2	N/A	Dry	N/A	5.26	41.14	N/A
BHR34	3	N/A	Dry	N/A	5.25	45.15	N/A
BHR34	4	N/A	Dry	N/A	5.26	41.14	N/A
BHR34	5	N/A	Dry	N/A	5.28	41.12	N/A
BHR34	6	N/A	Dry	N/A	5.26	41.14	N/A
BHR34	7	N/A	Dry	N/A	5.27	41.13	N/A
BHR34	8	N/A	Dry	N/A	5.26	41.14	N/A
BHR35	1	10.0-12.0	-0.55	36.73	11.01	25.17	Superficial
BHR35	2	N/A	-0.53	36.71	7.27	28.91	N/A
BHR35	3	N/A	-0.53	36.71	7.27	28.91	N/A
BHR35	4	N/A	-0.65	36.83	10.95	25.23	N/A
BHR35	5	N/A	-0.75	36.93	11.0	25.17	N/A
BHR35	6	N/A	-0.50	36.77	10.79	25.39	N/A
BHR35	7	N/A	0.22	35.96	11.02	25.16	N/A
BHR35	8	N/A	0.08	36.10	11.10	25.08	N/A
CP01	1	2.5-7.0	Dry	N/A	6.90	17.53	Superficial
CP01	2	N/A	Dry	N/A	6.90	17.53	N/A
CP01	3	N/A	Dry	N/A	7.00	17.43	N/A
CP01	4	N/A	Dry	N/A	7.00	17.43	N/A
CP01	5	N/A	Dry	N/A	7.00	17.43	N/A
CP01	6	N/A	Dry	N/A	7.00	17.43	N/A
CP01	7	N/A	Dry	N/A	6.69	17.74	N/A
CP01	8	N/A	Dry	N/A	6.57	17.86	N/A
CP02	1	2.5-5.5	Dry	N/A	5.56	20.13	Superficial

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
CP02	2	N/A	Dry	N/A	5.56	20.13	N/A
CP02	3	N/A	Dry	N/A	5.59	20.10	N/A
CP02	4	N/A	Dry	N/A	5.58	20.11	N/A
CP02	5	N/A	Dry	N/A	5.57	20.12	N/A
CP02	6	N/A	Dry	N/A	5.59	20.10	N/A
CP02	7	N/A	Dry	N/A	5.28	20.41	N/A
CP02	8	N/A	Dry	N/A	5.28	20.41	N/A
CP03	1	0.6-2.0	Dry	N/A	1.93	14.91	Superficial
CP03	2	N/A	Dry	N/A	1.93	14.91	N/A
CP03	3	N/A	Dry	N/A	1.95	14.89	N/A
CP03	4	N/A	Dry	N/A	1.94	14.90	N/A
CP03	5	N/A	Dry	N/A	1.93	14.91	N/A
CP03	6	N/A	Dry	N/A	1.93	14.91	N/A
CP03	7	N/A	Dry	N/A	1.41	15.43	N/A
CP03	8	N/A	Dry	N/A	1.41	15.43	N/A
CP04	1	2.0-3.0	2.84	20.06	2.86	20.04	Superficial
CP04	2	N/A	2.84	20.06	2.86	20.04	N/A
CP04	3	N/A	2.84	20.06	2.86	20.04	N/A
CP04	4	N/A	2.84	20.06	2.86	20.04	N/A
CP04	5	N/A	Dry	N/A	2.86	20.04	N/A
CP04	6	N/A	Dry	N/A	2.86	20.04	N/A
CP04	7	N/A	Dry	N/A	2.93	19.97	N/A
CP04	8	N/A	Dry	N/A	2.94	19.96	N/A
CP05	1	2.0-4.0	Dry	N/A	3.87	14.60	Chalk
CP05	2	N/A	Dry	N/A	3.87	14.60	N/A
CP05	3	N/A	Dry	N/A	3.87	14.60	N/A
CP05	4	N/A	Dry	N/A	3.87	14.60	N/A
CP05	5	N/A	Dry	N/A	3.87	14.60	N/A
CP05	6	N/A	Dry	N/A	3.87	14.60	N/A
CP05	7	N/A	Dry	N/A	3.95	14.52	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Water mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
CP05	8	N/A	Dry	N/A	3.95	14.52	N/A
CP06	1	5.0-7.0	Dry	N/A	6.94	32.66	Superficial
CP06	2	N/A	Dry	N/A	6.94	32.66	N/A
CP06	3	N/A	Dry	N/A	6.98	32.62	N/A
CP06	4	N/A	Dry	N/A	6.95	32.65	N/A
CP06	5	N/A	Dry	N/A	6.96	32.64	N/A
CP06	6	N/A	Dry	N/A	6.95	32.65	N/A
CP06	7	N/A	Dry	N/A	6.85	32.75	N/A
CP06	8	N/A	Dry	N/A	6.85	32.75	N/A
CP07	1	2.0-4.0	Dry	N/A	3.89	36.21	Superficial
CP07	2	N/A	Dry	N/A	3.89	36.21	N/A
CP07	3	N/A	Dry	N/A	3.88	36.22	N/A
CP07	4	N/A	Dry	N/A	3.88	36.22	N/A
CP07	5	N/A	Dry	N/A	3.87	36.23	N/A
CP07	6	N/A	Dry	N/A	3.87	36.23	N/A
CP07	7	N/A	Dry	N/A	3.91	36.19	N/A
CP07	8	N/A	Dry	N/A	N/A	N/A	N/A
CP08	1	5.0-10.0	Dry	N/A	10.17	45.54	Superficial
CP08	2	N/A	Dry	N/A	10.21	45.50	N/A
CP08	3	N/A	Dry	N/A	10.16	45.55	N/A
CP08	4	N/A	Dry	N/A	10.14	45.57	N/A
CP08	5	N/A	Dry	N/A	10.17	45.54	N/A
CP08	6	N/A	Dry	N/A	10.14	45.57	N/A
CP08	7	N/A	Dry	N/A	10.14	45.57	N/A
CP08	8	N/A	Dry	N/A	N/A	N/A	N/A
CP09	1	2.0-6.0	Dry	N/A	4.31	48.46	Superficial
CP09	2	N/A	Dry	N/A	6.99	45.78	N/A
CP09	3	N/A	Dry	N/A	6.98	45.79	N/A
CP09	4	N/A	Dry	N/A	4.02	48.75	N/A
CP09	5	N/A	Dry	N/A	3.97	48.80	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
CP09	6	N/A	Dry	N/A	4.02	48.75	N/A
CP09	7	N/A	Dry	N/A	6.66	46.11	N/A
CP09	8	N/A	Dry	N/A	N/A	N/A	N/A
CP10	1	2.0-6.0	Dry	N/A	5.92	43.51	Superficial
CP10	2	N/A	Dry	N/A	5.70	43.73	N/A
CP10	3	N/A	Dry	N/A	5.69	43.74	N/A
CP10	4	N/A	Dry	N/A	5.69	43.74	N/A
CP10	5	N/A	Dry	N/A	5.70	43.73	N/A
CP10	6	N/A	Dry	N/A	5.69	43.74	N/A
CP10	7	N/A	Dry	N/A	5.26	44.17	N/A
CP10	8	N/A	Dry	N/A	N/A	N/A	N/A
CP11	1	11.0-12.0	Dry	N/A	11.81	39.05	Superficial
CP11	2	N/A	Dry	N/A	11.81	39.05	N/A
CP11	3	N/A	Dry	N/A	11.80	39.06	N/A
CP11	4	N/A	Dry	N/A	11.80	39.06	N/A
CP11	5	N/A	Dry	N/A	11.80	39.06	N/A
CP11	6	N/A	Dry	N/A	11.76	39.10	N/A
CP11	7	N/A	Damp	N/A	11.88	38.98	N/A
CP11	8	N/A	Dry	N/A	N/A	N/A	N/A
CP12	1	8.5-9.5	9.40	42.28	9.51	42.17	N/A
CP12	2	N/A	9.21	42.47	9.50	42.18	N/A
CP12	3	N/A	9.31	42.37	9.43	42.25	N/A
CP12	4	N/A	9.40	42.28	9.48	42.20	N/A
CP12	5	N/A	9.41	42.27	9.46	42.22	N/A
CP12	6	N/A	Dry	N/A	9.49	42.19	N/A
CP12	7	N/A	Dry	N/A	8.53	43.15	N/A
CP12	8	N/A	9.06	42.62	9.62	42.06	N/A
CP13A	1	3.0-6.0	Dry	N/A	6.09	44.49	Superficial
CP13A	2	N/A	Dry	N/A	6.14	44.44	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Water mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
CP13A	3	N/A	Dry	N/A	6.11	44.47	N/A
CP13A	4	N/A	Dry	N/A	6.12	44.46	N/A
CP13A	5	N/A	Dry	N/A	6.12	44.46	N/A
CP13A	6	N/A	Dry	N/A	6.13	44.45	N/A
CP13A	7	N/A	Damp	N/A	6.25	44.33	N/A
CP13A	8	N/A	Dry	N/A	6.17	44.41	N/A
WS01	1	0.3-5.0	Dry	N/A	4.10	17.15	Superficial
WS01	2	N/A	Dry	N/A	4.12	17.13	N/A
WS01	3	N/A	Dry	N/A	4.11	17.14	N/A
WS01	4	N/A	Dry	N/A	4.12	17.13	N/A
WS01	5	N/A	Dry	N/A	4.11	17.14	N/A
WS01	6	N/A	Dry	N/A	4.12	17.13	N/A
WS01	7	N/A	Dry	N/A	2.79	18.46	N/A
WS01	8	N/A	Dry	N/A	3.82	17.43	N/A
WS02	1	0.6-4.8	Dry	N/A	3.65	18.79	Superficial
WS02	2	N/A	Dry	N/A	4.65	17.79	N/A
WS02	3	N/A	Dry	N/A	4.67	17.77	N/A
WS02	4	N/A	Dry	N/A	4.66	17.78	N/A
WS02	5	N/A	Dry	N/A	4.67	17.77	N/A
WS02	6	N/A	Dry	N/A	4.65	17.79	N/A
WS02	7	N/A	Dry	N/A	2.77	19.67	N/A
WS02	8	N/A	Dry	N/A	3.50	18.94	N/A
WS03	1	2.5-4.0	Dry	N/A	4.04	15.51	Superficial
WS03	2	N/A	Dry	N/A	4.11	15.44	N/A
WS03	3	N/A	Dry	N/A	4.09	15.46	N/A
WS03	4	N/A	Dry	N/A	4.09	15.46	N/A
WS03	5	N/A	Dry	N/A	4.09	15.46	N/A
WS03	6	N/A	Dry	N/A	4.09	15.46	N/A
WS03	7	N/A	Dry	N/A	4.13	15.42	N/A
WS03	8	N/A	Dry	N/A	4.23	15.32	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
WS04	1	1.5-3.0	Dry	N/A	2.39	19.35	Superficial
WS04	2	N/A	Dry	N/A	2.50	19.24	N/A
WS04	3	N/A	Dry	N/A	2.50	19.24	N/A
WS04	4	N/A	Dry	N/A	2.50	19.24	N/A
WS04	5	N/A	Dry	N/A	2.49	19.25	N/A
WS04	6	N/A	Dry	N/A	2.50	19.24	N/A
WS04	7	N/A	Dry	N/A	2.12	19.62	N/A
WS04	8	N/A	Dry	N/A	2.11	19.63	N/A
WS05	1	0.5-3.4	3.16	8.90	3.28	8.78	Superficial
WS05	2	N/A	3.00	9.06	3.30	8.76	N/A
WS05	3	N/A	3.06	9.00	3.29	8.77	N/A
WS05	4	N/A	Dry	N/A	3.30	8.76	N/A
WS05	5	N/A	Dry	N/A	3.30	8.76	N/A
WS05	6	N/A	Dry	N/A	3.30	8.76	N/A
WS05	7	N/A	3.19	8.87	3.36	8.70	N/A
WS05	8	N/A	3.23	8.83	3.38	8.68	N/A
WS06	1	3.5-5.0	3.85	9.20	4.78	8.27	Superficial
WS06	2	N/A	3.66	9.39	4.82	8.23	N/A
WS06	3	N/A	3.79	9.26	4.82	8.23	N/A
WS06	4	N/A	4.02	9.03	4.81	8.24	N/A
WS06	5	N/A	4.09	8.96	4.81	8.24	N/A
WS06	6	N/A	4.06	8.99	4.82	8.23	N/A
WS06	7	N/A	3.92	9.13	4.86	8.19	N/A
WS06	8	N/A	3.78	9.27	4.90	8.15	N/A
WS07	1	0.5-2.0	1.19	8.97	2.08	8.08	Superficial
WS07	2	N/A	1.03	9.13	2.18	7.98	N/A
WS07	3	N/A	1.37	8.79	2.20	7.96	N/A
WS07	4	N/A	1.38	8.78	2.20	7.96	N/A
WS07	5	N/A	1.42	8.74	2.19	7.97	N/A
WS07	6	N/A	1.41	8.75	2.20	7.96	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Water mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
WS07	7	N/A	1.23	8.93	2.12	8.04	N/A
WS07	8	N/A	1.06	9.10	2.16	8.00	N/A
WS15	1	1.0-4.0	Dry	N/A	3.91	23.41	Superficial
WS15	2	N/A	Dry	N/A	3.94	23.98	N/A
WS15	3	N/A	Dry	N/A	3.96	23.36	N/A
WS15	4	N/A	Dry	N/A	3.95	23.37	N/A
WS15	5	N/A	Dry	N/A	3.94	23.38	N/A
WS15	6	N/A	Dry	N/A	3.94	23.38	N/A
WS15	7	N/A	Dry	N/A	4.16	23.16	N/A
WS15	8	N/A	Dry	N/A	4.15	23.17	N/A
WS16	1	1.0-2.5	Dry	N/A	2.35	21.01	Superficial
WS16	2	N/A	Dry	N/A	2.38	20.98	N/A
WS16	3	N/A	Dry	N/A	2.38	20.98	N/A
WS16	4	N/A	Dry	N/A	2.41	20.95	N/A
WS16	5	N/A	Dry	N/A	2.39	20.97	N/A
WS16	6	N/A	Dry	N/A	2.41	20.95	N/A
WS16	7	N/A	Dry	N/A	2.56	20.80	N/A
WS16	8	N/A	Dry	N/A	2.45	20.91	N/A
WS18	1	1.5-2.5	Dry	N/A	2.28	32.58	Superficial
WS18	2	N/A	Dry	N/A	2.29	32.57	N/A
WS18	3	N/A	Dry	N/A	2.29	32.57	N/A
WS18	4	N/A	Dry	N/A	2.29	32.57	N/A
WS18	5	N/A	Dry	N/A	2.29	32.57	N/A
WS18	6	N/A	Dry	N/A	2.29	32.57	N/A
WS18	7	N/A	Dry	N/A	2.37	32.49	N/A
WS18	8	N/A	Dry	N/A	2.38	32.48	N/A
WS19	1	3.0-4.0	Dry	N/A	3.67	31.20	Superficial
WS19	2	N/A	Dry	N/A	3.67	31.20	N/A
WS19	3	N/A	Dry	N/A	3.67	31.20	N/A
WS19	4	N/A	Dry	N/A	3.66	31.21	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
WS19	5	N/A	Dry	N/A	3.66	31.21	N/A
WS19	6	N/A	Dry	N/A	3.66	31.21	N/A
WS19	7	N/A	Dry	N/A	3.49	31.38	N/A
WS19	8	N/A	Dry	N/A	3.76	31.11	N/A
WS20	1	2.0-3.0	Dry	N/A	2.87	33.84	Superficial
WS20	2	N/A	Dry	N/A	2.87	33.84	N/A
WS20	3	N/A	Dry	N/A	2.87	33.84	N/A
WS20	4	N/A	Dry	N/A	2.87	33.84	N/A
WS20	5	N/A	Dry	N/A	2.87	33.84	N/A
WS20	6	N/A	Dry	N/A	2.88	33.83	N/A
WS20	7	N/A	Dry	N/A	2.68	34.03	N/A
WS20	8	N/A	Dry	N/A	2.98	33.73	N/A
WS21	1	1.0-3.0	Dry	N/A	2.94	37.13	Superficial
WS21	2	N/A	Dry	N/A	2.94	37.13	N/A
WS21	3	N/A	Dry	N/A	2.94	37.13	N/A
WS21	4	N/A	Dry	N/A	2.94	37.13	N/A
WS21	5	N/A	Dry	N/A	2.94	37.13	N/A
WS21	6	N/A	Dry	N/A	2.94	37.13	N/A
WS21	7	N/A	Dry	N/A	2.91	37.16	N/A
WS21	8	N/A	Dry	N/A	3.03	37.04	N/A
WS22	1	2.0-4.0	Dry	N/A	4.29	46.47	Superficial
WS22	2	N/A	Dry	N/A	3.80	46.96	N/A
WS22	3	N/A	Dry	N/A	3.79	46.97	N/A
WS22	4	N/A	Dry	N/A	3.78	46.98	N/A
WS22	5	N/A	Dry	N/A	3.78	46.98	N/A
WS22	6	N/A	Dry	N/A	3.78	46.98	N/A
WS22	7	N/A	Dry	N/A	3.52	47.24	N/A
WS22	8	N/A	Dry	N/A	3.28	47.48	N/A
WS23	1	2.0-4.0	Dry	N/A	3.23	52.99	Superficial
WS23	2	N/A	Dry	N/A	3.23	52.99	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
WS23	3	N/A	Dry	N/A	3.26	52.96	N/A
WS23	4	N/A	Dry	N/A	3.22	53.00	N/A
WS23	5	N/A	Dry	N/A	3.23	52.99	N/A
WS23	6	N/A	Dry	N/A	3.22	53.00	N/A
WS23	7	N/A	Dry	N/A	3.20	53.02	N/A
WS23	8	N/A	Dry	N/A	3.22	53.00	N/A
WS24	1	2.0-4.0	Dry	N/A	3.36	53.90	Superficial
WS24	2	N/A	Dry	N/A	3.38	53.88	N/A
WS24	3	N/A	Dry	N/A	3.38	53.88	N/A
WS24	4	N/A	Dry	N/A	3.37	53.89	N/A
WS24	5	N/A	Dry	N/A	3.37	53.89	N/A
WS24	6	N/A	Dry	N/A	3.36	53.90	N/A
WS24	7	N/A	Dry	N/A	3.27	53.99	N/A
WS24	8	N/A	Dry	N/A	3.10	54.16	N/A
WS26	1	1.0-4.0	Dry	N/A	2.97	53.15	Superficial
WS26	2	N/A	Dry	N/A	2.97	53.15	N/A
WS26	3	N/A	Dry	N/A	2.96	53.16	N/A
WS26	4	N/A	Dry	N/A	2.96	53.16	N/A
WS26	5	N/A	Dry	N/A	2.96	53.16	N/A
WS26	6	N/A	Dry	N/A	2.96	53.16	N/A
WS26	7	N/A	Dry	N/A	2.69	53.43	N/A
WS26	8	N/A	Dry	N/A	2.47	53.65	N/A
WS28	1	0.75-2.75	Dry	N/A	2.71	52.42	Superficial
WS28	2	N/A	Dry	N/A	2.73	52.40	N/A
WS28	3	N/A	Dry	N/A	2.71	52.42	N/A
WS28	4	N/A	Dry	N/A	2.71	52.42	N/A
WS28	5	N/A	Dry	N/A	2.72	52.41	N/A
WS28	6	N/A	Dry	N/A	2.71	52.42	N/A
WS28	7	N/A	Dry	N/A	2.78	52.35	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Wa-ter mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
WS28	8	N/A	Dry	N/A	2.36	52.77	N/A
WS29	1	3.5-4.5	3.38	39.97	4.33	39.02	Superficial
WS29	2	N/A	2.96	40.39	4.46	38.89	N/A
WS29	3	N/A	3.41	39.94	4.39	38.96	N/A
WS29	4	N/A	3.69	39.66	4.40	38.95	N/A
WS29	5	N/A	4.10	39.28	4.39	38.96	N/A
WS29	6	N/A	4.27	39.08	4.39	38.96	N/A
WS29	7	N/A	3.82	39.53	4.97	38.38	N/A
WS29	8	N/A	3.33	40.02	4.45	38.90	N/A
WS30	1	1.0-5.0	Dry	N/A	3.84	44.13	Superficial
WS30	2	N/A	Dry	N/A	3.89	44.08	N/A
WS30	3	N/A	Dry	N/A	3.82	44.15	N/A
WS30	4	N/A	Dry	N/A	3.89	44.08	N/A
WS30	5	N/A	Dry	N/A	3.82	44.15	N/A
WS30	6	N/A	Dry	N/A	3.82	44.15	N/A
WS30	7	N/A	Dry	N/A	3.89	44.08	N/A
WS30	8	N/A	Dry	N/A	3.55	44.42	N/A
WS31	1	3.3-4.3	3.37	43.74	4.40	42.71	Superficial
WS31	2	N/A	2.96	44.15	4.39	42.72	N/A
WS31	3	N/A	3.32	43.79	4.36	42.75	N/A
WS31	4	N/A	3.60	43.51	4.38	42.73	N/A
WS31	5	N/A	4.10	43.01	4.36	42.75	N/A
WS31	6	N/A	4.28	42.83	4..36	42.75	N/A
WS31	7	N/A	3.27	43.84	4.42	42.69	N/A
WS31	8	N/A	3.61	43.50	4.50	42.61	N/A
WS33	1	1.0-5.0	0.81	49.27	4.61	45.47	Superficial
WS33	2	N/A	0.57	49.51	4.63	45.45	N/A
WS33	3	N/A	1.10	48.98	4.63	45.45	N/A
WS33	4	N/A	1.63	48.45	4.63	45.45	N/A
WS33	5	N/A	3.19	46.89	4.62	45.46	N/A

