BBV JV

Landscape Bund at Pool Wood Embankment

Appendix I – Environmental Setting and Site Design Report

Project No. 3020094 – Permit Application

RSK GEOSCIENCES WASTE & RESOURCES

MAY 2025

RSK GENERAL NOTES

Project No.: 3020094 (01)

Title: Appendix I - Environmental Setting and Site Design Report: Landscape Bund at Pool Wood Embankment

Client: BBV JV

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APPENDICES

1 INTRODUCTION

1.1 Report Context

RSK Environment Limited (RSK) was commissioned by Balfour Beatty Vinci Joint Venture ('BBV JV') to prepare an Environment Site Setting and Design (ESSD) report as part of supporting documentation for an application to obtain a Bespoke Deposit for Recovery Environmental Permit relating to earthworks to create a landscape bund along a stretch of the new HS2 rail line at Pool Wood near Birmingham (between chainages (Ch) 158+90000 and 159+800). The permitted section of this landscape bund will be between Ch 159+200 and 1598+750 and is hereafter referred to as the 'Site'.

The proposed works will require the deposition of material to raise the land on site to form a landscape bund along the HS2 rail embankment.

This Environmental Setting and Site Design (ESSD) report aims to describe the proposed scheme in relation to the environmental setting, identifying any potential contaminant source, pathways and receptors that have been identified within the Environmental Risk Assessment (ERA) for the site and will be used as the basis for supporting this risk assessment, outlining measures which will be implemented to reduce or eliminate these risks and support the Environmental Permit application.

Appendix F of the permit application presents a copy of the Environmental Risk Assessment for reference purposes. The report should be read in conjunction with the ERA and other supporting application information as detailed in **Section 1.4** below.

1.2 Operator and Agent

The Environmental Permit application and this summary have been prepared by RSK Environment Ltd (RSK) which is acting as an 'Agent' on behalf of the proposed 'Operator', Balfor Beatty Vinci Joint Venture (BBV JV), which is made up of four companies including:

- Balfour Beatty Group Limited - company registration number 00101073.
- VINCI Construction Grands Projects - company registration number FC017187.
- VINCI Construction Terrassement UK Limited - company registration number 10264076.
- VINCI Construction UK Limited - company registration number 02295904.

1.3 Background

The site forms part of the wider HS2 works in the area.

The primary subject of this ESSD and the wider environmental permit application is the landscape bund that is being created alongside Pool Wood Embankment. The landscape bund will be located to the adjacent west of the Pool Wood Embankment trace and is designed primarily to act as a visual/noise barrier for residents located to the west of the alignment. The whole landscape bund is designed to be approximately 850 m long, approximately 50 to 70 m wide and up to 14 m in height above existing ground level.

The area of the landscape bund to be constructed using material sourced from Middle Bickenhill Landfill (or other sources if required) is located at approximate Ch. 159+225 and 159+700.

A Site Location Plan is provided at **Appendix C of the permit application**.

The materials required to form site levels appropriate for the construction of the landscape bund will comprise the use of clean and natural materials generated on site, virgin materials imported to site and waste material imported to site from sites being developed as part of the overall HS2 development.

All of the waste material should derive from the nearby closed Middle Bickenhill Landfill (MBL) which will require excavating in order to create an appropriate platform upon which to build the Middle Bickenhill Cutting. Some additional suitable waste materials may be imported from elsewhere should they be required (i.e. a shortfall).

In order to accommodate this proposal, and deposit waste at the site, a bespoke environmental permit for waste recovery (Deposit for Recovery or DfR) will be required.

Appendix F of the permit application presents a copy of the Waste Recovery Plan (WRP). This WRP was approved by the Environment Agency on the 20 May 2024.

Activities at the site will be regulated under the Environmental Permitting (England and Wales) Regulations 2016 and will be carried out as defined under Annex II of the Waste Framework Directive can be summarised as follows:

- R10 Land Treatment resulting in benefit to agriculture or ecological improvement.
- R11 Use of waste obtained from any of the operations numbered R1 to R10.
- R13 Storage of wastes pending any of the operations numbered R1 to R12 excluding temporary storage, pending collection, on the site where it is produced).

1.4 Existing Information and Limitation

The following reports for the site have been completed. Relevant information from these sources has been gleaned to allow better interpretation of the site and underlying ground conditions:

- Pool Wood Embankment – Land Quality Management Report, November 2024 (1MC09-BBV_MSD-EV-REP-NS04_NL10-100167 Rev. C02) – **Appendix B of this report**.
- Hydrogeological Risk Assessment and Material Acceptability Criteria Assessment Report: Pool Wood Embankment Landscape Bund (1MC09-BBV_MSD-EV-REP-NS04_NL10-100217) – **Appendix J of permit application**.
- Ground Investigation Specification: Pool Wood Embankment (1MC09-BBV_MSD-EV-REP-NS04_NL10-100218 Rev. P01) – **Appendix C of this report**.
- Pool Wood Embankment -Ground Gas Risk Assessment (1MC09-BBV_MSD-EV-RIA-NS04_NL10-100006 Rev. P01) – **Appendix D of this report**.

Various design drawings contained within **Appendix C** of the **Permit Application**.

This ESSD report should be read in conjunction with the following documents that also support the Bespoke Environmental Permit application:

- Management System Summary – **Appendix B of permit application.**
- Site Plans – **Appendix C of permit application.**
- Non-technical Summary – **Appendix D of permit application.**
- Environmental Risk Assessment – **Appendix E of permit application.**
- Waste Recovery Plan – **Appendix F of permit application.**
- Waste Acceptance Procedure – **Appendix G of permit application.**
- Dust Management Plan – **Appendix H of permit application.**
- Hydrogeological Risk Assessment – **Appendix J of permit application.**
- Ground Gas Risk Assessment – **Appendix K of permit application.**

The comments given in this report and the opinions expressed are based on the assessments and surveys completed by 'others' or available from publicly available sources at the time the reports were prepared. There may be information pertaining to the site that has not been disclosed and therefore could not be taken into account within this report.

2 SITE DETAILS

The following section summarises the site setting.

2.1 Site Location and Description

Pool Wood Embankment is located approximately 10.00 km to the south-east of Birmingham City Centre. The M42 motorway and a roundabout are situated at the southern boundary and the M6 motorway is present at the northern boundary. The A446 is present approximately 450 m to the east of the site. The site extends from the south of the roundabout and runs alongside the M42 motorway until it encounters the M6 motorway to the north.

The wider Pool Wood Embankment asset is located between approximate Chainage (Ch.) 158+400 and 159+800 in Sub Lot 5 South at National Grid Reference SP 19427 86336.

The landscape bund is located to the immediate west of the trace between approximate Ch. 158+900 to 159+750.

Once constructed the landscape bund will be approximately 850m long, between 50 and 70m wide and up to 14 m in height above the neighbouring ground elevations.

The location within the landscape bund to receive waste materials and to be subject to the conditions of the Deposit for Recovery Environmental Permit will be located between approximate Ch. 159+200 and 159+700.

Figure 1 below shows the location of the Pool Wood Embankment and **Figure 2** shows the proposed permitted area within the landscape bund. More detailed drawings can be viewed at **Appendix C of the permit application**.

2.2 Topography

Currently the elevation ranges from approximately 99 mAOD in the south rising to 106 mAOD in the northern third from Ch. 159+100. Elevations fall to about 100 mAOD at the northern extreme of the asset (~Ch. 159+800). Elevations in the neighbouring areas are around 100 mAOD with the lowest elevations recorded to the east of the asset at around 97 mAOD associated with Coleshill Pools.

2.3 Site History

The site appears to have been predominantly agricultural in nature. However, there are some potentially contaminated areas that have been identified on site. These include:

- Brickworks with kiln and infilled pond – Potential contaminants include organics, metals, asbestos, sulphates and herbicides, pesticides and ground gas.
- Brickfield Farm and Brickfields Cottage – Potential contaminates include organics, solvents, metals, asbestos, herbicides and pesticides.
- Abandoned Well – Potential contaminants include metals, organics, sulphates, asbestos and ground gases.

Various phases of contaminated land assessment have been completed at the Site and the results of these assessments are presented within the Land Quality Management Report (see **Appendix B of this report**).

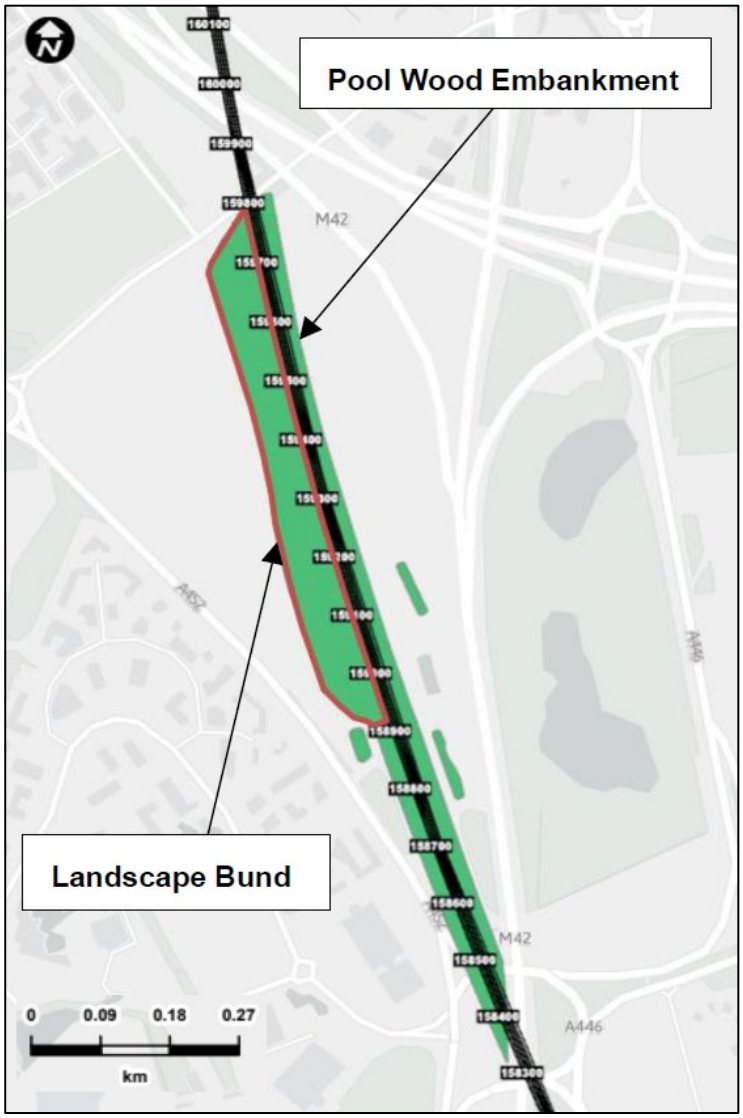


Figure 1: Location of Pool Wood Embankment

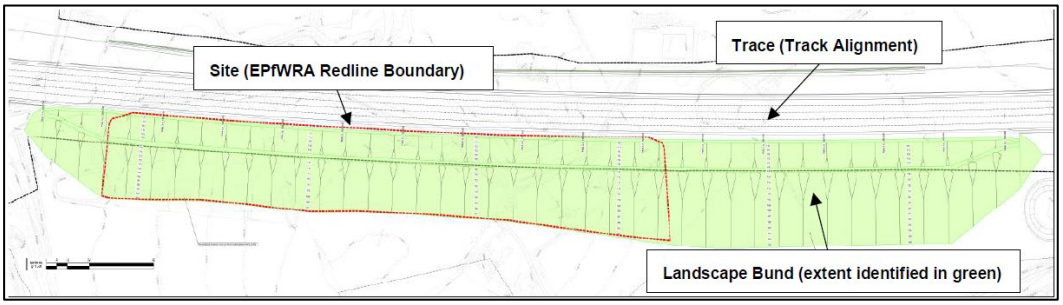


Figure 2: Area to be subject to the Deposit for Recovery Environmental Permit

2.4 The Surrounding Area

The area surrounding the site comprises residential areas, a business park and Coleshill and Bannerley Site of Special Scientific Interest (SSSI) as detailed in **Table 1**.

Table 1: Site Setting

To the north:	Residential properties
To the east:	M42 and Coleshill and Bannerley SSSI
To the south:	Birmingham Business Park
To the west:	Birmingham Business Park and residential properties

2.5 Site Classification and Development Needs

The railway alignment in the Pool Wood Embankment area will cut through open lands or agricultural fields and is flanked by Birmingham Business Park on the west side and by Coleshill and Bannerley Pools on the east side.

The construction of Pool Wood Embankment will be located on potentially contaminated land.

The permitted area itself will be located between Ch 159+200 and 159+700.

Three unnamed ponds are located at the Site. A drain is also present to the south of the Site, which has a north-east-west to northwest orientation. These ponds and drains will be removed as part of the works.

The River Blythe is the closest main watercourse located approximately 2.00 km to the east of the Site. This river flows in a northerly direction into the River Tame (part of the Trent Drainage Basin).

Coleshill and Bannerley Pools (designated as a Site of Special Scientific Interest (SSSI)) is located to the east of the site across the M42 and marshland areas are present to the south of the site.

The requirement for the landscape bund is to serve as a noise bund for the nearby Business Park and other nearby receptors at Pool Wood is clearly shown in the Environmental Statement that was submitted for Phase 1 of HS2 (available on gov.uk website). It will also serve as a visual barrier. The Environmental Statement is also supported by the High-Speed Rail (London – West Midlands) Act 2017. The obligation to undertake the works to complete the landscape bund is therefore a legal requirement.

The deposit for recovery of waste onto the land is supported by a Waste Recovery Plan (WRP) that has been submitted to the Environment Agency. A copy of the approval letter and the Waste Recovery Plan supporting the overall permit application is presented as **Appendix F of the permit application**.

2.6 Site Boundary and Site Security

During and post construction the site will be fenced off with access restricted to authorised personnel only.

Ownership of the site (and the wide landscape bund) will be retained by HS2 and public access will not be permitted.

During construction access to the site will be via a gated and manned entrance. Only site staff who have undertaken the relevant site induction process will be permitted access. All site staff will also be required to undertake a site-specific induction. There will be a security presence on site for 24 hours of every day while the site is being developed.

2.7 Geology

The underlying natural strata are recorded with the British Geological Survey(BGS) as Glaciolacusterine Deposits (GLD) from the approximate centre to the northern boundary of the Site (between Ch 159+125 to 159+750), which are in turn underlain by Glaciofluvial Deposits (GFD), likely to be present beneath the whole Site. The superficial deposits are underlain by the bedrock geology of the Mercia Mudstone Group.

Made ground is recorded at several points within the site boundary. Most of the made ground was encountered in the area of land associated with the former brickworks with kiln and infilled pond. The overall area covered by made ground is not considered to be significant. Made ground identified during ground investigation and/or encountered during construction works will be removed from the footprint of the site and wider asset and backfilled with competent natural material. Suitable excavated made ground will be reused as landscape fill within the Pool Wood Embankment Landscape Bund and the residue disposed at an appropriately permitted site.

Further information regarding the geology at the site is provided within the Hydrogeological Risk Assessment (**Appendix J of permit application**).

2.8 Hydrogeology

The published geological units identified at the Site and surrounding area have the following aquifer characteristics, as determined by the Environment Agency (EA):

- Glaciofluvial and Alluvial deposits – Secondary A aquifers, which contain permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers.
- Glaciolacustrine deposit – Non-productive.
- Mercia Mudstone Group – Secondary B aquifer, which contain predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering.

Monitoring wells located at and near to the asset have been monitored regularly between 2016 and 2022. Groundwater elevations during this period ranged from approximately 86 to 103 mAOD.

The dominant groundwater flow direction is anticipated to be easterly, towards Coleshill Pools.

Overall, the Glaciofluvial and Alluvium deposits would be the main transport mechanism for groundwater and where present, contaminant movement. Glaciolacustrine deposits and Mercia Mudstone Group would restrict groundwater and contaminant movements.

Four groundwater abstraction wells have been identified within a 1 km radius of the site. These include:

- Brickfields Farm Well – Located within the wider site boundary at Ch. 159+400. It is presumed that this was used for agriculture (i.e. irrigation and potable water for livestock). Its status is unknown.
- Unknown – Located approx. 30 m east of site boundary. It is presumed that this was used for agriculture (i.e. irrigation and potable water for livestock). Its status is unknown. Reported to have been infilled.
- Pool Farm – Located approx. 990 m northeast of the site. It is presumed that this was used for agriculture (i.e. irrigation and potable water for livestock). Its status is unknown.
- Bogs Farm – Located approx. 890 m southeast of the site. It is presumed that this was used for agriculture (i.e. irrigation and potable water for livestock). Its status is unknown.

The site does not fall within a Source Protection Zone.

There are no records of private water wells at and within a 1000 m radius of the Site boundary.

2.9 Hydrology

The site is intersected by three surface water catchments associated with the River Cole, the River Blyth and Hatchford Brook located to the northwest (~1.2 km), east (~2 km) and west (~1.7 km) of the site respectively.

All three catchments will affect surface flow and runoff water but are unlikely to have a significant effect on groundwater flow direction, which is more likely to be dictated by localized surface waters including the Coleshill and Bannerley Pools, which are located are located approximately 350 m to the east of the Site.

The Coleshill and Bannerly Pools are identified as Sites of Special Scientific Interest (SSSI).

Given the presence of Glaciolacustrine deposits, the site is not considered a major recharge area for these features although some runoff (recharge)/infiltration into the Glaciofluvial deposits at the margins of the Glaciolacustrine deposits is possible.

Post construction, all surface water drainage originating from the bund will be collected and conveyed south to Holywell Brook via a network of drains, and none will enter Hatchford or the River Cole catchment.

There are three unnamed ponds located at the Site, at approximate Ch 158+875, 159+175 and 159+250. A drain is also present to the south of the Site at Ch 158+550, which has a north-east-west to northwest orientation. These ponds and drains will be removed as part of the works.

Several land drains are recorded to the east of the Site.

2.10 Flood Risk

The site is located within an Environment Agency designated Flood Zone 1 which has a probability of fluvial flooding less than 1 in 1000 (<0.1%) in any given year.

2.11 Sensitive Land

A search has been conducted using the Environment Agency's Magic mapping system to identify any nature and heritage conservation sites and/or protected species and habitats within 1 km of the site, which must be considered as part of a bespoke permit application.

The following features are listed, which will be considered in more detail for the permit application.

Site of Special Scientific Interest (SSSI)

- Coleshill and Bannerly SSSI. Located approximately 120 m to the east at the closest point - comprises two pools and an area of bog between them which forms the only valley mire system in Warwickshire.

2.12 Previous Site Investigations

A detailed review of historical and current information relating to the site is provided within the Land Quality Management Report (**Appendix B of this report**). The Land Quality Report also includes a Conceptual Site Model for the Site.

2.13 Potential Contaminated Land Source Locations

The following sites have been identified in **Table 2** and the locations are shown on **Figure 3**.

Table 2: Summary of Contaminant Sources

ID	Source	Potential Contaminants of Concern
	On-Site	
1	Brick Works with Kiln and infilled pond	Potential contaminants include organics, metals, inorganics, asbestos, and ground gas.

ID	Source	Potential Contaminants of Concern
2	Brickfields Farm and Brickfields Cottage	Potential contaminants include organics, metals, inorganics, asbestos, herbicides and pesticides.
3	Infilled Well	Potential contaminants include metals, organics, sulphates, asbestos and ground gases.
4	Fly-tipping	Fly-tipping observed during site walkover. Potential contaminants include organics, metals and asbestos.
	Off-Site	
5	Birmingham Business Park	Potential contaminants include organics, metals, inorganics, and asbestos.
6	Depot and Motorway Maintenance Compound	Potential contaminants include organics, metals, and inorganics.
7	Gravel Pit	Potential contaminants include metals, organics, sulphates, asbestos and ground gases.
8	Brackenlands Farm Landfill	Potential contaminants include organics, inorganics, metals, asbestos, and ground gas.

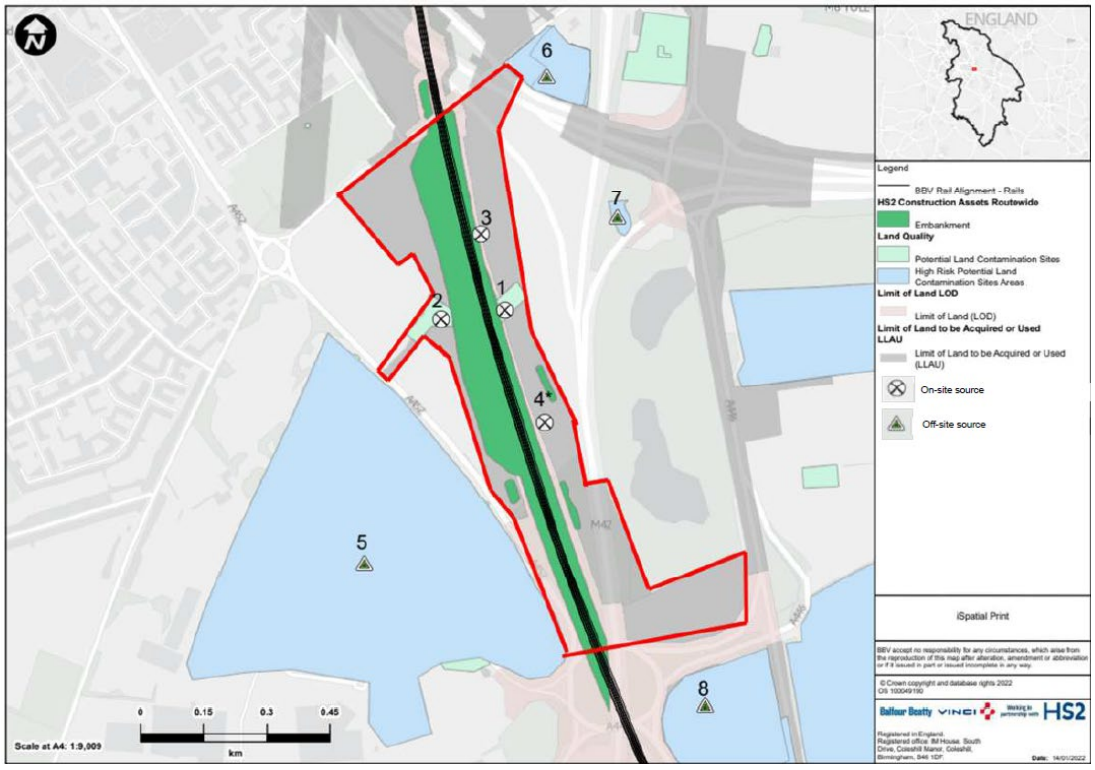


Figure 3. Location of Potential Contaminant Sources

Environment Agency records show that the historical Brackenlands Farm Landfill (ID 8 on **Figure 3)** is a shallow 2 m to 6 m sand and gravel borrow pit formed during the construction of the M42. The landfill is reported to have accepted inert and liquid/sludge waste including wastewater, sewage sludge and chemical waste mixed with municipal solid waste between 1975 and 1977. Currently there are no proposed temporary or permanent works to be undertaken by the Main Works Civil Contractor at Brackenlands Farm Historic Landfill. Therefore, this report does not consider contamination associated with the landfill site.

During a site walkover, there was evidence of surface waste encountered in the centre part of the asset (ID 4 on **Figure 3**), located near the former brick works with kiln and infilled pond. The material observed comprised of old carpets and plastic debris. It is anticipated that the waste is associated with fly-tipping and not directly associated with the land quality in the area. Any fly-tipping waste encountered on site will be removed during construction works.

2.14 Proposed Development/Landscape Bund Design

The main works at the site will comprise of an embankment to support the main line and a landscape bund to the adjacent west of the line to provide a visual and noise screening barrier.

Enabling earthworks in the area have already commenced to prepare the area for the construction of the embankment and the landscape bund.

The length of the embankment and accompanying landscape bund will be approximately 1,414 m. The height of the earthwork varies throughout the length of the landscape bund, with a maximum height from ground level to the top of the protection layer of approximately 14 m.

The landscape bund runs from Ch 158+920 to Ch 159+760 on the west side of Pool Wood Embankment. The internal gradient of the landscape bund is 1:3 and the external gradient is 1:4.

The section of the bund where waste will be deposited will be approximately 475 m long, between 50 and 70 m wide and up to 14 m in height above the neighbouring ground elevations. It will cover an area of approximately 30,000 m^2.

As outlined within the Hydrogeological Risk Assessment (**Appendix J of permit application**). The main features of the site are as follows:

- The site will be excavated to approximately 1 m below existing ground elevations to remove topsoil/subsoil materials and to accommodate the design features.
- Approximate 350 mm of (6C)[1] thick granular blanket wrapped in a synthetic geotextile material to reduce the ingress of fines into the blanket will be placed at the base of the site. The primary purpose of the blanket is to allow the collection of pore water displaced from the underlying Glaciolacustrine Deposits due to the surcharging effects of the newly placed overburden.

[1] 6C granular material is a type of granular fill material, often used in highway construction, characterized by its well-graded and consistently sized nature. It's primarily composed of crushed stone, typically with a single size of 125mm, but can also include smaller materials.

- The drainage blanket will be graded with an approximate 2% fall to the west to promote the flow of water to a drainage channel located along the western toe of the site. The same drainage channel will also receive runoff water from the surface of the site.
- An approximate 900 mm thick traffic layer comprising site won Glaciofluvial Deposits (main content) and Mercia Mudstone (minor content) placed above the drainage blanket layer. The purpose the permanent traffic layer is to protect the drainage blanket from the movement of plant and machinery during field operation and construction works.
- The material used in the construction of the site will be sourced from MBL(unless there is a shortfall in which case material will also be source from elsewhere on Sublot 5 and 6 of the HS2 development).
- The surface of the site will be completed with approximately 1 m of clean topsoil and subsoil to provide a suitable growing medium for plant growth.

Figure 4 shows the main design elements. A longitudinal profile of the landscape bund is provided within the Hydrogeological Risk Assessment.

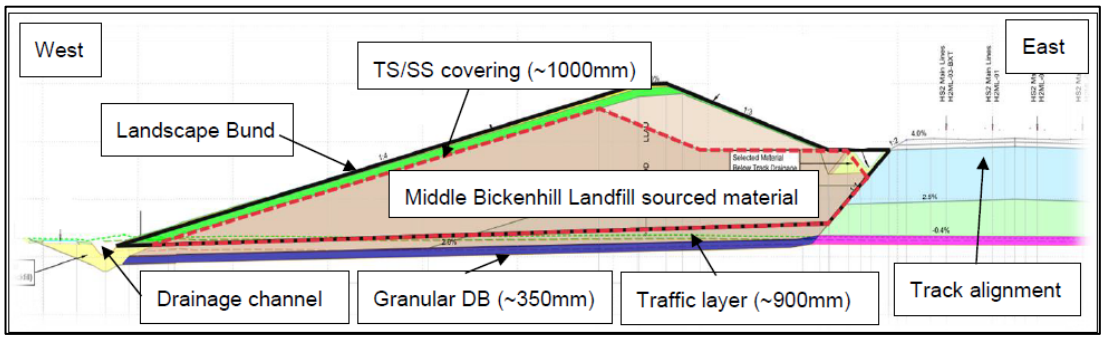


Figure 4. Cross section of Pool Wood Embankment Showing Main Design Elements

A culvert will be located within the Pool Wood Embankment. Pool Wood Culvert will be located at the end of a woodland. The culvert will be approximately 90 m in length with a cross sectional size of 2.55 m by 2.05 m.

Land drainage will comprise of two ditches around the western perimeter of the earthwork. It has been designed to collect external catchments and embankment flow runoff before discharging into Pool Wood culvert by gravity.

Embankment

No waste will be used in the construction of the embankment.

2.15 Material overview

Some of the material used within the embankment and for part of the landscape bund will comprise of clean and uncontaminated materials that meet specific structural specifications.

Class 9 stabilised cohesive fill will be used in steep slope areas and will be placed on top of the recovered material for the slope facing the HS2 railway embankment. The treatment with lime of the clean non-waste material to form Class 9 material will be carried out as a geotechnical treatment and not waste treatment process.

The majority of the materials to be reused on site within the landscape bund will be considered waste due to their nature and where they derive from.

It is anticipated that all of this material will derive from MBL. Before being accepted at site for deposit it will have been treated to remove any contaminants (i.e. any non-compatible/biodegradable waste and other visible contaminants that may be present) and to ensure it meets the assigned site-specific acceptance criteria (SSAC) as laid out with the Waste Acceptance Procedure (see **Appendix G of permit application**).

It has been calculated that approximately 178,810 m^3 of material will be excavated from the landfill. This material will then be subjected to treatment at source to remove any contaminants. Based on an estimated 10% of this excavated material being unsuitable for reuse it is estimated that approximately 160,929 m^3 of treated excavated waste material will potentially be suitable for reuse at Pool Wood Embankment.

Should there be a shortfall then suitable materials may potentially be sourced from elsewhere on sublots 5 and 6 of the HS2 development. At this time the precise locations are not known. As a result, a robust waste acceptance procedure will be adopted for all wastes received and accepted at the site. Additional waste types have been included within **Table 3** should this be required.

Records will be collected and retained to show the source of any deposited wastes and the testing that was undertaken to ensure its suitability.

The waste materials that could be deposited at the site can be categorised as outlined in **Table 3** below. All wastes will be characterised using the waste classification technical guidance WM3.

Table 3: Permitted Waste Types

EWC Code	Description
01	WASTES RESULTING FROM EXPLORATION, MINING, QUARRYING AND PHYSICAL AND CHEMICAL TREATMENT OF MINERALS
01 01	**Wastes from mineral excavation**
01 01 02	Waste from mineral non-metalliferous excavation
01 04	**Wastes from physical and chemical processing of non-metalliferous minerals**
01 04 08	Gravel and crushed rocks other than those mentioned in 01 04 07
01 04 09	Waste sand and clays
17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
17 01	**Concrete, bricks, tiles and ceramics**
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Tiles and ceramics
17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 05	**Soil, stones and dredging spoil**

EWC Code	Description
17 05 04	Soil and stones, including chalk, other than those mentioned in 17 05 03*
17 05 06	Dredging spoil other than those mentioned in 17 05 05*
17 05 08	Track ballast, other than those mentioned in 17 05 07*
19	WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE
19 12	**Wastes from the mechanical treatment of waste (e.g. sorting, crushing, compacting, pelletising) not otherwise specified**
19 12 05	Glass (for fill purposes only, not for use in restoration top layer)
19 12 09	Minerals (for example sand and stones)**
19 12 12	Crushed bricks, tiles, concrete and ceramics, including mixtures of materials***
19 13	**Waste from soil and groundwater remediation**
19 13 02	Solid wastes from soil remediation other than those mentioned in 19 13 01

*Where clean naturally occurring topsoil is received from the cover layers, then this may be used within the topsoil subject to suitability and agreement with the DJV land quality lead.

**Excludes fines from treatment of any non-hazardous waste and gypsum from recovered plasterboard.

***Can comprise of the following –

- Soil substitutes other than those containing dangerous substances only – should not include hazardous waste or dangerous substances. The soil substitute must be free from contaminants such as asbestos fragments, plastics, glass, metals, treated timber, foils and films. If deposited in place of non-waste topsoil it must meet the British Standard for topsoil BS 3882:2015
- Crushed bricks, tiles, concrete and ceramics, including mixtures of materials - excludes metal from reinforced concrete, fines form treatment of any non-hazardous waste and gypsum from recovered plasterboard.

3 COMPLIANCE POINTS

3.1 Groundwater

The Environment Agency have defined Source Protection Zones (SPZs) for 2,000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones and a fourth zone of special interest, which the Environment Agency occasionally applies, to a groundwater source. Within the SPZs the Environment Agency seek to restrict certain potentially polluting activities, with the most onerous restrictions applied to Zone 1. The development of the site would be undertaken in a manner to ensure that no contamination of groundwater occurred.

The proposed development site is not identified by the Environment Agency as being located within a source protection zone.

As documented in the Pool Wood Embankment Land Quality Management Report (**Appendix B of this report**), the site and wider are at have been subject to a series of ground investigation between 2017 and 2023. Over this period 34 exploratory holes were formed using percussive, rotary, and trial pitting methods up to a maximum depth of 35.6 mbgl.

Although there is uncertainty in deriving a flow direction within the Glaciofluvial Deposits, (due to the linear arrangement of the monitoring wells), considering the topography of the area, and the presence of a major watercourse (River Blythe) to the east of the site, the local groundwater flow direction is anticipated to be easterly, towards Coleshill Pool.