Monitoring Well	Monitoring Round (R)	Response Zone mbgl	Depth to Water mbgl	Depth to Water mAOD	Depth to Base mbgl	Depth to Base mAOD	Response Zone strata
WS33	6	N/A	3.66	46.42	4.63	45.45	N/A
WS33	7	N/A	1.13	48.95	4.56	45.52	N/A
WS33	8	N/A	0.58	49.50	4.72	45.36	N/A
WS34	1	1.0-2.0	Dry	N/A	1.63	19.42	Superficial
WS34	2	N/A	Dry	N/A	1.65	19.40	N/A
WS34	3	N/A	Dry	N/A	1.65	19.40	N/A
WS34	4	N/A	Dry	N/A	1.65	19.40	N/A
WS34	5	N/A	Dry	N/A	1.64	19.41	N/A
WS34	6	N/A	Dry	N/A	1.65	19.40	N/A
WS34	7	N/A	Dry	N/A	1.20	19.85	N/A
WS34	8	N/A	Dry	N/A	1.21	19.84	N/A
WS40	1	1.0-6.0	Dry	N/A	5.74	33.88	Superficial
WS40	2	N/A	Dry	N/A	5.75	33.87	N/A
WS40	3	N/A	Dry	N/A	5.72	33.90	N/A
WS40	4	N/A	Dry	N/A	5.73	33.89	N/A
WS40	5	N/A	Dry	N/A	5.74	33.88	N/A
WS40	6	N/A	Dry	N/A	5.73	33.89	N/A
WS40	7	N/A	Dry	N/A	5.57	34.05	N/A
WS40	8	N/A	Dry	N/A	5.57	34.05	N/A
WS41	1	1.0-6.0	Dry	N/A	5.69	31.68	Superficial
WS41	2	N/A	Dry	N/A	5.79	31.58	N/A
WS41	3	N/A	Dry	N/A	5.79	31.58	N/A
WS41	4	N/A	Dry	N/A	5.79	31.58	N/A
WS41	5	N/A	Dry	N/A	5.79	31.58	N/A
WS41	6	N/A	Dry	N/A	5.79	31.58	N/A
WS41	7	N/A	Dry	N/A	5.75	31.62	N/A
WS41	8	N/A	Dry	N/A	5.75	31.62	N/A

4.4.9 Laboratory test results from groundwater sampling are presented in Harrison Group Environmental's Factual Ground Investigation Report.

4.5 Ground Gas Monitoring

4.5.1 Four (4) rounds of ground gas monitoring have been undertaken within the Site Boundary on 7th to 10th February, 7th to 9th March, 11th to 14th April and 9th to 11th May 2022. Ground gas monitoring was completed using a calibrated Multi-parameter Gas Analyser GA5000/G50427 with reference to CIRIA C665 and BS 8576:2013 Guidance on Investigations for Ground Gas. A photo ionisation detector (PID) was used to monitor the volatile organic compounds (VOC) and was conducted using a calibrated Tiger Handheld VOC Detector. Monitoring data for the following parameters was gathered from the boreholes:

- VOC (ppm);
- methane (% vol);
- carbon dioxide (% vol);
- oxygen (% vol);
- carbon monoxide (ppm);
- hydrogen sulphide (ppm); and
- flow rate (l/hr).

4.5.2 Gas flow rates were measured at all monitoring boreholes and the contractor recorded the range in flow rates until a steady state was reached. Ground gas monitoring wells are summarised in Section 7 Table 7.1

4.6 Laboratory Analysis

Analytical Rationale

4.6.1 Table 4.5 summarises the analytical schedule for soil and groundwater samples together with the rationale for analysis.

Table 4.5: Summary of Analytical Strategies

Analytical Suite	Rationale	No. of Soil Samples Scheduled	No. of Soil Leachate Samples Scheduled	No. Of Groundwater Samples Scheduled to date
Heavy Metals (including As - Arsenic Ba - Barium Bo - Boron Cd - Cadmium Cu - Copper Cr (III) - Chromium (III) Cr (VI) - Chromium (VI) Pb - Lead Hg - Mercury Ni - Nickel Se - Selenium Sb - Antimony V - Vanadium Zn – Zinc)	Typically associated with a range of industrial uses in high concentrations. May be present in elevated concentrations in historical fill material depending on point of origin. May also occur naturally.	123	34	28
Inorganics (sulphate, ammoniacal nitrogen, total organic carbon (TOC))	Naturally occurring, with elevated concentrations potentially associated with industrial uses. May be present in elevated concentrations in historical fill material depending on point of origin.	123	34	28

Analytical Suite	Rationale	No. of Soil Samples Scheduled	No. of Soil Leachate Samples Scheduled	No. Of Groundwater Samples Scheduled to date
Organics (Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), Benzene, Toluene, Ethylbenzene and Xylenes (BTEX), phenols)	Typically associated with fuels and oils. May be present in elevated concentrations in historical fill material depending on point of origin.	17	34	28
Volatile Organic Compounds (VOCs)	Typically associated with fuels/ oils and with ash deposits. May be present in elevated concentrations in historical fill material depending on point of origin.	6	0	13
Semi-volatile Organic Compounds (SVOCs)	Typically associated with fuels/ oils and with ash deposits. May be present in elevated concentrations in historical fill material depending on point of origin.	6	0	13
Herbicides, Organophosphorus Pesticides (OPP)	Herbicides are commonly applied to agricultural land. Unlikely to be present in significant concentration.	31	0	17

4.7 Data Quality Assurance

4.7.1 The laboratory selected to perform the analysis (i2 Analytical Ltd) is accredited by UKAS to ISO 17025 and MCerts standards. Internal quality assurance checks are carried out by the laboratory data prior to the laboratory certificates being issued.