3.2 Surface Water

Coleshill and Bannerley Pools located ~350 m east (down hydraulic gradient) of the site represent the most sensitive surface water features in the area. As indicated it is unlikely that contaminants originating from the site would impact groundwater quality, therefore are unlikely to affect water quality and aquatic life at the pools.

All surface water drainage discharging from the bund (surface runoff, groundwater from GLD pore water dissipation and porewater contained in the deposited waste materials) will be conveyed to a land drain at the western toe of the site. From here it will be flow south, pass east through Pool Wood culvert into attenuation ponds and then continue to flow south along the M42 drain systems eventually discharging into Hollywell Brook ~2.9 km south of site.

As a precautionary approach and to provide added protection to groundwater, the western toe drain up to Pool Wood culvert and to the east of the culvert up to its point of discharge into the M42 highway drainage system will be lined (synthetic or using low permeability materials). Post construction, it is unlikely that surface waters originating from the site would interact with the underlying ground or discharge into the Coleshill Pool area.

The risks to the drainage system, Hollywell Brook, and the need for control measures will be assessed in a Risk Assessment produced in accordance with the EA's H1 methodology (see **Appendices B and C of the Environmental Risk Assessment**).

3.3 Air

There are no proposed direct or indirect discharges to air from the proposed development This section of the ESSD is not considered to be applicable.

In addition, the site does not fall within an Air Quality Management Area for PM10 and NO2.

A ground gas risk assessment has been completed (see **Appendix D of the permit application**) to assess the risks associated with the placement of materials from MBL at the site. The report concluded that risks to offsite human health and property is negligible.

3.4 Amenity

Risks to amenity have been fully assessed within the Environmental Risk Assessment (**Appendix E of the permit application**).

Receptors that have been considered at and closest to the site include the following:

- People and property
  - Residential areas - The nearest properties are located to the north and west with the nearest being approximately 250 m to the north.
- Education and Health
  - The closest school is located 550 m to the northwest of the site.
  - The closest health facility is located 620 m southwest of the site.
- Commercial businesses
  - Birmingham Business Park is located to the south and west of the site.
- Public access/footpaths/playing fields
  - Bluebell Recreation Ground is located 120 m north of the site.
- Animals/ecology/habitats
  - Coleshill and Bannerly SSSI is located 350 m east of the site.

The risks that have been assessed further include:

- Fugitive Surface Emissions (including mud & debris, dust, odour, litter and pests).
- Noise and Vibration.
- Uncollected Run-off Water.
- Accidents (acceptance of unknown soils, fuel storage and on-site fuelling, equipment failure and vandalism).

The Environmental Risk Assessment has concluded these risks to be low/negligible based on location, the nature of the proposed waste activities and the management measures in place. Controls to mitigate the risks are identified within the Environmental Risk Assessment and also discussed further in **Section 4**.

4 POLLUTION CONTROL MEASURES

The Environmental Risk Assessment (ERA) prepared for the permit application addresses the risks on site and outlines a number of methods to mitigate these risks. The following section provides some more detail on the control measures to be implemented to mitigate the effects of emissions and accidents at the site.

4.1 Potential Risk: Emissions

4.1.1 Control of Mud and Debris

Waste material will comprise of off-site wastes, primarily comprised of treated excavated materials from MBL. Suitable wastes from other sources will only be received and deposited should additional material be required and available.

The deposit of material on the public highway will be treated as an emergency and will be cleaned with a road sweeper.

Site staff, drivers and other personnel on site will be asked to report to the site manager should they observe excessive mud and debris on roads so that the appropriate actions can be taken.

The following will be adopted at the site to ensure mud and debris are not deposited off site:

- Visual assessment for the presence of any debris on vehicles as they leave the site.
- Vehicles will be required to undergo wheel washing prior to leaving site using the facilities provided.
- Vehicle running surfaces across the site area will have a top layer of road plannings where possible and any turning and unloading area surface will comprise of well compacted hardcore.

4.1.2 Control of Dust

All site operations will be carried out to minimise the creation of dust. Formal inspections for the appearance of dust at the site boundary, within the Site and on the access road into the site will take place at regular intervals throughout the day and on a daily basis.

Water will be made available during dusty conditions. If dust is observed the operator will use the hose to spray any access roads leading though the site, any dusty surfaces and stockpiled soils and waste to minimise excessive dust generation.

Vehicles will be limited in speed to 10 mph to help minimise the generation of dust and the site access route and roads will be maintained to prevent dispersal.

Stockpiles on site will be managed sufficiently in terms of maximum heights for material heights and construction.

Site staff will continually monitor the activities on site and take appropriate action in the event of excessive dust generation. Staff and other users of the site will be asked to report any excessive dust to the site management so that the appropriate actions can be taken.

Works will stop immediately if dust from operations on site is posing a risk to local businesses and/or adjacent residents. Monitoring may be required on site in the form of frisbees.

A Dust Management Plan (**Appendix H of the permit application**) for the site has been developed to discuss in detail appropriate control methodology to be employed on site during operation of the works.

4.1.3 Odour Control

In the highly unlikely event that malodorous waste is brought on site it will be quarantined and covered before it is determined the most appropriate method to treat the waste or remove it from site.

As accepted waste is unlikely to produce odour, an Odour Management Plan is not required.

4.1.4 Litter Control

Litter is unlikely to present a problem due to the waste accepted on site. However, daily inspections of the site will be carried out for the presence of any windblown litter and site operatives will be instructed to collect any litter and place it in a designated skip/container for disposal/recovery before the end of the working day.

4.1.5 Control of Pests

It is highly unlikely that vermin will present a problem because of the waste types handled at the site. However, presence of a pest control contractor will be arranged within 48 hours if any problems are encountered. The site will be inspected daily for the presence of vermin and any actions noted in the site diary or site inspection form.

4.1.6 Control and Monitoring of Noise and Vibration

It is not anticipated that site operations will cause a noise or vibration nuisance to the surrounding areas and therefore a Noise Impact Assessment is not required. However, the Best Practicable Means will be employed on site at all times to ensure that all plant and equipment do not exceed what is considered to be background noise levels.

The following control measures will be in place to manage noise disruption at the site:

- Waste vehicle movements in and out of site will be limited, it's as discussed it is very unlikely that waste from off-site will need to be brought into the site.
- Vehicles will be limited in speed to 10 mph to help minimise noise at the site.
- Core working hours for the site will be Mon-Fri 8am to 6pm and Sat 8am to 1pm. A period of up to one hour before and up to one hour after core working hours are outlined within the sites Construction Environmental Management Plan for start-up and close down activities such as deliveries, workforce arrival/departure, unloading, maintenance and general preparation works etc. During this period plant and machinery that is likely to cause disturbance to local residents will not be allowed to operate.
- Tipper stop-start motion to dislodge soil from the tipper will not be allowed unless absolutely necessary.

- Site equipment/vehicles will be inspected and properly maintained to ensure no loose rattling can occur during site operations.

Site operations are not expected to generate any vibrations that could cause a hazard to the identified receptors. The only site operation that could have produced detectable vibrations is soil compaction. However, this potential risk has been eliminated as operations will be undertaken more than 25 m from any nearby sensitive receptors and by selecting the use of non-vibrating rollers.

A noise and/or vibration management plan is not considered necessary for this site.

4.1.7 Control of Uncollected Run-off Water in Operational Areas

Precipitation run-off from site operations is unavoidable. Precipitation is considered likely to collect on the exposed site surface soils and eventually infiltrate the ground.

Silt management plans will be prepared if required.

Groundwater monitoring is ongoing and the assessment of results will identify whether any mitigation measures for infiltration are required.

Where high precipitation events and storms are predicted any surface water which does not infiltrate the ground will either be removed by tanker to a suitably permitted facility and/or an Environmental Permit will be obtained by the contractor to discharge surface water to a suitable receptor.

Daily inspections will be carried out during periods of high/intense precipitation event.

4.2 Potential Risk: Accidents

4.2.1 Reuse of Unknown Soils

The reuse of waste materials accepted at site will be carried out in accordance with the (**Appendix D**).

4.2.2 Acceptance of Unknown Soils

All incoming wastes will be assessed and if the analyses meet site acceptance criteria (as detailed in **Reference G of the permit application**), then the soil will be approved for acceptance.

Waste transfer documentation will be checked to ensure the description is accurate.

It may also be necessary to undertake some verification sampling and chemical testing of waste soils assigned to the site. For homogeneous waste, each waste stream or waste source must be sampled and tested to ensure compliance.

4.2.3 Fuel Storage and Fuelling Hazards

Fuel storage will be in compliance with The Control of Pollution (Oil Storage) (England) Regulations 2001. Any mobile filling bowsers will have taps and valves which are locked and locked when not in use and pipework will be fitted with manually operated pumps with a lockable valve.

4.2.4 Equipment Failure and Vandalism

Equipment will be stored in a designated secure area of hard standing on site. A visual inspection of site equipment will be made each day before work commences. If a leak is identified from a fuel line or hydraulic hose, then the machine will not be used until the leak is fixed. A spill kit will be used to contain and clean-up contamination.

If a leak occurs during operation on the site, then the affected equipment will cease operation. A spill kit, kept with the equipment, will be deployed to absorb any spillage and therefore minimise further contamination. An on-site repair will be made as quickly as possible to stop the leak. If any soil has been contaminated, then the affected area will be excavated and removed from site in a skip. The contaminated soil will be sampled and analysed so that the material can be disposed of to the correct licensed facility.

4.3 Post Closure

Post remediation, on the assumption that the SSAC are adhered too, the reuse of material sourced from MBL should present a low risk to human health and controlled waters post development. Whilst individual determinants will meet the SSAC, the inherent design of the site and ground conditions will also limit/prevent interaction between the placed MBL sourced materials, human health, and controlled waters.

It is currently assumed that 12 months of post-construction monitoring will be required to demonstrate that operations associated with the placement of MBL sourced materials at the site has not significantly impacted on water quality. However, if analytical data consistently demonstrates compliance with baseline conditions, with stakeholder approval, the post construction monitoring timeframe and range of determinants tested could be reduced. Conversely, should post construction monitoring demonstrate non-compliance and persistently elevated determinant concentrations, in consultation with stakeholders' intervention measures would be considered and/or the monitoring programme be extended.

Post development, the site and wider landscape bund will be covered in subsoil and topsoil and a grassed landscape condition similar to the pre-development agricultural land grassed fields with a greater diversity of grasses comprising species rich and heath grassland planting. The ownership of the site and wider landscape bund will be retained and maintained by HS2 post development. Consequently, the area will be fenced off with no public access. Only maintenance workers will need periodic access to the site post development to prevent overgrowth of vegetation and inspections of the HS2 trace. The species mix for the landscape bund grassland planting will be selected for slope stability and robustness as well as amenity and biodiversity.

4.4 Complaints Procedure

All complaints will be noted in the site diary and a record of the complaint, including any action taken to alleviate the problem will be recorded.

5 MONITORING

Although the assessment undertaken indicates that material from MBL combined with the site design and mitigation measures to be employed should present a low risk to controlled waters and human health monitoring and testing will be undertaken to ensure that:

- Risks associated with material placement at the site primarily to groundwater and surface waters remain low.
- The effects (if any) on water quality and potential risks to groundwater and surface water associated with excavation and construction works are fully assessed.
- An early warning system to detect if there is a departure from baseline conditions that could be reasonably attributed to the placement of landfill material at the site is present.
- To ensure a robust dataset is available to support the future surrender of the environmental permit.

5.1 Weather

Monitoring of weather is not considered to be applicable to the operations at the site. However, should it be required meteorological information can be collected and recorded using the Met Office local weather information website and will include:

- Total rainfall.
- Prevailing wind direction and strength.

5.2 Groundwater and Surface Water

Routine surface water and groundwater analytical testing will be undertaken at designated surface water and groundwater monitoring points in the vicinity of the site before, during and after operations.

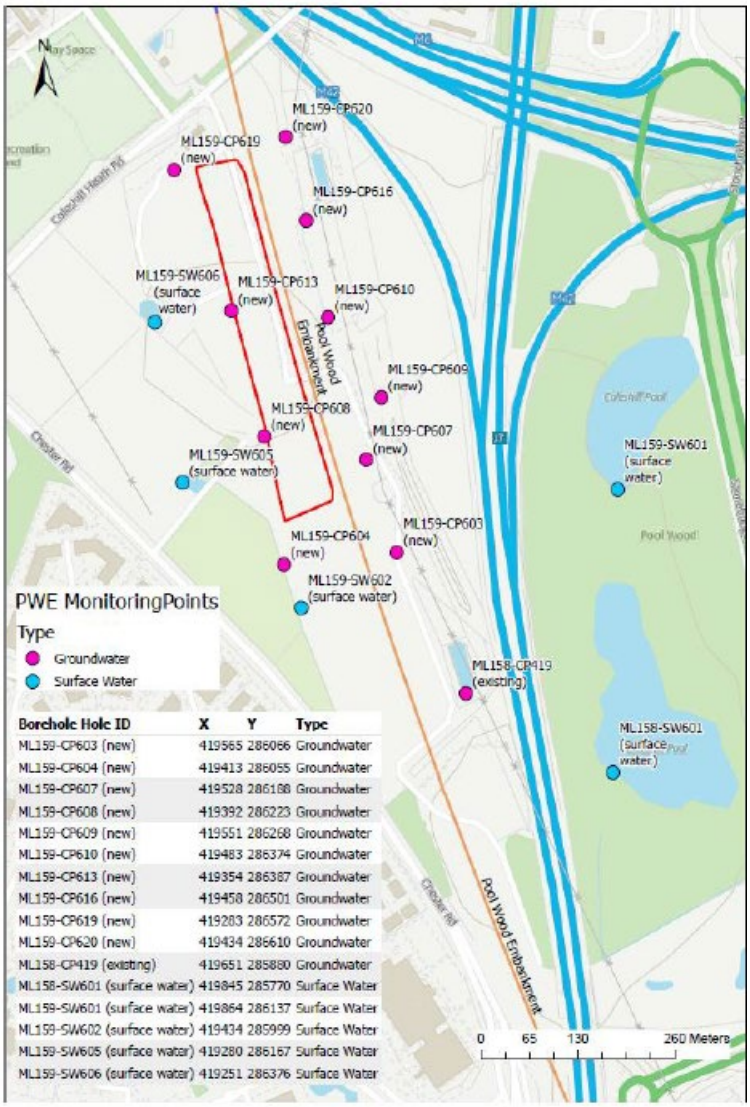
Where possible groundwater and surface water sampling locations will be situated both up and down gradient of the site to allow comparison with background locations/conditions.

Monitoring/sampling locations will remain serviceable and present for the duration of the monitoring programme.

Where possible existing monitoring/sampling locations have been selected. However, discussions with BBV have indicated that many of the existing monitoring locations at and in the vicinity of the site have or will be decommissioned to accommodate the future construction of the asset and/or are unlikely to remain serviceable or present for the duration of the monitoring programme.

One existing groundwater monitoring well and ten new groundwater wells to be installed will provide sufficient network coverage. All wells will be installed in the Glaciofluvial Deposits.

One existing and four new surface water sample locations have been selected to form part of the monitoring network. The location of the existing and new groundwater and surface water monitoring/sampling locations is shown in **Figure 5**.



Borehole Hole ID	X	Y	Type
ML159-CP603 (new)	419565	286066	Groundwater
ML159-CP604 (new)	419413	286055	Groundwater
ML159-CP607 (new)	419528	286188	Groundwater
ML159-CP608 (new)	419392	286223	Groundwater
ML159-CP609 (new)	419551	286268	Groundwater
ML159-CP610 (new)	419483	286374	Groundwater
ML159-CP613 (new)	419354	286387	Groundwater
ML159-CP616 (new)	419458	286501	Groundwater
ML159-CP619 (new)	419283	286572	Groundwater
ML159-CP620 (new)	419434	286610	Groundwater
ML158-CP419 (existing)	419651	285880	Groundwater
ML158-SW601 (surface water)	419845	285770	Surface Water
ML159-SW601 (surface water)	419864	286137	Surface Water
ML159-SW602 (surface water)	419434	285999	Surface Water
ML159-SW605 (surface water)	419280	286167	Surface Water
ML159-SW606 (surface water)	419251	286376	Surface Water

Figure 5. Location of Groundwater and Surface Water Monitoring points (Source: Hydrogeological Risk Assessment)

Within a week following well installations, monitoring/sampling will be completed weekly. Commencement of monitoring will begin at least eight weeks prior to the placement of waste at site.

Once the deposition of waste materials starts, monitoring will be undertaken on a monthly basis. This will continue until twelve months after all material has been placed within the landscape bund. Assuming there is no impact to groundwater quality or water quality after this period of time monitoring will be undertaken every two months until the environmental permit can be surrendered.

The Hydrogeological Risk Assessment outlines the analysis that will be undertaken.

5.3 Gas monitoring

A Ground Gas Risk Assessment (**Appendix D** of this report) has been prepared. It concludes that as the most potentially contaminating materials will be removed from the waste material accepted for reuse, and as there will be a granular drainage blanket and above ground level, the risk of lateral migration of gas will be minimised.

As a result the gas generation resulting from the material placed is unlikely to cause significant impacts and the risks to human health and property post development are considered to be very low.

Therefore no further gas protection measures or gas monitoring are required.

Should ground gas be identified as an issue, a programme of monitoring will be proposed and agreed with the Environment Agency.

APPENDICES

APPENDIX A
SERVICE CONSTRAINTS

1. Service Constraints

1.1. This Report (the “Report”) and any study, inspection, investigation, sampling, testing and or interpretation carried out in connection with the Report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) trading as Carbon Zero Consulting, Leap Environmental or RSK Geosciences, for the Client named in the first paragraph of the Report (the "Client") in accordance with the terms of an RSK Fee Proposal including RSK Environment Standard Terms and Conditions (the “Appointment”) between RSK and the Client, unless otherwise stated in the first paragraph of the Report. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by a geo-environmental consultant at the time the Services were performed. Nothing in this Report shall be construed as imposing any fitness for purpose obligation. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the Client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.

1.2 Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services. RSK shall not be liable in respect of any action or proceedings arising out of or in connection with this Report whether in contract, in tort, for breach of statutory duty or otherwise after the expiry of six (6) years from either (i) the date of the Report or (ii) such earlier date as prescribed by law, unless varied in the terms of the Appointment.

1.3 Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent, or condone any party, other than the Client relying upon the Services. Should this Report or any part of this Report, or details of the Services or any part of the Services, be made known to any such party, and such party relies thereon, that party does so wholly at its own and sole risk, and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent geo-environmental consultant and/or lawyer.

1.4 The Client shall not, without the prior written consent of RSK, assign, transfer, charge, mortgage, subcontract, or deal in any other manner with all or any of the benefits provided in this Report. Unless specified in the Appointment, RSK shall not be obliged to assign the benefit of the Report whether by collateral warranty, third party rights pursuant to the Contracts (Rights of Third Parties) Act 1999, letter of reliance or otherwise. If RSK agrees to any assignment of the benefit of this Report, in whatever form, benefits to third parties through collateral warranties, third party rights or letters of reliance shall not be provided unless a fee for each right, warranty or letter is agreed. The form of wording used in the warranty or letter shall be provided by RSK for agreement by the Client. Any reasonable changes to the form of wording will be implemented by mutual agreement, however the terms in the warranty or letter cannot offer the third party any greater benefit than the Appointment offered to the Client.

1.5 It is the understanding of RSK that this Report is to be used for the purpose described in the introduction to the Report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the Report is used, or the proposed use of the site change, this Report may no longer be valid and any further use of or reliance upon the Report in those circumstances by the Client without the review and advice of RSK shall be at the Client's sole and own risk. RSK shall not be liable for any use of this Report for any purpose other than that for which it was provided.

1.6 The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the Report inaccurate or unreliable. The information and conclusions contained in this Report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the Report in the future shall be at the Client's own and sole risk.

1.7 The observations and conclusions described in this Report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out, or required by the Appointment between the Client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this Report, RSK did not seek to evaluate the presence on or off site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas, fuel storage, persistent bio-accumulative or toxic chemicals (including PFAS and related compounds) or other radioactive or hazardous materials, unless specifically identified in the Services.

1.8 The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of desk based publicly available information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services and the limitations below:

a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.

b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.

c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the Client or third parties, including laboratories and information services, during the performance of the Services.

d. The Client has identified in writing to RSK, the information, reports, findings, surveys and preliminary works RSK may not rely upon when providing the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK, and including the doing of any independent investigation of the information provided to RSK, save as otherwise provided in the terms of the Appointment between the Client and RSK.

1.9 Any site drawing(s) provided in this Report is (are) not meant to be an accurate base plan for scale measurement but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for accurate setting out and should be considered indicative only.

1.10 Should RSK be requested to review the Report after the date of issue of this Report, RSK shall be entitled to additional payment at the existing rates, or such other terms as agreed between RSK and the Client.

2. Service Constraints where the Report provides an intrusive assessment of ground conditions:

2.1 The intrusive environmental ground investigation aspects of the Services are a limited sampling of soil from the site, at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this Report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent

of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope agreed between the Client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species (not tested) are not present.

2.2 The comments given in this Report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. The extent of the exploratory holes, laboratory testing and monitoring undertaken may have been restricted due to a number of factors including accessibility, the presence of buried or overhead services, current development, site usage, timescales or the Client's specification. The exploratory holes only assess a small proportion of the site area with respect to the site as a whole, and as such may only provide an indicative assessment of ground conditions on site. There may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised. The presence of hotspots of undisclosed contamination or exceptional and unforeseen ground conditions cannot be discounted.

2.3 Where the Services include Investigation of an exploratory nature or relating to physical ground works, any costings and prices provided in the Report are estimated and provided for guidance purposes only. The actual cost and time quantities shall be remeasured and shall be dependent upon the ground or other conditions, constraints present, and number and depth of the investigation locations, which shall influence the number of samples and tests required, and the quantities of soil being classified.

2.4 Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works. However, this Report does not constitute an asbestos survey. On this basis, the presence of asbestos on site cannot be discounted and a full asbestos survey should be undertaken.

2.5 Unless stated otherwise, only preliminary geotechnical recommendations are presented in this Report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed. Eurocode 7 gives guidance on the type of sampling, sample quality, number and spacing of intrusive investigations, and number of laboratory tests required. It is intended that the Geotechnical Information section of this Report will fulfil the general requirements of the Ground Investigation Report as set out in section 6 of Eurocode7, although this is subject to the restrictions imposed on the investigation, as listed above. For geotechnical design, Eurocode 7 requires the Geotechnical Design Report to address both the geotechnical and structural aspects of the geotechnical design for both the limit and serviceability states. The Geotechnical Appraisal section of this Report will not meet the requirements of a Geotechnical Design Report (GDR) and should therefore be used for preliminary guidance only.

3. Service Constraints where the Report relates to Surface Water Management:

3.1 The Surface Water Management Inspection (SWMI) Report, documents provided, observations, actions, and recommendations, with respect to the management of potential pollution issues to surface waters, made during the site Inspection visit, are those present at the time of the visit, and may not represent those recorded by others on the same day.

3.2 The comments given in this Report and the opinions expressed are based on the weather, ground and ground water conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the inspection and therefore could not be taken into account. In addition, groundwater levels and flows, may vary from those Reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.

3.3 RSK places a degree of dependence upon oral information provided by site representatives, which is not readily verifiable through visual inspection, or supported by any available written documentation. RSK shall not be held responsible for conditions or consequences arising from relevant facts that were not fully disclosed by facility or site representatives at the time this Report was prepared.

3.4 This Report is a live document, to be continually reviewed and updated as the development progresses or other changes occur on site. RSK can only maintain the currency of this Report through the Client requesting support with supplementary site visits or attendance at meetings ahead of key stages of the development in relation to surface water management. Our risk rating assesses a number of risk factors in line with the source-pathway- receptor model and is therefore subject to constant change.

3.5 Standard design drawings are indicative. Material types, dimensions and construction details will need to be adjusted by the Client to suit the specific conditions / flows on Site.

3.6 The full responsibly for implementing the site-specific protection and maintenance measures to protect the surface water system as stated in this Report, remains with the Client and their site management team. Additional control measures may be required to achieve the objectives set out in the Surface Water Management Plan to be implemented and financed by the Client.

4. Service Constraints where the Report relates to Waste Management:

4.1 In accordance with the definition provided in the Waste Framework Directive (WFD), materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Naturally occurring soils are not considered waste if re-used on the site of origin for the purposes of development. Soils such as made ground that are not of clean and natural origin (irrespective of whether they are contaminated or not) and other materials such as recycled aggregate, do not necessarily become waste until the criteria above are met. Excavation arisings from the development may therefore be classified as waste if surplus to requirements and/or unsuitable for re-use.

4.2 It is the duty of the waste producer, to ensure that all waste is accurately classified prior to waste disposal. Technical Guidance WM3 (EA, 2018) sets out in its Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. Unless otherwise stated, the waste assessment presented in this Report should be considered as preliminary and further testing and assessment of the waste under the provisions of a Waste Sampling Plan may be required to obtain the necessary level of data required for basic characterisation of the waste in support of disposal.

4.3 Unless stated otherwise in the Report, information relating to historical operations at the site was not reviewed as part of the assessment by RSK. In addition, unless otherwise stated in the Services, RSK was not present during the collection of the samples nor had any input on the chemical testing suite. Therefore, the waste assessment and classification detailed in this Report are based solely on any information that were provided to RSK (e.g., laboratory chemical data, exploratory hole records) and were completed without prejudice for our Client.

4.4 RSK's assumes that any ground investigation data, chemical testing results etc., that were provided by the Client to inform the waste assessment and supporting review were carried out in accordance with current best practice and relevant guidance/ standards, where applicable. Thus, the

comments given in this Report and the opinions expressed are based solely on the information provided by the Client. However, it is noted that there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account as part of the RSK assessment.

5. Service Constraints for Construction Environmental Management Plan Reports:

5.1 This Report should be considered in the light of any changes in legislation, statutory requirement or industry practices that may have occurred subsequent to the date of issue.

5.2 The measures and comments outlined in this Report and any opinions expressed are based on the plans provided at the time and discussions with relevant parties. However, there may be conditions pertaining to the site that have not been disclosed by investigations and therefore could not be taken into account.

5.3 This CEMP is a live document and is subject to change throughout the project, as and when necessary, to ensure management of environmental aspects remains relevant, and to ensure continued compliance with legislation and commitments as they may change. RSK understands that this CEMP will be reviewed by the Client every six months and updated as and when necessary.

5.4 It is the full responsibility of the Principal Contractor/ Client to ensure that their works do not contravene legal requirements, and adherence to this CEMP alone cannot be a full defence regarding legal action against the Principal Contractor.

6. Service Constraints where the Report relates to Ground Gas Membrane Verification:

6.1 This Report is limited to the verification of the gas resistant membrane/vapour membrane/ radon barrier after installation and no inspections were undertaken of the substrate (i.e. prepared ground). The Report therefore does not constitute as a full verification of ground gas protection system.

6.2 The comments given in this Report and the opinions expressed, are based on the condition of the ground gas membrane as encountered at the time of inspection by suitably qualified personnel. RSK cannot accept liability for any subsequent change to the status of the gas membrane by follow-on trades or other construction activity.

6.3 Where not designed by RSK, the verification of protection measures is carried out with reference to the gas protection design provided by the Client. RSK assume the scope of gas protection measures as determined by third parties to be correct and to have achieved any required approval from authorities.

6.4 The Ground Gas Design Report/Remediation Strategy and Verification Plan contains details of the procedures to be adopted for inspection and validation of the works. However, it should be noted that responsibility for the correct implementation of the strategy lies with the appointed contractor. RSK cannot be held responsible for any remedial works that are carried out without the agreed procedures involving either direct supervision by RSK, or inspection and validation of the works by a representative from RSK.

7. Service Constraints for Environmental Due Diligence (EDD)Reports:

7.1 The comments given in this Report and the opinions expressed are based on the information obtained and reviewed as part of the desk-based assessment. However, there may be conditions pertaining to the Site that have not been disclosed by the assessment and therefore could not be taken into account. Furthermore, no intrusive investigations, monitoring or sampling have been undertaken to confirm the environmental status of the site, therefore any comments relating to ground conditions and subsurface contamination are based solely on a review of desk-based information.

7.2 This Report describes the results of the EDD exercise. The scope of this EDD Report, where appropriate, covers legal or regulatory compliance with respect to UK or international regulations associated with environmental matters.

7.3 As with any EDD exercise, there is a certain degree of dependence upon information provided by the target company. The EDD does not include a site walkover / visit or liaison with site representatives unless identified in the Services. Therefore, the assessment is based on the available desk study information. Also, there is a certain degree of dependence upon oral information provided by site representatives, which is not readily verifiable through visual inspection, or supported by any available written documentation. RSK shall not be held responsible for conditions or consequences arising from relevant facts that were not fully disclosed by facility or site representatives at the time this EDD exercise was performed.

7.4 This Report, including all supporting data and notes (collectively referred to hereinafter as "information"), was prepared or collected by RSK for the benefit of its Client.

7.5 The comments given in this Report and the opinions expressed are based on the information obtained and reviewed as part of the desk-based assessment and the site inspection visit. However, there may be conditions pertaining to the Site that have not been disclosed by the assessment and therefore could not be taken into account. Furthermore, no intrusive investigations, monitoring or sampling have been undertaken to confirm the environmental status of the Site therefore any comments relating to ground conditions and subsurface contamination are based solely on a review of desk-based information and observations collected during the site inspection visit.

8. Service Constraints for Ground source heat energy Reports:

8.1 It is understood that this is a desktop survey only and that there are no requirements for a site walkover, service utility survey, or provision of service plans. These services can be provided upon request if required.

8.2 At a later stage, it is possible that a thermal response test (TRT) will need to be completed, for which a test borehole will have to be drilled, and these would be costed at the time. RSK can provide all aspects of subsequent site work for a GSHP system if required.

9. Service Constraints for Water Abstraction Borehole Reports:

9.1 The Report aims principally to only identify and assess the suitability of the site for a water abstraction borehole. This Report should be considered in the light of any changes in legislation, statutory requirements, and industry practices, that have occurred subsequent to the date of the Report.

9.2 Unless stated in the Report, the opinions expressed in this Report including all comments and recommendations provided are on the basis of the information obtained from a desk-based assessment.

APPENDIX B
LAND QUALITY MANAGEMENT REPORT, NOVEMBER 2024 (1MC09-BBV_MSD-EV-REP-NS04_NL10-100167 REV. C02)

Balfour Beatty VINCI Working on behalf of HS2

Contract No. 1MC13

Pool Wood Embankment Land Quality Management Report

Document Number: 1MC09-BBV_MSD-EV-REP-NS04_NL10-100167

Current Revision	Author	Reviewed By	Approved By	Date Approved	Reason for Review
C02	D. Littig J Olsen	M Bickley	Remant Doorgakant/A Mobbs	28/11/2024	For HS2 Acceptance

Stakeholder Review Required (SRR)

☐ Yes – Please Specify Below

☒ No

Purpose of SRR

☐ Comment

☐ Information

☐ Approval

Handling Instructions: Produced by BBV for project use only

Review Required

Team	Yes/No	Name	Position	Date
Quality				
Health & Safety				
Environment & Sustainability				
Other teams if required				

Revision History

Previous Revision	Author	Reviewed By	Approved By	Date Approved	Reason for Review
P01	D. Littig	J. Olsen M. Bickley T. Hodges	N Matharu	17/03/2022	S3 For comment
C01	D. Littig	J. Olsen M. Bickley T. Hodges	N Matharu T Baxendale	29/03/2022	For HS2 Acceptance
P02	D. Littig J Olsen	M Bickley	Remant Doorgakant	22/07/2024	S4-Fit For Stage Acceptance
P03	D. Littig J Olsen	M Bickley	Remant Doorgakant	21/11/2024	S4-For HS2 Acceptance
C02	D. Littig J Olsen	M Bickley	Remant Doorgakant/A Mobbs	28/11/2024	For HS2 Acceptance

Revision Summary

Paragraph Modified	Details of Modification

Contents

1 SCOPE AND PURPOSE

This report is applicable to all activities undertaken by the Balfour Beatty VINCI Joint Venture (BBV) and its supply chain on the Main Works Civils Contracts (MWCC) for Sectors N1, project references [1MC08] and [1MC09] (referred to in this document as the Project) for the provision of Design and Construction services in accordance with the requirements of the contract.

It describes how land quality will be managed on the project to ensure that the objectives identified in section 5 are met or exceeded. This report, together with the processes included in the BBV Way and any associated documents listed in section 2.3 meet the requirements of the contract (as specified in the documents listed in section 2.1) and the standards listed in section 2.2. The report should be read in conjunction with the documents listed in section 2.3.