5 Ground Conditions

5.1 Ground Conditions

5.1.1 The ground conditions encountered during the ground investigation are summarised in Table 5.1. The information provided is a summary of the ground conditions encountered within the Site Boundary and a separate summary for the pavement core logs is provided in Table 5.1a. A full lithological description is recorded on the exploratory hole logs that are provided as part of Harrison Group Environmental's factual report.

Table 5.1: Summary of Ground Conditions

Stratum	**Description**	**Depth to Base (mbgl)[mAOD]**	**Approx. Average Thickness (where encountered) (m)**
Asphalt	Asphalt was recorded at five locations where the exploratory hole was located on a road.	0.02-0.4 [16.42-58.51]	0.02-0.4 on existing roadways across the area of the Site Boundary
Topsoil	Dark brown sandy clay or clayey sand with gravels of flint, sandstone, quartz and chalk. Rare to frequent roots and rootlets.	0.1 – 0.8 [8.30-57.23]	0.2 to 0.5
Made Ground	Dark brown gravelly sand or sandy clay with gravels of flint, coal and brick. Occasional rootlets.	0.04 – 0.55 [15.4-58.54]	0.3 – 0.55
Superficial Deposits	Yellowish brown / orange brown silty gravelly sand or sandy clay. Gravels include flint, chalk, quartz and sandstone. In some instances the sand and clay horizons appeared the be cyclical.	0.5 – 34.9 [-17.04-56.66]	0.2 – 34.5
Chalk bedrock	White chalk with varying degrees of strength and hardness. Silty lenses and sandy horizons, typically in the north-east of the Site Boundary.	2.0 – 60.5 [-51.69-20.05]	Unproven

Table 5.1a: Summary of Ground Conditions of the Pavement Cores

Stratum	Description	Depth to Base (mbgl) [mAOD]	Approx. Average Thickness (where encountered) (m)
Black Surface Dressing	60-75% aggregate fine-grained igneous rock Very low voids.	0.01 [15.79-57.23]	0.01
Asphalt	60% aggregate of grey angular to subangular fine to medium (2mm to 10mm) porous stone.	0.06-0.11 [15.73-57.23]	0.08
Black Macadam	75-80% aggregate of grey and pink angular to sub-rounded fine to medium grained (6mm-20mm) igneous rock. Up to 5% voids (2mm-15mm). Good bond.	0.1-0.57 [15.79-57.23]	0.22
Bitumen	6% aggregate of angular to sub rounded fine to medium (4-13 mm) flint. No voids. Good bond.	0.2 [16.94]	0.2
Concrete	Aggregate of subangular to sub rounded fine to medium flint.	0.14-0.3 [16.84-58.51]	0.2
Sub-base	Pink very sandy silty angular to sub-angular fine to medium gravel of fine-grained igneous	0.13-0.43 [15.86-54.82]	0.32

5.1.2 The ground conditions encountered within the Site Boundary are generally comparable to the geology described in the British Geological Survey (BGS) map of the area with respect to natural ground.

5.1.3 The underlying bedrock is Chalk, which comprises the undifferentiated components of the Lewes Nodular Chalk Formation, the Seaford Chalk Formation, the Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation. Chalk was encountered at 42 locations at depths varying from 2 – 60.5mbgl. There is no obvious trend of depth to the chalk being greater in any particular area within the Site Boundary.

5.1.4 The Chalk is overlain by superficial deposits comprising peat, alluvium and river terrace deposits encountered across the floodplain. The Lowestoft Formation (Glacial Till) was encountered across the area within Site Boundary and was typically found overlying the chalk. Due to the similarities in the till encountered, the glacial deposits have been grouped together as the Lowestoft Formation.

The thickness was found to generally increase towards the A47. The Sheringham Cliffs Formation (granular glacial deposits) were encountered across the area within Site Boundary, with the thickness decreasing towards the A47. The Sheringham Cliffs Formation was typically encountered above the Lowestoft Formation and below the topsoil. Cohesive components of the Sheringham Cliffs Formation were typically found as pockets and lenses of varying thicknesses between the main granular components.

5.1.5 Of the 153 exploratory locations within the Site Boundary, 43 locations encountered the chalk. Of those 43 locations, eight had deposits of clay directly overlying the chalk and an additional three locations were not directly overlain by clay, but had a thickness of clay within 2 m of the top of the chalk. Due to a lower density of deeper boreholes it is not possible to say whether the clay forms a continuous layer in the south west of the Site Boundary extents or whether these are localised pockets of clay. Within the north of the Site Boundary, the borehole logs suggest that the clay is only present in small lenses and not in a continuous layer.

5.2 Groundwater

5.2.1 The depth to resting groundwater level was recorded during the groundwater monitoring rounds. A summary of the groundwater levels throughout the monitoring period is provided in Table 5.2.

Table 5.2: Summary of Groundwater Observations - Alignment Refinement

Monitoring Well	Response zone strata (m bgl)	Surface Elevation (m AOD)	First Round 07/02/2022 10/02/2022	Second Round 07/03/2022 09/03/2022	Third Round 11/04/2022 14/04/2022	Fourth Round 09/05/2022 11/05/2022	Fifth Round 18/07/2022 19/07/2022	Sixth Round 12/09/2022 13/09/2022	Seventh Round 13/02/2023 15/02/2023	Eighth Round 14/03/2023 21/03/2023
BHR29	Chalk (27.0-30.0)	23.48	10.38 [13.10]	10.34 [13.14]	10.46 [13.02]	10.64 [12.84]	11.01 [12.47]	11.40 [12.08]	10.60 [12.88]	10.69 [12.79]
BHR31	Chalk (13.5-14.5)	37.91	Dry	Dry	Dry	Dry	13.99 [23.92]	Dry	Dry	Dry
BHR32	Superficial (29.9-34.9)	54.91	18.51 [36.40]	18.57 [36.34]	18.60 [36.31]	18.61 [36.30]	18.68 [36.23]	18.80 [36.11]	19.03 [35.88]	18.96 [35.95]
BHR33	Chalk (38.0-40.0)	44.17	7.69 [36.48]	7.67 [36.50]	7.70 [36.47]	7.74 [36.43]	7.90 [36.27]	8.04 [36.13]	7.80 [36.37]	7.97 [36.20]
BHR35	Superficial (10.0-12.0)	36.18	-0.55[3] [36.73]	-0.53 [36.71]	-0.53 [36.71]	-0.65 [36.83]	-0.75 [36.93]	-0.59 [36.77]	0.22 [35.96]	0.08 [36.10]
CP04	Superficial (2.0-3.0)	22.90	2.84 [20.06]	2.84 [20.06]	2.84 [20.06]	2.84 [20.06]	Dry	Dry	Dry	Dry
CP12	Superficial (8.5-9.5)	51.68	9.40 [42.28]	9.21 [42.47]	9.31 [42.37]	9.40 [42.28]	9.41 [42.27]	Dry	Dry	9.06 [42.62]
WS05	Superficial (0.5-3.4)	12.06	3.16 [8.90]	3.00 [9.06]	3.06 [9.00]	Dry	Dry	Dry	3.19 [8.87]	3.23 [8.83]
WS06	Superficial (3.5-5.0)	13.05	3.85 [9.20]	3.66 [9.39]	3.79 [9.26]	4.02 [9.03]	4.09 [8.96]	4.06 [8.99]	3.92 [9.13]	3.78 [9.27]

[3] Water sitting in standpipe above ground level in BHR35.

Monitoring Well	Response zone strata (m bgl)	Surface Elevation (m AOD)	First Round 07/02/2022 10/02/2022	Second Round 07/03/2022 09/03/2022	Third Round 11/04/2022 14/04/2022	Fourth Round 09/05/2022 11/05/2022	Fifth Round 18/07/2022 19/07/2022	Sixth Round 12/09/2022 13/09/2022	Seventh Round 13/02/2023 15/02/2023	Eighth Round 14/03/2023 21/03/2023
WS07	Superficial (0.5-2.0)	10.16	1.19 [8.97]	1.03 [9.13]	1.37 [8.79]	1.38 [8.78]	1.42 [8.74]	1.41 [8.75]	1.23 [8.93]	1.06 [9.10]
WS29	Superficial (3.5-4.5)	43.35	3.38 [39.97]	2.96 [40.39]	3.41 [39.94]	3.69 [39.66]	4.10 [39.28]	4.27 [38.96]	3.82 [39.53]	3.33 [40.02]
WS31	Superficial (3.3-4.3)	47.11	3.37 [43.74]	2.96 [44.15]	3.32 [43.79]	3.60 [43.51]	4.10 [43.01]	4.28 [42.83]	3.27 [43.84]	3.61 [43.50]
WS33	Superficial (1.0-5.0)	50.08	0.81 [49.27]	0.57 [49.51]	1.10 [48.98]	1.63 [48.45]	3.19 [46.89]	3.66 [46.42]	1.13 [48.95]	0.58 [49.50]

Notes: Depth to groundwater level given in mbgl, reduced levels in brackets as metres above Ordnance Datum (m AOD)

5.2.2 Table 5.2 shows the monitoring results during eight (8) rounds of groundwater level monitoring. Only thirteen (13) of the 45 installed monitoring wells had groundwater present. The remainder of the monitoring wells were found to be dry during all eight (8) monitoring rounds.

5.2.3 Three of the water bearing wells were installed in the chalk (BHR29, BHR31 and BHR33) and the remainder of the wells were installed in the superficial deposits. Groundwater levels in the chalk varied from 12.08 to 36.50 m AOD. Groundwater levels in BHR29 ranged from 12.04 – 13.14 m AOD and levels in BH33 ranged from 36.13 – 36.5 over the eight (8) monitoring rounds. Groundwater was observed in BHR31 in one monitoring round at 13.99 m AOD; only minimal amounts of groundwater was observed (3 cm in the base of the well). Given the lack of monitoring wells in the chalk producing groundwater, it is not possible to determine an accurate groundwater direction. However, given these three data points, it suggests the groundwater within the chalk is flowing to the north-east. This would be expected, as the groundwater is likely to flow towards the River Wensum within the north of the Site Boundary.

5.2.4 Ten monitoring wells were installed in the superficial deposits and groundwater levels ranged from 8.74 – 49.51 m AOD. Groundwater levels suggests that there is a general flow towards the north-east. Again, this is likely to represent the flow towards the River Wensum. The lack of water in many of the monitoring wells and the presence of a variety of granular and cohesive material within the superficial deposits may indicate that the groundwater is not continuous within the various water bearing strata present within the superficial deposits.

5.2.5 Given the absence of any aquitards between the granular superficial deposits and the chalk aquifer at many locations it is considered likely that groundwater is continuous between the superficial deposits and bedrock strata. Perched water may still be present within the superficial deposits above any layers of low permeability soils, but these are unlikely to present a separate groundwater body.

5.3 Field Evidence of Contamination

5.3.1 The section below summarises visual and olfactory evidence of contamination encountered throughout the ground investigation.

Soil

5.3.2 Generally, soil samples across the extents of the Site Boundary did not show evidence of visual and olfactory contamination. A summary of Photo-Ionisation Detector (PID) readings (where VOC concentrations were recorded above the average within the Site Boundary) is presented as Table 5.3 below.

Table 5.3: Summary of Visual/ Olfactory/ PID Evidence of Contamination

Monitoring Well	Depth to base (mbgl)	Visual Evidence	Olfactory Evidence	Max PID Concentration 07/02/22 -10/02/22	Max PID Concentration 07/03/22 – 09/03/22	Max PID Concentration 11/04/22 14/04/2022	Max PID Concentration 09/05/2022- 11/05/2022
BHR29	29.28-29.48	None recorded	None recorded	0.5ppm	2.3ppm	0.6ppm	0.7ppm
CP02	5.56-5.59	None recorded	None recorded	0.8ppm	1.0ppm	2.0ppm	<0.1ppm
WS29	4.33-4.49	None recorded	None recorded	1.3ppm	2.1ppm	1.3ppm	2.1ppm
WS31	4.36-4.40	None recorded	None recorded	1.3ppm	1.7ppm	0.9ppm	1.6ppm
WS33	4.61-4.63	None recorded	None recorded	1.3ppm	1.8ppm	0.2ppm	0.4ppm

5.3.3 The PID results displayed in Table 5.3 were the most elevated concentrations recorded across the Site Boundary extents which, given the absence of any visual and olfactory evidence, are anticipated to be localised areas of limited impact and not of any significance.

Groundwater

5.3.4 No visual or olfactory evidence of groundwater contamination, such as odours or the detection of light non-aqueous phase liquids (LNAPL) or dense non-aqueous phase liquids (DNAPL) was recorded during the groundwater monitoring visits.

6 Ground Contamination – Generic Quantitative Risk Assessment

6.1 Introduction

6.1.1 The results of the contamination testing from the additional investigation have been screened against the following generic assessment criteria (GAC) to allow for the interpretation of soil and groundwater chemical analyses:

Human Health

- Following the withdrawal of the Soil Guideline Values (SGVs) and in the absence of an industry-wide, accepted set of GAC, it is down to individual practitioners to derive their own soil assessment criteria for human health. On this basis Norfolk County Council prepared a set of GAC for use on this project.
- Norfolk County Council prepared the criteria using the approach provided within DEFRA's SR2, SR3, SP1010, CLEA Workbook v1.071 and SR47 guidance documents to produce a set of minimal risk GACs. The chemical-specific data within two key publications were considered during their production: CL:AIRE 20108 and LQM 20159.
- The criteria has been developed to ensure the re-use of excavated materials does not represent a potential human health risk to future users of the public open space area. Limited values have been generated using CLEA v1.06 assuming a public open space exposure scenario that considers female children between 0-6 years old as the most sensitive receptor with an exposure frequency defined by 78 days/year (25 days/year for ages 0-1 years old) with a 3-hour daily exposure.
- Soil Organic Matter (SOM) of 1% was used for conservatism.
- It is to be noted that all re-use criteria values are subject to consultation and agreement with the relevant statutory bodies and shall be treated as draft until written confirmation of their acceptance has been received.

Water Quality

- The Proposed Scheme is located with a Source Protection Zone 3 for total catchment. The River Wensum and other unnamed water features are also present within the Site Boundary and within close proximity of the Site Boundary. For these reasons, Norfolk County Council directed that groundwater and soil leachate samples are to be assessed using

the Drinking Water Standards (DWS) and Environmental Quality Standards (EQS) for fresh water.

Ground Gas

- As the Proposed Scheme comprises a road scheme, it is not considered appropriate to derive gas screening values to determine a 'characteristic situation' for gas in accordance with BS8485:2015+A1:2019 , as this guidance is based on considering risks to buildings.
- Instead, the results of the ground gas monitoring have been assessed using guidance provided in the Health and Safety Workplace Exposure Limits HSE EH40/2005 to consider the risk to workers in confined spaces. The methane concentrations have also been assessed against the lower explosive limit (LEL) and upper explosive limit (UEL).

6.1.2 The assessment criteria outlined above for human health and water quality have been used to provide an initial screen of chemical results from the soil, soil leachate, groundwater and ground gas monitoring. The findings from the assessment are shown below. Further details relating to the legislative context and methodologies are presented in Appendix A.

6.2 Human Health Assessment

Soil Screening Results

6.2.1 The soil laboratory test results and soil screening assessment are presented as part of Harrison Group Environmental's factual report.

6.2.2 A total of 123 soil samples were tested for a suite of determinands selected based on the Site Boundary extent's historical and contemporary uses (as detailed in Table 4.4). This comprised twenty-five (25) samples taken from pavement cores, six (6) samples of Made Ground (excluding the pavement cores) 56 samples from the superficial deposits (42 from sand layers, 11 from clay layers, two (2) from silt layers and one from gravel horizons), twenty-nine (29) samples of topsoil, two (2) peat samples , and five (5) chalk samples. The chemical concentrations were screened against the Norfolk County Council's GAC.

6.2.3 Metals were recorded above the limit of detection in all locations across the extents of the Site Boundary, however, none were above Norfolk County Council's GACs (based on public open spaces). Similarly, PAHs were detected at locations across the extents of the Site Boundary but not above Norfolk County Council 's GACs in the majority of samples. All exceedances were from the pavement core samples and are discussed below.

6.2.4 The pH range for the samples (excluding the pavement cores) varied from 5.6 – 9.7, with the average measuring 7.9. Total organic carbon was measured in all samples with the exception of the pavement cores. The concentration varied from 0.1 to 6.4 %, and the average was 0.66% which is in line with the assumption that SOM should be measured for 1%.

6.2.5 Total petroleum hydrocarbons (tested using the TPH-CWG methodology) were analysed in 18 samples. TPH fractions were measured below the detection limit with the exception of Aromatic (EC21-EC35) in WS02 at 0.2 m bgl, where the concentration was measured to be 11 mg/kg. The concentrations is below the Norfolk County Council's GAC. Benzene, toluene, ethylbenzene and xylene (BTEX) were measured in the same 18 samples, and all concentrations were below the detection limit.

6.2.6 VOCs and SVOCs were analysed in six samples from the Made Ground, topsoil and shallow superficial deposits. None exceeded the method detection limit. with the exception of SVOCs in WS02 (0.2 m). The SVOCs that exceeded the method detection limit were PAHs and in line with the speciated PAH concentrations. None exceeded the Norfolk County Council GACs.

6.2.7 Pesticides and acid herbicides were analysed in 31 samples from the shallow strata (<0.9 m bgl). An additional herbicide suite was analysed in two samples from the topsoil. All concentrations were below the method detection limit with the exception of Pendimethalin, which was noted at five (5) locations above the level of detection of 10µg/kg, as listed below:

- WS18 (11µg/kg at 0.2m),
- WS20 (22µg/kg at 0.2m),
- WS22 (18µg/kg at 0.2m),
- TP27 (13µg/kg at 0.2m) and
- CP02 (23µg/kg at 0.1m)

6.2.8 Twenty-five (25) samples were collected from the pavement cores on existing public highways within the Site Boundary. The samples from the pavement cores were analysed for phenol and PAHs only.

6.2.9 Norfolk County Council's GACs did not include phenol, however a review of the data against The Applicant derived GAC for phenol for a public open space end use scenario (380 mg/kg) confirms that none of the samples exceed the criteria.

6.2.10 Of the sixteen (16) EPA PAHs, only benzo(a)pyrene and naphthalene are included in Norfolk County Council's list of GACs. Ten (10) of the pavement cores exceeded Norfolk County Council GAC for benzo(a)pyrene, as shown in Table

6.1 below. The concentrations of naphthalene were all below Norfolk County Council 's GAC.

6.2.11 The remaining EPA PAHs were compared against Norfolk County Council's Public Open Space GACs and no exceedances were recorded.

Table 6.1: Summary of the PAH concentrations in the pavement cores

Contaminant	No of Samples Exceeding the GAC	GAC (mg/kg)	Min (mg/kg)	Max (mg/kg)	Distribution Comment (for Locations see Figure 2)
Benzo(a) pyrene*	10	11	<0.05	1,400	All ten exceedances were recorded in the pavement cores. Lowest exceedance was 55 mg/kg at PC-002 (0.00-0.03mbgl) and the highest exceedance was 1,400 mg/kg at PC-020 (0.01-0.04mbgl).
Naphthalene	0	1240	<0.05	1,100	Maximum recorded at PC-020 (0.01-0.04mbgl).

6.2.12 It is noted that cyanide was not analysed in soil samples during this investigation and will be included in subsequent investigation works.

Asbestos

6.2.13 No visible fragments of potential asbestos-containing materials were observed during the ground investigation.

6.2.14 Of the 123 soil samples subjected to chemical testing and analysis, eight samples from the Made Ground, topsoil, and shallow superficial deposits were screened for the presence of asbestos. None of them recorded the presence of any identifiable levels of asbestos.

6.2.15 It is noted that while no asbestos was detected in the samples subjected to analysis, there is the potential for asbestos to be identified elsewhere within the Site Boundary in locations not targeted by the ground investigation. However, given the testing and site history, the likelihood of soils being contaminated by asbestos is considered to be low.

6.3 Soil Leachate Assessment

Methodology

6.3.1 Leachate testing is undertaken on soil samples in the laboratory by vigorous mixing of soil and water to ascertain the degree to which contaminants in soil may leach into the dissolved phase. The process represents a 'worst case' scenario as the vigorous laboratory process would not be expected to be replicated on site either during construction or operation of the Proposed Scheme. As such, the leachate testing results generally provide an over estimation of the true leachability of contaminants in soils. The exception is for volatile substances, which may volatilise and be lost during the leachate preparation process, as such leachate results for VOCs should be treated with caution.

Leachate Screening Results

6.3.2 Leachate preparation and testing has been completed on 34 soil samples. The samples include 16 from the pavement cores and one other sample from the Made Ground. There is one sample of topsoil, two from peat horizons, two from the chalk and a total of 12 from the superficial (made up of five clay, five sand, one silt and one gravel sample). Samples were selected for testing based upon those with higher concentrations of substances identified in soils to establish a worst-case leachate scenario. Samples were tested for heavy metals, inorganics (including ammoniacal nitrogen, chloride and nitrate), TPH, PAH, and phenols.

6.3.3 The GACs used for soil leachate are a combination of the DWS and EQS as described in Section 6.1.1. Details on the exceedances of the DWS or EQS in the soil leachate samples are summarised in Table 6.2. The results of soil leachate testing and the soil leachate data assessment are detailed in Harrison Group Environmental's factual report.

Table 6.2: Summary of Soil Leachate Exceedances

Substance	Units	EQS criteria	DWS	Discussion	Location of Exceedances (m bgl)
Arsenic	mg/l	0.05	0.01	Two (2) samples exceed the DWS. No EQS exceedances.	0.012 mg/l at CP13A (1.00) 0.012 mg/l at BHR14 (0.5)

Substance	Units	EQS criteria	DWS	Discussion	Location of Exceedances (m bgl)
Copper	mg/l	0.001	2	Fourteen (14) samples exceed the EQS with the maximum at TP04. No DWS exceedances.	0.0038 mg/l at WS29 (0.5) 0.0019 mg/l at TP50 (3.0) 0.0075 mg/l at CP13A (0.5) 0.0053 mg/l at BHR12 (0.7) 0.0064 mg/l at BHR14 (0.5) 0.0041 mg/l at WS12 (1.9-2.0) 0.0055 mg/l at BHR17 (1.) 0.0013 mg/l at TP25 (0.5) 0.007 mg/l at BHR19 (1.0) 0.004 mg/l at WS10 (1.0-1.3) 0.0064 mg/l at WS11 (0.4-0.7) 0.011 mg/l at TP04 (0.2) 0.0064 mg/l at TP27 (0.2) 0.0067 mg/l at BHR15 (1.0)
Lead	mg/l	0.0012	0.01	Six (6) samples exceed the EQS with the maximum at 0.0052 mg/l at TP04. No DWS exceedances.	0.0015 mg/l at TP50 (3.0) 0.003 mg/l at CP13A (3.0) 0.0028 mg/l at WS23 (2.7-3.0) 0.0052 mg/l at TP04 (0.2) 0.0039 mg/l at TP27 (0.2) 0.0036 mg/l at BHR15 (1.0)

Substance	Units	EQS criteria	DWS	Discussion	Location of Exceedances (m bgl)
Nickel	mg/l	0.004	0.02	Thirteen (13) samples exceed the EQS with the maximum recorded at 0.015 mg/l at CP13A. No DWS exceedances.	0.0045 mg/l at TP43 (2.0) 0.0051 mg/l at WS29 (5.0) 0.0049 mg/l at TP50 (3.0) 0.015 mg/l at CP13A (0.5) 0.0045 mg/l at BHR14 (0.5) 0.0066 mg/l at BHR17 (6.6) 0.0047 mg/l at WS23 (2.7-3.0) 0.0049 mg/l at BHR19 (1.0) 0.0043 mg/l at WS10 (1.0-1.3) 0.0045 mg/l at WS11 (0.4-0.7) 0.0067 mg/l at TP04 (0.2) 0.0064 mg/l at TP27 (0.2) 0.0058 mg/l at BHR15 (1.0)
Zinc	mg/l	0.0129	-	Two (2) samples exceed the EQS with the maximum recorded at CP13A. No DWS exceedances.	0.018 mg/l at CP13A (0.5) 0.013 mg/l at BHR19 (1.0)

Substance	Units	EQS criteria	DWS	Discussion	Location of Exceedances (m bgl)
Naphthalene	µg/l	2	N/A	Nine (9) samples exceed the EQS for naphthalene. All samples are from the Pavement Core samples. The maximum was 700 µg/l at PC-017.	200 µg/l at PC-011 (0.0-0.03) 11 µg/l at PC-011 (0.04-0.07) 11 µg/l at PC-013 (0.01-0.06) 540 µg/l at PC-016 (0.02-0.1) 640 µg/l at PC-017 (0.02-0.08) 700 µg/l at PC-017 (0.08-0.1) 440 µg/l at PC-018 (0.03-0.1) 590 µg/l at PC-018 (0.1-0.13) 540 µg/l at PC-019 (0.05-0.1)
Anthracene	µg/l	0.00001	N/A	Eight (8) samples exceed the EQS for anthracene. All samples are from the Pavement Cores. The maximum was 28 µg/l	14 µg/l at PC-011 (0.0-0.03) 16 µg/l at PC-011 (0.04-0.07) 28 µg/l at PC-016 (0.02-0.1) 20 µg/l at PC-017 (0.02-0.08) 16 µg/l at PC-017 (0.08-0.1) 18 µg/l at PC-018 (0.03-0.1) 20 µg/l at PC-018 (0.1-0.13) 10 µg/l at PC-019 (0.05-0.1)

Substance	Units	EQS criteria	DWS	Discussion	Location of Exceedances (m bgl)
Fluoranthene	µg/l	0.0063	-	Nine (9) samples exceeded the EQS for fluoranthene. All samples are from the Pavement cores. The maximum is 11 µg/l at PC-018.	2.6 µg/l at PC-011 (0.0-0.03) 5.8 µg/l at PC-011 (0.04-0.07) 0.28 µg/l at PC-013 (0.01-0.06) 10 µg/l at PC-016 (0.02-0.1) 9.3 µg/l at PC-017 (0.02-0.08) 5.9 µg/l at PC-017 (0.08-0.1) 8.7 µg/l at PC-018 (0.03-0.1) 11 µg/l at PC-018 (0.1-0.13) 3.8 µg/l at PC-019 (0.05-0.1)
Benzo(a)pyrene	µg/l	N/A	0.01	Three (3) samples exceed the DWS for benzo(a)pyrene. All samples are from the pavement cores. The maximum is 0.91 µg/l at PC-018.	0.34 µg/l at PC-016 (0.02-0.1) 0.35 µg/l at PC-017 (0.02-0.08) 0.91 µg/l at PC-018 (0.1-0.13)
Sum of 4 PAH*	µg/l	N/A	0.1	One sample exceeds the sum of PAHs at PC-018.	2.35 µg/l at PC-018 (0.1-0.13)

*includes benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and dibenz(a,h)anthracene

6.3.4 Only two (2) leachate samples recorded concentrations in excess of the DWS criteria. These were at BHR14 and CP13A for arsenic (DWS of 0.01mg/l). However, this is only a marginal exceedance (defined as less than ten times the DWS value).