This report is written on the basis that BBV are able to undertake their business in the normal manner. Where significant disruption occurs that fundamentally affects the implementation of this report (e.g. health pandemic), an addendum will be prepared to describe how the requirements of this document shall be modified for the duration of the disruption. Once any period of disruption has ended, the addendum shall be withdrawn and BBV shall revert to the current version of this document.

2 REFERENCE DOCUMENTS

2.1 Contract

Document Title	Document Number
HS2 Technical Standards (Water Resources and Flood Risk Consents)	HS2-HS2-EV-STD-000-000015
HS2, “Environmental Statement, Volume 5: Land quality CFA 19: Coleshill Junction”. November 2013.	ES 3.5.2.19.8
HS2, “Environmental Statement, Volume 5: Water resources assessment (WR-003-019) CFA 19: Coleshill Junction”. November 2013.	ES 3.5.2.19.13
HS2 Geo-environmental Report for Sub Lots 5 and 6	1MC09-BBV_MSD-EV-REP-N002-100042

2.2 Standards

This report has been produced in accordance with the following technical standards and regulatory guidance documents:

- ISO 9001: 2015 Quality Management System
- ISO 14001: 2015 Environmental Management System
- ISO 45001: 2018 Occupational Health and Safety
- Land Quality Technical Standard (HS2-HS2-EV-STD-000-000027 P05)

- Groundwater Technical Standard (HS2-HS2-EV-STD-000-000010 P07)
- Material Management Plan (MMP) Framework Technical Standard (HS2-HS2-EV-STD-000-000006 P03)
- Environment Agency (2004): “Model Procedures for the Management of Land Contamination”, CLR11 United Kingdom (UK) Government: Land contamination: risk management. https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks
- Environment Agency (2006): “Remedial Targets Methodology: Hydrogeological risk Assessment for Land Contamination”
- Environment Agency (2021): “Land contamination risk management”
- UK Government: Groundwater protection. https://www.gov.uk/government/collections/groundwater-protection
- Environment Agency (2009): “Updated Technical background to the CLEA Model”, Science Report. SC050021/SR3
- Environment Agency (2009): “Human Health Toxicological assessment of contaminants in soil”, Science Report. SC050021/SR2
- DEFRA (2010): “SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document”

2.3 Associated BBV Procedures

Document Title	Document Number
N/A	

2.4 The BBV Way

The BBV Way is the Balfour Beatty VINCI Integrated Management System for the project. It contains the processes that we will use to manage the project – it is held in the following location:

The BBV Way

3 ABBREVIATIONS

AC	Acceptability Criteria
AOD	Above ordnance datum
BBV	Balfour Beatty VINCI
mbgl	metres below ground level
BS	Birmingham Spur
C4SL	Category 4 Screening Level
CCB	Consolidated construction boundary
CL: AIRE	Contaminated land: Applications in real environments
CLEA	Contaminated land exposure assessment
CLR	Contaminated Land Report
COSHH	Control of Substances Hazardous to Health
CSM	Conceptual Site Model
DEFRA	Department for Environment, Food and Rural Affairs
DJV	Mott MacDonald / Systra Design Joint Venture
DoE	Department of the Environment
DoW CoP	Definition of Waste Code of Practice
DS	Design Sulphate
DWS	Drinking Water Standard
DQRA	Detailed Quantitative Risk Assessment
EA	Environment Agency
EIC	Environmental Industries Committee
ES	Environmental Statement
EQS	Environmental Quality Standard
EWC	Enabling Works Contractor
GIS	Geographic Information System
GFDUD	Glaciofluvial deposits – Upper Devensian
GQRA	Generic Quantitative Risk Assessment
HCV	Health Criterion Value
HS2	High Speed Two Limited, also referred to as “HS2” or “EMPLOYER”
IP	Industry Profile
LLAU	Limits of land to be acquired and used
LOD	Limits of deviation

LQ	Land Quality
LQM	Land Quality Management
MBAT	Metals bioavailability assessment tool
MDL	Method Detection Limit
MGR	Made Ground
MM	Mott MacDonald
MMG	Mercia Mudstone Group
MMP	Material Management Plan
MRV	Minimum Reporting Value
MWCC	Main Works Civils Contracts
OS	Ordnance Survey
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PE	Polyethene
PID	Photo Ionisation Detector
POS	Public Open Space
PPE	Personal Protective Equipment
ppm	parts per million
S4UL	Suitable for Use Level
SOI	Scale of Interest
SOM	Scale of Measurement
SPOSH	Significant Possibility of Significant Harm
SPR	Source – Pathway – Receptor
SuRF	Sustainable Remediation Forum
TPH	Total Petroleum Hydrocarbons
WHO	World Health Organisation
WQS	Water Quality Standards
WRAP	Waste and Resources Action Programme

4 RESPONSIBILITIES

Role	Main Responsibilities
D. Littig John Olsen (MM/Systra DJV)	Remediation Strategy/Land Quality Management Report and groundwater risk assessment author
Matthew Bickley (MM/Systra DJV)	Remediation Strategy/Land Quality Management Report Checker
Remant Doorgakant (MM/Systra DJV)	DJV Environment coordinator, Remediation Strategy/Land Quality Management Report Approver
Stephen Phipps (BBV)	BBV Materials Manager, BBV Reviewer
Paul Sandall (BBV)	BBV Contaminated Land Specialist, BBV Reviewer

5 OBJECTIVES AND STRATEGY

Previous investigations at Pool Wood Embankment are detailed within the Environmental Statement (ES)[i] and the Sublot 5 and 6 Geo-environmental Report[ii] (1MC09-BBV_MSD-EV-REP-N002-100042) which assessed the risks to sensitive receptors as moderate/low.

In accordance with the guidance and technical standards listed in Section 2.2; this report is a risk-based assessment of contamination risks to human health, controlled waters and the built environment that develops the Conceptual Site Model presented in the Sub-lot 5 and 6 Geo-Environmental Report through further Generic Quantitative Risk Assessment (GQRA) and a Detailed Quantitative Risk Assessment (DQRA), where applicable, and identifies if pollutant linkages are present and require remedial action. If risks have been identified that require remediation, recommendations on the remediation strategy and the approach to be taken will be provided.

6 DESIGN INFORMATION

6.1 Site location

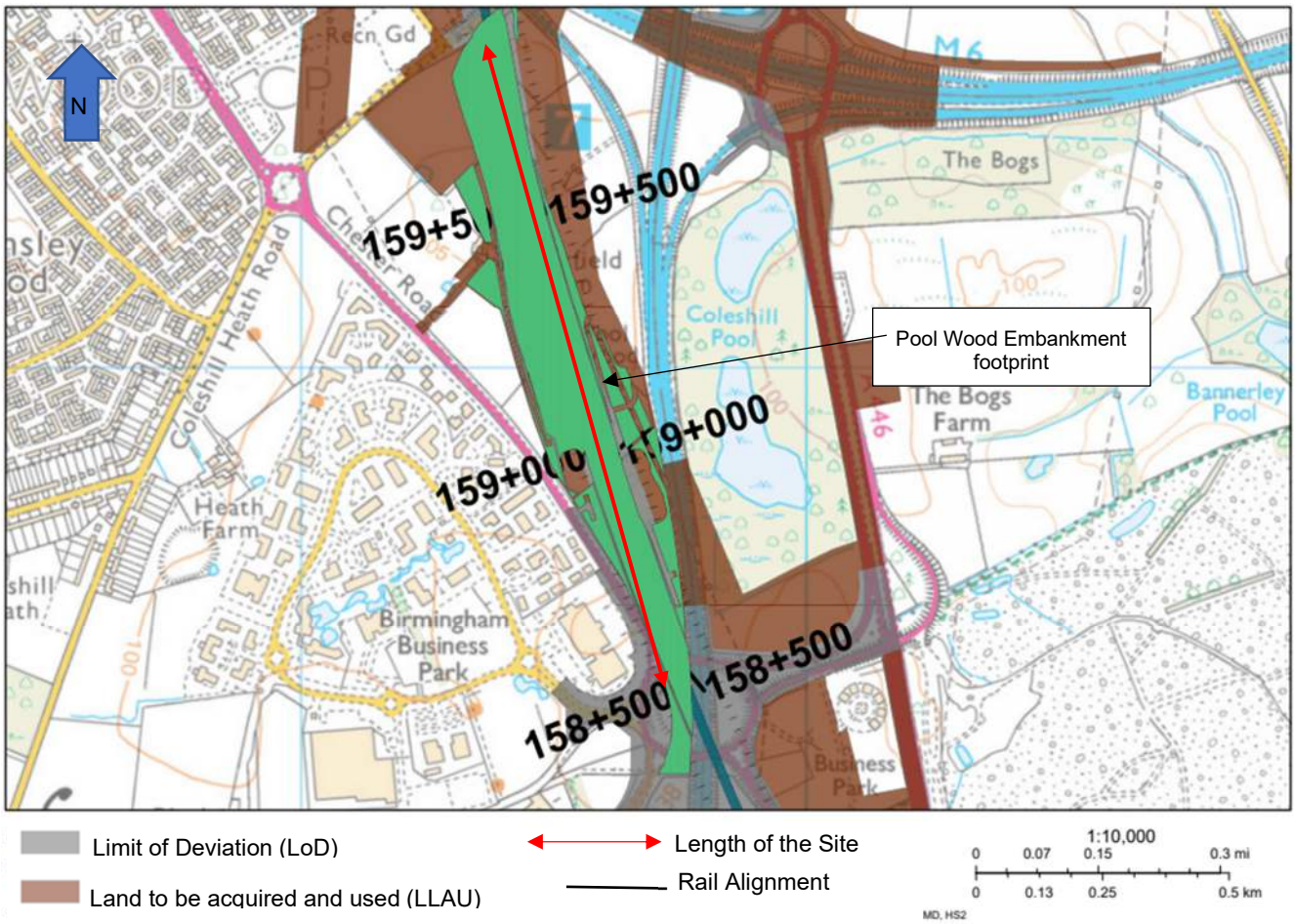
Pool Wood Embankment (PWE) is located ~10km to the south-east of Birmingham City Centre. The M42 motorway and a roundabout is situated at the southern boundary and the M6 motorway is present at the northern boundary. The A446 is present ~450m to the east of PWE and begins to the south of the roundabout and runs alongside the M42 motorway until it encounters the M6 motorway to the north.

It is understood that highways works will be undertaken at the roundabout, as part of the Enabling Works Contract (EWC), therefore, risks associated with land contamination in this area will be managed by the EWC. Consequently, the limits of PWE within this report only considers the area to the north of the roundabout from Chainages (Ch) 158 + 500 to 159 + 915.

It is important to note that the Limit of Deviation (LoD) specify the limits where the scheduled works may be constructed, and Limits of land to be acquired and used (LLAU), is the area that outlines the additional limits for other works (e.g., ancillary works such as the provision of environmental mitigation), as well as the limits of land required in connection with the construction and future maintenance of the project. Contamination sources will be considered within the Area of Concern (AoC), which has been defined as PWE, LOD and the LLAU (hereafter referred to as the 'site'). Potential contamination sources located beyond the AoC are considered to be "off-Site" sources.

For the purposes of this report the 'site' is considered to be the extent of PWE between chainages (Ch) 158+500 to 159 + 915; incorporating all sub-assets within these change limits and the LoD and LLAU. Figure 1 shows the location of the site.

Figure 1 Site location



Source: HS2 Phase 1 MWCC web interface MOATA

6.2 Development proposal

The federated model for the site is located in 1MC09-BBV_MSD-GT-DM3-NS04_NL10-158320, and is shown in Figure 2 and 3.

The length of the mainline embankment track bed will be approximately 1414m. The height of the embankment varies throughout its length, with a maximum height from ground level to the top of the protection layer of approximately 11m (without considering the landscape bund) and has a maximum side slope of 1:3. The width for the embankment is approximately 31m. Dig and replace is proposed for the majority of the embankment to remove areas of soft ground and Made Ground with rigid inclusions proposed from Ch 159+015 to Ch 159+695.

The landscape bund is located to the immediate west of the trace between approximate Ch. 158+920 to 159+760. Once constructed the landscape bund will be approximately 800m long, between 50 and 70m wide and up to 14.5m in height above the neighbouring ground elevations.

With respect to the landscape bund it should be noted that previous iterations of the design incorporated the use of prefabricated vertical drains (PVDs) installed on a grid basis to penetrate the full depth of the underlying soft Glaciolacustrine Deposits, terminating in the Glaciofluvial Deposits.

The PVDs were to be connected to a 750mm drainage blanket situated at the base of the landscape bund and top of the Glaciolacustrine Deposits. In turn, water accumulating in the drainage blanket would discharge into a drainage channel at the western toe of the landscape bund.

The function of the PVD was to ensure the undrained shear strength of the foundation soils (Glaciolacustrine Deposits) would achieve the design parameters though pore water pressure displacement caused by the surcharging effects of the newly placed overburden. However, as documented in two Field Change Requests (1MC09-BBV-DS-CRR-NS04_NL10-000175 and 1MC09-BBV-DS-CRR-NS04_NL10-000173), given the consolidation effects of the Glaciolacustrine Deposits associated with enabling works (stockpiling) the need for the PVDs was removed from the geotechnical design and the thickness of the drainage blanket reduced to 350mm. The main design features of the landscape bund are as follows:

- Dig out and replace of between approximately 1 to 2m of below existing ground elevations to remove soft ground, Made Ground, topsoil/subsoil materials and to accommodate design features.
- The base of the bund will contain an approximate 350mm (6F5) thick granular blanket wrapped in a synthetic geotextile material to reduce the ingress of fines into the blanket to allow the collection of pore water displaced from the underlying Glaciolacustrine Deposits.
- The drainage blanket will be graded with an approximate 2% fall to the west to promote the flow of water to a drainage channel located along the western toe of the site. The same drainage channel will also receive runoff water from the surface of the bund.
- An approximate 900mm thick traffic layer comprising Glaciofluvial Deposits and Mercia Mudstone will be placed above the drainage blanket layer, designed to protect the drainage blanket from plant the movement of plant during construction works.
- The bund will be completed with approximately 1m of clean topsoil and subsoil to provide a suitable growing medium for plant growth. The surface will be sloped (between 1:3 and 1:4 on the external side and 1:3 on the internal side) to promote surface runoff to a land drain located at the western toe of the landscape bund. The western land drain will also be tied into the drainage blanket receiving pore water from the underlying Glaciolacustrine Deposits and any pore water contained in the overlying bund material sourced from MBL (within the permit for waste recovery boundary) and other HS2 locations. All water will be directed south and then east below Pool Wood culvert to the M42. Water will then enter the M42 highway drainage and flow south through culverted drains eventually discharging into Hollywell Brook. It should be noted that although drainage to the M42 is managed under an existing arrangement drainage and flood risk assessment work was ongoing at the time of reporting. It is not envisaged that modifications to the drainage system will affect the overall conceptual understanding of surface water flow from the land drain into the highway drainage system.

From a land quality perspective, the elimination of the PVD removes a series of direct (preferential) pathways, thereby reducing the risks of contaminant migration into the underlying more sensitive and productive Glaciofluvial Deposits, and surrounding surface waters.

It should be noted that the landscape bund will be partly constructed from remediated material originating from Middle Bickenhill Landfill (MBL) located approximately 1.8km south of the site at Ch. 157+125 to 157+375. The landfill materials are to be managed under a Permit for Waste Recovery. Various supporting assessments have been completed to support the permit application which have concluded a low risk associated with the reuse of landfill materials at the bund. The reader is encouraged to review the HS2 report entitled “Hydrogeological Risk Assessment and Material Acceptability Criteria Risk Assessment: Pool Wood Embankment Landscape Bund” 1MC09-BBV_MSD-EV-REP-NS04_NL10-100217. Consultation within the DJV has confirmed that as long at the material originating from MBL adheres to the geotechnical earthwork specification and the site-

specific acceptability criteria as stated in the remediation implementation plan, no mitigation or non-standard measures are required to accommodate the MBL fill.

Several other assets and sub-assets interface with the site, these are the M42 Motorway Box Structure (to the south), Coleshill Heath Road Underbridge (to the north), Pool Wood Culvert located around Ch 158+900 and Ch 158+650 and three balancing ponds at around Ch 158+800, Ch 158+900 and Ch 159+100. The location of these assets and sub-assets can also be seen within Figure 2. It's important to note that this report comprises a detailed assessment solely for Pool Wood Embankment.

Figure 2 Pool Wood Embankment Federated Model viewed from the south

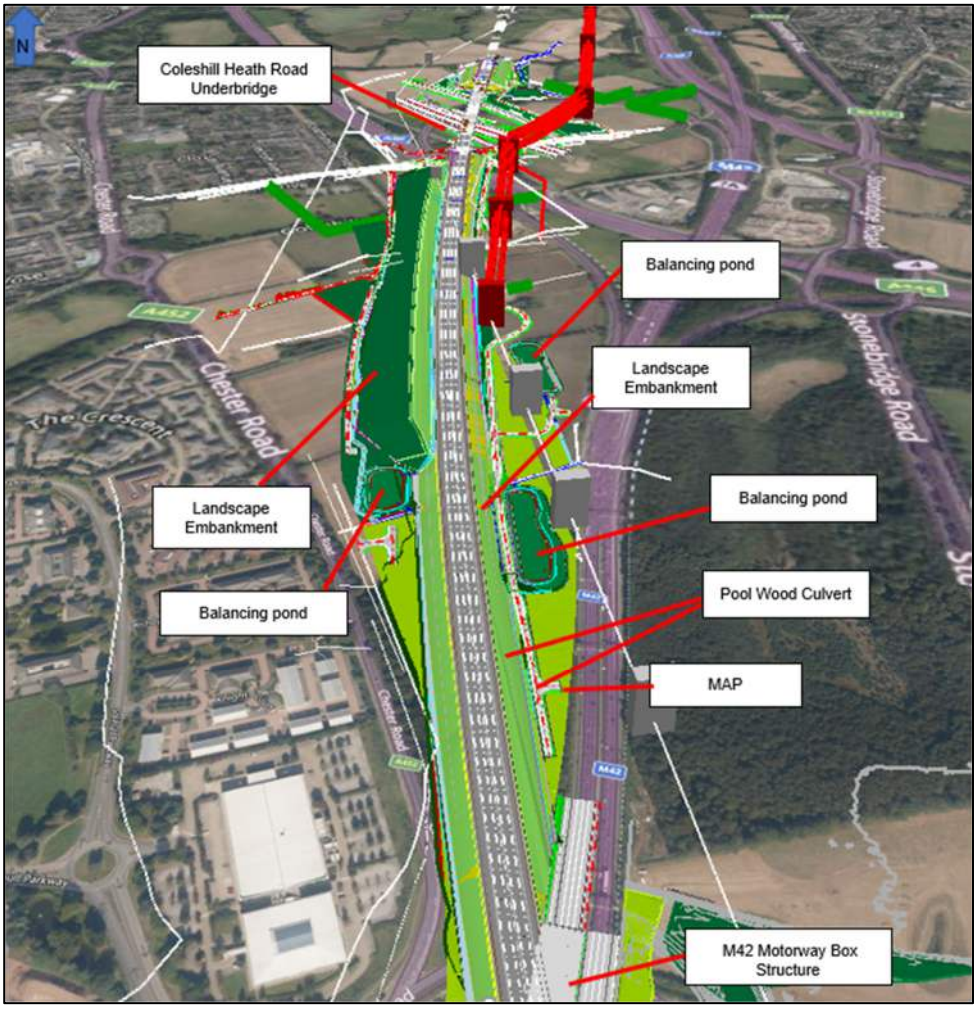
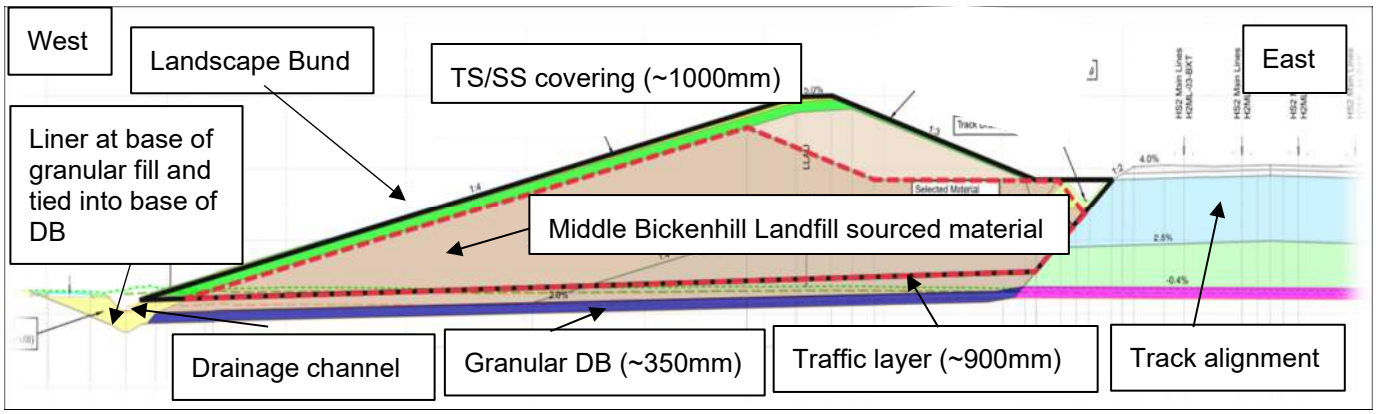


Figure 3 Cross section of Pool Wood Embankment showing main design elements of the site



Source: extract from drawings entitled "Pool Wood Embankment Ground Improvement – Advanced Works Drawing Index", March 2022 (1MC09-BBV_MSD-GT-DSH-NS04_NL10-218300)

With reference to Figure 3, the design shows the drainage blanket entering the east side wall below the invert level of the drainage channel. To accommodate elevations along the channel this cannot be avoided. However, DJV are proposing to install a liner below the granular fill (shown in yellow in Figure 3) to prevent potential migration of mobile contaminants into the underlying ground/groundwater. The channel will be lined to Pool Wood culvert (a concrete structure) and up to its point of discharge into the M42 highway drainage system. The highway drain is itself culverted below the highway. It is important to note that this is a 'belt and braces' approach, as the volume of water originating from the bund material is likely to be minimal to due compaction, adherence to the earthwork's specification and the handling of material during the remediation implementation plan. The sloped nature of the bund and surface reinstatement with covering soil will also limit infiltration through the bund material and potential contaminant mobilisation. Discharge from the drainage blanket will not interact with attenuation ponds.

A second element relates to the risks from drainage to Hollywell Brook from the landscape bund, which is the subject of a H1RA (currently under production). The outcome of the H1RA will inform the need for treatment or not before water is released into the highway drainage system. One aspect of the design that will alleviate this issue is the installation of measures to mitigate risks associated with flood risk to highway drainage. The drainage channel is being redesigned as a larger attenuation ditch to reduce flow rate into the watercourse and providing a control point on the downstream end of the ditch. The channel design is to be confirmed, but likely adopt one of the following:

- A single flow control chamber at the downstream end, prior to outfall to highway channel
- A series of weirs or orifices to throttle the flow along the ditch, limiting the outflow rate to the watercourse.

In either case, the reduction in flow rate will increase the dilution of surface water before outfalling into the watercourse. Should the H1 RA fail after a full assessment, the appropriate method to provide the remediation can be discussed and incorporated into the ditch design.

As indicated in Figure 3, a 900m protection layer (containing mainly cohesive materials) was placed above the 350mm drainage blanket. The 900mm layer is designed to protect the integrity of the blanket from machine movements during construction and earthworks. Consultation with the DJV Geotechnical team have confirmed that the thickness of protection layer should be sufficient to protect the blanket and maintain its functionality.

7 ENVIRONMENTAL SETTING

This chapter provides a review of historical and current information to establish where previous land use activities were located, and the likely areas of associated contamination. This section also identifies if, and where, sensitive receptors are present, and if they might potentially be affected by site contamination.

7.1 Environmental Statement

The Environmental Statement (ES) HS2 Phase One environmental statement volume 5: land quality classified contaminated land into the following four categories:

- **Group A Sites**: Fall fully/partially within the land required to construct the Proposed Scheme, potentially affected by soil/groundwater contamination and ground gas.
- **Group B Sites**: Fall fully/partially within the land required to construct the Proposed Scheme, potentially affected by soil/groundwater contamination only.
- **Group C Sites**: Fall outside the land required to construct the Proposed Scheme, potentially affected by soil/groundwater contamination and ground gas.
- **Group D Sites**: Fall outside the land required to construct the Proposed Scheme, potentially affected by soil/groundwater contamination only.

The following Land Quality Sites were identified as “High Risk Potential Land Contamination Sites”, within or near site:

- 24-41: Packington operational landfill – Group A
- 24-43: Melbick Nursery – Group B
- 24-44: Brackenlands Farm Landfill (historical) - Group A
- 24-54: Coleshill Civic Amenity Site landfill (historical) - Group A
- 24-46: Birmingham Business Park - Group B
- 24-56: Infilled gravel pit - Group C
- 24-58: Highways Agency Depot (operational) - Group B

The following Land Quality Sites were identified as “Potential Land Contamination Sites” within or near the site:

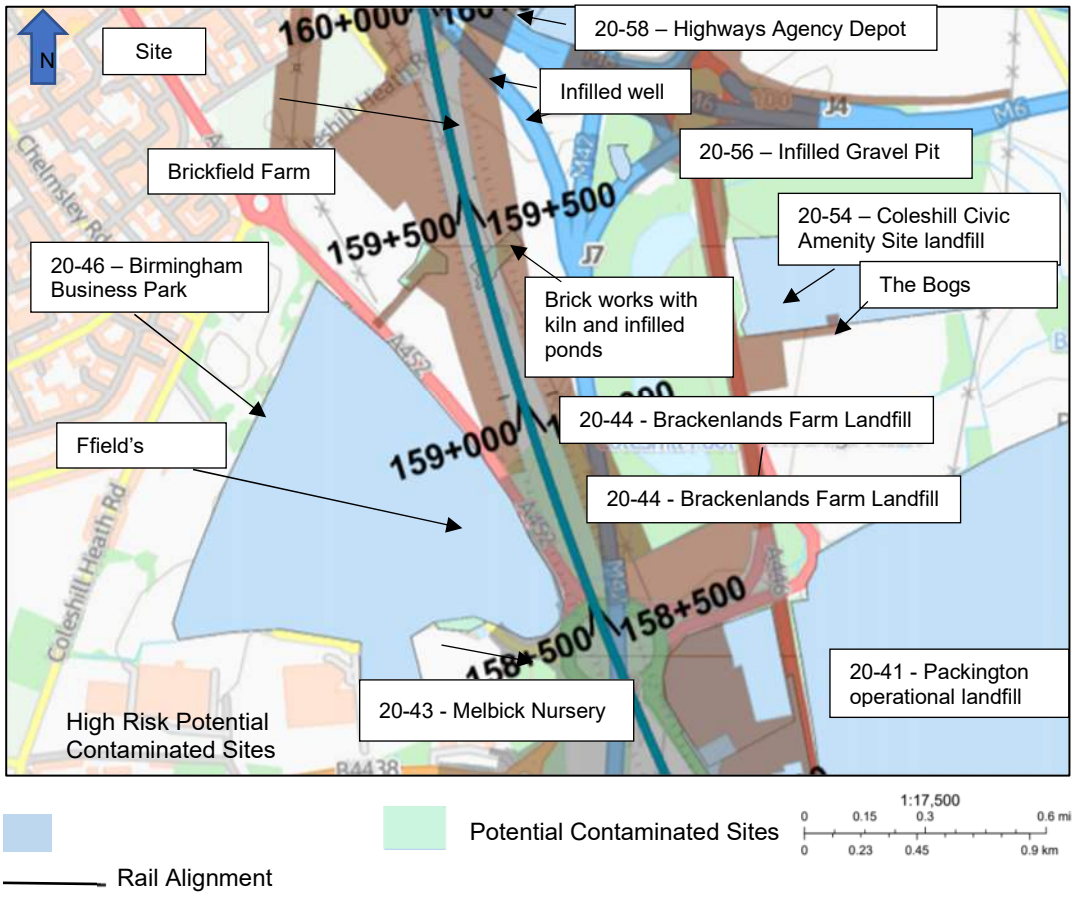
- Brickfield Farm
- Former Brick Works with kiln and infilled pond
- Infilled well
- Infilled Ponds (2No.)
- Fifield’s Farm
- The Bogs Farm

These Land Quality Sites are shown in Figure 4 and 5.

The baseline Conceptual Site Model (CSM) and preliminary qualitative risk assessment[iii] recorded the following moderate risks:

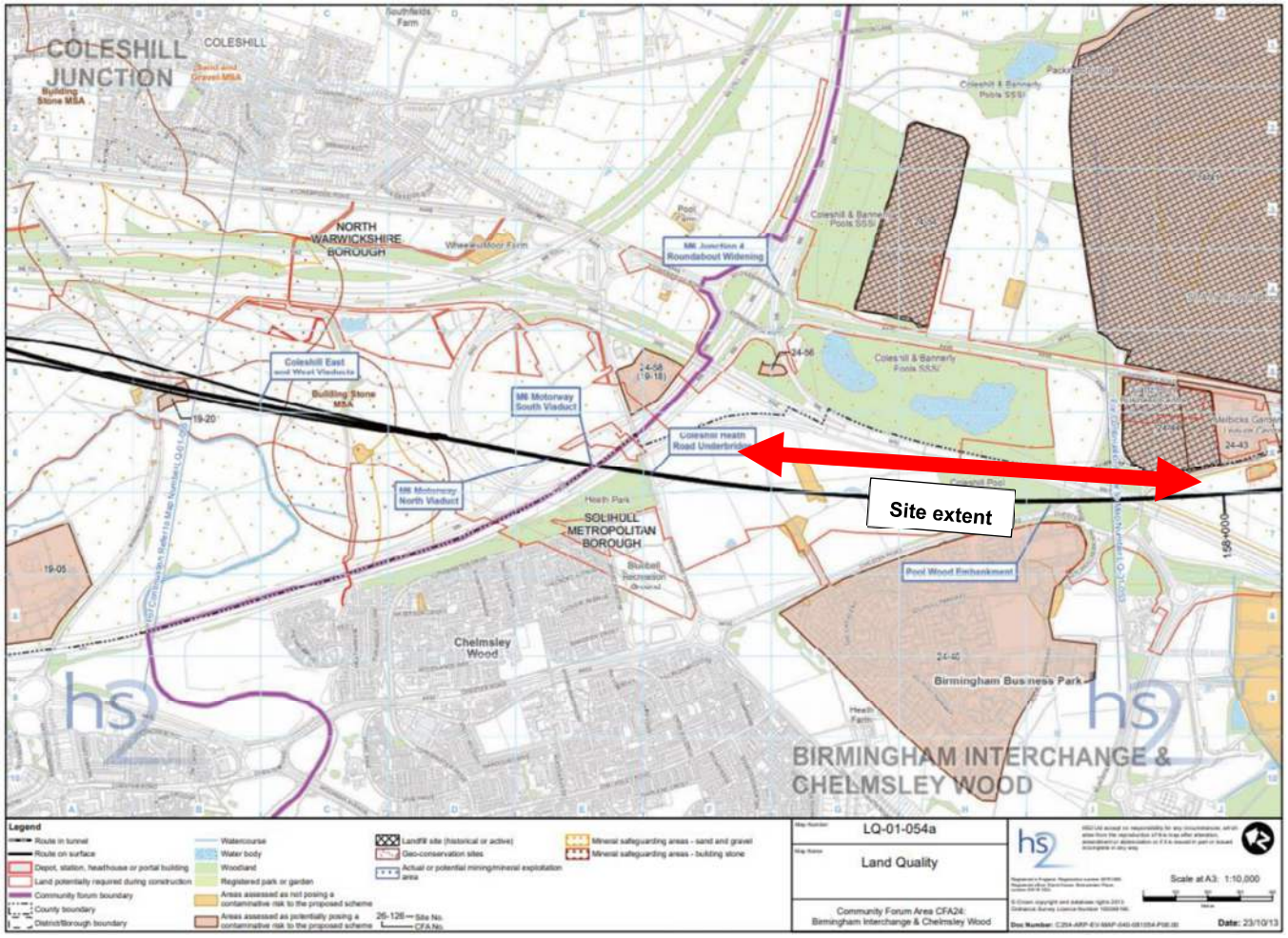
- Risks from contaminated soils/groundwater to groundwater through vertical and lateral migration.
- Risks from contaminated soil/groundwater to surface waters through groundwater migration and direct run-off from site.

Figure 4 Land Quality Sites identified within the Environmental Statement



Source: HS2 Phase 1 MWCC web interface MOA

Figure 5 Land Quality features extracted from the ES



7.2 Site history

Maps contained in the Delta Junction Geotechnical Desk Study Volume 1 and Volume 2 (C223-CSI-GT-REP-030-000003 P06)[iii] report was reviewed to obtain information on historical land use activities at the site and surrounding area to identify potential historical sources of contamination. Table 1 presents a summary of the information contained within these maps.

Table 1: Summary of historical land use

Year	On-site	Off-site (250m or significant feature)	Contamination source
1888	The site comprises mostly of open fields. A brick works named "Old Brick Works" with associated buildings and a kiln is present in the northern part of the site. An unnamed pond is also present in the centre of the site. A woodland area known as "Pool Wood" is situated in the southern part of the site, extending towards to the east of the Site.	"Coleshill Pool" is present ~250m east of the site, which comprises of a woodland area and a lake. A gravel pit is identified ~240m to the north-east of the site. Chester Road and an unnamed farm are located ~50m and 30 m west of the site respectively. Several unnamed ponds are identified within ~250m to the west of the site.	Gravel Pit Brick works
1889	No significant change.	A well is recorded ~10m east of the site.	-
1903	The brick works is no longer present.	The unnamed farm ~30m to the west of the site is now identified as Brickfield farm. Brickhill Street Farm is present ~250m to the north-east of the site.	Brick works
1949/ 1979	A land drain crosses the centre of the site, with a north-west to south-east orientation. In the southern part of the site a second drain is present with a south-west to north-east orientation.	No significant change.	-
1951	No significant change.	Melbick Nursery is present ~250m to the south-east of the site.	-
1954	No significant change.	The gravel pit previously identified to the east of the site is no longer recorded. Sand and gravel works are identified ~450m to the south-east of the site. The A446 is present ~450m to the east of the site.	Potentially infilled gravel pit Sand and gravel works
1962/ 1982	An overhead power line crosses the site in a south-east to north-west direction.	Two pylons are present ~20m to the east and to the west of the site associated with the overhead lines. Brickfields Cottage is present ~80m to the east of the site. Brackenlands Farm is located ~135m to the south-east of the site. The M42 motorway is present at the eastern boundary of the site, while the M6 motorway is at the northern boundary of the site.	-
1970	A roundabout, associated with the M42 motorway, is shown at the southern boundary of the site.	A Highways Agency Depot is ~50m north of the site.	Unknown depot activity
1999	No significant change.	Birmingham Business Park present to the west of the site.	Birmingham Business Park
2019	A possible depot comprising large containers, heavy machinery and parking spaces is present at the northern boundary of the site. An access road to the depot and to the pylons are also identified.	No significant change.	Unknown depot activity
2020	The possible depot in the north of the site is no longer present.	No significant change.	
2021	No significant change.	A Motorway Maintenance Compound is present ~180m north of the site and has replaced the previously identified depot. Edenhouse Solutions, Rolton Group and Hitachi Data Systems offices are present ~230m south-east of the site whilst at ~450m the SUEZ recycling and recovery UK is identified. Earthworks are noted near the southern boundary.	Motorway Maintenance Compound SUEZ recycling and recovery UK

7.3 Site walkover

A walkover was attempted at Pool Wood Embankment area on September 2020, however, due to the ongoing enabling works, access was limited and observations were undertaken from the Coleshill

Heath Road, located at the northern boundary of the asset. The observations including photographs are include within Appendix A.

During the walkover, there was evidence of surface waste encountered in the centre part of the asset (Ch. ML159+176 to ML159+450), located near the former brick works with kiln and infilled pond. The material observed comprised of old carpets and plastic debris. It is anticipated that the waste is associated with fly-tipping and not directly associated with the land quality in the area. Also, for the purpose of this report, it has been assumed that any fly-tipping waste encountered on site will be removed during construction works.

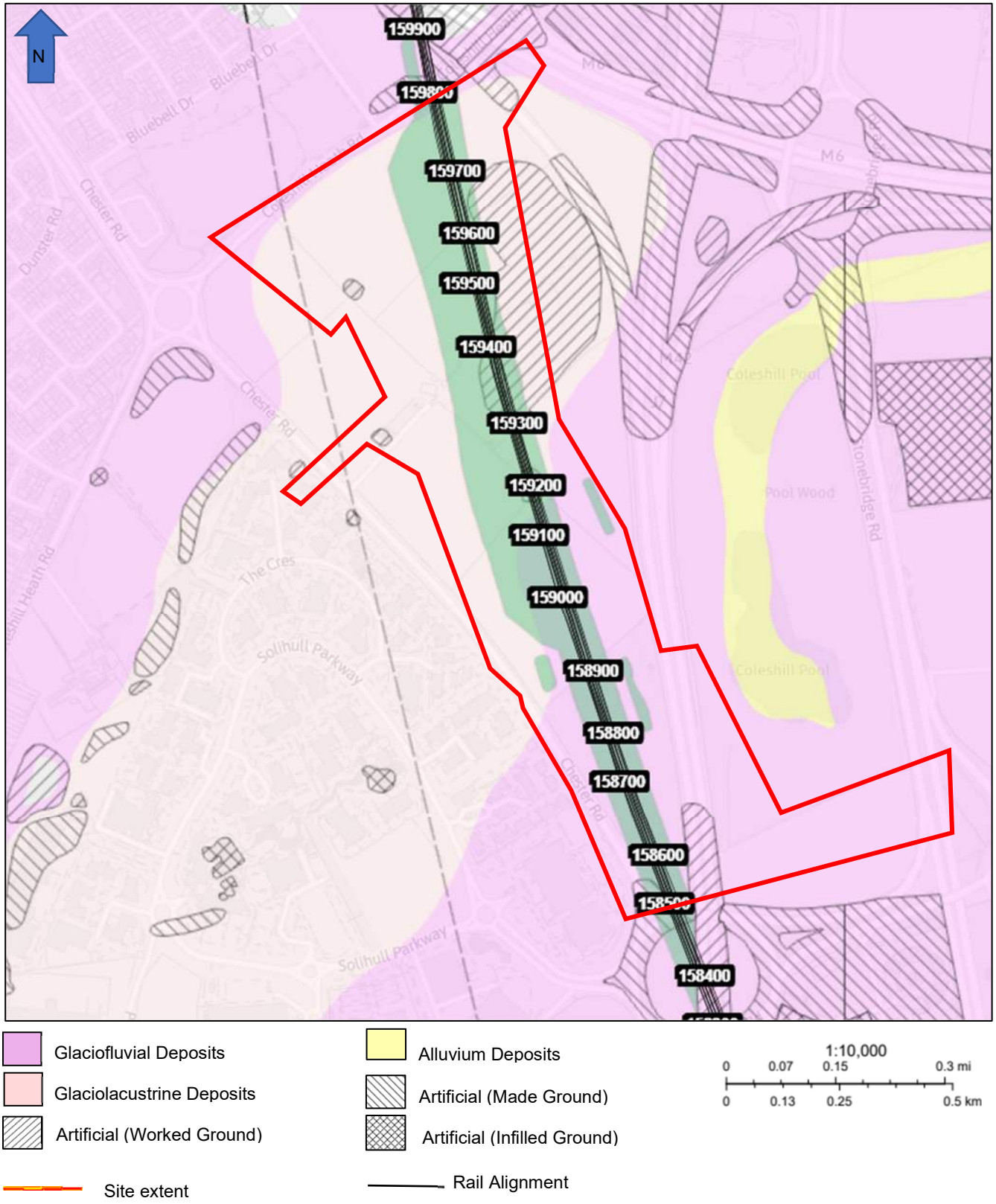
7.4 Published geology

British Geological Survey records were reviewed to assess site and local geology. Made Ground is recorded at approximate Ch 158+500 to 158+550, 159+150 to 159+200 and 159+275 to 159+500. Glaciolacustrine Deposits (comprising of clay and silt) are present from the central part to the northern boundary of the site, between approximate Ch 159+125 to 159+750, which are in turn underlain by Glaciofluvial Deposits (comprising sand and gravel), likely to be present beneath the whole site. Alluvial deposits (comprising clay, silt sand and gravel) are recorded approximately 200m to the east of the site associated with Coleshill Pools.

The superficial deposits are underlain by the bedrock geology of the Mercia Mudstone Group, which includes the Branscombe Mudstone Formation and the Sidmouth Mudstone Formation (comprising mudstone and siltstone). An unnamed inferred fault is recorded between these bedrock formations, trending with a south-north orientation.

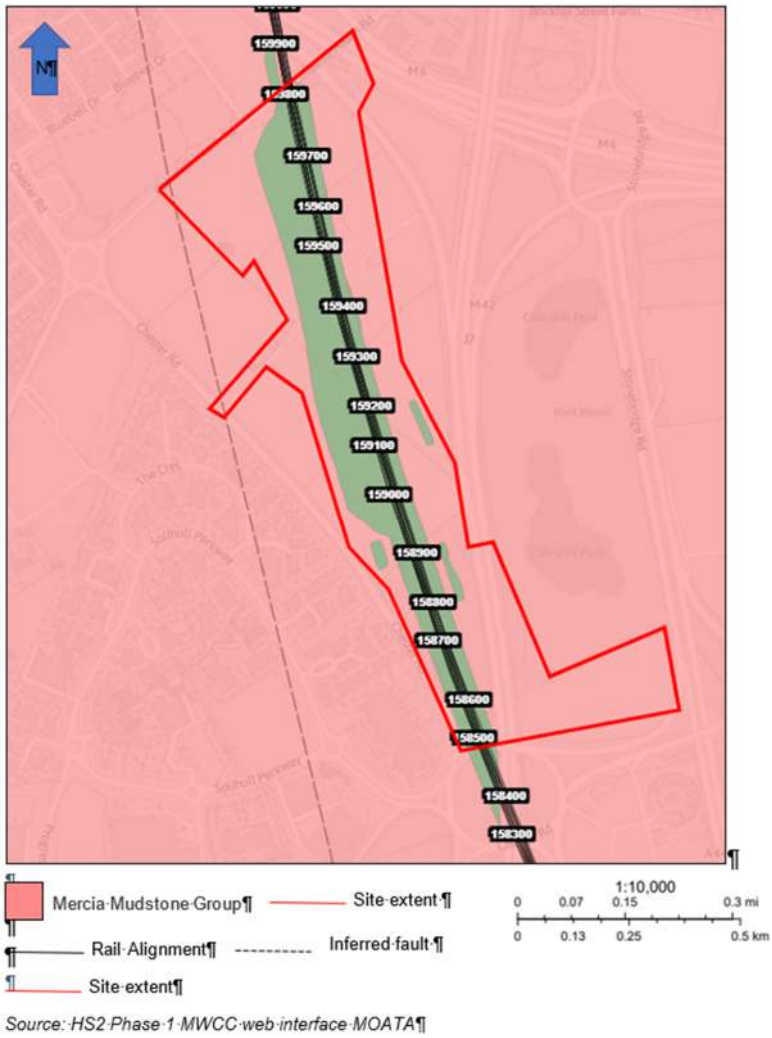
The superficial and bedrock geology for the Site and surrounding area are shown in Figure 6 and 7.

Figure 6 Artificial and superficial geology at and near the site



Source: HS2 Phase 1 MWCC web interface MOATA

Figure 7 Bedrock geology at and near the site



Source: HS2 Phase 1 MWCC web interface MOATA

7.5 Published hydrogeology

The published geological units identified at the site and surrounding area have the following aquifer characteristics, as determined by the Environment Agency (EA):

- Glaciofluvial and Alluvial deposits – Secondary A aquifers, which contain permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers.
- Glaciolacustrine deposit – Non-productive.
- Mercia Mudstone Group – Secondary B aquifer, which contain predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering.

A review of the iSpatial database has identified four former/current groundwater abstraction wells within a 1km radius of the site as listed in Table 2. There is no source protection zone within a 2km radius of the site. Figure 8 shows the location of the aquifer designations and groundwater abstractions identified at the site.

Table 2 Summary of groundwater abstraction wells at and near to the site

ID	Location	Use	Geology	Status
Brickfields Farm Well (A)	Ch. 159+400 (within site boundary)	Presumed for agriculture – irrigation and potable water for livestock	Presumed to be installed in the GFD	Unknown
None (B)	Ch. 159+500 (adjacent to eastern boundary of site)	Presumed for agriculture – irrigation and potable water for livestock	Presumed to be installed in the GFD	Infilled – no further details available
Pool Farm (C)	~950m northeast of the site	Presumed for agriculture – irrigation and potable water for livestock	Presumed to be installed in the GFD	Unknown
Bogs Farm (D)	~850m southeast of the site	Presumed for agriculture – irrigation and potable water for livestock	Presumed to be installed in the GFD	Unknown

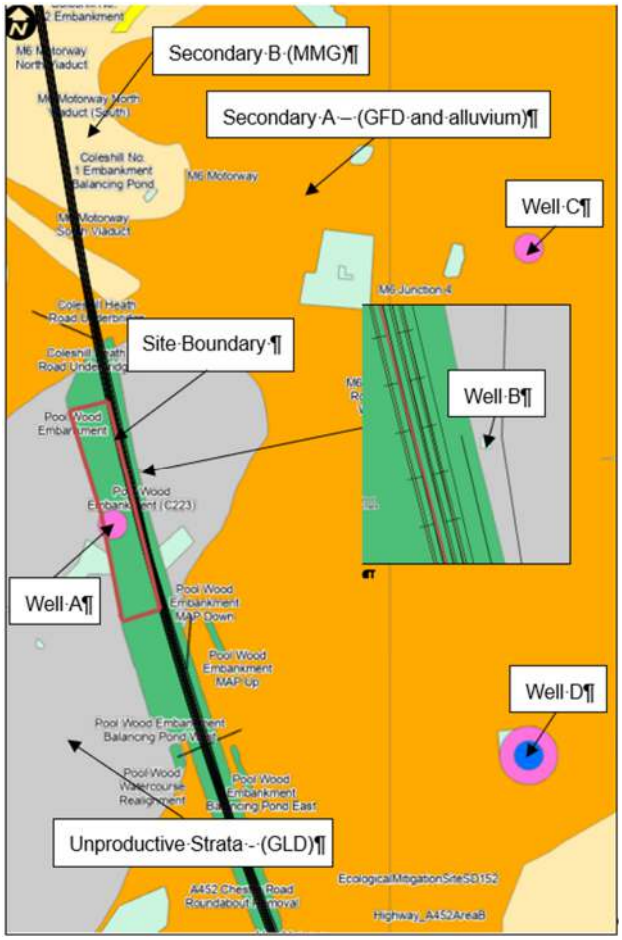
With respect to the Brickfields Farm Well (A), following a review of historical maps discussions with North Warwickshire Borough Council (Freedom of Information request) and BBV and it is likely that Well A does not exist and refers to Well (B). The error is likely associated with the coordinate positioning of Well A.

For the infilled Well B adjoining the eastern boundary of the site, as the former well is not located directly below the site, the risks of contaminant migration from the site into the underlying GFD should be low. Further, all groundwater and surface water drainage originating from the site will be conveyed to Hollywell Brook located ~2.0km south of the site via a network of lined drainage channels and attenuation ponds further reducing the likelihood of vertical migration into the underlying GFD. Further the well is not located directly under the permitted boundary so there is unlikely to be a direct preferential pathway to the underlying GFD from the site. Moreover, modelling used to derive acceptability criteria for material reuse assesses risks to the base of the unsaturated zone, if determinant concentrations meet the modelled output for the base of the unsaturated zone, they will be protective of the former well location. As part of its due diligence and to confirm the status of the former abstraction well BBV are in communications with the former landowner and are to complete some exploratory assessment work at the location. The culmination of this work will be used to inform

(if required) on a strategy to decommission the infilled well in accordance with best practise and EA guidance to mitigate risks to controlled waters associated with the infilled abstraction well further. Consultation with the DJV geotechnical team have confirmed that the risks associated with settlement and instability associated with the infilled well is low.

For Pool Farm (C) and Bogs Farm (D), given the distance to these abstraction wells and the attenuation pathway, it is unlikely that mobile contaminants originating from site would adversely impact on water quality at the two abstraction points, therefore the risk of impact to water quality at these points is low.

Figure 8 Aquifer classification and location of groundwater abstraction wells within 1km radius of the site

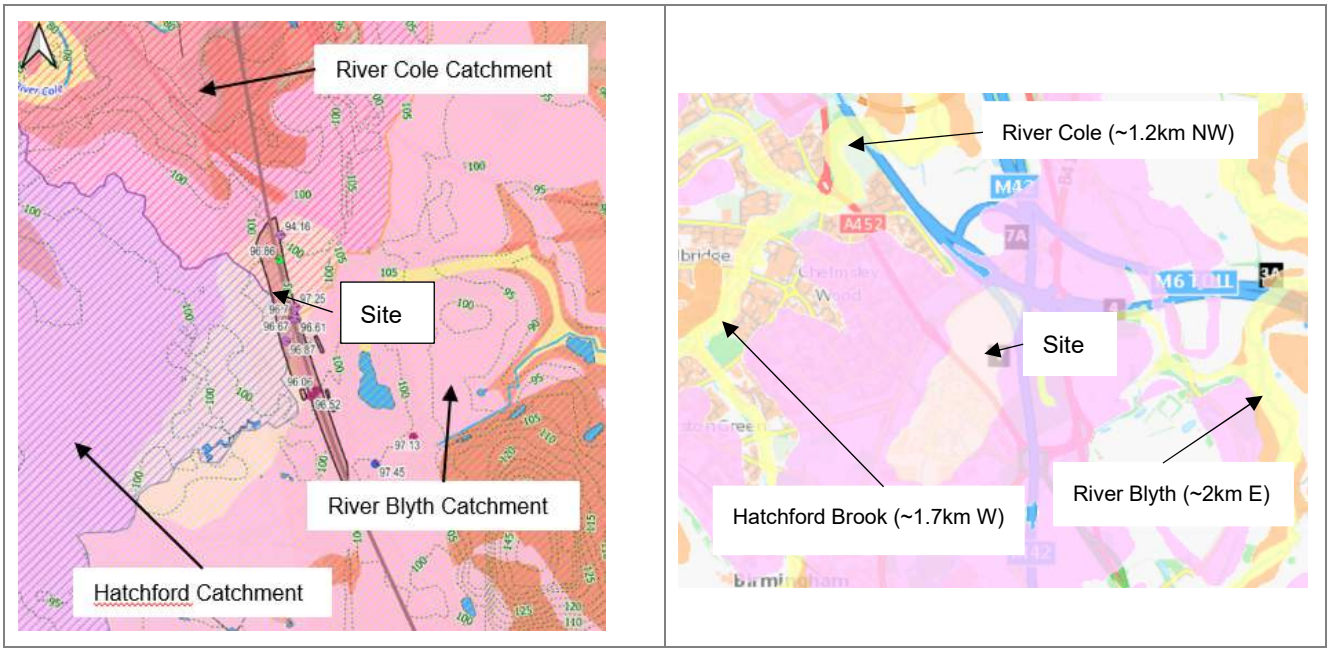


Source: iSpatial 2024

7.6 Hydrology

The site is intersected by three surface water catchments associated with the River Cole, the River Blyth and Hatchford Brook located to the northwest (~1.2km), east (~2km) and west (~1.7km) of the site respectively. All three catchments will affect surface flow and runoff water but are unlikely to have a significant effect on groundwater flow direction, which is more likely to be dictated by localized surface water features. Figure 9 shows the location of catchments in relation to the site.

Figure 9 Location of catchments and main surface waters in relation to the site



Source: QGIS 2024

Coleshill and Bannerley Pools, two sensitive surface water features are located approximately 350m east of the site. Both features are designated as Sites of Special Scientific Interest (SSSI) and groundwater dependent terrestrial ecosystems (GWDTE) likely to be fed by the Glaciofluvial Deposits (GFD) and alluvial deposits present in the vicinity of the site. Given the presence of Glaciolacustrine Deposits (GLD) underlying most of the site, the site is not considered a major recharge area for these features although runoff (recharge)/infiltration into the GFD at the margins of the GLD and in areas where GLD (southern half of the site) is absent is possible.

There is a network of land drains to the east of the site associated with the Colehill Pool area. The pools discharge into a drain located to the northeast of the pools, eventually discharging into the River Blyth via a network of west to east flowing land drains. A drain to the south of the pools was severed at Stourbridge Road and flows west into the M42 drainage system that flows south away from the site.

Post construction site drainage (surface runoff, groundwater from GLD pore water dissipation and water contained in the materials used to construct the site) will be conveyed to a network of land drains (embankment, landscape bund and track) and attenuation ponds and then continue to flow south along the M42 drain systems eventually discharging into Hollywell Brook ~2.9km south of site. All drains and attenuation ponds will be lined. Post construction, it is unlikely that surface waters originating from the site would interact with the underling ground or discharge into the Coleshill Pool area. Figure 10 shows the current drainage design for Pool Wood Embankment.

Three unnamed ponds are located at the site, at approximate Ch 158+875, 159+175 and 159+250. These ponds will be removed as part of the development. Two small surface water ponds (A and B) are located approximately 90 and 200m west of the site. Both ponds are likely to be runoff fed. Both ponds are to remain post development. Figure 11 shows the surface water features encountered at and within a 250m radius of the site.

Figure 10 Drainage layout for Pool Wood Embankment

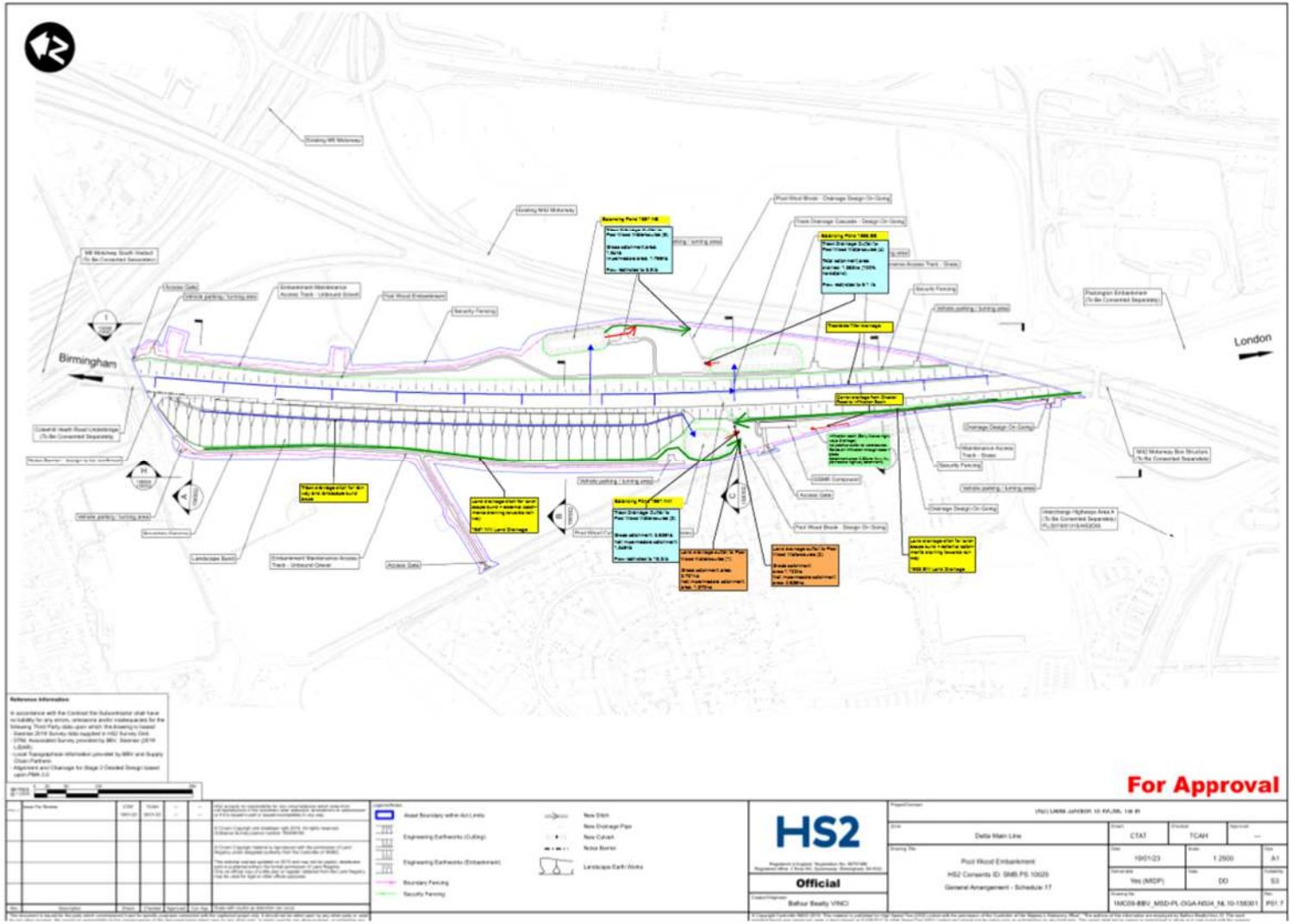
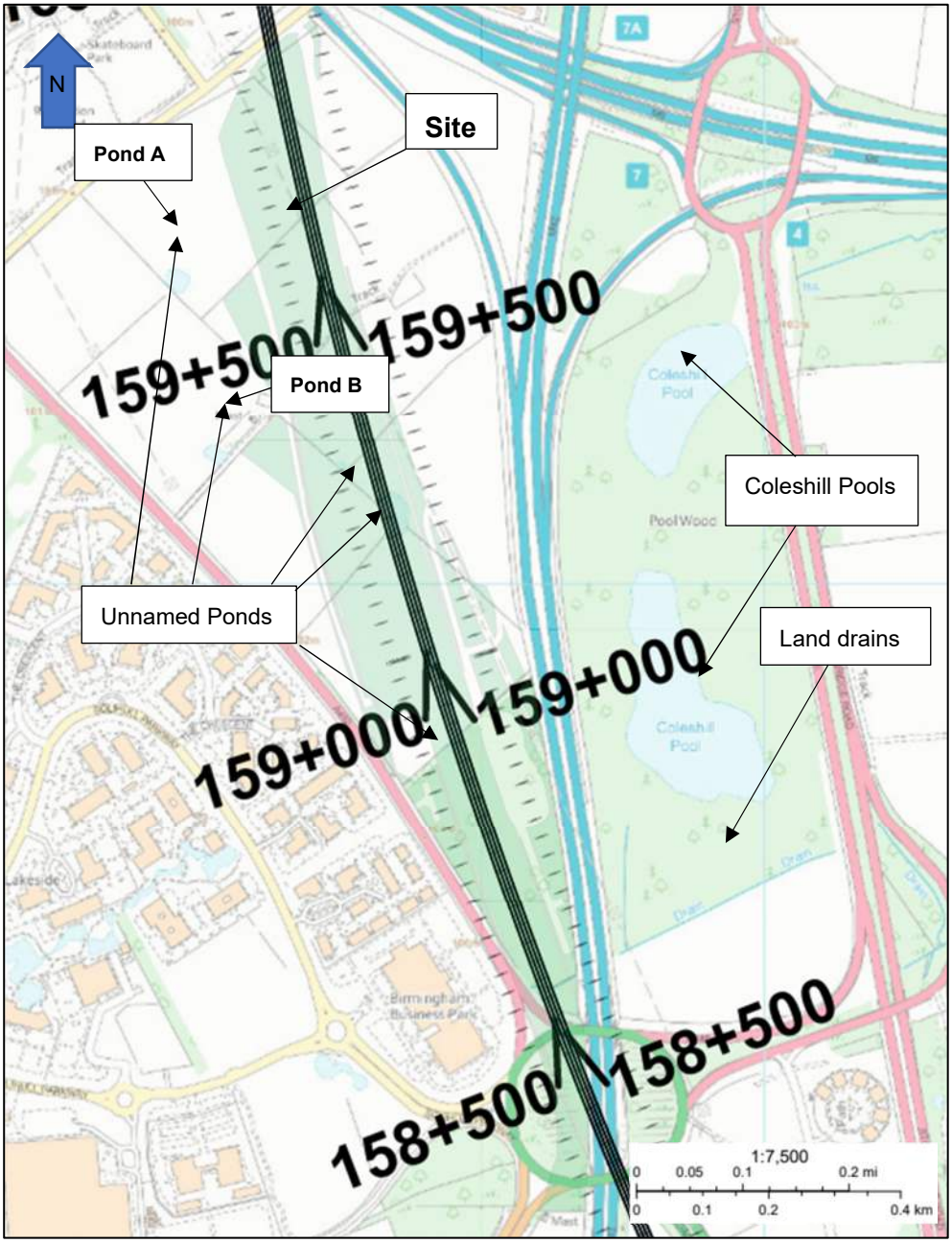


Figure 11 Surface water features at Pool Wood Embankment



Source: HS2 Phase 1 MWCC web interface MOATA

Rail Alignment

7.7 Encountered geology and hydrogeology

7.7.1 Ground investigations

Ground investigation data from the following reports was used to inform the geological understanding at the Site:

- Delta Junction Area A, RPS, 2017[iv]
- HS2 PHASE 1 Area North Additional GI Location NL10 To NL12, Soil Engineering, 2020[v]

Subsequent to the above investigations, an additional ground investigation was undertaken in March 2021 by Soil Engineering as part of the BBV Stage 2 works. As part of the investigation, additional boreholes were drilled. A summary of the exploratory holes completed at and near the site up to September 2023 are presented in **Error! Reference source not found.**, and shown in Figure 12.