6.3.5 The exceedances of the EQS standard were noted for copper, lead, nickel and zinc in several locations, however, was most frequently recorded at TP04 and CP13A. With the exception of the result of 0.011mg/l for leachable copper at TP04, the exceedances are considered to be marginal. It should also be noted

that the process of extracting leachate from the soils in the laboratory is not considered likely to represent conditions on-site.

6.3.6 All the Norfolk County Council specified GACs for PAHs have exceedances, which are shown in Table 6.2 above. All exceedances are from the Pavement Cores. Of the sixteen leachate samples from the Pavement Cores, at least one PAH exceedance is recorded in nine samples. It is noted that the process for extracting soil leachate is vigorous and is unlikely to represent conditions on-site. Further discussion of the Pavement Cores is included in Section 9.

6.4 Controlled Waters Assessment

Methodology

6.4.1 Norfolk County Council specified GAC for controlled waters have been selected to assess potential risks to the identified environmental receptors which includes:

- Superficial Alluvium, Head Deposits (Secondary B Aquifer);
- River Terrace Deposits, Sheringham Cliffs Formation (Secondary A Aquifer);
- Lowestoft Formation (Secondary Undifferentiated Aquifer);
- Bedrock geology of Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation (Principal Aquifer); and
- River Wensum and various unidentified surface water features.

6.4.2 Three (3) groundwater sampling rounds have been completed on 7th – 10th February 2022, 13th to 15th February 2023 and 14th to 21st of March 2023. In total, 26 samples have been collected and analysed by the laboratory. All samples were obtained from monitoring wells with response zones in different geologies (see Table 6.3 for the response zones).

6.4.3 Samples were tested for metals, inorganics (including ammoniacal nitrogen, chloride and nitrate), total petroleum hydrocarbons, PAH, VOCs, SVOCs, phenols, herbicides and organophosphorus pesticides. Of the 45 monitoring wells installed across the extents of the Site Boundary, only twelve (12) had water present during the first monitoring round. The response zones of the groundwater monitoring wells with water are shown in Table 4.4.

Groundwater Screening Results

6.4.4 Table 6.3 identifies the contaminants in groundwater which were found to exceed the DWS and EQS.

Table 6.3: Summary of Groundwater Exceedances of GAC

Substance	EQS (mg/l)	DWS (mg/l)	Concentration of Exceedance and Location	Discussion
pH	6.5-10	6.5-10	12.2-12.5 at BHR35 during all three rounds	The water in BHR35 recorded pH outside the range stated in the EQS and DWS. BHR35 is screened within the superficial and chalk deposits.
Total Cyanide	0.001	0.05	0.014-0.069 mg/l in BHR33, BHR35, CP12, WS29 and WS31	Cyanide exceeded the EQS in five samples collected during the third monitoring round. One of these samples (from CP12) also exceeded the DWS. The exceedances were from wells screened in the chalk and the superficial deposits.
Sulphate as SO_4	N/A	25	30.7-134 mg/l in BHR29, BHR32, BHR35, WS06, WS07, WS33 and CP12	Exceedances of the DWS for sulphate were noted in wells which were screened in both the superficial deposits and the chalk.
Ammoniacal Nitrogen as N	0.6	0.389	6.2-6.9 mg/l in BHR35	Exceedances of the DWS and the EQS were measured at BHR35 during monitoring rounds 2 and 3. BHR35 is screened within the superficial and chalk deposits.
Arsenic	50	10	13.4 - 14 mg/l at BHR35	The DWS was exceeded for arsenic at one location. 13.4 mg/l and 14 mg/l was measured in rounds 2 and 3, respectively at BHR35. BHR35 is screened within the superficial and chalk deposits.
Cadmium	0.00025	0.005	0.00027 mg/l at BH35	BHR35 exceeded the EQS during the first monitoring round. No DWS exceedance was noted duirng any monitoring rounds. BHR35 is screened within the superficial deposits.

Substance	EQS (mg/l)	DWS (mg/l)	Concentration of Exceedance and Location	Discussion
Copper	0.001	2	From 0.0011mg/l to 0.0086 mg/l in all monitoring wells	20 of 22 samples exceed the EQS. No DWS exceedances. The exceedances were from wells screened in the chalk and the superficial deposits.
Lead	0.0012	0.01	0.0014mg/l at BHR35	One sample (1) exceeds at BHR35 during the first monitoring round. No DWS exceedances were recorded. BHR35 is screened within the superficial and chalk deposits.
Mercury	0.000007	0.01	The only detectable concentrations were noted between 0.00021 - 0.00025 mg/l at BHR35	Concentrations above the limit of detection were noted during all three monitoring rounds at BHR35. No exceedances of DWS. BHR35 is screened within the superficial deposits.
Nickel	0.004	0.02	0.026 – 0.056 mg/l at BHR35	Exceedances of both DWS and EQS in BHR35 during all three rounds. BHR35 is screened within the superficial deposits.
Zinc	0.0129	N/A (not applicable)	0.014 – 0.091 at WS33, BHR29, BHR32 and BHR33.	Two (2) exceedances of the EQS were noted in BHR32 and BHR33 in the first monitoring round. BHR29 noted an exceedance of the EQS during the third monitoring round. WS33 noted exceedances of the EQS during the second and third monitoring rounds. BHR29 and BHR32 are screened within the chalk and BHR33 and WS33 are screened within the superficial deposits.
TPH-CWG Aromatic >C10-C12	0.002	0.9	0.072 mg/l at BHR35	One (1) exceedance of the EQS in BHR35 during the first monitoring round. BHR35 is screened within the superficial deposits

Substance	EQS (mg/l)	DWS (mg/l)	Concentration of Exceedance and Location	Discussion
TPH-CWG Aromatic >C12-C16	0.0001	0.9	The only detectable concentration was 0.045 mg/l at BHR35	One (1) exceedance of the EQS in BHR35 during the first monitoring round. BHR35 is screened within the superficial deposits.

6.4.5 Metals including cadmium, copper, lead, mercury, nickel and zinc exceed the EQS. Arsenic and nickel exceed the DWS value. Only nickel exceeds both the EQS and DWS. The majority of the exceedances are marginal (i.e. less than one order of magnitude), with the exception of mercury and nickel. The majority of exceedances are noted at BHR35, which is screened in the superficial and chalk deposits.

6.4.6 Cyanide exceeded the EQS in five samples, all of which were collected during the third monitoring round. One of the samples from CP12 also exceeded the DWS for cyanide. Sulphate as SO_4 was noted to be above the DWS at several locations across the extents of the Site Boundary. Ammoniacal nitrogen as N was found to exceed the DWS and EQS in BHR35 during the second and third monitoring round.

6.4.7 Two aromatic TPH fractions (C10-C12 and C12-C16) exceed the EQS, both are located in BHR35 and were recorded during the first monitoring round. No further exceedances were noted during the second and third monitoring round. The DWS for aromatic and aliphatic TPH was not exceeded in any samples.

6.4.8 Thirteen (13) samples were analysed for VOC and SVOCs. None of the results were measured above the detection limit.

6.4.9 Seventeen (17) samples were analysed for pesticides and herbicides, including organochlorine pesticides, organophosphorus pesticides and organonitrogen pesticides. None of the samples tested had concentrations above the method detection limit with the exception of pendimethalin recorded at CP12 during the third round of groundwater monitoring. The concentration was a small amount over the detection limit, measuring 0.04 µg/l compared to a detection limit of <0.03 µg/l. The exceedance is minimal and localised.

6.4.10 It should be noted that the laboratory detection limits for the following determinands were above the EQS values:

- Anthracene;
- Fluoranthene;
- Mercury;

- TPH-CWG Aromatic >C10-C12;
- TPH-CWG Aromatic >C12-C16;
- TPH-CWG Aromatic >C16-C21; and
- TPH-CWG Aromatic >C21-C35.

6.4.11 It should also be noted that testing for cyanide, sulphur as SO4 and ammoniacal nitrogen as N were not analysed for during the first round.

Controlled Waters Summary

6.4.12 The pH of the water in BHR35 was recorded to be alkali, outside the acceptable range for both the EQS and DWS during both rounds of sampling. Cyanide exceeded the EQS in five samples, all of which were collected during the third monitoring round. One of the samples from CP12 also exceeded the DWS for cyanide. Sulphate as SO_4 was noted to be above the DWS at several locations across the extents of the Site Boundary. Ammoniacal nitrogen as N was found to exceed the DWS and EQS in BHR during the second and third monitoring round.

6.4.13 The arsenic and nickel concentrations also exceeded the DWS in BHR35 during more than one round. No other DWS exceedances were recorded during the three groundwater monitoring rounds. Concentrations above the EQS were recorded for metals in all three sampling rounds and aromatic TPH fractions in the first sampling round, with the majority of the exceedances in BHR35. Given the repeated exceedances at BHR35 it is suggested that the contamination is localised and is not present elsewhere within the Site Boundary (i.e. in a contaminant plume) over the period of the three sampling rounds.

6.4.14 Pendimethalin was recorded in one location during the third round of groundwater monitoring at location CP12. The concentration was a small amount over the detection limit, measuring 0.04 µg/l compared to a detection limit of <0.03 µg/l. The exceedance is minimal and localised.

7 Ground Gas Risk Assessment

7.1 Background

7.1.1 The results of the gas monitoring have been assessed using guidance provided in the Health and Safety Executive Workplace Exposure Limits HSE EH40/2005[4]. to consider the risks to workers in confined spaces. The lower explosive limit (LEL) and upper explosive limit (UEL) have also been considered for methane.

7.1.2 As the Proposed Scheme comprises a road it is not considered appropriate to derive a gas screening value to determine the 'characteristic situation' for gas in accordance with BS8485:2015+A1:2019 as this guidance is based on considering risks to new buildings.

7.2 Ground Gas Data

7.2.1 Results from the four (4) rounds of ground gas monitoring undertaken on the 7th to 10th February, 7th to 9th March, 11th to 14th April and 9th to 11th May 2022 have been summarised in the following table for wells installed during the ground investigation. The monitoring sheets are presented in Harrison Group Environmental's factual report.

7.2.2 All rounds of ground gas monitoring were completed under high pressure conditions, with the falling pressure conditions in the 48hrs prior to the March, April and May monitoring rounds and relatively steady pressures in the 48hrs prior to the February monitoring round.

7.2.3 Thirty-eight (38) locations were monitored during the gas monitoring rounds. Of these locations, four (4) were flooded (where the presence of groundwater was noted within the screened section of the well) during various rounds, and the data is unlikely to be representative of the ground gas regime. The monitoring wells at locations BHR29, BHR32, BHR33 and BHR35 had groundwater that completely covered the screened response zone, preventing ground gas from entering the well. BHR32 and BHR35 are screened within the superficial deposits and BHR29 and BHR33 are screened in the chalk.

7.2.4 As the Proposed Scheme comprises a road, gases generated from groundwater are not considered to present a risk to current or future users. Drainage and service routes may have the potential to form preferential pathways for ground gas migration and should be considered as enclosed spaces presenting a risk

[4] HSE (2020) EH40/2005 Workplace Exposure Limits

to maintenance workers. Excavations undertaken by maintenance workers could also become confined spaces.

Flow Rates

7.2.5 The flow rates were all recorded at 0.0 (l/hr) in all monitoring wells with the exception of the following (recorded at a steady state):

- BHR35 at 0.2 l/hr (10th February 2022);
- CP03 at -0.1 l/hr (9th March and 13th April 2022);
- CP08 at 0.8 l/hr (7th March 2022) and 0.2 l/hr (9th May 2022);
- CP12 at -0.1 l/hr (10th February 2022), 0.1 l/hr (7th March, 11th April and 9th May 2022);
- WS05 at 0.1 l/hr (11th May 2022);
- WS23 at 0.1 l/hr (7th February and (9th May 2022);
- WS24 at -0.1 l/hr (11th April 2022); and
- WS34 and WS41 at -0.1 l/hr (9th March 2022).

Hydrogen Sulphide

7.2.6 The results obtained for hydrogen sulphide were below detection limits (<1ppm) in all of the four (4) monitoring rounds with the exception of CP02 on 13th April 2022, when hydrogen sulphide was recorded at 1ppm at peak and steady state.

Carbon Monoxide

7.2.7 The results obtained for carbon monoxide were below detection limits (<1ppm) in all four (4) rounds of monitoring with the exception of those stated in Table 7.1 below (recorded at steady flow rates):

Table 7.1: Summary of Carbon Monoxide concentrations above detection level.