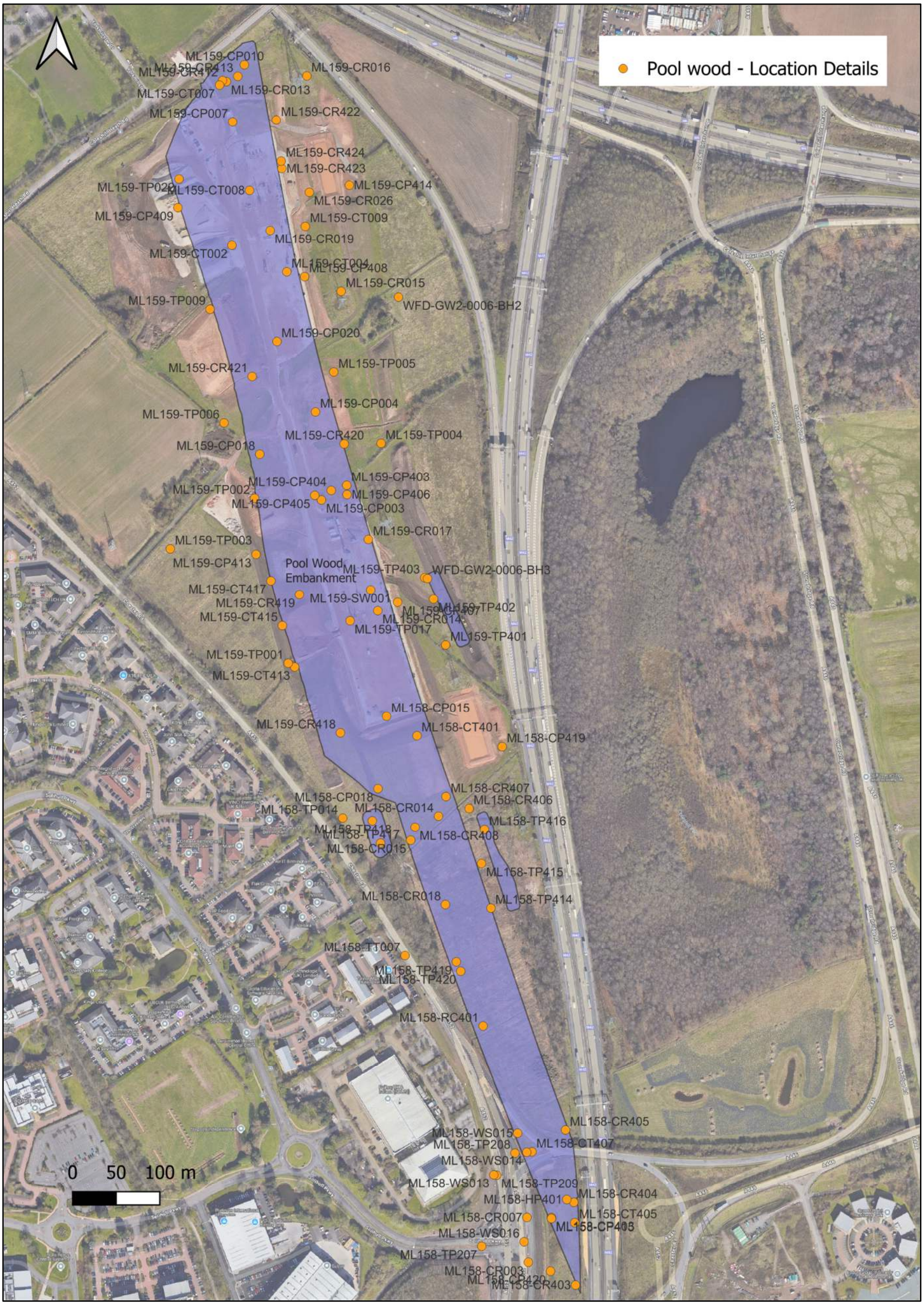
Table 3 Summary of ground investigations

Investigation technique	Number	Borehole ID	Maximum depth (mbgl)
Cable tool percussion drilling	16	ML158-CP002* ML158-CP007* ML158-CP419* ML158-CP020* ML158-CP021* ML158-CP402* ML159-CP403* ML159-CP404* ML159-CP405* ML159-CP406* ML159-CP010 ML159-CP007 ML159-CP020 ML159-CP004 ML159-CP003* ML158-CP015* ML158-CP018 ML159-CP413* ML159-CP414* ML159-CR422* ML159-CR419	15.00

Investigation technique	Number	Borehole ID	Maximum depth (mbgl)
Rotary drilling	17	ML159-CR003 ML159-CR013 ML159-CR016 ML159-CR026 ML159-CR019* ML159-CR015 ML159-CR017 ML159-CR014* ML158-CR014* ML158-CR015* ML158-CR018* ML158-CR016 ML158-CR405* ML158-CR406* ML158-CR407 ML158-CR408* ML158-RC401* ML159-CR408* ML159-CR412* ML159-CR413* ML159-CR420*	35.60
Windowless sampling	4	ML158-WS015 ML158-WS014 ML158-WS013 ML158-WS201*	4.39
Trial pits	10	ML159-TP022 ML159-TP009 ML159-TP005 ML159-TP006 ML159-TP004 ML159-TP002 ML159-TP003 ML159-TP017 ML159-TP001 ML158-TP014	4.50

*Note: * Boreholes completed as monitoring well.*

Figure 12 Exploratory hole locations



7.7.2 Ground model

Made Ground is encountered at the centre of the site at Ch 159+275 to 159+400, and at its southern and northern boundary. The superficial Glaciolacustrine Deposits were encountered from the centre of the site at approximate Ch 159+175, and in the northern part of the site at approximate Ch 159+350 to 159+600. These deposits were underlain by the Glaciofluvial Deposits which underlay the entire Site, which are in turn underlay by the bedrock geology of the Mercia Mudstone Group.

A summary description of the geology encountered at the Site during the previous investigations is shown in **Error! Reference source not found.**. Generalised cross-sections showing the geology encountered at and near to the site are presented in Figure 14 shows the locations where Made Ground was encountered during the ground investigations.

Table 4 Encountered geology at and near to the site

Strata	Distribution	Typical depth range (m bgl)	Description
Topsoil	Located across the site at boreholes listed in Table 3	0 to 0.50	Mixture of granular and cohesive. Mostly recorded as agriculturally reworked deposits. Generally recorded as clay or sand.
Made Ground	ML158-CR408 ML158-WS013 ML158-WS014 ML159-CP004 ML159-CP003 ML158-WS013 ML159-CR003 ML159-TP005 ML158-WS015 ML159-CP403 ML159-CP404 ML159-CP405 ML159-CP406 (encountered at the southern and northern boundary and the centre of the Site)	0 to 5.65	Mixture of granular and cohesive materials. Mostly described as sand and gravel and clay. Gravel includes ash, flint, brick, concrete, ceramic glass and charcoal
Glaciolacustrine Deposits	ML159-CP018 ML159-CP004 ML159-CR014 ML159-CR015 ML159-CR019 ML159-CP403 ML159-CP405 ML159-CP406 ML159-CP413 ML159-CP414 (encountered in the centre and northern part of the Site)	0.20 to 9.50	Mostly cohesive described as sandy silty or sandy clay.

Strata	Distribution	Typical depth range (m bgl)	Description
Glaciofluvial Deposits	Encountered across the Site in all boreholes listed in Table 3.	0 to 12.60	Mixture of granular and cohesive. Granular materials mostly described as fine to coarse sand and cohesive as sandy clay.
Weathered Mercia Mudstone Group (Grade III/IV)	Encountered across the Site in all boreholes listed in Table 3.	0.50 to 15.00	Very high strength reddish orange, brown silty CLAY
Unweathered Mercia Mudstone Group (Grade I/II)	Encountered across the Site in all boreholes listed in Table 3.	8.61 to 35.60 (depth not proven)	Very weak, medium to thickly bedded, reddish brown MUDSTONE. Bedding is horizontal, undulating, smooth and clean

Figure 13 Generalised geological cross-section of the site (Sheet 1-2)

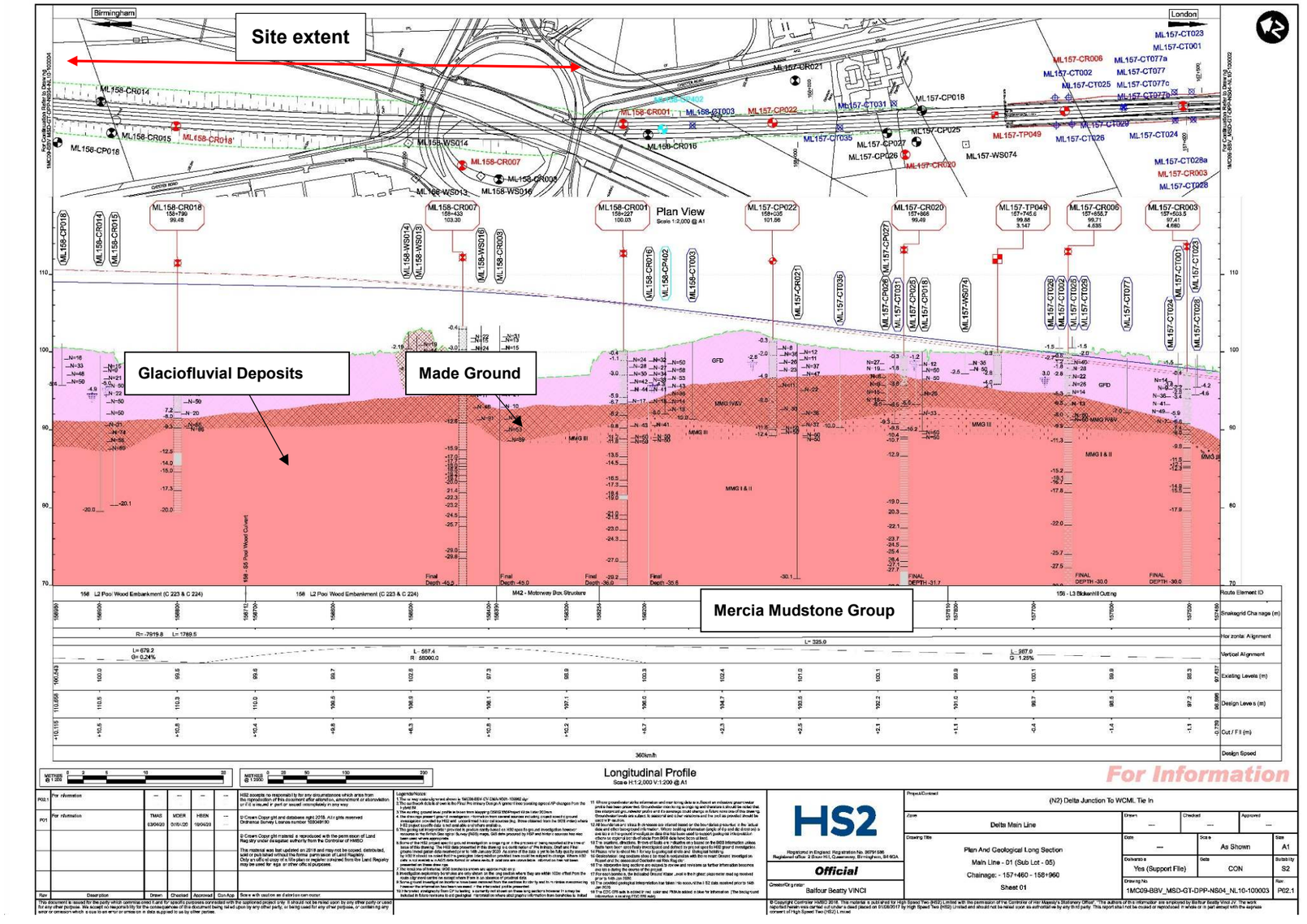


Figure 14 Generalised geological cross-section of the Site (Sheet 2-2)

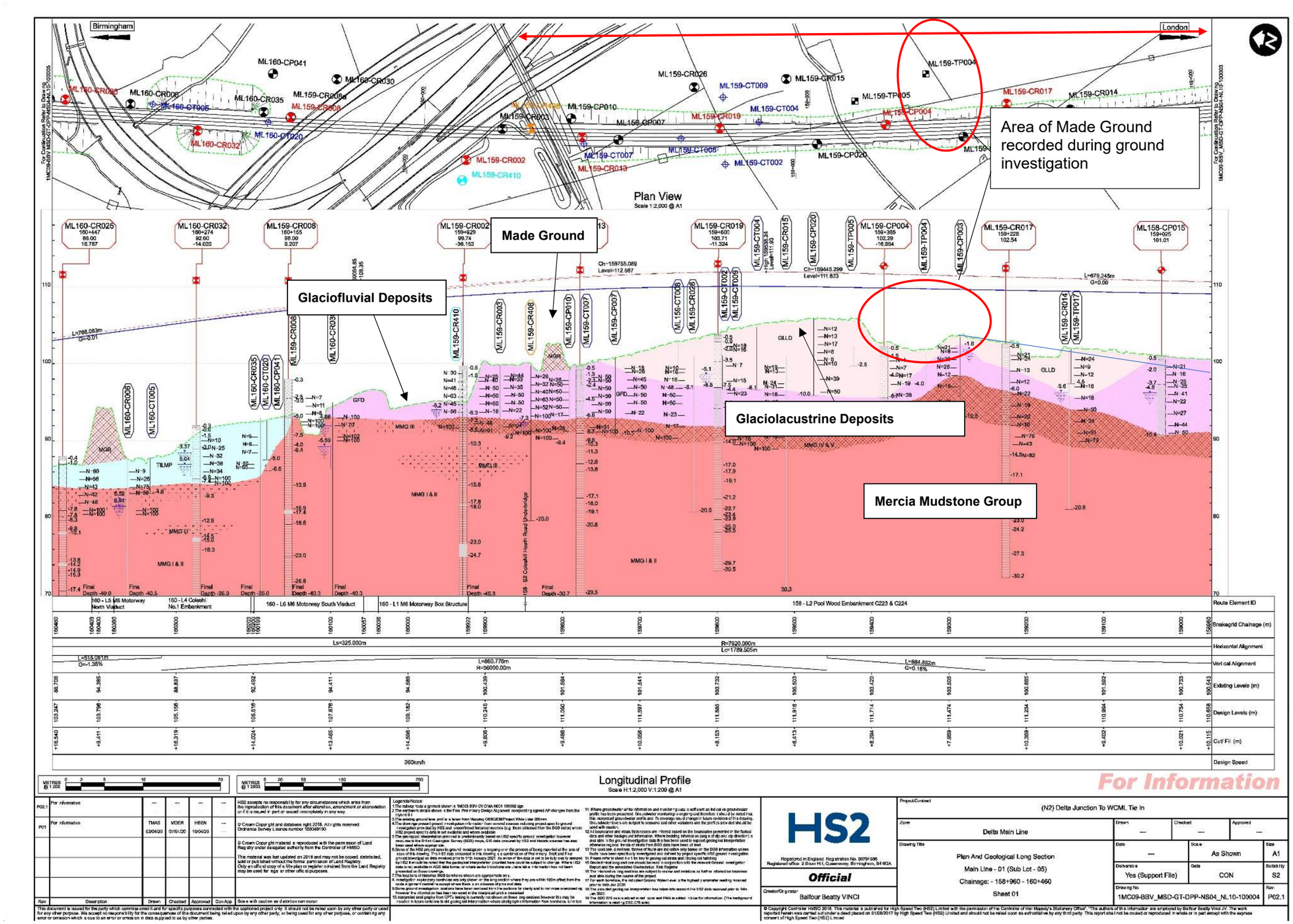
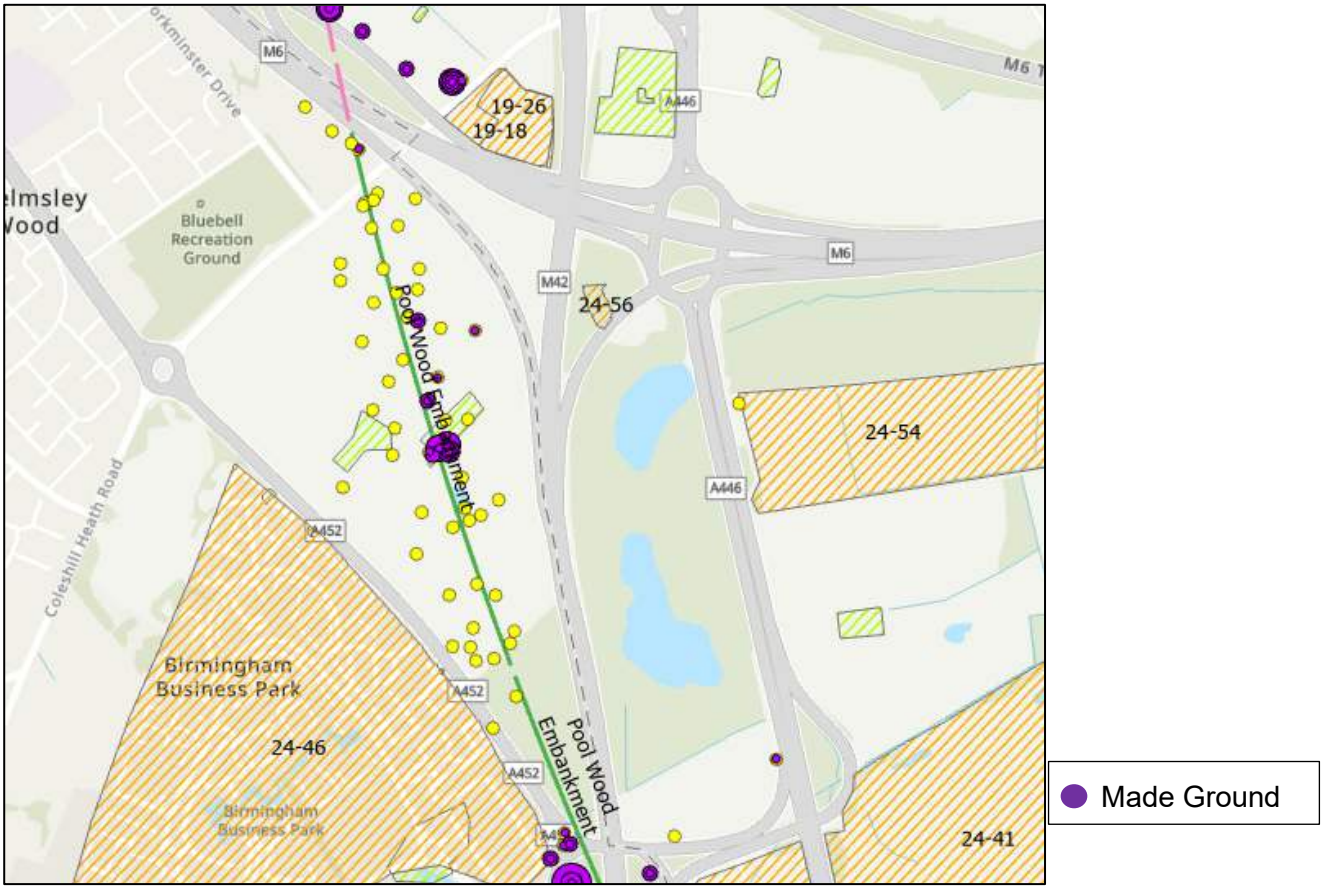


Figure 15 Locations where Made Ground encountered



Source QGIS, 2024

7.7.3 Visual/olfactory evidence of contamination

Visual and/or olfactory evidence of contamination was recorded in eight samples from six exploratory holes at the site. A summary of visual and olfactory evidence of contamination is provided in **Error! Reference source not found.**5.

Table 5 Summary of Visual and/or Olfactory Evidence of Contamination

Hole ID	Top (mbgl)	Base (mbgl)	Geological Formation	Description
ML159-CR018	3.3	4	Made Ground	Dense, orangish brown, clayey, fine and medium SAND and angular to subrounded, fine to coarse GRAVEL of sandstone, quartzite and roadstone. Strong odour (undefined).
ML159-TP015	1.1	1.8	Glaciofluvial Deposits	Dark brown, mottled black, very gravelly, fine and medium SAND with low cobble content and decomposing organic odour (undefined). Gravel is subrounded and rounded, medium and coarse of quartzite. Cobbles are subrounded and rounded of quartzite.
ML159-TP015	1.8	2.1	Glaciofluvial Deposits	Firm and stiff, friable, dark brown mottled black, slightly sandy, very gravelly CLAY with moderate organic odour

				(undefined). Gravel is subrounded and rounded, medium and coarse of quartzite.
ML159-CP003	0	1.10	Made Ground	Turf over dark brown slightly gravelly clayey fine to coarse SAND. Gravel is angular to subrounded fine to coarse of mixed lithologies including flint and quartzite with occasional glass, metal, pottery fragments, ash, slag, brick, rope plastic wood
ML159-CP403	0.7	5.3	Made Ground	Dark brown to black sandy subangular to subrounded fine to coarse gravel sized fragments of brick, glass, sandstone, wood and quartzite. Sand sized fragments are fine to coarse of ash.
ML159-CP403	5.3	5.65	Made Ground	Dark grey to black slightly gravelly sandy clay. Sand is fine to coarse. Gravel is angular to subangular fine to medium of sandstone and siltstone. Slight sewage odour*
ML159-CP405	0	0.20	Made Ground	Black sandy angular to subangular fine to medium gravel sized fragments of bituminous material. Sand sized fragments are fine to coarse of bituminous material.
ML158-WS015	0	0.20	Made Ground	Firm dark brown sandy very gravelly SILT. Sand is fine to medium. Gravel is angular to rounded fine to coarse of mixed lithologies including flint, quartzite, slag and charcoal.

* Note: A slightly sewage odour was encountered at the base of the Made Ground at ML159-CP403 which is the anticipated bottom of the infilled pond. No sewage odour was recorded within other strata and there is no evidence of an old foul sewer or cess pit encountered at this location. It is anticipated that the odour is from the decaying of organic rich debris at the bottom of the infilled pond.

7.7.4 Photo ionisation detection readings

Elevated photo ionisation detection (PID) readings were not recorded within the boreholes. A maximum concentration of 16.30 parts per million by volume was recorded at ML159-CP403 (4.0mbgl).

7.7.5 Groundwater monitoring elevations

Data from thirty-four screens installed in thirty-two boreholes located within or near the site was used to characterise the groundwater conditions at the Site. ML159-CP404 and ML159-CR420 contain dual installations. Groundwater monitoring data collected for the period between November 2016 to September 2023 are shown in Table 6. A location plan of the boreholes is shown in Figure 15. Groundwater elevations for May 2017, February 2021, July 2021 and August 2021 is shown in Figure 16, 17, 18, and 19 respectively. It should be noted that monitoring wells where the response zone crossed multiple strata were not included within this assessment, due to potential errors.

Table 6 Groundwater monitoring data for the site

Borehole ID	Response zone top	Response zone base	No. of monitoring rounds	No. of wells monitored dry	Strata Screened	Shallowest reading	Average reading	Deepest reading	Ground level Elevation
ML158-CP015-1	95.51	93.51	17	0	GFDUD	96.25	95.8	95.6	101.01
ML158-CP020-1	97.61	94.61	54	0	GFDUD	98.36	97.3	96.46	99.61
ML158-CP021-1	98.02	95.02	54	0	GFDUD	98.35	96.9	95.82	100.02
ML158-CR014-1	94.51	92.01	48	0	GFDUD	96.86	95.6	94.29	99.51
ML158-CR015-1	95.41	92.41	40	0	GFDUD	97.03	95.9	94.94	100.41
ML158-CR018-1	95.48	92.48	12	0	GFDUD	96.21	95.9	94.42	99.48
ML158-CR407-1	91.64	89.64	35	0	MMG	96.56	95.8	91.27	99.64
ML159-CP003-1	101.98	98.98	30	0	GFDUD	103.18	101.4	100.54	103.48

Borehole ID	Response zone top	Response zone base	No. of monitoring rounds	No. of wells monitored dry	Strata Screened	Shallowest reading	Average reading	Deepest reading	Ground level Elevation
ML159-CP404-1	94.3	91.3	21	0	GFDUD	97.65	96.8	96.35	103.30
ML159-CP404-2	102.3	99.3	19	0	GFDUD	101.43	101.0	100.28	103.30
ML159-CP405-1	102.76	98.76	21	0	MGR	103.22	101.7	99.06	103.76
ML159-CP406-1	94.31	91.11	21	0	GFDUD	97.54	96.6	93.41	102.81
ML159-CR014-1	93.98	92.48	16	0	GFDUD	96.35	95.9	95.67	101.98
ML158-CR408	89.71	86.71	27	0	MMG	92.52	90.9	87.62	99.71
ML159-CR412-1	89.74	79.74	21	0	GFDUD	96.34	93.1	92.39	99.74
ML159-CR413-1	89.69	84.69	24	0	MMG	97.46	93.9	89.59	99.69

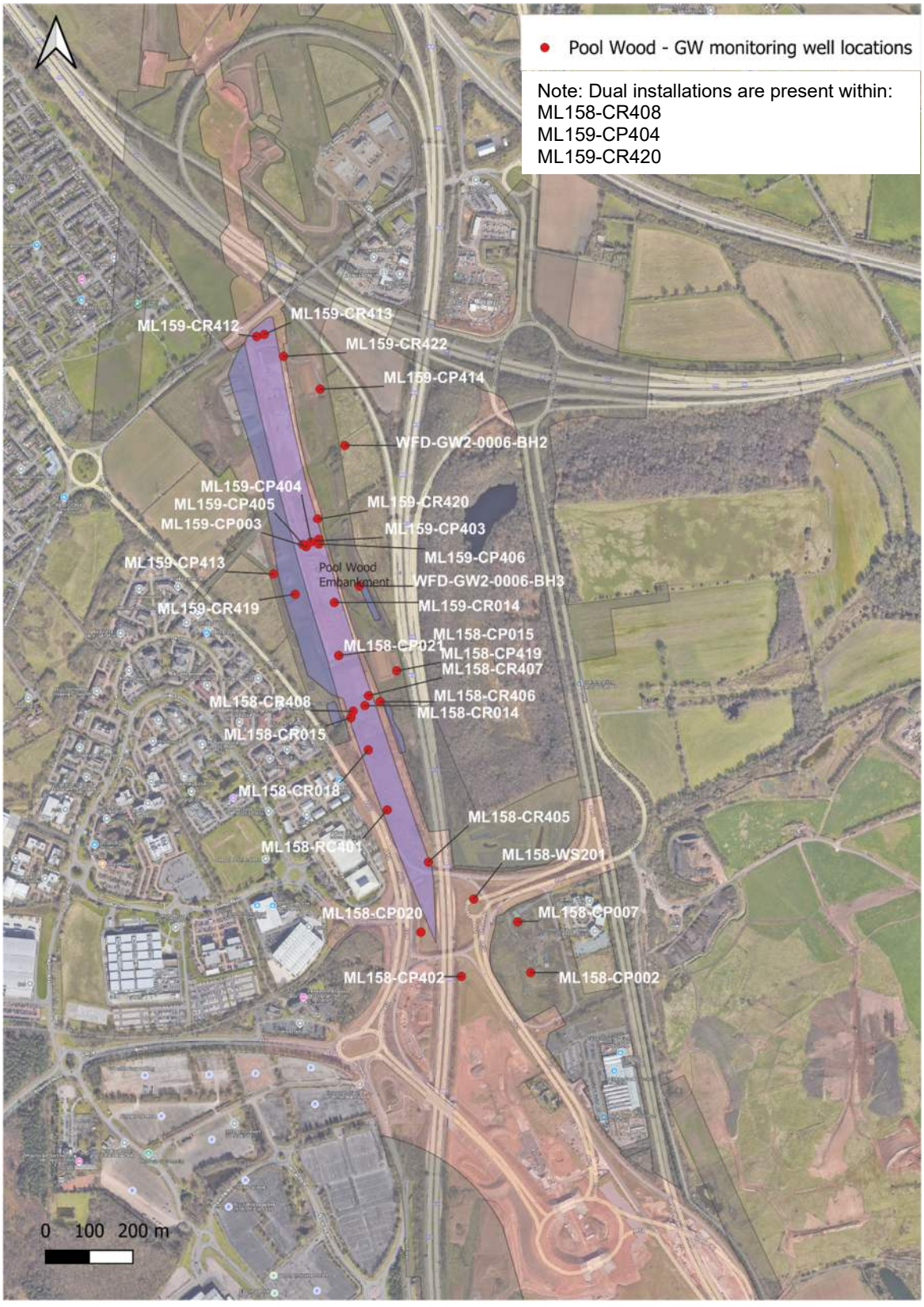
Borehole ID	Response zone top	Response zone base	No. of monitoring rounds	No. of wells monitored dry	Strata Screened	Shallowest reading	Average reading	Deepest reading	Ground level Elevation
ML159-CR419-1	95.81	90.81	16	0	GFDUD	97.35	96.9	96.41	101.71
ML159-CR420-1	81.12	71.12	16	0	MMG	97.31	91.6	76.92	101.12
ML159-CR420-2	96.42	91.42	16	0	BCMU	97.3	96.6	93.92	101.12
ML159-CR422-1	96.69	92.69	25	0	GFDUD	97.71	96.0	93.09	100.69
WFD-GW2-0006-BH2-1	95.3	92	1	0	GFDUD	96.6	96.6	96.6	100.30
WFD-GW2-0006-BH3-1	95.57	91.57	1	0	GFDUD	97.57	97.5	97.57	101.57
ML158-CP002	101.95	99.45	16	0	MGR	102.71	100.96	99.42	102.95
ML158-CP007	98.17	95.17	16	0	GFDUD	97.24	96.86	96.64	103.17

Borehole ID	Response zone top	Response zone base	No. of monitoring rounds	No. of wells monitored dry	Strata Screened	Shallowest reading	Average reading	Deepest reading	Ground level Elevation
ML158-CP402	97.99	93.29	1	0	GFDUD	95.71	95.71	95.71	99.99
ML158-WS201	103.78	102.78	13	0	GFDUD	104.68	103.8	103.25	105.78
ML158-CP419	97.26	92.27	34	0	GFDUD	97.34	96.47	94.06	99.26
ML159-CP413	95.87	92.07	34	0	GFDUD	99.9	96.5	95.9	102.07
ML159-CP414	98.12	91.92	33	0	GFDUD	97.0	96.4	92.6	99.12
ML158-CR405	72.69	69.69	9	0	GFDUD	92.8	91.0	80.1	99.69
ML158-CR406	94.3	91.3	16	0	GFDUD	96.6	95.8	93.7	99.30
ML158-CR408	97.95	92.5	17	0	GFDUD	97.4	96.6	92.5	100.25

Borehole ID	Response zone top	Response zone base	No. of monitoring rounds	No. of wells monitored dry	Strata Screened	Shallowest reading	Average reading	Deepest reading	Ground level Elevation
ML158-RC401	94.3	91.3	16	0	MMG	97.0	96.4	94.2	99.30
ML159-CP403	94.2	90.23	20	0	MMG	99.14	96.9	96.3	103.23

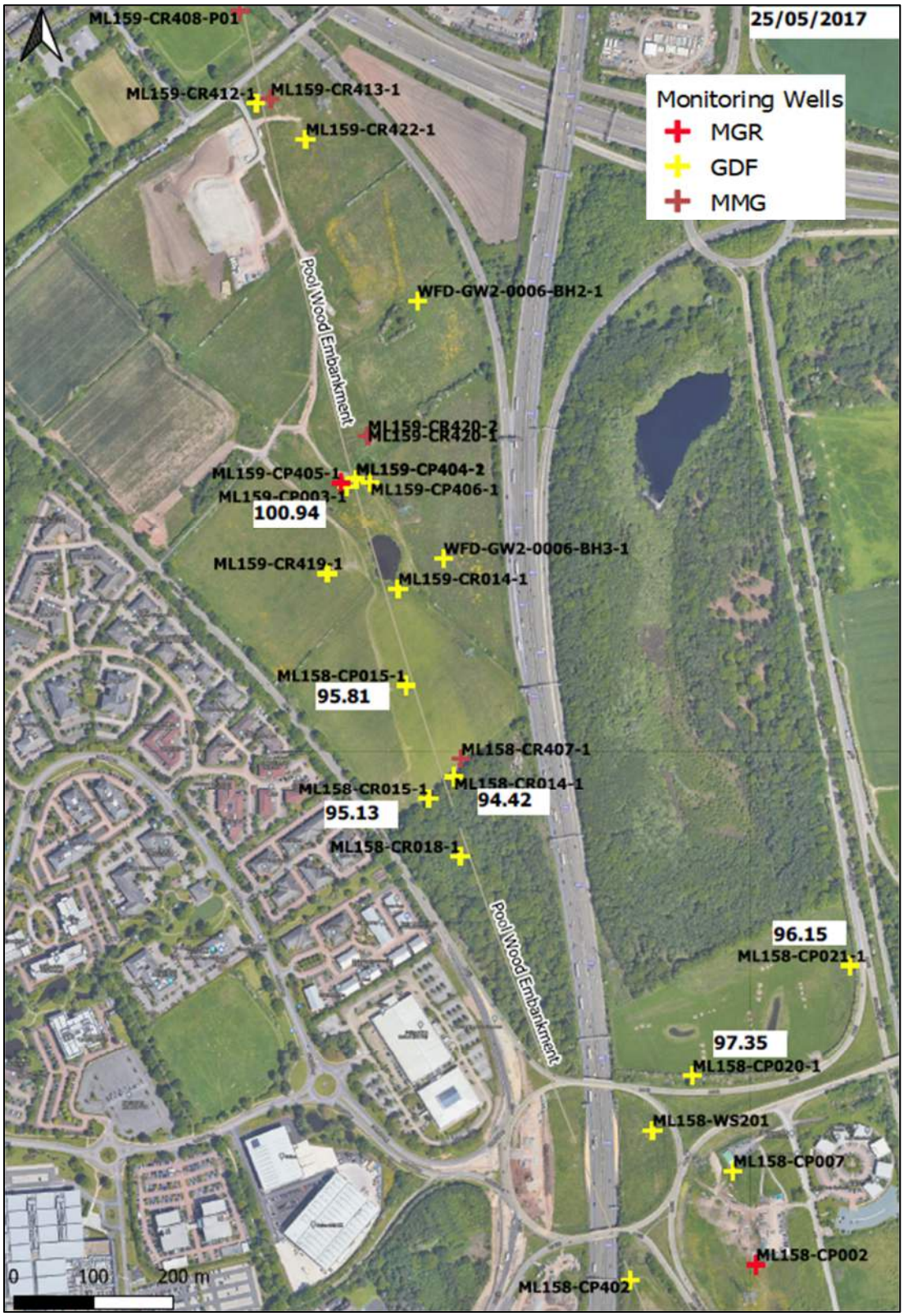
Note:- all measurements are recorded as mAOD

Figure 16 Groundwater monitoring well locations



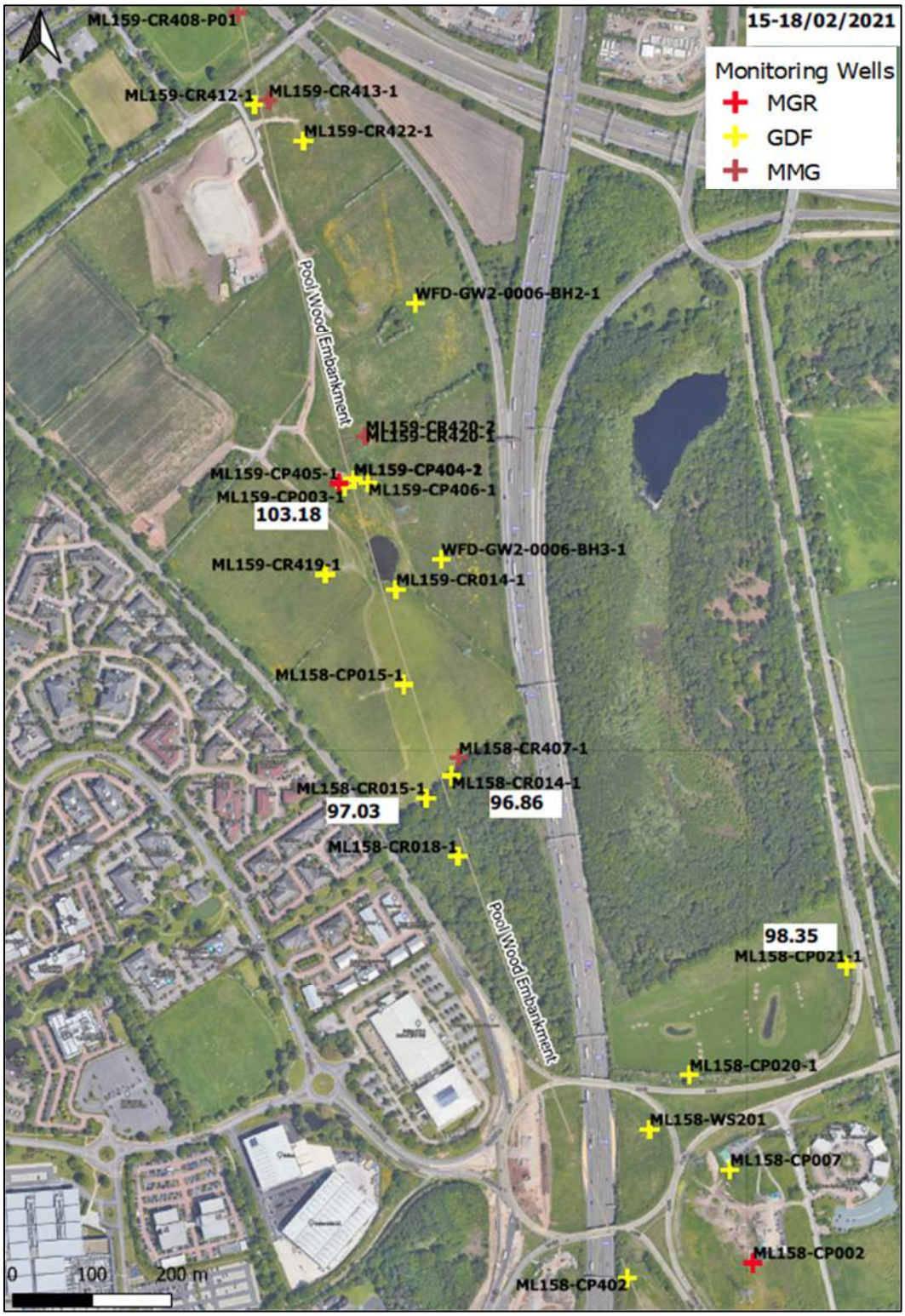
Source: QGIS, 2024

Figure 17 Groundwater monitoring elevations - May 2017 (mAOD)



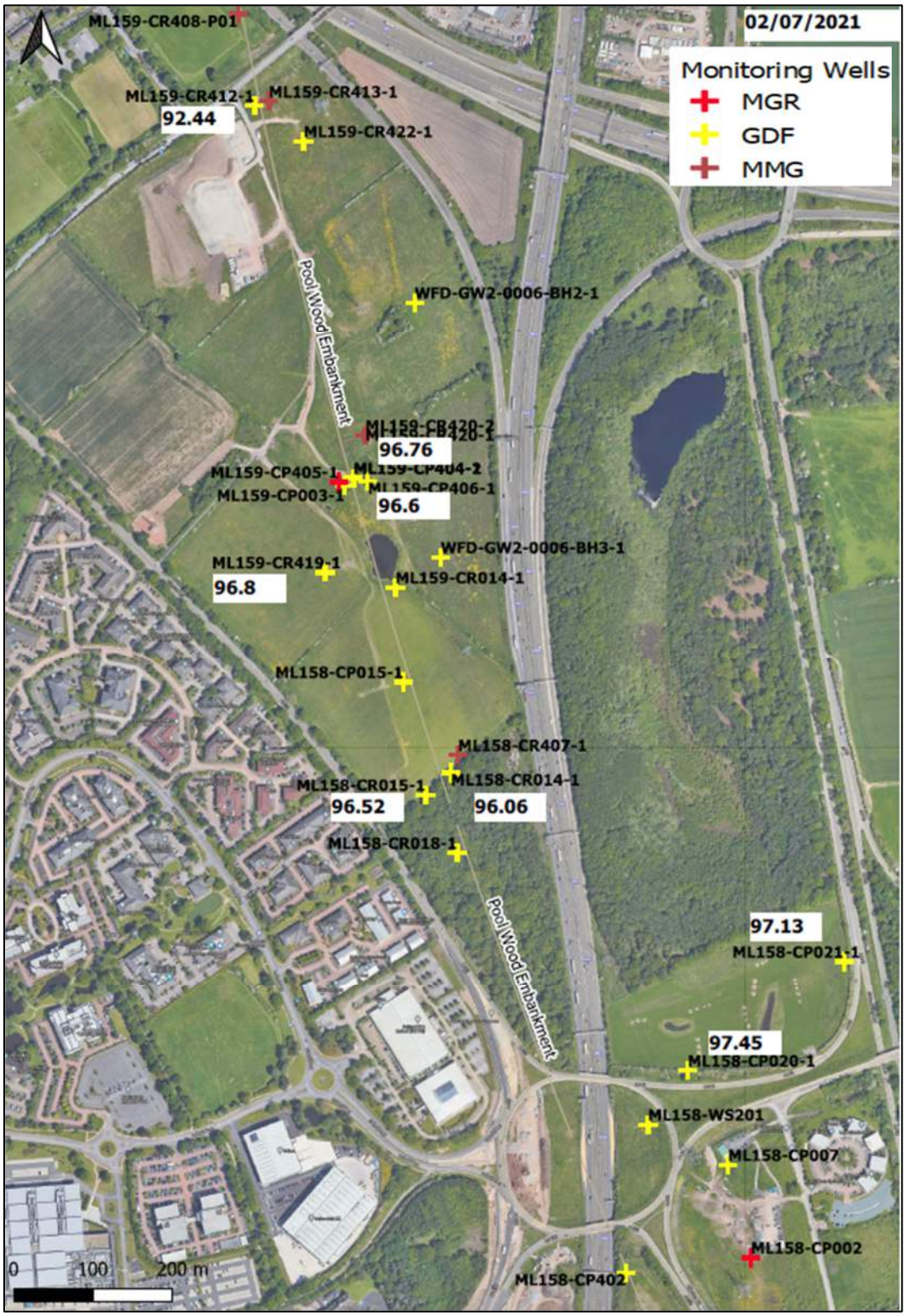
Source: QGIS, 2022

Figure 18 Groundwater elevations - February 2021 (mAOD)



Source: QGIS, 2022

Figure 19 Groundwater elevations - July 2021 (mAOD)



Source: QGIS, 2022

Figure 20 Groundwater elevations - August 2021 (mAOD)

Source: QGIS, 2022

The assessment of groundwater monitoring levels has identified the following:

- Groundwater elevations within the Made Ground were shallower than those recorded in the superficial deposits, which could suggest a perched water table within the Made Ground. As there are only two monitoring wells that targeted Made Ground, it is not possible to accurately characterise the groundwater elevations in this stratum.
- A water table is observed within the Glaciofluvial Deposits, which is likely perched above the low permeability Mercia Mudstone Group.
- In general, groundwater elevations over time shows a consistent pattern in the magnitude of the responses. Some variability is apparent which may reflect seasonal variations and the presence of cohesive and granular deposits within the Glaciofluvial Deposits.
- Allowing for data from the cable percussive and rotary boreholes, the highest groundwater elevations with the Glaciofluvial deposits were encountered in the centre of the Site and the lowest elevations were recorded to the south and to the north of the Site.
- Although there is uncertainty in deriving a flow direction within the Glaciofluvial Deposits, (due to the linear arrangement of the monitoring wells), considering the topography of the area, and the presence of a major watercourse (River Blythe) to the east of the site, the local groundwater flow direction is anticipated to be easterly, towards Coleshill Pool.

7.7.6 Conceptual Hydrogeological Model

The site and local area are underlain by a mixture of low to moderately permeable geological units associated with Made Ground, glacial superficial deposits, and mudstone bedrock.

The Made Ground will likely have variable permeability due to a mixture of granular and cohesive materials. Due to its variable nature, it is anticipated that water within the Made Ground will be disconnected. As indicated above, Made Ground will be removed as part of the dig and replace with cohesive materials to prepare the ground for construction works. Following the removal of topsoil/subsoil, the footprint of the site will be underlain by Glaciolacustrine Deposits which are generally non-productive units, mainly containing low permeability materials that will inhibit the movement of groundwater. The Glaciolacustrine Deposits appear to shallow and disappear in all directions from the site. Given its inherent properties, the Glaciolacustrine Deposits is not considered to be a major groundwater recharge area for the underlying Glaciofluvial Deposits.

Specific to Made Ground, BBV have confirmed that all Made Ground and that associated with the LQ Site in the east of the asset 'Former Brick Works and Infilled Pond' has been removed from below the footprint of the asset and shallower below the access road to the east of the asset. As built drawings are to be provided by BBV. As per the earthworks specification the area of excavation has been backfill with suitable material followed by the installation of rigid inclusions. This requirement is captured in the geotechnical risks register (entries 2495 and 2499). The DJV geotechnical have confirmed that are no concerns over settlement. DJV groundwater have confirmed that impacts on groundwater flow are likely to be localised to the area of infill and not of a concern. Drainage also has no concerns over the area of backfill.

The Glaciolacustrine Deposits are underlain by Glaciofluvial Deposits which are a Secondary A Aquifer mainly containing productive units of sand and gravel. Due to its higher permeability, these deposits can support the movement of groundwater. The inherently higher permeability of the Glaciofluvial Deposits compared to the lower permeability of the Glaciolacustrine Deposits is reflected in the associated hydraulic conductivity rates recorded in both deposits. The Glaciofluvial Deposits likely extends from below the site east below the alluvial deposits associated with the Coleshill Pool area.

The Glaciofluvial Deposits are underlain by laterally extensive Mercia Mudstone Group, which is a lower permeability lithological unit (Secondary B Aquifer) than the Glaciofluvial Deposits. The exception to this is the siltstone/sandstone bands within the Mercia Mudstone Group, where permeability values may be slightly higher. While there may be some hydraulic connection between the superficial deposits and mudstone, the horizontal bedding of the mudstone is such that vertical permeabilities tend to be very low, hence they support a water table in the overlying superficial strata. Given the low permeability characteristics of the mudstones, they are likely to inhibit the movement of groundwater at the site.

Based on a review of groundwater elevations, catchment data and surface waters, the groundwater flow direction within the vicinity of the site is anticipated to be easterly/northeasterly towards Coleshill/ Bannerley Pools and the River Blythe, with dominant flow likely to be through the Glaciofluvial Deposits. The Coleshill/ Bannerley Pools are Site of Special Scientific Interest (SSSI) and Groundwater Dependent Terrestrial Ecosystems (GWDTE) and likely in part supplied by groundwater originating from the Glaciofluvial Deposits underlying the site.

There is a network of existing and proposed land drains at and to the east of the site. Two post development ponds are located to the west of the site. Drainage originating from the site is to be conveyed to Hollywell Brook located approximately 2.9km south of the site via a network of land drains.

7.8 Contaminated land sources plan

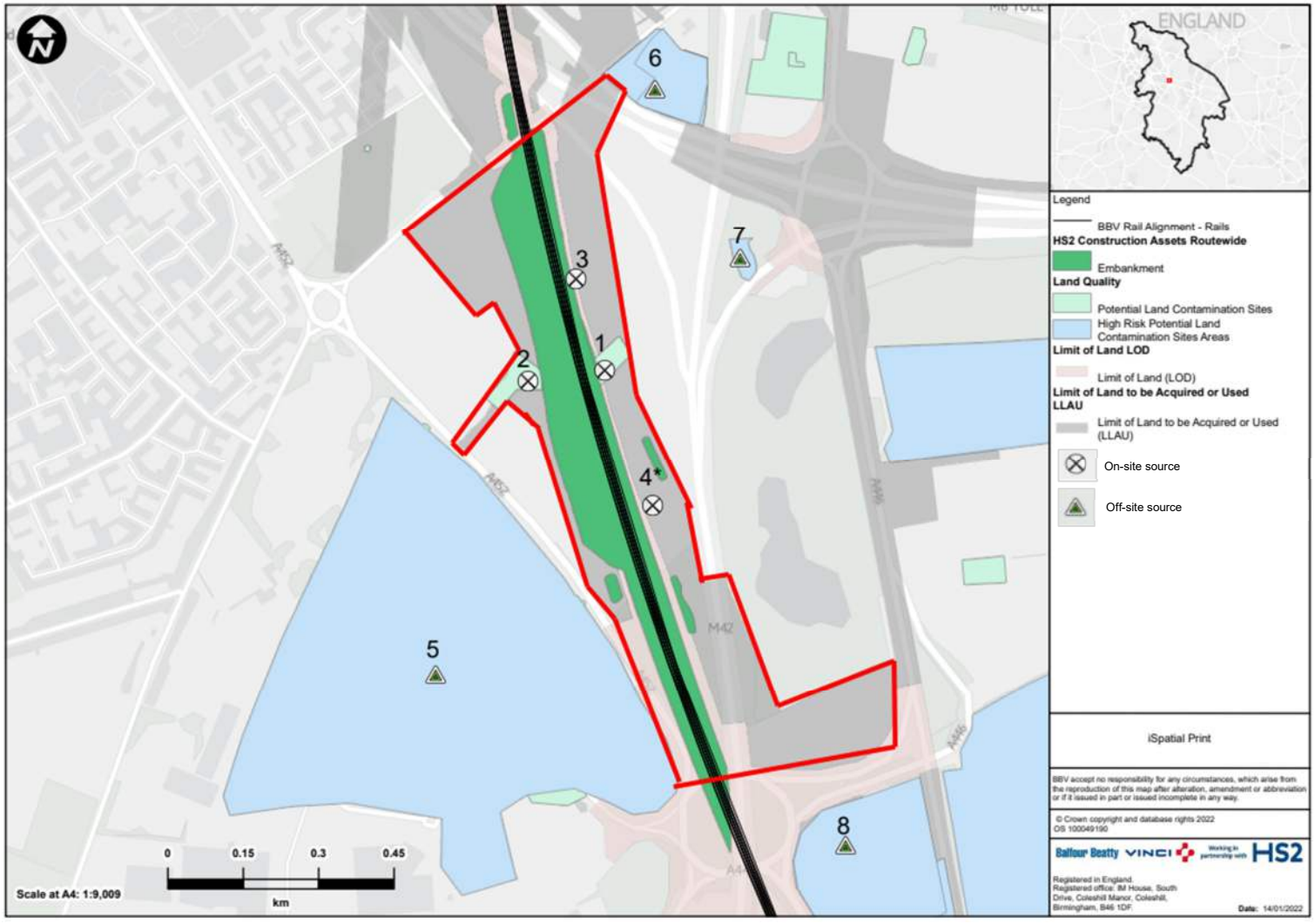
The completion of the Sublot 5 and 6 Consolidation report involved the generation of a contaminated land sources plan, which summarised all the potential contaminated land constraints, identified from the Environmental Statement and the Main Works Civils Contract assessment. The location of contaminated land constraints is summarised in Table 7 and shown in Figure 20.

The Environment Agency reports that the historical Brackenlands Farm Landfill (ES LQ 24-44) is a shallow 2m to 6m sand and gravel borrow pit formed during the construction of the M42. The landfill accepted inert and liquid/sludge waste including wastewater, sewage sludge and chemical waste mixed with municipal solid waste between 1975 and 1977. The western and northern margins of the landfill mark the boundary between the LoD and LLAU except for a portion of the LoD which is within the south-western corner of the landfill. Currently there are no proposed temporary or permanent works to be undertaken by the MWCC at Brackenlands Farm Historic Landfill. Therefore, this report does not consider contamination associated with the landfill site.

Table 7 Summary of contaminant sources

Sources	Source ID	Location and Potential Contaminants of Concern
On-Site		
Brick Works with kiln and infilled pond	1	Potential contaminants include organics, metals, inorganics, asbestos, and ground gas.
Brickfield Farm and Brickfields Cottage	2	Potential contaminants include organics, metals, inorganics, asbestos, herbicides and pesticides
Infilled Well	3	Potential contaminants include metals, organics, sulphates, asbestos and ground gases.
Fly-tipping	4	Fly-tipping observed during site walkover. Potential contaminants include organics, metals and asbestos
Off-Site		
Birmingham Business Park	5	Potential contaminants include organics, metals, inorganics, and asbestos
Depot and Motorway Maintenance Compound	6	Potential contaminants include organics, metals, and inorganics
Gravel Pit	7	Potential contaminants include metals, organics, sulphates, asbestos and ground gases
Brackenlands Farm Landfill	8	Potential contaminants include organics, inorganics, metals, asbestos, and ground gas

Figure 21 Location of potential contaminant sources



*Note: * - Fly-tipping source considered across the site*

8 SUMMARY OF RISK ASSESSMENTS

8.1 Summary of main contamination risks

The main risks identified with the Sub-lot 5 and 6 geo-environmental report[ii] associated with site that require further assessment are presented in 1MC09-BBV_MSD-EV-REP-N002-100042.

There is a potential for short term moderate risks to construction, maintenance workers and surrounding users from contaminants in soil and groundwater during redevelopment and asset maintenance works. These receptors could be exposed by direct contact, inhalation and ingestion pathways. In line with current legislation, guidance documents and occupational health and safety practises; risks to construction, maintenance workers and surrounding users should be mitigated by appropriate working/construction methods and standard good working practices such as use of dust suppression techniques to prevent liberation of transient dusts, wearing the correct Personal Protective Equipment (PPE) to prevent exposure. Risk identification and how to mitigate against such risks will be addressed through the development of risk assessments at the detailed design phase and through the adoption of measures specified in the Code of Construction Practice (CoCP), the COSHH Regulations 2017 and the CDM Regulations 2015. As such these receptors are not considered further within this report.

Table 8 Low/Moderate to Moderate risks identified from the Subplot 5 and 6 Geo-environmental Consolidation report

Geo-environmental risk	Detail
Moderate risks from impacted soils to controlled water receptors (Glaciofluvial Deposits, Mercia Mudstone aquifer units and Coleshill Pools)	Moderate to high soil concentrations of total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH) are mainly present within Made Ground and to a lesser extent within topsoil. Soil leachate concentrations above assessment criteria for metals were reported mainly within Made Ground and the Glaciofluvial Deposits.
Moderate risks from impacted groundwater to controlled water receptors (Glaciofluvial Deposits, Mercia Mudstone aquifer units and Coleshill Pools)	Groundwater data reported TPH, metals at concentrations above assessment criteria in samples collected from the Glaciofluvial Deposits. The Glaciofluvial deposits are likely to be in hydraulic connection with the Coleshill Pools located to the east of the Site.

8.2 Risk assessment framework

The Sublot 5 and 6 Consolidation Geo-environmental report[ii] (1MC09-BBV_MSD-EV-REP-N002-100002) reviewed environmental data to determine if there were unacceptable land quality risks, which led to the development of a series of conceptual site models for defined areas within the subplots. The ground investigation cut-off date for the consolidation geo-environmental report was August 2019. However, subsequent monitoring and sampling events undertaken up to September 2021 have also been used in this report.

The risk assessment was undertaken following the methodologies described in Appendix D and in accordance with the framework set out in the in the Land Contamination: Risk Management (LC:RM)[vi].

The risk assessment and development of the CSM was based on the identification of sources from a review of the environmental setting, field investigation, monitoring data and soil/groundwater analysis including the data collected up to September 2021. A summary of source areas and locations where analytical and monitoring data was obtained from is presented in Section 7.0 and 10 respectively. The results of the risk assessment were used to identify potential viable pollutant linkages (source-pathways-receptors) and the requirement for additional ground investigation, risk assessment and/or the need for remediation to mitigate risks. Qualitative definitions of risk are shown in Appendix CC.

9 CONCEPTUAL SITE MODEL (CSM)

9.1 Introduction

This section summarises the potential pollutant linkages and their associated risk rating as presented in the Sublot 5 and 6 Consolidation report[ii] (1MC09-BBV_MSD-EV-REP-N002-100002) for the Site. Section 9.2 to 9.4 summarises the potential source, pathways and receptors and Section 9.5 presents a summary assessment of the linkages with recommendations to mitigate risks, and for the next phases of assessment.

9.2 Risks to Human Health

9.2.1 Sources

The sources of contamination for risks to human health are:

- S1a: Contaminated soils – on-site (Source 1,2, 3 and 4)
- S1b: Contaminated soils – off-site (Sources 5, 6, 7 and 8)
- S1c: Asbestos contaminated soils (Sources 1, 2, 3, and 4)
- S2: Ground gases (Sources 1, 3, 7 and 8)
- S3: Contaminated groundwater (Sources 1 to 8)

9.2.2 Pathways

The pathways for human health exposure to contamination are:

- P1: Direct contact, ingestion, inhalation of dust/vapour from contaminated soils
- P2: Inhalation of vapour from contaminated waters
- P3: Direct contact, ingestion from contaminated waters
- P7: Inhalation of ground gases

9.2.3 Receptors

The human health receptors are:

- R1: On-site users – commercial/public open space
- R2: Off-site users – commercial/public open space

9.3 Risks to controlled waters

9.3.1 Sources

The sources of contamination for risks to controlled waters are:

- S1a: Contaminated soils – on-site (Source 1, 2, 3 and 4)
- S1b: Contaminated soils – off-site (Sources 5, 6, 7 and 8)
- S3: Contaminated groundwater (Sources 1 to 8)

9.3.2 Pathways

The pathways for controlled waters exposure to contamination are:

- P5a: Vertical and lateral migration via natural pathways
- P5b: Vertical and lateral migration via anthropogenic pathways

9.3.3 Receptors

The controlled water receptors are:

- R3: Controlled waters on-site - Groundwater Secondary A Glaciofluvial Deposits and the Secondary B Mercia Mudstone Group aquifer units
- R4: Controlled waters off-site - Groundwater Secondary A Alluvium/Glaciofluvial Deposits and the Secondary B Mercia Mudstone Group aquifer units. Surface waters and the GWDTE Coleshill Pools

9.4 Risks to property

9.4.1 Sources

The sources of contamination for risks to property are:

- S1a: Contaminated soils – on-Site (Sources 1, 2, 3 and 4)
- S1b: Contaminated soils – off-Site (Sources 5, 6, 7 and 8)
- S2: Ground gases (Sources 1, 3, 7 and 8)
- S3: Contaminated groundwater (Sources 1 to 8)

9.4.2 Pathways

The pathways for property exposure to contamination are:

- P6: Direct contact
- P4: Exposure to explosive gases

9.4.3 Receptors

The property receptors are:

- R5: Property Receptors – buildings, foundations and services (on and off-site)

9.5 Summary conceptual Site model

The CSM is summarised in **Error! Reference source not found.**9. Definitions of probability, consequence and risk are defined in the Sublot 5 and 6 Consolidation Geo-environmental[ii] report (1MC09-BBV_MSD-EV-REP-N002-100002) and presented in Appendix C of this report.

Table 9 Conceptual site model

Source	Pathway	Receptor	Geo-environmental report risk assessment	Risk management deliverables	Method of assessment
S1a: Contaminated soils – on-site (Source 1,2, 3 and 4 -) S1b: Contaminated soils – off-site (Sources 5, 6, 7 and 8 -) S3: Contaminated groundwater (Sources 1 to 8- **Error! Reference source not found.**)	P1: Direct contact, ingestion, inhalation of dust/vapour from contaminated soils P2: Inhalation of vapour from contaminated waters P3: Direct contact, ingestion from contaminated waters	R1: On-site users – commercial/ public open space R2: Off-site users – commercial/public open space	S1a, S1b, S3 > P1, P2, P3 > R1, R2 Probability: Unlikely Consequence: Medium Risk Rating: Low	SL5 and 6 Consolidation Geo-environmental Report and Land Quality Management Report	Generic Quantitative Risk Assessment
	P6: Direct contact	R5: Property– buildings, foundations and services (on and off-site)	S1a, S1b, S3 > P6 > R5 Probability: Likely Consequence: Medium Risk: Moderate	GIR/GiDR and durability report (1MC08-BBV-MN-REP-N001-100001)[vii] for foundation design sulphates; water supply pipe assessment and specification for potable mains to be undertaken by BBV)	BRE Special Digest Special Digest-1
S1c: Asbestos contaminated soils (Source 1, 2, 3 and 4)	P1: Inhalation of contaminated soils	R1: On-site users – commercial/public open space R2: Off-site users – commercial/public open space	S1c > P1 > R1 & R2 Risk assessment provided by asbestos specialist	Asbestos Remediation Strategy/Management Plan	Construction Industry Research and Information Association (CIRIA) C733
S2: Ground gas (Sources 1, 3, 7 and 8)	P7: Inhalation of ground gases	R1: On-Site users – commercial/ public open space R2: Off-Site users – commercial/ public open space	Probability: Unlikely Consequence: Negligible Risk Rating: Very Low No elevated gas levels were recorded. Additionally, the open-air environment and absence of buildings minimises the possibility of any gas build-up (if any).	Land Quality Management Report and Foundations Work Risk Assessment	Generic Quantitative Risk Assessment
	P4: Exposure to explosive gases	R5: Property – buildings, foundations and services (on and off-Site)	Probability: Unlikely Consequence: Negligible Risk Rating: Very low No elevated explosive ground gases recorded. Furthermore, the open-air environment and absence of buildings further minimises the possibility of any gas build up (if any).	Land Quality Management Report and Foundations Work Risk Assessment	

Source	Pathway	Receptor	Geo-environmental report risk assessment	Risk management deliverables	Method of assessment
S1a: Contaminated soils – on-site (Source 1,2, 3 and 4 -)	P5a: Vertical and lateral migration via natural pathways	R3: Controlled waters on-site Groundwater: Secondary A Glaciofluvial Deposits and Secondary B – Mercia Mudstone Group aquifer units R4: Controlled waters off-site Groundwater: Secondary A Alluvium/Glaciofluvial Deposits and Secondary B Mercia Mudstone Group aquifer units Surface water: Coleshill Pools (GWDTE)	S1a > P5 > R3, R4 Probability: Likely Consequence: Medium Risk: Moderate	Land Quality Management Report and Foundations Work Risk Assessment	Detailed Quantitative Risk Assessment
	P5b: Vertical and lateral migration via anthropogenic created pathways				
S3: Contaminated groundwater (Sources 1 to 8)	P5a: Vertical and lateral migration via natural created pathways	R3: Controlled waters on-site Groundwater: Secondary A Glaciofluvial Deposits and Secondary B Mercia Mudstone Group aquifer units R4: Controlled waters off-site Groundwater: Secondary A Alluvium/Glaciofluvial Deposits and Secondary B Mercia Mudstone Group aquifer units Surface water: Coleshill Pools (GWDTE)	S3a > P5a > R3, R4 Probability: Likely Consequence: Medium Risk: Moderate	Land Quality Management Report and Foundations Work Risk Assessment	Detailed Quantitative Risk Assessment
	P5b: Vertical and lateral migration via anthropogenic created pathways		S3 a> P5b > R63, R4 Probability: Likely Consequence: Medium Risk: Moderate/low	Land Quality Management Report and Foundations Work Risk Assessment	Detailed Quantitative Risk Assessment

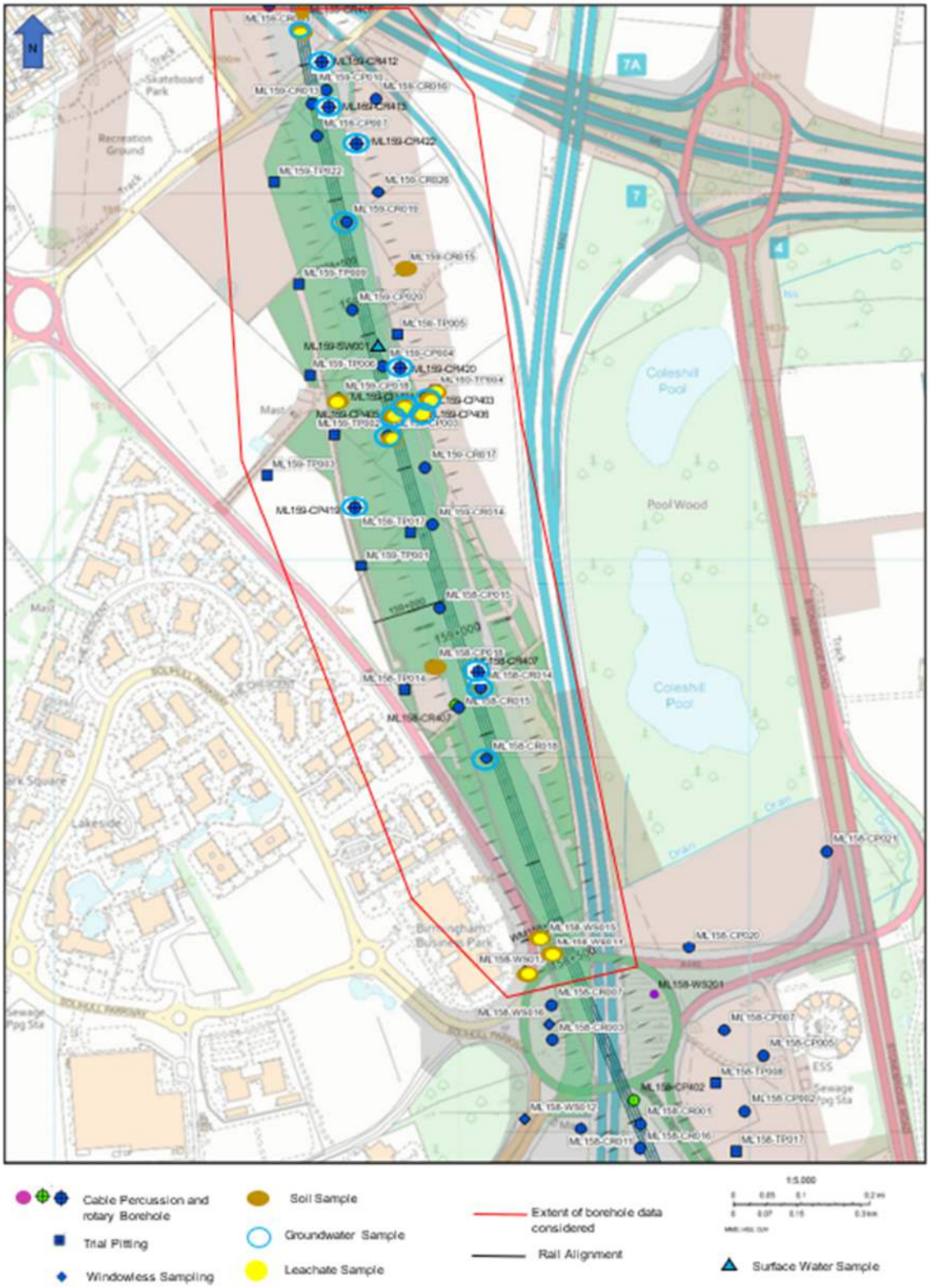
10 SITE INVESTIGATION - CONTAMINATION DATA

Based on the potential contaminative sources discussed in Section 7, soil and groundwater samples were collected from exploratory holes were formed across the site and submitted for laboratory analysis. Figure 21 shows the locations where soil, leachate, groundwater analytical samples were collected respectively.

This assessment also includes contamination data contained within the Sub Lot 5 and 6 Consolidation Geo-Environmental report[ii] (1MC09-BBV_MSD-EV-REP-N002-100002) and the subsequent contamination data collected up to September 2023. The full contamination data is presented within 108It should be noted that some analysis contained within this section is from outside the site boundary.

The risk assessment was undertaken following the methodologies described in Appendix DB and in accordance with the framework set out in the in the Land Contamination: Risk Management (LC:RM).