Well ID	Screened strata	Carbon Monoxide (ppm)	Steady Flow rate (l/hr)	Date of Monitoring Round
BHR29	Chalk	8 2 1	0.0 0.0 0.0	8th March 2022 12th April 2022 10th May 2022
BHR30	Superficial	1 1 2	0.0 0.0 0.0	8th March 2022 12th April 2022 10th May 2022

Well ID	Screened strata	Carbon Monoxide (ppm)	Steady Flow rate (l/hr)	Date of Monitoring Round
BHR32	Superficial	6 8 21 17	0.0 0.0 0.0 0.0	8th February 2022 8th March 2022 11th April 2022 10th May 2022
BHR33	Chalk	1 1 1	0.0 0.0 0.0	7th February 2022 11th April 2022 9th May 2022
BHR34	Superficial	1	0.0	9th May 2022
CP02	Superficial	1 72 170 12	0.0 0.0 0.0 0.0	7th February 2022 9th March 2022 13th April 2022 11th May 2022
CP07	Superficial	19 1 3	0.0 0.0 0.0	8th February 2022 7th March 2022 9th May 2022
CP08	Superficial	6 6 3 5	0.0 0.8 0.0 0.2	8th February 2022 7th March 2022 11th April 2022 9th May 2022
CP12	Superficial	1	-0.1	10th February 2022
WS04	Superficial	15 2	0.0 0.0	7th February 2022 13th April 2022
WS06	Superficial	1 2	0.0 0.0	14th April 2022 11th May 2022
WS07	Superficial	2 1 2	0.0 0.0 0.0	9th February 2022 14th April 2022 11th May 2022
WS29	Superficial	2 3 1	0.0 0.0 0.0	9th February 2022 7th March 2022 9th May 2022
WS31	Superficial	1	0.0	9th May 2022

Methane

7.2.8 The methane concentration ranged between below detection limits (<1%) and 0.1% in all boreholes with the exception of CP12 at 0.4% at a steady flow rate on the 10th February 2022.

7.2.9 Carbon Dioxide

7.2.10 Carbon dioxide steady state concentrations ranged between below detection limits (<0.1%) to the highest concentration recorded in WS16 at 2.8% at steady and peak concentrations on the 12th April 2022.

Oxygen

7.2.11 Oxygen steady rate concentrations ranged between the lowest recorded at 17.1% at WS16 on the 12th April 2022 and the highest concentration recorded at 22.6% at WS16 on the 7th February 2022.

Workplace Exposure Assessment

7.2.12 The gas monitoring results for carbon dioxide, methane (including LEL and UEL), carbon monoxide and hydrogen sulphide have been assessed against the short term and long-term workplace exposure limits as indicated by the Health and Safety Executive in Workplace Exposure Limits EH40/2005. The results of this assessment are summarised in Table 7.2.

Table 7.2: Summary of Gas Monitoring Assessment

Substance	Long Term Workplace Exposure Limit (8-hour TWA reference Period) (ppm)	Short Term Workplace Exposure Limit (15-minute reference Period) (ppm)	LEL/ UEL (%)	No. of wells with Long Term Exceedances	No. of Wells with Short Term Exceedances	Peak Concentration
Carbon Monoxide	30 (0.003%)	200 (0.02%)	N/A	1	0	72 and 170ppm at CP02 (9th March 2022 and 13th April 2022)
Hydrogen Sulphide	5	10	N/A	0	0	1ppm at CP02 (13th April 2022)
Carbon Dioxide	5000 (0.5%)	15000 (1.5%)	N/A	38	38	2.8% at WS16 (12th April 2022)

Substance	Long Term Workplace Exposure Limit (8-hour TWA reference Period) (ppm)	Short Term Workplace Exposure Limit (15-minute reference Period) (ppm)	LEL/ UEL (%)	No. of wells with Long Term Exceedances	No. of Wells with Short Term Exceedances	Peak Concentration
Methane	N/A	N/A	>5 / >17	0	0	0.4% at CP12 (10th February 2022)

Note: TWA = time-weighted average

7.2.13 Methane concentrations did not fall between the LEL and UEL at any location, and therefore did not fall within the explosion limit. It should be noted that the ground gas data was not obtained from BHR35 during round 2 and 3 due to the headworks being flooded.

7.2.14 Carbon dioxide concentrations were recorded above the long-term workplace exposure of 0.5% in all monitoring wells with the exception of the following recorded at steady flow rate of:

- 0.2% at BHR32 (8th February 2022), CP11 (9th February 2022), CP12 (10th February 2022, 7th March 2022), WS01 (13th April 2022), WS04 (7th February 2022), WS07 (9th February 202022), WS26 and WS28 (08th February 2022);
- 0.3% at CP07 (8th February 2022), WS05 (14th April 2022), WS18 and WS20 (7th February 2022); and
- 0.4% at BHR30 and WS03 (7th February 2022); and WS41 (8th February 2022).

7.2.15 All rounds at BHR33, CP08 and WS30 recorded concentrations of carbon dioxide below the long-term exposure limit.

7.2.16 Carbon dioxide concentrations were recorded above the short-term exposure limit of 1.5% in the following monitoring wells (at steady flow rate):

- 1.5% at WS07 (14th April 2022), WS18 (8th March 2022, 12th April 2022), WS21 (12th April 2022), WS22 (7th February 2022) and WS29 (11th April 2022)
- 1.7% at WS33 (7th March 2022) and WS40 (9th March 2022)
- 1.8% at WS29 (7th March 2022) and WS40 (12th April 2022)

- 1.9% at WS28 (7th March 20/22) and WS40 (8th February 2022)
- 2.1% at BHR34 (7th March 2022)
- 2.5% at WS16 (8th March 2022)
- 2.8% at WS16 (11th April 2022)

8 Ground Contamination Risk Evaluation

8.1 Revised Conceptual Site Model

8.1.1 The information presented in the previous sections of this report has been collated and evaluated to refine the preliminary conceptual site model for the Proposed Scheme. The conceptual site model has been updated in accordance with the guidance contained within CIRIA document C552 and EA/NHBC publications.

Contaminants

8.1.2 A summary of the potential sources identified includes those as given in Table 8.1.

Table 8.1: Summary of Potential Sources Identified

Contaminants	Comment
Contaminants in soils	Ten (10) samples from seven (7) locations exceeded the Norfolk County Council's GAC (based on public open space) for benzo(a)pyrene. All ten samples were located within the pavement cores. The pavement cores were located on parts of Fakenham Road, Ringland Lane, Weston Road and Breck Road. This is likely due to coal tar being present in the macadam at these locations. No other exceedances of the GACs were recorded. Concentrations of Pendimethalin above the detection limit were noted at five (5) locations. The locations are spread out across the extents of the Site Boundary and were all at depths of <0.9 m bgl. The concentrations ranged from 11 – 23 µg/kg. The source of the pendimethalin is likely to be from the use of herbicides and pesticides for agricultural purposes. There is no Norfolk County Council's derived GACs for pendimethalin.

Contaminants	Comment
Contaminants in groundwater	Leachate testing undertaken on soil samples from two (2) locations recorded marginal exceedances for arsenic against the DWS at BHR14 and CP13A. Exceedances of EQS were noted for copper, lead, nickel and zinc in up to fourteen (14) locations, however, was most frequently at its recorded at its highest concentrations at TP04 and CP13A. The exceedances were measured across all ground types – Made Ground, Superficial, Topsoil, Peat and Chalk and is likely to represent background levels within the Site Boundary. TP04 and CP13A are situated within the Made Ground and superficial deposits, respectively, and are located at either ends of the Proposed Scheme. There is no indication in the logs of contaminated material in these samples. Soil leachate testing results also indicate the exceedance of the EQS and DWS in up to nine (9) samples, all of which are from the Pavement Cores. This is likely to represent the presence of coal tar in the macadam used for the road surface. Groundwater EQS exceedances of cyanide, ammoniacal nitrogen, metals and aromatic TPH fractions were identified. BHR35 recorded the most exceedances out of all locations. The pH of the water in BHR35 was recorded to be alkali, outside the acceptable range for both the EQS and DWS. The sulphate, arsenic, nickel and cyanide concentrations also exceeded the DWS in BHR35. The sulphate and copper exceedances are across the majority of groundwaster samples collected and is therefore likely to represent background levels of the determinands at within the Site Boundary. Cyanide concentrations were only detected above the limit of detection during the third monitoring round and therefor the sporadic exceedances are unlikely to be a significant risk to the controlled waters. BHR35 recorded the most exceedances in the groundwater. BHR35 is located to the south-west of the Site Boundary, to the east of the B1535 and is screened in partially in the superficial and partially in the chalk. Historical imagery shows a historical waste water treatment plant up hydraulic gradient of BHR35 and the concentrations of determinands noted in this location may be relating to historical off-site processes.

Contaminants	Comment
Ground gas	The ground gas monitoring results have been assessed against the WELs as set out in EH40. Since the Proposed Scheme is a road scheme, the WELs are more appropriate to assess the risk from gas, due to the lack of enclosed structures. Hydrogen sulphide and carbon monoxide were all measured at concentrations below the short and long term WELs. Carbon dioxide was found in concentrations above the short and long term WELs in all locations during at least one (1) monitoring round. These concentrations across the extents of the Site Boundary are likely to represent the degassing of the natural soils. Methane concentrations did not fall between the LEL and UEL at any location, and therefore did not fall within the explosion limit. Risk assessments should be undertaken for works in confined space, as set out in the CDM regulations, and mentioned in Section 7 above.

Receptors

8.1.3 The site-specific receptors that could potentially be affected by the contamination hazards are summarised in Table 8.2.

Table 8.2: Potential Receptors

Feature	Comment
Future Proposed Scheme Users	Users of the Proposed Scheme including members of the public
Groundworkers / maintenance workers	Any workers coming in contact with the ground including construction workers and future maintenance workers.
Groundwater	Principal Aquifer of the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation. Alluvium and Head Deposits (Secondary B Aquifer), River Terrace Deposits and Sheringham Cliff Formation (Secondary A Aquifer) and Lowesoft Formation (Secondary Undifferentiated).
Surface water	River Wensum and various other unnamed surface water features within the Site Boundary and in the surrounding area.
Infrastructure and foundations	Concrete foundations may be impacted by aggressive ground conditions. This risk is assessed in the Geotechnical Ground Investigation Report by Ramboll and as such is not considered further in this report.

Pathways

8.1.4 In order for the identified contaminants to reach potential receptors there have to be viable pathways for the contaminants to travel from the sources to those receptors. Potential pathways were identified within the preliminary conceptual site model and are discussed further in Table 8.3 in relation to the identified sources and receptors.

Table 8.3: Potential Pathways and Pollutant Linkages

Receptor	Pathway	Comment
Future Proposed Scheme Users (i.e. members of the public) and Construction workers (during construction) Maintenance workers (during operation)	Dermal contact Ingestion of soil/ soil dust Inhalation and accumulation of asphyxiative/ explosive ground gas and vapours	Future Proposed Scheme users and construction/ maintenance workers may be exposed to contaminated soil via dermal contact/ingestion/inhalation during use or maintenance (including intrusive groundworks) of the Proposed Scheme. Construction and maintenance workers may be exposed to potentially asphyxiative ground gas and vapours when working in deep excavations. PPE and best-practice health and safety measures will be required to mitigate this risk. It is unlikely that future users (members of the public) will come into contact with the soil given that the majority of the Proposed Scheme will be covered in hardstanding. Landscaped areas will be capped using soil that is suitable for public open space.
Groundwater	Leaching and/ or vertical migration of contaminants to groundwater	Given that the Proposed Scheme is underlain by a Principal Aquifer and highly permeable soils there may be potential for vertical and lateral migration of groundwater through the Site Boundary extents, as well as onto Site Boundary from off-site sources. Piled foundations are likely to be required for the Proposed Scheme in specific areas (e.g. road bridges). The deep foundations may open up a pathway from the shallow groundwater in the superficial deposits to the principal aquifer in the chalk. Since the majority of the superficial deposits are granular, and no aquitards are present, it is unlikely that this will impact on the deep groundwater.

Receptor	Pathway	Comment
Surface Water	Lateral migration of contaminants to surface water receptors through groundwater or surface water runoff.	The River Wensum and associated floodplain crosses the Site Boundary in the north. In addition, there are multiple other unnamed water features located within the Site Boundary. There is a potential for contaminated run-off from the Proposed Scheme to enter these water courses. Initial data suggests that groundwater flow direction in both the superficial and the chalk deposits are to the north east, towards the River Wensum. The River is likely to be in hydraulic continuity with the groundwater and lateral migration may also impact the surface waters running through the extents of the Site Boundary. The Proposed Scheme will have a surface water drainage system included within the design, therefore reducing the risk from contaminated run off to surface water courses. There will be similar requirements for the control of surface water run-off during the construction works.

8.2 Qualitative Risk Assessment

8.2.1 Potential pollutant linkages are identified using the source-pathway-receptor framework detailed in Appendix A. An assessment of the potential significance of each linkage is then made by consideration of the likely magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration/exposure pathways between them.

8.2.2 This qualitative assessment has been undertaken in accordance with NHBC (National House Building Council) and Environment Agency guidance. Further details of which are provided in Appendix A including definition of risk categories.

8.2.3 Table 8.4 below summarises the pollutant linkages and risk ratings associated with the Proposed Scheme as assessed following interpretation of the results of the ground investigation.

Table 8.4: Ground Contamination Risk Assessment

Source	Pathway	Receptor	Consequence of Risk	Probability of Risk being Realised	Risk Classification	Requirement for Further Action
Contaminants in soils	Direct contact, ingestion and inhalation of dust, gas and/ or vapours.	Construction workers/ maintenance workers	Mild	Unlikely	Very Low	None required provided use of PPE and health and safety best practices during construction and maintenance works. Future Proposed Scheme users unlikely to come into direct contact with soil or soil dust
Contaminants in soils	Direct contact, ingestion and inhalation of dust, gas and/ or vapours.	Future Proposed Scheme users	Mild	Unlikely	Very Low	None required provided use of PPE and health and safety best practices during construction and maintenance works. Future Proposed Scheme users unlikely to come into direct contact with soil or soil dust
Contaminants in soils	Leaching and vertical migration. Lateral migration.	Groundwater[1] Surface water[2]	Mild	Low	Low	None required. Piling for bridges may create a pathway, however since the majority of the superficial deposits are granular, the groundwater in the chalk is likely already to be impacted by the groundwater in the superficial deposits.
Contaminants in groundwater	Lateral migration.	Groundwater Surface water	Mild	Low	Low	None required.
Ground gas	Migration into confined spaces.	Construction workers/ maintenance workers	Medium	Low	Low to Moderate	Health and safety best practices in excavations and confined spaces.