Figure 22 Sample locations at and near the site



10.1 Observations of Asbestos Contamination

No asbestos was detected in samples collected from the site. Also, during the ground investigation no asbestos or fibres materials were identified. An Asbestos Risk Assessment has been produced by RSK which should be followed if asbestos is encountered at the site The report is located at (1MC09-BBV_MSD-EV-REP-NS04_NL10-100208).

10.2 Organic contaminants identified in soil

10.2.1.1 Human health

The concentrations of all organic determinants were reported below Commercial and POS_{park} assessment criteria.

10.2.2 Controlled waters

Appendix C presents the results of the semi-quantitative screening assessment presented in the Sublot 5 and 6 Geo-environmental report[ii] (1MC09-BBV_MSD-EV-REP-N002-100002) for the soil TPH and PAH analytical data with the additional sampling undertaken up to September 2023. The report used the following system to classify the magnitude of the parameter concentration:

- Low – soil concentration <100 mg/kg for TPH and <10 mg/kg for PAHs
- Moderate – soil concentration 100 to <1000 mg/kg for TPH and 10 to <100 mg/kg for PAHs
- High – soil concentration >= 1000 mg/kg for TPH and >= 100 mg/kg for PAHs

Table 10 Moderate and high organic soil concentrations

Borehole ID	Depth (mbgl)	Strata	Contaminant	Result (mg/kg)
ML158-WS015	0.2	MGR	TPH Aromatics >C12-44	103
			EPH/TPH >C21-40	213
ML159-CP003	0.05		EPH/TPH >C16-21	401
			EPH/TPH >C21-40	5270
	1.05		EPH/TPH >C16-21	143
			EPH/TPH >C21-40	1240
ML159-CP018	0.30	Topsoil	EPH/TPH >C21-40	162
ML159-CP403	1	MGR	TPH Aromatics >C21-35	410
	2		TPH Aromatics >C21-35	190
	3		TPH Aliphatics >C21-35	1300
			TPH Aromatics >C12-16	120
			TPH Aromatics >C16-21	1500
			TPH Aromatics >C21-35	6800
			TPH Aromatics >C35-44	350
	4		TPH Aromatics >C16-21	1000
			TPH Aromatics >C21-35	4600
			TPH Aromatics >C35-44	250
	5		TPH Aromatics >C21-35	250

Borehole ID	Depth (mbgl)	Strata	Contaminant	Result (mg/kg)
ML159-CP404	0.5		TPH Aromatics >C21-35	590
	1		TPH Aromatics >C21-35	350
	2		TPH Aromatics >C21-35	170
	3		TPH Aromatics >C21-35	390
	4		TPH Aliphatics >C21-35	130
	4		TPH Aromatics >C21-35	530
ML159-CP406	0.3		TPH Aromatics >C21-35	230
	0.5		TPH Aromatics >C21-35	130

Note: Orange cells represent a moderate organic soil risk to controlled waters. Red cells represent a high organic soil risk to controlled waters. MGR = Made Ground

The location of soil hydrocarbon exceedances is shown in Figure 22.

10.3 Inorganic contaminants identified in soil

10.3.1 Human health

Except those inorganic determinants listed in Table 11, all other samples reported inorganic determinants at concentrations below Commercial and POS_{park} assessment criteria. Figure 23 shows the location of the inorganic exceedances.

Table 11 Human health inorganic soil exceedances

Determinant	Generic Assessment Criteria (mg/kg)	No. Samples Analysed		Location and Exceedances
		Total	No. Above Generic Assessment Criteria	
PoS Park				
Lead	1300	31	2	ML159-CP403 at 3mbgl = 4300 mg/kg ML159-CP403 at 4mbgl = 1400mg/kg
Commercial				
Lead	2300	31	1	ML159-CP403 at 3mbgl = 4300mg/kg
Nickel	980	31	1	ML159-CP403 at 3mbgl = 1000mg/kg

Figure 23 Location of human health soil inorganic exceedance

Source: iSpatial, 2024

10.3.2 Water receptors

Table 12 presents the inorganic leachate exceedances at the site. Exceedance locations are shown in Figure 25.

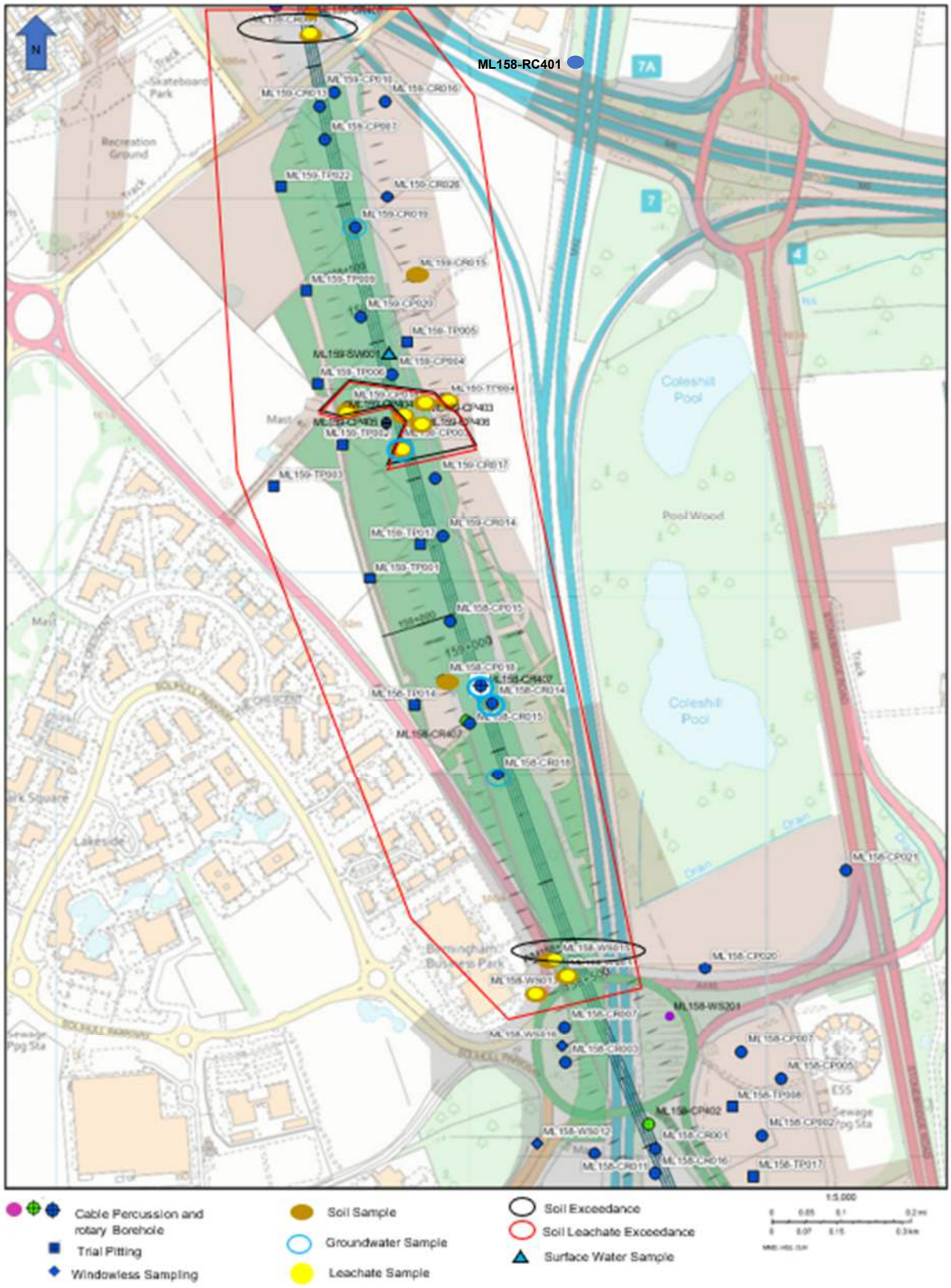
Table 12 Soil leachate exceedances at the Site

Borehole ID	Depth (mbgl)	Strata	Contaminant	*DWS (mg/l)	*EQS (mg/l)	Result (mg/l)
ML159-CP003	0.05	MGR	Chromium - Hexavalent	-	0.0034	0.00482
	1.05		Cadmium	0.005	0.00015	0.000161
			Nickel	0.02	0.02	0.166
ML159-CP018	0.30	Topsoil	Cadmium	0.005	0.00015	0.000431
			Chromium III	-	0.0047	0.169
			Copper	2	0.03	0.134
ML159-CP403	0.5	MGR	Cadmium	0.005	0.00015	0.00031
			Nickel	0.02	0.02	0.12
	1.0		Copper	2	0.03	0.043
	3		Cadmium	0.005	0.00015	0.00063
			Nickel	0.02	0.02	0.3
			Zinc	5	0.03	0.095
			Chromium - Hexavalent	-	0.0034	0.01

Borehole ID	Depth (mbgl)	Strata	Contaminant	*DWS (mg/l)	*EQS (mg/l)	Result (mg/l)
	5		Nickel	0.02	0.02	0.038
			Zinc	5	0.03	0.045
ML159-CP404	0.5		Copper	2	0.03	0.057
			Nickel	0.02	0.02	0.031
			Zinc	5	0.03	0.045
			Chromium - Hexavalent	-	0.0034	0.03
	1		Nickel	0.02	0.02	0.028
			Chromium - Hexavalent	-	0.0034	1.5
	3		Chromium - Hexavalent	-	0.0034	1.5
	5	GFD	Chromium - Hexavalent	-	0.0034	0.0097
ML159-CP406	0.3	MGR	Chromium - Hexavalent	-	0.0034	0.0044
	0.5			-	0.0034	0.028
	1			-	0.0034	0.13
ML158-RC401	1	GFD	Cyanide	0.05	0.001	0.2

Note: *DWS = Drinking Water Standards and EQS Environmental Quality Standards. Red cells indicate an exceedance of the Water Quality Standards. MGR = Made Ground, GFD = Glaciofluvial Deposits

Figure 24 Location of soil and soil leachate exceedances at and near the site



10.4 Organic and inorganic contaminants identified within groundwater

Error! Reference source not found. Table 13 lists the groundwater exceedances at the site. Exceedance locations are shown on Figure 25.

Table 13 Groundwater exceedances at and near the Site

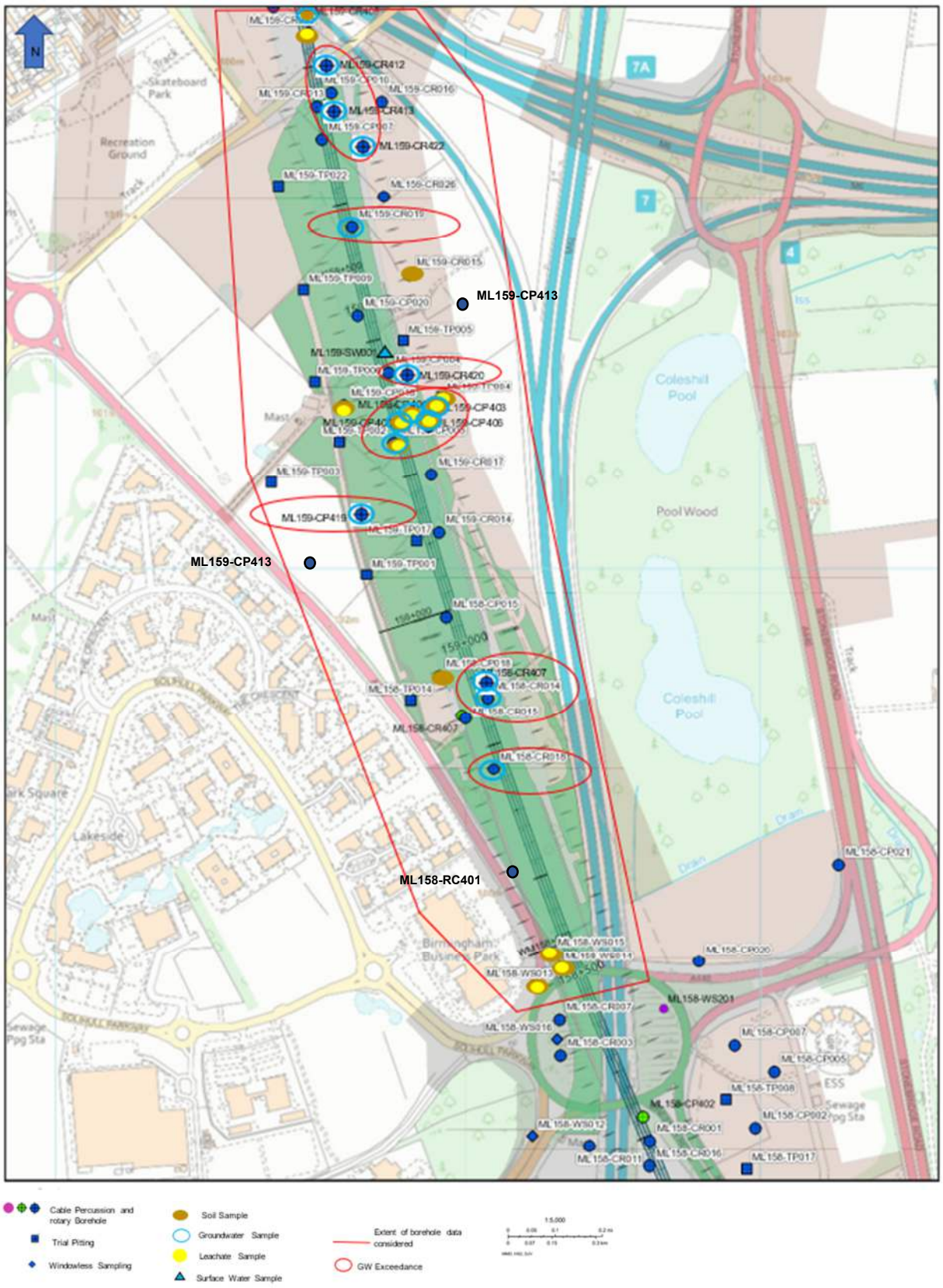
Borehole ID	Response zone (mbgl)	Strata	Contaminant	*DWS (mg/l)	*EQS (mg/l)	Result (mg/l)
ML158-CR018	4 – 7	GFD	Cadmium	0.005	0.00015	0.000196
			Iron	0.2	1	8.29
			Zinc	5	0.03	0.0839
			Manganese	0.05	0.41	0.272
			Aliphatics >C21-35	0.01	-	0.028
			Bis(2-ethylhexyl)phthalate	-	0.0013	0.00575
			Isoproturon	0.0001	0.0003	0.000501
ML159-CR019	7 – 12		Cadmium	0.005	0.00015	0.000533
			Chromium III	-	0.0047	0.045
			Copper	2	0.03	0.0708
			Iron	0.2	1	178
			Lead	0.01	0.008575	0.0618
			Nickel	0.02	0.02	0.0466
			Zinc	5	0.03	0.118
			Manganese	0.05	0.41	3.12
			Nitrate as N	11.295	-	29
			Nitrate NO3	50	-	130
			Aliphatics >C21-35	0.01	-	0.137
			Isoproturon	0.0001	0.0003	0.000492
			Ammoniacal Nitrogen as N	0.38	0.2	0.67
ML158-CR014	5-8		Ammoniacal Nitrogen as N	0.38	0.2	0.23
			Phenol	0.0005	0.0077	0.038
			Nickel	0.02	0.02	0.041
			Chromium - Hexavalent	-	0.0034	0.0037
			Chromium III	-	0.0047	0.08
ML158-CR406	5-8	GFD	Magnesium	50	-	56
			Ammoniacal Nitrogen as N	0.38	0.2	0.26
ML158-CR407	8-10	MMG	Magnesium	50	-	51
			Nitrate as N	11.295	-	19
ML159-CP003	1.20-4.20	GFD	Ammoniacal Nitrogen as N	0.38	0.2	0.78
			Potassium	12	-	30
			Zinc	5	0.03	0.16
ML159-CP403	9-13		Ammoniacal Nitrogen as N	0.38	0.2	0.47
			Magnesium	50	-	110

Borehole ID	Response zone (mbgl)	Strata	Contaminant	*DWS (mg/l)	*EQS (mg/l)	Result (mg/l)
			Chromium - Hexavalent	-	0.0034	0.03
ML159-CP406	8.5-11.7		Ammoniacal Nitrogen as N	0.38	0.2	1.5
			Cadmium	0.005	0.00015	0.00029
			Chromium - Hexavalent	-	0.0034	0.0036
			Magnesium	50	-	100
ML159-CP404	1-4	MGR	Ammoniacal Nitrogen as N	0.38	0.2	13
			Magnesium	50	-	97
			Potassium	12	-	36
			Sulphate as SO4	250	-	730
			Nickel	0.02	0.02	0.027
	9-12	GFD	Nickel	0.02	0.02	0.03
			Chromium - Hexavalent	-	0.0034	0.004
			Magnesium	50	-	97
			Nitrate as N	11.295	-	23
			Nitrate NO3	50	-	100
ML159-CR408	10-13	MMG	Ammoniacal Nitrogen as N	0.38	0.2	0.32
			Magnesium	50	-	52
			Nitrate as N	11.295	-	17
			Chromium - Hexavalent	-	0.0034	0.0036
			Zinc	5	0.03	0.05
ML159-CR422	4-8	GFD	Nitrate as N	11.295	-	20
			Nitrite as N	0.152	-	0.19
ML159-CR419	5.9-10.9	GLD	Magnesium	50	-	56
			Nitrite as N	0.152	-	0.37
			Nitrate as NO3	50	-	120
ML159-CR420	Unknown		Cadmium	0.005	0.00015	0.00017
			Magnesium	50	-	65
ML159-CP405	1-5	GFD	Ammoniacal Nitrogen as N	0.38	0.2	1.9
			Cadmium	0.005	0.00015	0.0006
			Lead	0.01	0.008575	0.024
			Potassium	12	-	15

Borehole ID	Response zone (mbgl)	Strata	Contaminant	*DWS (mg/l)	*EQS (mg/l)	Result (mg/l)
			Selenium	0.01	-	0.012
			Zinc	5	0.03	0.093
ML159-CR412	10-20	MMG	Nitrate as N	11.295	-	25
			Nitrate as NO2	50	-	110
ML158-RC401	5-8	MMG	Nickel	0.02	0.02	0.06
			Ammoniacal Nitrogen as N	0.38	0.2	0.24
ML159-CP413	6.2-10	GFD	Magnesium	49	50	95
			Nitrate a N	11.295	-	27
			Nitrate as NO3	50	-	120
ML159-CP414	1.6-7.2	GFD	Potassium	12	-	26

Note: *DWS are the Drinking Water Standards and EQS are the Environmental Quality Standards. Red cells indicate an exceedance of the Water Quality Standards. MGR = Made Ground, GFD = Glaciofluvial Deposits, MMG = Mercia Mudstone Group, GLD = Glaciolacustrine Deposits

Figure 25 Location of groundwater exceedances at and near the site



10.5 Ground gas

Seven monitoring wells located across the site were monitored for ground gasses up to September 2023 (refer to 1). A summary of the gas monitoring data is presented in Table 14.

Except for ML158-CR408, the gas assessment indicated that all other sampling points would place the site under Characteristic Situation 1 (very low risk). Due to a slightly elevated gas screening values above assessment criteria, ML158-CR408 was classified as Characteristic Situation 2 (low risk).

Methane and carbon monoxide are explosive in air between 5% – 15% and 12.5% – 74.2% respectively. A hazard exists when a flammable ground gas accumulates in a confined space at concentrations above the Lower Explosive Limit (LEL). All recorded concentrations of carbon monoxide and methane were below the LEL.

Table 14 Maximum Gas Screening Value Summary

BH ID	Response Zone (m bgl)	Strata screened	No. of monitoring rounds	Flow range (l/hr)	Methane range (%v/v)	Carbon Dioxide range (%v/v)	Max GSV	CS
ML158-CP020-1	2.0-5.0	GFD	11	<0.1-0.5	<0.1 – 0.3	1.0 – 2.1	0.009	CS1
ML158-CP021-1	2.0-5.0	GFD	9	<0.1-0.6	<0.1-0.3	0.2-4.3	0.02	CS21
ML158-CR407-1	8-10	MMG	5	0.1-0.8	<0.1-0.1	0.1-0.8	0.001	CS1
ML159-CR408	10-13	MMG	6	<0.1-0.5	<0.1-0.1	0.1-5	0.007	CS1
ML158-WS201	2-3	GFD	11	<0.1-1.7	<0.1	0.6-1.3	0.02	CS1
ML158-CR408	2.3-7.75	GFD	6	0.2-6.3	<0.1-0.8	1.2-2.8	0.19	**CS2**
ML158-RC401	5-8	MMG	5	<0.1-0.2	<0.1-0.1	0.1-1	0.0004	CS1

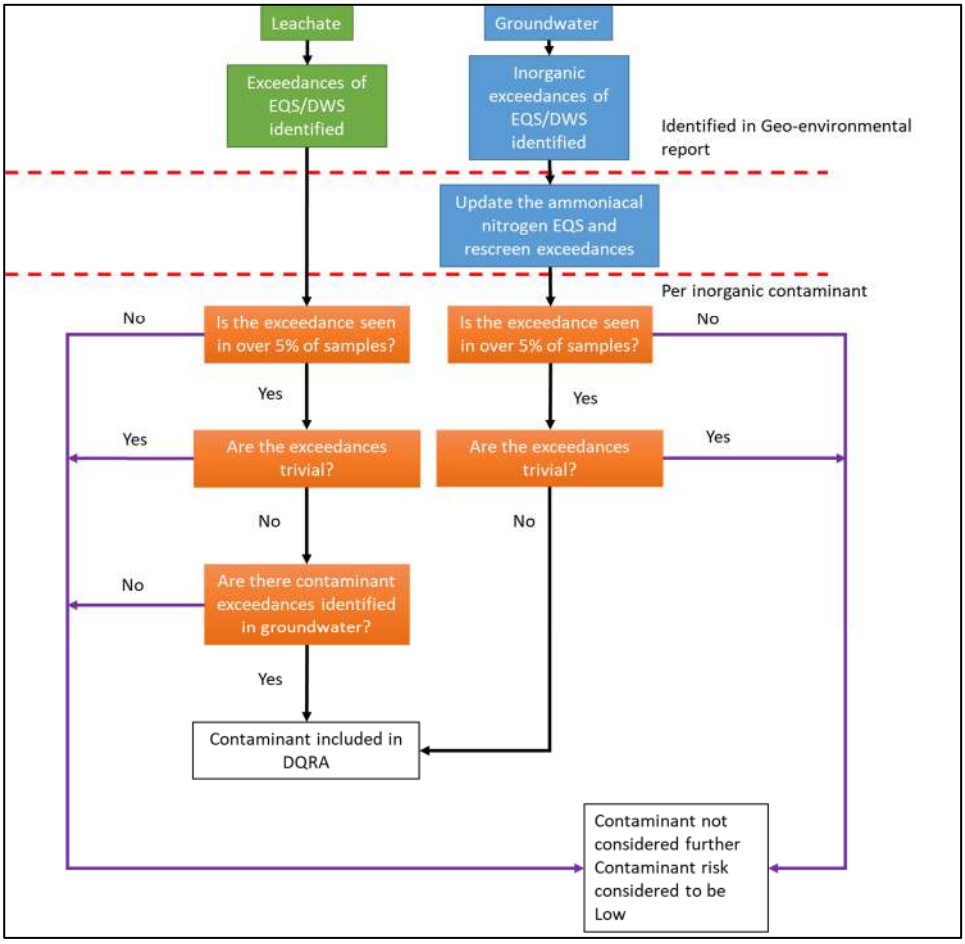
11 GENERIC QUANTITATIVE RISK ASSESSMENT

11.1 Screening assessment & contaminants of concern

Where exceedances of the generic assessment criteria have been identified within Section 10, these were subject to discussions and a screening assessment to determine if they were deemed to be contaminants of concern (CoC) requiring fate and transport modelling (as shown in Figure 24). The screening assessment included:

- Whether the proposed design mitigates the risk to sensitive receptors (e.g., removal of Made Ground and/or covering an area reported to contain CoC).
- A refined standard for Ammoniacal nitrogen as N based on unionised ammonia.
- A screening assessment of the hydrocarbon exceedances detected in soil and groundwater that may pose a risk to controlled waters
- A consideration of whether inorganic exceedances are within both leachate and groundwater samples.
- A statistical analysis of inorganic leachate and groundwater exceedances where the percentage of the exceedances is calculated for each contaminant to identity whether exceedances are observed within less or above 5% of the samples tested. Determinant exceedances identified within less than 5% of the samples tested would not be considered to be a CoC given that an appropriate number of samples were tested.
- Comparison to sublot wide background concentrations for leachate samples

Figure 26 Process for determining inorganic contaminants of concern



The risk assessment was undertaken following the methodologies described in 12.2 and presented in Appendix B and in accordance with the framework set out in the in the Land Contamination: Risk Management (LC:RM)[viii].

11.2 Risk of soil and groundwater contamination to human health

Various exceedances of the UK DWS were identified within groundwater samples. However, the site is not located within an actual or future groundwater abstraction recharge area therefore the risk of groundwater contamination to human health is considered to be low.

Exceedances for PoS Park and commercial have been reported at ML159-CP403 in Made Ground samples. Lead was reported above the PoS Park at 3m and 4mbgl at concentrations of 4300 and 1400mg/kg respectively. Commercial exceedances were detected for lead and nickel, at 3mbgl, at concentrations of 4300 and 1000mg/kg respectively. The exceedances are located within the footprint of the site and will be subject to dig out and replacement of Made Ground materials material to facilitate the geotechnical design requirements. This operation will remove the source of contamination, removing the risk to future human health receptors. Post development risk of site soil contamination to human health is considered to be low.

Contaminated and non-contaminated materials generated from site earthworks allocated for reuse will be subjected to validation testing and management under the Materials Management Plan Route A and Route B. All requirements of Appendix 6/8 of the Specification for Civil Engineering Works (SCEW) shall also be followed.

11.3 Risk of organic soil contamination on controlled waters

As summarised in Table 10, moderate to high concentrations of aromatic/aliphatic and extractable petroleum hydrocarbons were reported in Made Ground and Topsoil samples collected from ML158-WS015, ML159-CP003, ML159-CP018 ML159-CP403, ML159-CP403, ML159-CP404 and ML159-CP406 at depths ranging from 0.05 to 5mbgl. Except for ML158-WS015 and ML159-CP018, the remaining four boreholes are located in the Former Brickworks with Kiln and Infilled Pond LQ (FBIP) site. Hydrocarbons associated with the boreholes located in the FBIP will be removed as part of the dig and replace to facilitate geotechnical design requirements.

Except for Aromatic >C12-16, all other hydrocarbons are of low to very low mobility and unlikely to migrate and impact controlled waters. Aromatic >C12-16 are of moderate mobility and in relative terms are more likely to migrate into controlled waters compared to the heavier end hydrocarbons. A review of logs suggests that the hydrocarbons are in part associated with ash contained in the Made Ground.

In all cases where data is available, the vertical extent of hydrocarbon impacts has been established and there is no evidence of groundwater impacts in samples collected from the boreholes listed in Table 10, including at ML159-CP403 where Aromatic >C12-16 soil hydrocarbons were detected. On the basis that aromatic >C12-16 hydrocarbons are of moderate mobility, this determinand was subjected to Detailed Quantitative Risk Assessment (DQRA). The remaining hydrocarbons are not considered to be contaminants of concern.

11.4 Risk of leachable soil inorganic contamination on controlled waters

Leachable inorganic soil contaminant exceedances presented in Table 15 were subjected to screening to determine the need for further assessment and modelling as presented in Appendix B.

As shown in Table 15 to facilitate the assessment process, soil leachate inorganic concentrations were compared to background sub lot concentrations presented in the Sublot 5 and 6 Geo-environmental report[ii] (1MC09-BBV_MSD-EV-REP-N002-100002). Statistical analysis was undertaken on inorganic leachate results across the Sub-Lot 5-6 route to characterise the distribution of exceedances and contamination sources that are outside known Land Quality sites.

As shown in Table 15, of the leachable determinands reported at the site, hexavalent chromium and nickel were identified as potential contaminants of concern at the FBIP land site. On this basis, both contaminants were subject to Detailed Quantitative Risk Assessment.

Table 15 Comparison of background and site leachate concentrations

	Hexavalent Chromium (mg/l)		Copper (mg/l)		Trivalent Chromium (mg/l)		Nickel (mg/l)		Zinc (mg/l)		Cadmium	
	SL5/6 wide conc.	Site conc.	SL5/6 wide conc.	Site conc.	SL5/6 wide conc.	Site conc.	SL5/6 wide conc.	Site conc.	SL5/6 wide conc.	Site conc.	SL5/6 wide conc	Site conc
Max	0.106	1.5	0.134	0.134	0.169	0.16	0.166	0.3	0.392	0.095	0.0017	0.00063
Min	0.003	<0.0001	0.0009	<0.0006	0.001	<0.001	0.000758	0.0005	0.002	0.001	0.00002	<0.00008
Mean	0.00772	0.09	0.02170	0.01	0.00738	0.006	0.00715	0.02	0.08972	0.01	0.00025	0.0001
Median	0.00300	0.003	0.01050	0.0062	0.00300	0.003	0.00200	0.002	0.05450	0.008	0.00010	0.00009
Geometric Mean	0.00398	0.002	0.0115	0.006	0.003072	0.003	0.002819	0.003	0.038	0.008	0.000131	0.0001

Note: grey cells show where site concentrations are above the corresponding value noted within Geo-Environmental Report but within the same order of magnitude and pink cells show where site concentrations are an order of magnitude above the corresponding value noted within Geo-Environmental Report (minimum values have not been included). For statistical analysis, where the contamination concentrations are below the detection limit, the result has been set to the detection limit. Conc. = Concentrations.

Table 16 Determination of inorganic soil leachate contaminants of concern (CoC)

Contaminant	EQS (mg/l)	DWS (mg/l)	No. of Samples	EQS exceedances – Number (Percentage)	DWS exceedances – Number (Percentage)	Exceedances identified within groundwater data	Discussion	Recommendations
Copper	0.03	2	26	3 (9)	0	Yes	EQS (0.03mg/l) exceedances of 0.043 and 0.134mg/l identified. Leachate samples were mainly associated with the FBIP land quality site was below and consistent with background concentrations and detected marginally above (0.07mg/l) the EQS (0.03mg/l) in one groundwater sample not associated with the FBIP land quality site. Exceedances were consistent with background concentrations and not present in groundwater at the leachate sample location and considered to be trivial.	Copper is not considered a CoC
Hexavalent Chromium	0.0034	-	18	7 (38)	0	Yes	EQS (0.0034mg/l) exceedances ranged from 0.0044 to 1.5mg/l. Whilst there was some consistency with background parameters, the maximum and mean concentration were an order of magnitude above background concentrations. Exceedance locations were only located within the FBIP land quality site. Marginal exceedances (0.0036 and 0.004mg/l) were reported at two groundwater sample locations associated with the same land quality site. Exceedances are not considered to be trivial.	Hexavalent Chromium is considered a CoC
Nickel	0.02	0.02	38	6 (15)	6 (15)	Yes	EQS and DWS (0.02mg/l) exceedances of 0.028 to 0.3mg/l respectively identified only in the FBIP land quality site. Concentrations were below and consistent with background concentrations and detected marginally above (0.03 to 0.06mg/l) the water standards in five widespread groundwater sample locations. Two marginal exceedances (0.027 and 0.03mg/l) were reported in groundwater samples collected from the FBIP land quality site. Exceedances are likely to reflect a combination of background variations and possible contaminants located in the FBIP land quality site therefore exceedances are not considered trivial.	Nickel is considered a CoC
Cadmium	0.00015	0.005	26	4 (15)	0	Yes	EQS exceedances (0.00015mg/l) ranged from 0.00016 to 0.00063mg/l. Some of the exceedances are located within the FBIP land quality site, but concentrations were below and consistent with background concentrations and detected marginally above the EQS (0.00017 to 0.0006mg/l) at five widespread groundwater sample locations. Exceedances are consistent with background concentrations and considered to be trivial.	Cadmium is not considered a CoC

Contaminant	EQS (mg/l)	DWS (mg/l)	No. of Samples	EQS exceedances – Number (Percentage)	DWS exceedances – Number (Percentage)	Exceedances identified within groundwater data	Discussion	Recommendations
Chromium III	0.0047	-	20	1 (5)	0	Yes	A single EQS (0.0047mg/l) exceedance of 0.169mg/l was identified not associated with a land quality site. Concentrations were below and consistent with background concentrations. Two groundwater exceedances (0.04 and 0.08mg/l) were reported not associated with the leachate exceedance. Exceedance was consistent with background is considered to be trivial.	Chromium III is not considered a CoC
Zinc	0.03	5	16	3 (18)	0	Yes	EQS (0.03mg/l) exceedances ranged from 0.043 to 0.095mg/l. Exceedances are located in the FBIP land quality site, but concentrations were below background concentrations and detected marginally above (0.05 to 0.16mg/l) the EQS in five widespread groundwater sample locations, none associated with the leachate sample location. Exceedances are consistent with background variations and considered to be trivial.	Zinc is not considered a CoC
Cyanide	0.001	0.05	38	1 (2)	0	No	A concentration of 0.2mg/l was reported at ML158-RC401, above the EQS and DWS. No free cyanide (the more toxic form of cyanide) was detected in soil, leachate, or groundwater therefore the risk of cyanide on aquatic life is considered to be low.	Cyanide is not considered a CoC

11.5 Risk of inorganic groundwater contamination on controlled waters

Groundwater contaminant exceedances presented in Table 13 were subjected to screening to determine the need for further assessment and modelling as presented in Appendix B.