Note: Risks identified as being moderate/low or higher are considered to be significant and warrant further consideration.

1 Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation=Principal Aquifer. Superficial Alluvium, Head Deposits= Secondary B Aquifer. Superficial River Terrace Deposits and Sheringham Cliff Formation=Secondary A Aquifer. Lowesoft Formation- Secondary (Undifferentiated) Aquifer.

2 Nearest surface watercourse = River Wensum within the north of the Site Boundary.

9 Preliminary Waste Assessment

9.1 Methodology

9.1.1 A preliminary waste classification has been undertaken using HazWaste-OnlineTM to assess whether the soils present within the Site Boundary are likely to be hazardous or not hazardous (in accordance with Technical Guidance WM3) should they need to be disposed off-site as waste. This was accomplished using the soil sample results obtained from the ground investigation. Further details on the waste classification methodology are presented in Appendix A.

9.1.2 The following materials are expected to be excavated as part of the Proposed Scheme:

- Topsoil stripped from the surface within the Site Boundary;
- Road planings stripped from existing roadways;
- Natural soils (superficial deposits) and limited made ground for the creation of new roadways, junctions and infiltration ponds for highway drainage;
- Arisings from piling works (including superficial deposits and chalk bedrock); and
- Natural soils and chalk arising from underpasses, bridges and associated foundations.

9.1.3 From the information gathered during this investigation and the assessment included in Section 6, it is expected that excavated natural soils will be suitable for re-use from a chemical perspective.

9.1.4 The made ground samples indicate that re-use of this material is also suitable. However caution should be paid to the re-use of made ground, due to the material being more heterogenous than natural deposits. Made ground should be segregated from the natural deposits.

9.1.5 The samples from the pavement cores indicated that the re-use of the macadam / asphalt near surface in areas of soft landscaping will not be possible due to the presence of PAHs.

9.1.6 Suitability for re-use from a geotechnical perspective is discussed in the Ramboll Geotechnical Report.

9.1.7 Material that is surplus to requirement will be considered as a waste.

9.1.8 A total of 123 samples were tested as part of the ground investigation. 25 samples were taken from pavement cores and six samples were taken from Made

Ground (excluding the pavement cores) encountered during the site investigation. In total, 56 samples were taken from the superficial deposits (42 from sand, 11 from clay, two from silt and one from gravel horizons), 29 from the topsoil, two from the peat, and five from the chalk. The samples were assessed using the HazWasteOnline assessment tool. These comprised samples of topsoil, made ground, natural superficial deposits, and shallow chalk deposits.

9.1.9 The HazWasteOnline output sheets are provided in Appendix B.

9.1.10 Based on the results of the HazWasteOnline assessment, a total of six samples from five locations were identified as hazardous material. All six samples were from the pavement cores, the location of which are shown in Figure 3. These hazardous samples are summarised below:

- PC-011 at 0.00-0.03 m bgl (hazardous property HP14 - Ecotoxic);
- PC-011 at 0.04-0.07 m bgl (hazardous property HP14 - Ecotoxic);
- PC-016 at 0.02-0.10 m bgl (hazardous properties HP7 - Carcinogenic and HP14 - Ecotoxic);
- PC-017 at 0.02-0.08 m bgl (hazardous property HP14 - Ecotoxic);
- PC-018 at 0.10-0.13 m bgl (hazardous property HP14 - Ecotoxic); and
- PC-020 at 0.01-0.04 m bgl (hazardous properties HP7 - Carcinogenic, HP11 – Mutagenic and HP14 – Ecotoxic).

9.1.11 PC-011 was collected from Fakenham Road, PC-016, PC-017 and PC-018 were from Ringland Lane and PC-020 was collected from Breck Road. PC-011 was one location on Fakenham Road that had hazardous material. It is noted that 11 other locations on Fakenham Road were deemed not to be hazardous. All Pavement Cores from Ringland Road were hazardous or had elevated PAH concentrations. PC-020 was the only pavement core from Breck Road.

9.1.12 Due to the heterogeneity of the sample results, as well as the low density of sample locations on Breck Road and Ringland Road, the conservative recommendation from the initial assessment is that no road planings should be re-used within the Proposed Scheme. Further detailed quantitative risk assessment (DQRA) may be undertaken to determine whether specific areas may be identified for the re-use of road planings. For example, areas of fill with limited water infiltration (i.e. within embankments beneath the proposed road), and away from surface water features may be deemed to be a suitable area for re-use of the road planings, subject to DQRA. Further information on the design and the construction programme would be necessary to assess whether further DQRA would be beneficial.

9.1.13 The six samples from the pavement cores were deemed to be hazardous due to their PAH concentrations. Table 9.1 gives the PAH concentrations for all the hazardous samples. It is noted that the pavement cores were only analysed for PAH concentrations and further determinands may prove to be hazardous should further analysis be undertaken.

Table 9.1: Summary of PAH concentrations for hazardous samples

Determinand (laboratory Concentration)	**Unit**	**PC-011**	**PC-011[2]**	**PC-016**	**PC-017**	**PC-018[2]**	**PC-020**
Classification Result		**Hazardous**	**Hazardous**	**Hazardous**	**Hazardous**	**Hazardous**	**Hazardous**
Depth	m	0.00-0.03	0.04-0.07	0.02-0.10	0.02-0.08	0.10-0.13	0.01-0.04
Moisture {Dry Weight Moisture Correction}	%	0.01	0.01	0.01	0.01	0.01	0.01
Naphthalene	mg/kg	55	14	290	200	330	**1,100**
Acenaphthylene	mg/kg	33	46	44	28	<0.05	48
Acenaphthene	mg/kg	120	290	430	300	430	1,000
Fluorene	mg/kg	190	400	440	340	380	930
Phenanthrene	mg/kg	**1,500**	**2,100**	**1,900**	**1,400**	**1,600**	4,900
Anthracene	mg/kg	410	690	550	370	470	1,400
Fluoranthene	mg/kg	**1,200**	**1,700**	**2,300**	**1,400**	**1,100**	4,500
Pyrene	mg/kg	950	**1,400**	**1,900**	**1,200**	830	3,700
Benzo[a]anthra-cene	mg/kg	490	690	**1,200**	760	400	1,900
Chrysene	mg/kg	320	470	670	410	280	1,300
Benzo[b]fluoran-thene	mg/kg	480	620	**1,200**	670	250	1,700
Benzo[k]fluoran-thene	mg/kg	98	200	250	190	140	700
Benzo[a]pyrene; benzo[def]chry-sene	mg/kg	310	470	790	500	220	**1,400**

Determinand (laboratory Concentration)	**Unit**	**PC-011**	**PC-011[2]**	**PC-016**	**PC-017**	**PC-018[2]**	**PC-020**
Indeno[123-cd]pyrene	mg/kg	110	150	270	170	100	640
Dibenz[a,h]anth-racene	mg/kg	36	49	80	53	31	180
Benzo[ghi]pery-lene	mg/kg	110	150	250	150	110	600
Coronene	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hazard Property		HP14	HP14	HP7, HP14	HP14	HP14	HP7, HP11, HP14

Notes

HP14: Ecotoxic: 'waste which presents or may present immediate or delayed risks for one or more sectors of the environment'.

HP11: Mutagenic: 'waste which may cause a mutation, that is a permanent change in the amount or structure of genetic material in a cell.

HP 7: Carcinogenic: 'waste which induces cancer or increases its incidence'.

9.1.14 Should the asphalt and macadam associated with the existing roads be surplus to requirements the material would be considered as a waste. Material derived from the locations indicated above in Table 9.1 should be classified as hazardous waste with the remaining material classified as not hazardous.

9.1.15 Waste Acceptance Criteria (WAC) testing was not undertaken as part of this ground investigation. There would be a benefit in future stages of the work for WAC testing to be carried out on the material that will be disposed from site. Samples from topsoil, superficial deposits and made ground have been classed as not hazardous. Further WAC testing would be beneficial to the contractor to determine whether the material can be disposed of to an inert landfill. For the pavement cores that were classed as hazardous, WAC testing will be required prior to disposal at a hazardous landfill and may help to determine whether the material can be disposed of at a stable non-reactive hazardous waste landfill.

9.1.16 It is noted that waste classification has been undertaken on localised samples and is only indicative of the waste classification of the strata the samples have been collected from. Further assessment will be required during the

construction works for a more accurate representation of the materials to be removed from site.

9.1.17 Any waste material will require off-site disposal to a suitably licensed soil treatment or waste disposal facility by a suitably qualified contractor. Waste duty of care information (including the types and amounts of waste disposed of, waste classification and WAC analysis, waste transfer and consignment notes and applicable site and carriers' licenses) should be maintained.

9.2 Asbestos

9.2.1 Where waste contains identifiable pieces of asbestos (i.e., any particle of a size that can be identified as potentially being asbestos by a competent person by the naked eye), then Further testing and assessment will be required.

9.2.2 Where the asbestos is deemed to be of a fibrous nature (free fibres and fibre bundles the Health and Safety Executive (HSE) require that the handling of the material is undertaken by a suitably licensed company. The Carriage of Dangerous Goods (etc.) Regulations 2009 (CDG2009) applies in this instance.

9.2.3 The Hazardous Waste (England and Wales) Regulations 2005 requires that any waste having an asbestos (ACM) content greater than 0.1% w/w be classified as Hazardous Waste. Any waste with an asbestos content of less than 0.1% w/w can be classified as non-hazardous waste, unless there are other contaminants present which would make the waste hazardous. Additionally, if the waste contains fibres that are free and dispersed then the waste will be hazardous if the waste as a whole contains 0.1% w/w or more asbestos.

9.2.4 It is noted that while no asbestos was detected in the samples subjected to analysis or visually during the ground investigation, there is the potential for asbestos to be identified elsewhere within the Site Boundary in locations not targeted by the ground investigation.

9.3 Discussion/ Summary

9.3.1 The results of the preliminary waste assessment suggest that the macadam within the roadways has the potential to be classified as hazardous should it be removed from site as waste. All other material (including topsoil, made ground, superficial deposits and the shallow chalk) have been shown to be not hazardous.

9.3.2 Separate material streams are anticipated to be generated by the following groundworks at the site: macadam breakout from the roadways; topsoil strip; cutting from Mainline chainage 2400 to 2780 and 2940 to 3780; and pile arisings. Based on ground conditions identified to date, potentially hazardous

materials of the types defined above are anticipated to be encountered as part of the road surface breakout.

9.3.3 Other material excavated within the Site Boundary (except the existing road surfaces) is considered to be suitable for general re-use on-site provided that:

- Construction and maintenance workers utilise appropriate PPE and health and safety best practices;
- Further targeted testing of material excavated on site show that chemical concentrations are below the Norfolk County Council's re-use criteria; and
- Material is confirmed to be geotechnically suitable for reuse in accordance with an Earthworks Specification (to be prepared separately).

9.3.4 Topsoil, made ground, superficial deposits and the shallow chalk from the proposed cutting and piling works are anticipated to be suitable for re-use or disposal off-site as not hazardous waste, however if visual or olfactory evidence of contamination is identified in these materials during excavation, then the impacted material should similarly be stockpiled separately and subjected to additional chemical testing prior to disposal or reuse.

9.3.5 Asphalt and macadam is not considered to be a suitable material for re-use on-site in line with the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoW CoP) without further assessment. As such, all asphalt broken out from the existing roadway during groundworks should be stockpiled separately and subjected to chemical testing to confirm an appropriate disposal route. Based on testing undertaken to date, some of the material from the road surfaces is anticipated to be classified as hazardous for the purposes of waste disposal. Further assessment would be required to establish whether this material is suitable for re-use as engineering fill or landscaping fill, and this will require a DQRA to be undertaken to establish site specific acceptability criteria.

9.3.6 While no asbestos was identified during the ground investigation or chemical testing of soil samples, given the inherent heterogeneity of made ground it would be prudent to make a provisional allowance for encountering visible fragments of ACMs and asbestos-impacted soils that will need to be disposed of under appropriate Duty of Care procedures. Contractor vigilance and specialist advice is advised along with further asbestos screening and/ or quantification testing to determine the appropriate waste stream for materials requiring disposal.

9.3.7 Note that the indicative waste classifications provided as a part of this assessment should be confirmed by any receiving facility prior to disposal, under Duty of Care, following discussions with the producer of the waste. WAC analysis is

likely to be required to be undertaken by the contractor prior to disposal, under current legislative requirements post excavation.

9.3.8 Should the re-use of site won materials be required, consideration should be given to adoption of the CL:AIRE DoW COP which would enable the works to be completed without made ground, road planings and contaminated soils being automatically regarded as a waste material. This would require the preparation of a Materials Management Plan (MMP) and, in due course, an MMP Verification Report to demonstrate that the requirements of the MMP have been met. Please note that if the CL:AIRE DoW CoP is to be applied, the MMP will need to be declared by a Qualified Person before earthworks are commenced, due to the need to demonstrate certainty of use before the materials are excavated. Please note that an MMP may not be worthwhile if only limited volumes of made ground and contaminated soils are present, where re-use under exemptions from the Environmental Permitting Regulations may be more appropriate.

9.3.9 It should be noted that disposal of surplus site won soils to landfill is not considered to be sustainable. The most sustainable solution is to minimise excavations and maximise opportunities to re-use site won materials on-site. However, where surplus materials remain, alternative approaches to disposal to landfill should be explored. These could include recycling of the materials at an off-site soil treatment centre, or identifying alternative sites where these materials can be re-used (subject to compliance with the Environmental Permitting Regulations (as amended) at the receiving site as the material would still need to be handled as a waste).

10 Conclusions and Recommendations

10.1 Summary

10.1.1 This Ground Contamination Interpretative Report has been prepared to aid in the design and construction of the Proposed Scheme. This report has been prepared to refine the conceptual site model for the Proposed Scheme and provide a qualitative risk assessment with respect to contaminated land.

10.2 Human Health Assessment

10.2.1 Chemical testing results from a total of 123 soil samples were screened against Norfolk County Council's specified GAC for public open space. All concentrations were below Norfolk County Council's GAC with the exception of benzo(a)pyrene which was recorded above the GAC in the pavement cores in ten (10) samples. The maximum exceedance recorded in PC-020 between 0.01-0.04 mbgl at 1,400mg/kg. No potential ACMs were identified during the ground investigation and no asbestos fibres were identified in the 123 soil samples screened for asbestos.

10.2.2 The use of Norfolk County Council's specified GACS based on public open space is considered to be conservative, due to the majority of the Proposed Scheme being covered in hardstanding or imported topsoil, with minimal potential for direct contact with underlying soil.

10.2.3 Pendimethalin is a selective herbicide used to control broadleaf and grassy weeds . It is slightly toxic by the oral and eye route and is practically non-toxic by the dermal and inhalation routes. Pendimethalin dissipates in the environment by binding to soil, and is essentially immobile in soil. Pendimethalin is slightly to moderately persistent in aerobic soil environments. Persistence decreases with increased temperature, increased moisture and decreased soil organic carbon. Pendimethalin's high affinity to bind to soil and sediment particles is likely to limit the concentrations within the surface water and groundwater.

10.2.4 The risk to the future Proposed Scheme users of the scheme from contaminants in the soil is considered to be low. Provided that construction workers and future maintenance workers utilise appropriate vigilance and work in accordance with construction health and safety best practice, the risk to them from contaminants in soil is also anticipated to be Low.

10.3 Controlled Waters Assessment

10.3.1 Leachate testing has been completed for 34 soil leachate samples. Only two (2) locations recorded leachate concentrations in excess of the DWS – these were

located at BHR14 and CP13A for arsenic, however the exceedance was only marginal. Exceedances of the EQS were noted for leachable copper, lead, nickel and zinc at several locations, however, was most frequently recorded at its highest concentrations at TP04 and CP13A.

10.3.2 There are exceedances of the EQS and DWS for PAHs. All exceedances are from the Pavement Cores. The pavement core samples were collected from the asphalt and macadam from roadways within the Site Boundary. Given some of the Pavement Cores were found to be hazardous, it is likely these will be removed from site unless further assessment is undertaken to identify an appropriate location for re-use. Such assessment would need to include a DQRA so that site specific acceptability criteria can be set for these materials. Given that the exceedances are marginal and the process of extracting leachate from the soils is not likely to represent conditions within the ground, the risk to controlled waters is considered to be Low.

10.3.3 Twenty six (26) groundwater samples have been collected and were screened against DWS and EQS.

10.3.4 Exceedances were noted across the Site Boundary extents for copper, zinc (EQS) and sulphate as SO_4 (DWS). The majority of these exceedances are marginal and are likely to represent background conditions of the geology and hydrogeology. Cyanide exceeded the EQS in five samples, all of which were collected during the third monitoring round. One of the samples from CP12 also exceeded the DWS for cyanide. The sporadic nature of the exceedances suggests that there is continuous risk to the controlled waters from cyanide.

10.3.5 The pH of the water in BHR35 was recorded to be alkali, outside the acceptable range for both the EQS and DWS during all rounds of sampling. Ammoniacal nitrogen as N was found to exceed the DWS and EQS in BHR during the second and third monitoring round. The arsenic and nickel concentrations also exceeded the DWS in BHR35 during more than one round. No other DWS exceedances were recorded during the three groundwater monitoring rounds. Concentrations above the EQS at BHR35 were recorded for metals in all three sampling rounds and aromatic TPH fractions in the first sampling round. Given the repeated exceedances at BHR35 it is suggested that the contamination is localised and is not present elsewhere within the Site Boundary (i.e. in a contaminant plume) over the period of the three sampling rounds. Historical imagery shows a waste water treatment plant up hydraulic gradient (off-site) of BHR35 and this may be reason behind the elevated concentrations recorded at this location.

10.3.6 Pendimethalin was recorded in one location during the third round of groundwater monitoring at location CP12. The concentration was a small amount over

the detection limit, measuring 0.04 µg/l compared to a detection limit of <0.03 µg/l. The exceedance is minimal and localised.

10.4 Ground Gas Assessment

10.4.1 An exceedance of the long term WEL for carbon monoxide was measured in CP02 during one monitoring round (13/04/22).

10.4.2 Monitoring results exceeded both the long and short term WELs for carbon dioxide at all wells during at least one monitoring round. The carbon dioxide concentrations are likely to represent the natural ground conditions beneath the extents of the Site Boundary given the similarity of the concentrations across the large spatial area. However, the flow rates are consistently low across the extents of the Site Boundary.

10.4.3 It should be noted that under current health and safety legislation, construction and maintenance workers are required to carry out appropriate risk assessments and instigate appropriate mitigation measures to protect themselves, other human receptors and the environment from contamination that may be present. Such risks must be adequately mitigated by the measures required under legislation, specifically the Construction Design Management (CDM) Regulations, which required the potential risks to human health and the environment from construction activated are appropriately identified and all necessary steps taken to eliminate / manage that risk. On this basis it has been assumed that personal protective equipment (PPE) and health and safety best practises will be adopted during the construction works and acute risks to construction workers / site visitors during construction have therefor not been considered as part of this assessment. However the data from ground investigation reports should be provided to the construction team and used to inform the PPE and Health and Safety requirements.

10.5 Material Re-Use & Preliminary Waste Classification

10.5.1 Based on the results of a preliminary waste assessment, materials within the Site Boundary with the potential to be classified as hazardous for the purposes of disposal include material from the macadam in the existing roadways. This material should be stockpiled separately and subjected to chemical testing to confirm waste classification or suitability for re-use on-site as appropriate.

10.5.2 Other materials excavated at the site are considered to be suitable for re-use on-site provided that:

- Construction and maintenance workers utilise appropriate PPE and health and safety best practices;

- Further targeted testing of material excavated within the Site Boundary show that chemical concentrations are below the Norfolk County Council's re-use criteria; and
- Material is confirmed to be geotechnically suitable for reuse in accordance with an Earthworks Specification (to be prepared separately).

10.5.3 However, it is noted that the Made Ground, road planings and any unexpected contamination identified during the works is chemically tested throughout the construction works to ensure the material is in line with the findings of this investigation.

10.6 Recommendations for Further Work

10.6.1 Based on the results of the ground investigation, no significant sources of contamination have been identified that would preclude development, with the site considered to be of low contamination risk. It is noted that this risk assessment takes into account the finalised layout of the Proposed Scheme, however if significant changes are subsequently made to the proposed layout, then the assessment will need to be revised.

10.6.2 Based on the findings of this risk assessment, the following actions are recommended to be undertaken prior to the commencement of construction works:

- Preparation of a Land Quality Method Statement to fulfil the requirements of a remediation strategy, outlining the mitigative measures to be undertaken in relation to risks identified to human health and controlled waters and in the event of identifying areas of unexpected contamination during the enabling works and construction phase;
- Management of construction works to ensure that the requirements of the Land Quality Method Statement and MMP (if any) are complied with, including the collection of evidence to demonstrate that this was the case;
- On completion of construction works, preparation of a Verification Report using the collated evidence to demonstrate that the Land Quality Method Statement and MMP requirements (if any) have been implemented.

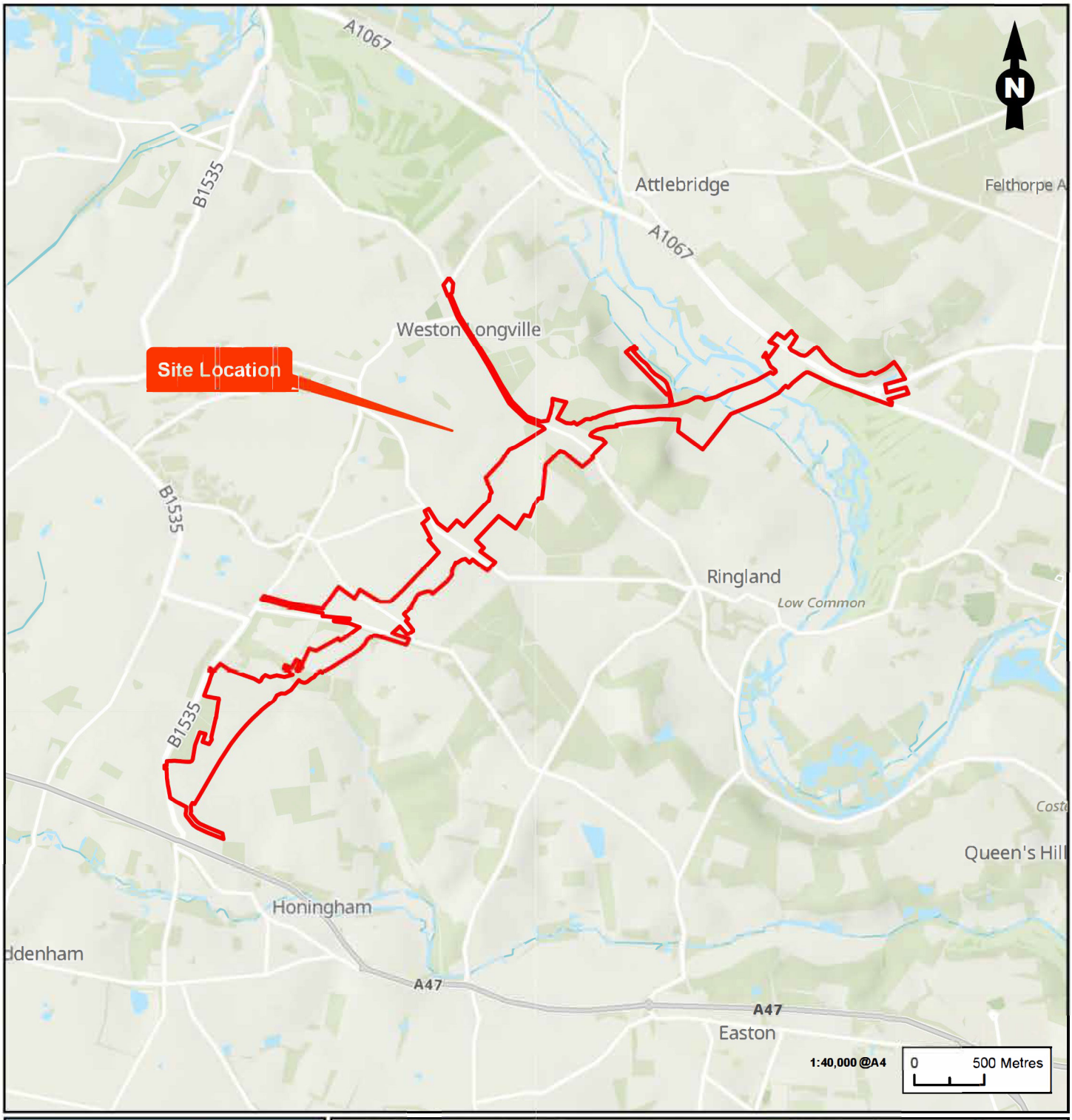
10.6.3 For any remaining surplus material, opportunities should be explored to divert the material from disposal at landfill.

10.6.4 A separate DQRA will be prepared by the Applicant to discuss the re-use of the road planings.

10.6.5 In all cases the recommendations outlined above should be implemented in line with the Proposed Scheme programme.

FIGURES

FIGURE 1 SITE LOCATION



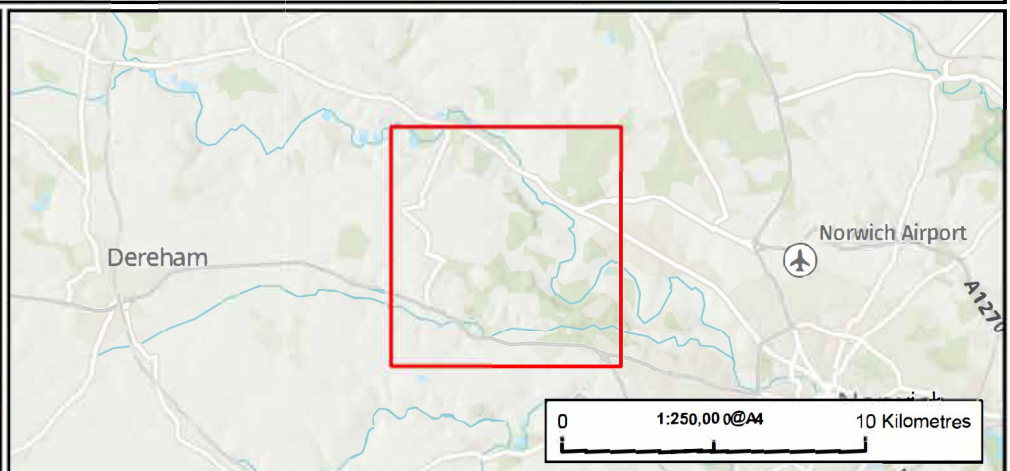


Figure Title: Figure 1: Site Location	Project Name: Norwich Western Link Road	Date: May 2022	RAMBOLL
		Scale: As shown	
Project Number: 1620010282	Client: Ferrovial Construction (UK) Limited	Issue: 1	Prepared By: CT