As shown in Table 17, of the groundwater determinands reported at the site, hexavalent chromium was identified as a potential contaminant of concern. Accordingly, hexavalent chromium was subject to Detailed Quantitative Risk Assessment.

An aliphatic >C21-35 exceedances of 0.137mg/l and 0.02 above the UKDWS of 0.01mg/l was reported in January 2017 at ML159-CR019 and ML158-CR018 respectively (screened in the Glaciofluvial Deposits). A subsequent sampling round in October 2021 reported aliphatic >C21-35 below laboratory detection limits (ML159-CR019 only). No other hydrocarbons were reported at either location during sampling events and there was no evidence of contamination in the borehole logs or the presence of Made Ground. Neither borehole is located at a land quality site. With reference to Petroleum Hydrocarbons in Groundwater (CL:AIRE, 2017), aliphatic >C21-35 are of very low mobility. The culmination of the evidence suggests an identifiable and persistent source is no present and due to its very low mobility risk to controlled waters are considered to be low.

A marginal bis(2-ethylhexyl)phthalate exceedances of 0.005mg/l above the EQS of 0.0013mg/l was reported in January 2017 at ML158-CR018 (screened in the Glaciofluvial Deposits). There is no evidence of a source in the borehole log. The determinant is characterised to be of low mobility based on a high partition coefficient (strong ability of absorb onto soil and organic matter) and low solubility. Accordingly, the risks to controlled waters are considered to be low.

Table 17 Determination of inorganic groundwater contaminants of concern (CoC)

Contaminant	EQS (mg/l)	DWS (mg/l)	No. of Samples	EQS exceedances – Number (Percentage)	DWS exceedances – Number (Percentage)	Discussion	Recommendations
Cadmium	0.00015	0.005	43	10 (23)	0 (0)	EQS exceedances range from 0.00017 to 0.0009mg/l. Exceedance concentrations were similar and reported across the site both within and outside land quality sites with leachate concentrations reflective of background concentrations. The exceedances of cadmium are considered to be marginal and to pose a low risk to controlled waters.	Cadmium is not considered a CoC
Iron	1	0.2	2	2 (100)	2 (100)	EQS and DWS exceedances of 8.29 and 178mg/l were recorded in ML158-CR018 and ML159-CR019. As no land quality areas are located near these boreholes the source of iron at these locations is unclear. It is possible that impacts may be associated with off-site and natural sources and therefore remediation of the groundwater at these locations is unlikely to be effective.	Iron is not considered a CoC
Zinc	0.03	5	43	5 (11)	0 (0)	EQS exceedances of 0.05 to 0.16mg/l were detected within five locations (ML158-CR018, ML159-CR019, ML159-CP405 and ML159-CP003 and ML158-CR408. Exceedance locations are widespread with leachate concentrations deemed to be reflective of background concentrations. The exceedances are considered to be trivial and reflective of site wide concentrations	Zinc is not considered a CoC
Manganese	0.41	0.05	2	1 (50)	2 (100)	EQS and DWS exceedances of 0.272 and 3.12mg/l were identified. As no land quality areas are located near the boreholes and considering that the local groundwater flow direction is generally to the east (towards Coleshill Pool), the source of manganese at these locations is unclear. It is possible that impacts may be associated with off-Site sources and therefore remediation of the groundwater at these locations is unlikely to be effective. Manganese was not encountered in exceedance within the soil leachate samples. Manganese is often elevated in natural ground and mobility can be affected by natural changes in redox.	Manganese is not considered a CoC
Isoproturon	0.0003	0.009	4	2 (50)	0 (0)	Isoproturon is a banned herbicide. DWS exceedances of 0.000501 and 0.000492mg/l were recorded which are regarded as marginal. As the presence of isoproturon is likely to be due to historic dispersed and regional agricultural land uses near the Site, the parameter is not considered to be a CoC. Levels of Isoproturon are expected to decline following an EU wide ban in 2017.	Isoproturon is not considered a CoC
Chromium III	0.0047	-	33	2 (6)	0 (0)	Exceedance of 0.045 to 0.08mg/l was recorded were reported at two locations not associated with land quality sites. A single leachable exceedance was reported at ML159-CP018 and not associated with the groundwater locations. The groundwater exceedances are considered to be trivial and reflective of site wide concentrations.	Chromium is not considered a CoC
Copper	0.03	2	50	1 (2)	0 (0)	A single EQS exceedance of 0.0708mg/l was recorded at ML159-CR019 and represent <5% of the sample population. The location is not associated with a land quality site or leachable copper reported at ML159-CP404. The groundwater exceedance is considered to be trivial and reflective of site wide concentrations.	Copper is not considered a CoC
Lead	0.008575	0.01	43	2 (4)	2 (4)	Exceedance of 0.024 and 0.0618mg/l was recorded above the EQS and DWS at ML159-CR019 and ML159-CP405 and represent <5% of the sample population. The highest concentration of lead were encountered at ML159-CR019. No land quality area are located near these boreholes and/or no leachable lead reported at the site. The groundwater exceedance are considered to be trivial and reflective of site wide concentrations.	Lead is not considered a CoC

Contaminant	EQS (mg/l)	DWS (mg/l)	No. of Samples	EQS exceedances – Number (Percentage)	DWS exceedances – Number (Percentage)	Discussion	Recommendations
Nickel	0.02	0.02	43	4 (9)	4 (9)	Marginal EQS and DWS exceedances of 0.03 to 0.06mg/l were recorded at ML159-CR019, ML159-CR014, ML159-CP404 and ML159-RC401. Apart from ML159-CP404, the boreholes are noted located in a land quality site. As concentrations (0.03mg/l) a ML159-CP404 were consistent with the other site wide concentrations, groundwater exceedance are considered to be trivial and reflective of site wide concentrations.	Nickel is considered a CoC
Nitrate as N	-	11	43	0 (0)	8 (18)	Exceedances ranging from 17 to 29mg/l was recorded above the DWS. No principal aquifer or groundwater abstraction well was located within or near the Site. It is possible that impacts are associated with off-site sources and widespread agricultural activity in the region. The groundwater exceedances are considered to be trivial and reflective of site wide concentrations.	Nitrate as N is not considered a CoC
Magnesium	-	50	60	0 (0)	9 (15)	DWS exceedances of 51 to 110mg/l were recorded. As the presence of magnesium is likely to be due to the agricultural land uses at and near the site and/or reflective of background concentration, the presence of magnesium is considered to be trivial.	Magnesium is not considered a CoC
Potassium	-	12	77	0 (0)	4 (5)	DWS exceedances ranges from 15 to 36mg/l. As the presence of potassium is likely to be due to the agricultural land uses at and near the site and/or reflective of background concentrations, the presence of potassium is considered to be trivial.	Potassium is not considered a CoC
Sulphate as SO_4	-	250	77	0 (0)	3 (3)	Three exceedances of 670 to 730mg/l were detected above DWS and represents <5% of the sample population. Its presence likely reflects widespread agricultural activity or background concentrations.	Sulphate as SO_4 is not considered a CoC
Chromium Hexavalent	0.0034	-	35	4 (11)	0 (0)	EQS exceedances of 0.0036 and 0.03mg/l were reported at ML158-CR014, ML159-CP403, ML159-CP406 and ML159-CR408. The heist concentration was reported at ML159-CP403 within the FVBIP land quality site. Given the leachate of leachable hexavalent chromium and groundwater impacts at the same location, exceedances are not considered trivial.	Chromium Hexavalent is considered a CoC
Nitrite	0.152	-	43	0 (0)	2 (4)	Exceedances of 0.19 and 0.37mg/l above the DWS were reported and represents <5% of the sample population. Concentrations were encountered at ML159-CR422 and ML159-CR419. Both monitoring wells are not associated with Made Ground. There are no land quality areas located near these boreholes and likely originate from agricultural activities. Concentrations are considered to be trivial.	Nitrite is not considered CoC
Phenol	0.0077	0.0005	43	1 (2)	1 (2)	EQS and DWS exceedances of 0.038mg/l were reported at ML158-CR014 and represents <5% of the sample population. The exceedance has been identified at a single location and is not associated with Made Ground. There are no land quality areas located at or near the monitoring well. The concentration is considered to be trivial.	Phenol is not considered CoC
Nitrate as NO3	-	50	43	0 (0)	4 (11)	Exceedances of 110 to 130mg/l above the DWS were reported and Concentrations are widespread and likely associated with agricultural practises. Concentrations are considered to be trivial.	Nitrate as NO3 is not considered CoC
Nitrate as NO2	-	50	43	0 (0)	1 (2)	Exceedances of 110mg/l above the DWS were reported at ML159-CR412 and represents <5% of the sample population. Concentrations are widespread and likely associated with agricultural practises. Concentrations are considered to be trivial.	Nitrate as NO2 is not considered CoC

11.6 Assessment of ammonia exceedances

Seven groundwater exceedances of ammoniacal nitrogen as N against the DWS (0.38 mg/l) and EQS (0.2 mg/l), were reported across to the site. The EQS for total ammonia was calculated at 0.3 mg/l due:

- Water hardness < 200mg/l (determined in the geo-environmental report)
- Site elevation >80m.
- A Type 6 river[ix], which equates to a "Good Status" for ammoniacal nitrogen as N EQS standard of 0.3 mg/l.

Ammoniacal nitrogen as N is the calculation of the total ammonia which comprises ammonia (NH_3) and ammonium (NH_4^+) which is ionised. Ammonia is more toxic to fish than the ammonium, and therefore the EQS for ammonia is more stringent. To determine the proportion of ammonia and ammonium within the ammoniacal nitrogen as N readings, the following equations are used:

$$pKa = 0.0901821 + \frac{2729.92}{T} \quad (1)$$

$$f_{NH_3} = \frac{1}{10^{(pKa-pH)} + 1} \times 100 \quad (2)$$

$$f_{NH_4^+} = 100 - f_{NH_3} \quad (3)$$

Where

- pKa (-) is the acid dissociation constant
- T (°K) is the temperature of the receiving water, in Kelvin
- f_{NH3} (%) is the percentage of the ammoniacal nitrogen that is un-ionised ammonia (NH_3)
- pH (-) is the pH of the receiving water body
- f_{NH4+} (%) is the percentage of the ammoniacal nitrogen that is ionised ammonium (NH_4^+)

The closest surface water sampling point is ML159-SW001, which is located at the site, where a pH of 7.8 was reported. A conservative surface water temperature of 15 °C (288.15 °K) has been used in the calculations. This is conservative as surface water temperatures are typically lower, but higher temperatures relate to a greater proportion of ammoniacal nitrogen comprising ammonia. Table 18 details the concentration of ammonia and ammonium in the groundwater samples where exceedances were identified.

Table 18: Assessment of ammoniacal nitrogen as N exceedances

Borehole (strata)	ML159-CR019 (GFD)	ML159-CP003 (GFD)	ML159-CP403 (GFD)	ML159-CP406 (GFD)	ML159-CP404 (MGR)	ML159-CR408 (MMG)	ML159-CP405 (GFD)
Ammoniacal nitrogen as N (mg/l)	0.67	0.78	0.47	1.5	13	0.32	1.9
Surface water temperature (ºK)	288.15	288.15	288.15	288.15	288.15	288.15	288.15
Surface water pH (-)	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Acid dissociation constant, pka (-) – equation 1	9.564	9.564	9.564	9.564	9.564	9.564	9.564
Derived ammonia (%) – equation 2	1.69	1.69	1.69	1.69	1.69	1.69	1.69
Derived ammonium (%) – equation 3	98.31	98.31	98.31	98.31	98.31	98.31	98.31
Ammonia concentration (mg/l)	0.01	0.013	0.008	0.025	**0.220**	0.005	0.032
Ammonia EQS (mg/l)	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Ammonium concentration (mg/l) – equation 4	0.66	0.77	0.46	1.47	12.78	0.31	1.87

Notes: GFD = Glaciofluvial Deposits, MMG= Mercia Mudstone Group, MGR

When comparing the derived ammonia values against the SEPA**Error! Bookmark not defined.** found within The Water Framework Directive[xlvi] EQS for ammonia, one ammonia exceedances was recorded at ML159-CP404 (screened within the Made Ground) at a concentration of 0.22mg/l in August 2021. Subsequent rounds of monitoring in 2022 have seen in reduction in ammonia concentrations. Where ammoniacal nitrogen was detected above (6.5 and 7.8mg/l) the EQS value of 0.2mg/l and assessed for ammonia content values have been reported at 0.11 and 0.13mg/l indicating a reduction in concentrations over time.

Samples collected from the Glaciofluvial Deposits at ML159-CP404 reported ammoniacal nitrogen concentrations were below the below the EQS of 0.2mg/l.

Organic matter ranging from 11 to 18% was also detected at ML159-CP404 (Made Ground), which could indicate that the high concentration of ammoniacal nitrogen at this location could be the decomposition of organic matter. There is no evidence that ammoniacal nitrogen has impacted the superficial deposits at this location.

Also, the borehole logs indicates that there is a >4m thick layer of cohesive Glaciofluvial Deposits between the Made Ground and a granular Glaciofluvial Deposits which the cohesive strata is likely to offer an effective barrier to the movement of the contamination into the underlying aquifer. Therefore, it is unlikely that the exceedances would pose a significant risk to the controlled waters.

It is important to note that the Made Ground identified at ML159-CP404 and likely associated with FBIP will be removed to facilitate the development of the site, thus removing the source of ammoniacal nitrogen, further mitigating the risks to controlled waters.

12 DETAILED QUANTITATIVE RISK ASSESSMENT

The GQRA (Section 10 and 11) identified potential unacceptable pollutant linkages for soil aromatic >C12-16, leachate hexavalent chromium, and nickel, and groundwater hexavalent chromium. Therefore, a DQRA was required to determine if the pollutant linkages presented an inacceptable risk.

12.1 Reference to the conceptual model

The DQRA aims to assess whether the following moderate risk pollutant linkages identified by the generic quantitative risk assessment would still be present following a more detailed site-specific assessment, and if there is the need for the adoption of remedial measures to mitigate against the risks to receptors post development:

- S1a > P5a/b > R3, R4 – risks from contaminated soils (Made Ground) migrating though the Glaciofluvial Deposits into Coleshill Pond to the east of the Site.
- S3> P5a/b > R3, R4 – risks from contaminated groundwater migrating through the Glaciofluvial Deposits into Coleshill Pond.

From reviewing published, groundwater monitoring and analytical data, the risks posed to Coleshill Pond assumes that the groundwater flow direction is easterly.

Unnamed ponds and drains were encountered at the site, however, for the purpose of this report, it is anticipated that these features will be infilled as part of the proposed embankment construction, and/or not as risk, therefore they are not considered to be a receptor. However, if the design changes a review of this assessment would be required.

The River Blythe is located 2km to the east of the site beyond the Coleshill Pond, due to its location beyond Coleshill Pond this surface water feature is not considered further in this report.

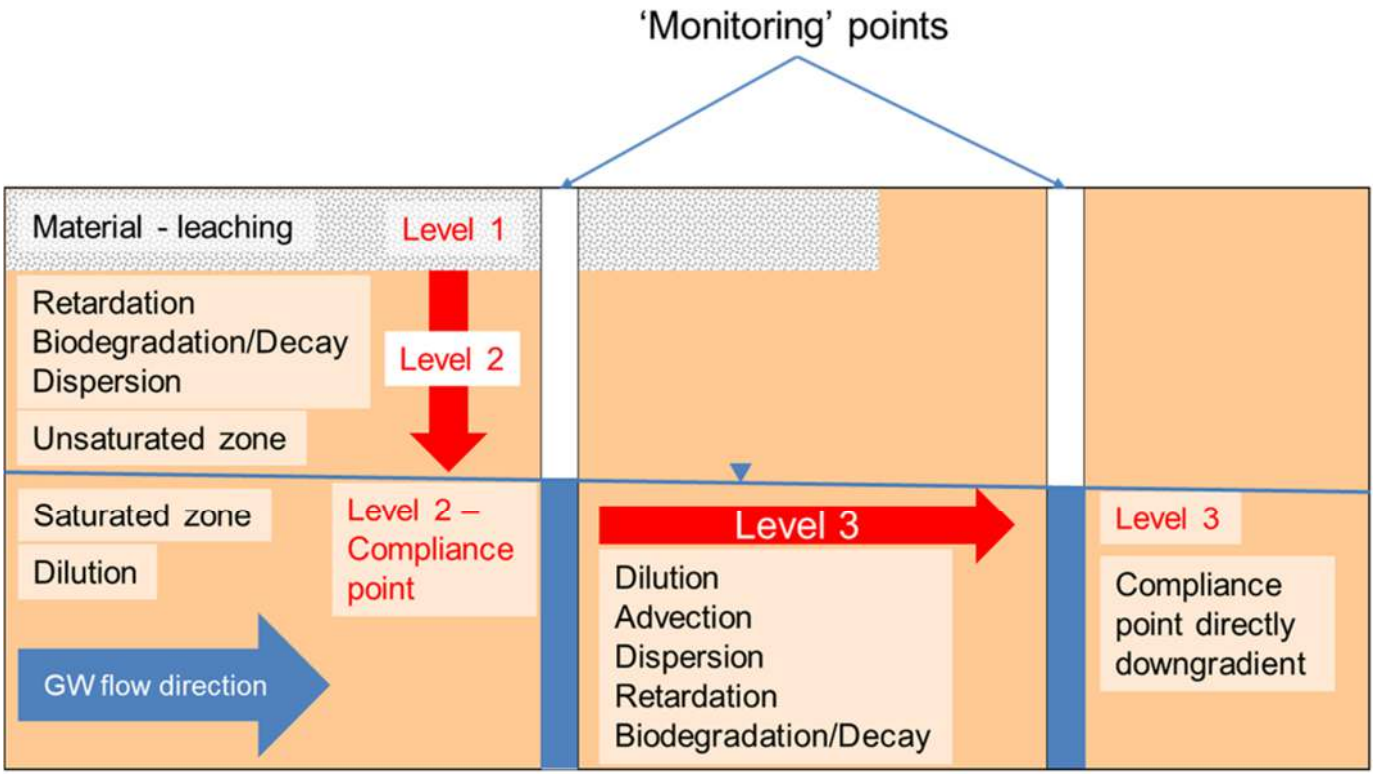
ConSim software (Version 2.5), a deterministic fate and contaminant transport model was used to assess how contaminants identified in the GQRA will change over time and distance from the source locations at the Site.

Using the source concentrations, the ConSim model uses tired analysis to calculate individual determinant concentrations over time at defined compliance points. The model also uses algorithms to quantify the effects of natural attenuation by dispersion, retardation and biodegradation on the concentrations of the determinant along the flow path from the source. The ConSim model is tiered into three levels as follows:

- Level 1 - the model predicts porewater concentrations from soil analyses and the partitioning between the solid and liquid phases.
- Level 2 - the model simulates migration through the unsaturated zone to the water table with consideration of degradation, adsorption and dispersion in the unsaturated pathway and dilution within the aquifer.
- Level 3 - model simulates the fate and transport of dissolved compounds at defined compliance points or receptors down hydraulic gradient of contaminant entry into the saturated zone. As with Level 2, the model simulates the processes of degradation, retardation and dispersion within the aquifer on the determinant.

The three levels are shown in Figure 27.

Figure 27 ConSim modelling methodology



12.2 Modelling undertaken

12.2.1 Models generated

Two ConSim models were generated for the soil and groundwater source contamination. Table 19 details the modelling undertaken.

Table 19: Summary of ConSim modelling

Model	Source	Pathway	Receptor (compliance point)	Level
1	Contaminants within the Made Ground	Vertical migration from the Made Ground into the Glaciofluvial Deposits and lateral movement through the Glaciofluvial Deposits	Base of the unsaturated zone	2
			Immediately down-gradient of source (5m point)	3
			10m downgradient of source	3
			50m down gradient of source	3
2	Groundwater contaminated within the Glaciofluvial Deposits	Lateral movement through the Glaciofluvial Deposits	5m downgradient of source	3
			50m down gradient of source	3

12.2.1.2 Summary of contaminants of concern

A summary of the CoCs for each of the models is shown in Table 20 Contaminants of concern modelled with ConSim.

Table 20 Contaminants of concern modelled with ConSim

Contaminant of Concern	Model 1 (soil source)	Model 2 (groundwater source)
Metals		
Hexavalent Chromium	✓	✓
Nickel	✓	
Organics		
Aromatics >C12-16	✓	✖

12.2.2 Compliance with regulations and policy (determination of compliance points and standards)

The Groundwater Daughter Directive (2006/118/EC) defines hazardous and non-hazardous substances for the purposes of groundwater protection. Hazardous substances should be prevented from entering groundwater (the “prevent” objective). Entry of non-hazardous substances into groundwater should be limited to prevent pollution (the “limit” objective). Where there is evidence of contaminants having already entered groundwater due to historical contamination, the ‘prevent’ objective may not be achievable and therefore the ‘limit’ objective may be considered appropriate. This is supported by the Water Framework Directive (2000/60/EC) with respect to improving water quality.

Concentrations at the receptor have been determined using input concentrations from soil and soil leachate analysis. Attenuation, retardation and dispersion factors are then calculated by the model and used to simulate the movement of the selected compounds through the ground.

There are three compliance points within the saturated zone (level 3 assessment), as follows:

- Immediately downstream the entry into the saturated zone (5m) – this is the default compliance point used by the model to represent concentrations of contaminants entering the Glaciofluvial deposits (aquifer)
- A 10m downstream of the source – this relates to the Glaciofluvial deposits (aquifer)
- A maximum compliance point of 50m downstream from the source

The Environment Agency Groundwater Protection pages on gov.uk (formerly GP3) provides guidance on the selection of different compliance points and targets, and the level of modelling which is appropriate for Hazardous and Non-Hazardous substances. For substances which have been deemed hazardous, but no minimum reporting value has been determined, the laboratory detection limit of the contaminant has been used. This is compliant with the Environment Agency’s Remedial Targets Methodology as shown in Appendix B.

Tables 21 and 22 detail the compliance values used for each of the contaminants, within the ConSim models. The highest concentration identified for each TPH compound were used as input concentration for a more conservative analysis.

Table 21 Determinants and compliance values used for Model 1 (soil source contamination migration)

Contaminant	Substance	Compliance standard	Compliance value (mg/l)	Input concentration
Inorganics				
Hexavalent Chromium	Hazardous	EQS	0.0034	1.5 mg/l
Nickel	Non-Hazardous	EQS – M-BAT	0.02	0.3 mg/l
Organics				
Aromatic > C12 - C16	Hazardous	DWS	0.01	120 mg/kg

Note: Values represent the maximum concentrations recorded.

Table 22 Determinants and compliance values used for Model 2 (groundwater source contamination migration)

Contaminant	Hazardous Substance	Compliance standard	Compliance value (mg/l)	Input concentration (mg/l)*
Hexavalent Chromium	Hazardous	EQS	0.0034	0.03

*Maximum concentration found in groundwater

12.2.3 Model input parameters

Modelling has been undertaken using physical and chemical parameters derived from Site specific and literature data, as shown in Appendix E.

The retarded travel time of each compound was simulated to predict the time of travel from the source to the receptor. Environment Agency Remedial Targets Methodology (2006)[xvi] assumes a risk acceptable to a receptor if the retarded travel time is >1,000 years and the contamination spreads no further than tens of metres from the source. **Error! Reference source not found.**3 shows the general input parameters used for the models.

Table 23 Model input parameters

Model input	Model 1 (soil source zone)	Model 2 (groundwater source zone)
Level used	Level 2 and level 3 analysis	Level 3a analysis
Active processes	The model uses retardation in the unsaturated zone and aquifer. Biodegradation and retardation were applied in the unsaturated zone and aquifer. A calculated declining source terms was not used.	
Simulation parameters	The model has been run for 1001 iterations to increase the confidence level (or percentile) in the results.	
Background concentrations	Background groundwater contaminant concentrations were not considered for a more conservative analysis.	

12.2.4 Model assumptions

The main assumptions within model 1 (soil source) and model 2 (groundwater source) are as follows:

- The Made Ground is the source of contamination, with water identified in the Made Ground as perched;

- The unsaturated pathway comprises the unsaturated Glaciofluvial Deposits, the thickness of which has been determined by measuring the depth of the groundwater level from the bottom of the Made Ground;
- Dry bulk density, air filled soil porosity and water filled soil porosity for Made Ground were obtained from borehole BD162-TP003, located off-site. No compaction data was available for onsite Made Ground, therefore data considered to representative of Made Ground conditions at the site was obtained from BD162-TP003 located approximately 2km north of the site (around Ch162+100). The Ground Investigation Report (Report E2), suggests that due to the large variety of Made Ground across to the area, site specific parameters should be considered;
- Hydraulic conductivity has been determined from in-situ permeability tests of the Glaciofluvial Deposits. The data was taken from Permeability Statistics for HS2 N1/N2 (document number:1MC08-BBV_MSD-GT-CAL-N001-100209;
- Total organic carbon values for Made Ground and the Glaciofluvial Deposits were determined from soil samples taken across Sublot 5 and 6;
- The anticipated horizontal hydraulic gradient within the Glaciofluvial Deposits is east towards the Coleshill Pond;
- Based on the ground model mostly low permeability Glaciolacustrine Deposits are expected in the source area, however, in the interests of conservatism these deposits were not included in the model;
- The main receptor is the Coleshill Pools located around 330m east of the site. However, a maximum compliance point of 50m has been used instead for a more conservative analysis;
- The highest soil leachate concentrations were used in the model; and,
- Effective porosity has been determined from literature reviews.

12.2.5 Model outputs

Outputs generated from the models are shown in the **Error! Reference source not found.**. Values identified with red text represent concentrations in exceedance of the WQS, while values that are in bold represent retarded travel times greater than 1,000 years. Where retarded travel time exceeds 1,000 years no action is required due the anticipated low risk at the compliance point, even if the WQS is exceeded.

Acceptability criteria (AC) are derived based on the following equation:

$$AC = Water\ quality\ standard \times \frac{Input\ concentration}{Concentration\ at\ receptor\ (95\%\ percentile)}$$

AC = mg/l or mg/kg depending on input concentration units.

Water quality standard = mg/l

Input concentration = mg/l (inorganic) or mg/kg (organic)

Concentration at receptor = mg/l

Non-Applicable (N/A) = No AC is derived due to anticipated low risk

Table 24 Modelling outputs from ConSim model 1 (soil source)

Contaminant	WQS (mg/L)	Source of Standard	Input conc.	Retarded travel time to the base of the unsaturated zone -50th percentile (yrs)	Concentration at the base of the unsaturated zone at 1000 years -95th percentile (yrs)	Retarded travel time to the 5m compliance point - 50th percentile (yrs)	Concentration at the 5m compliance point at 1000 years - 95th percentile (mg/l)	Retarded travel time to 10m compliance point - 50th percentile (yrs)	Concentration at the 10m compliance point at 1000 years - 95th percentile (mg/l)	Retarded travel time to the 50m compliance point -50th percentile (yrs)	Concentration at the 50m compliance point at 1000 years - 95th percentile (mg/l)	Controlled water Soil AC
Hexavalent Chromium	0.0034	EQS	1.5 mg/l	975.474	1.40505	**>1000**	0.439127	**>1000**	0.391521	**>1000**	0.177713	**N/A**
Nickel	0.02mg/l	EQS (MBAT)	0.3 mg/l	**>1000**	0	**>1000**	0	**>1000**	0	**>1000**	0	**N/A**
Aromatic > C12-16	0.01g	DWS	120 mg/kg	**>1000**	0.0962626	**>1000**	0.014588	**>1000**	0.0109106	**>1000**	0	**N/A**

Note: Organic compounds were input into ConSim as mg/kg, inorganic compounds were input as mg/l. Bold cells relate to retarded travel times being greater than 1,000 years and red cells relate to exceedances against the water quality standard.

Table 25 Modelling outputs from ConSim (model 2 groundwater)

Contaminant	WQS (mg/l)	Standard	Input conc (mg/l)	Retarded travel time to the 5m compliance point (50th percentile)	Concentration at the 5m compliance point at 1000 years (95th percentile)	Retarded travel time to the 10m compliance point (50th percentile)	Concentration at the 10m compliance point at 1000 years (95th percentile)	Retarded travel time to the 50m compliance point (50th percentile)	Concentration at the 50m compliance point at 1000 years (95th percentile)	Controlled water Soil AC	Retarded travel time to the 115m compliance point (50th percentile)	Concentration at the 115m compliance point at 1000 years (95th percentile)
Hexavalent Chromium	0.0034	EQS	0.03	2.32413	0.03	48.856	0.03	421.021	0.029	0.003	**>1000**	0.029

12.2.5.1 Soil contamination – model output

The soil model simulations do not identify significant contamination risk associated with inorganics and organic contaminants. Hexavalent chromium, nickel and aromatics >C12-16 will reach the 5m compliance point in excess of 1000 years. In both cases the risks to controlled waters and Coleshill Pools is considered to be low.

It should be noted that the Made Ground soils associated with hexavalent chromium and aromatics >C12-16 will be removed to facilitate the development of the site, thus leading to source removal, further mitigating risks to controlled waters.

12.2.5.2 Groundwater contamination – model output

For the groundwater, the model does not identify contamination risks associated with hexavalent chromium. Although modelling indicates that hexavalent chromium could reach the 50m compliance point in <1000 years at a concentration of 0.029mg/l, at a compliance point of 115m, the modelled travel time would be >1000 years. The risk to Coleshill Pools is considered to be low.

It should be noted that the overlying Made Ground soils possibly associated with groundwater hexavalent chromium at ML159-CP403 (maximum recorded hexavalent chromium concentration) will be removed to facilitate the development of the site, thus leading to source removal, further mitigating risks to controlled waters. As hexavalent chromium is not considered to pose a significant risk to the controlled waters and any remediation is not considerate practically reasonably.

12.2.5.3 Potential for Residual non-aqueous phase liquid

An assessment of the potential for mobile non-aqueous phase liquids (NAPL) has been undertaken in accordance with Brost *et al*. (2000)[x]. This paper recognises that NAPL can exist at concentrations significantly above the soil saturation limit while effectively immobilised in the pore spaces. Above the residual NAPL concentration (C_{res}) NAPL is considered to be potentially mobile and free flowing. Actual mobility depends upon the composition of NAPL mixtures and the pore space, with lighter TPH fractions and lower soil porosities resulting in higher C_{res} limits. Two methods of C_{res} prediction are presented in Brost *et al.* (2000): C_{res} based on empirical and theoretical measurements. The paper derives lower (more conservative) C_{res} thresholds from empirical studies than modelled results. As a result, conservative literature values from an empirical study by Cohen and Mercer (1990)[xi] have been selected based on equivalent Site soil conditions and credible NAPL mixtures observed at the Site to determine potential risks from mobile NAPL. A $C_{res,soil}$ of 3879mg/kg has been used based on the soil type *"coarse sand and gravel"* and a conservative assumption that the hydrocarbons present represent middle distillates as a worst case.

Based on this value, the reported TPH Aromatics >C21-35 concentrations of 4600 and 6800mg/kg at 3.0 and 4.0mbgl in Made Ground at ML159-CP403 may pose a risk to controlled waters due to potential free-phase mobility. The stratum description recorded states "Dark brown to black sandy subangular to subrounded fine to coarse gravel sized fragments of brick, glass, sandstone, wood and quartzite. Sand sized fragments are fine to coarse of ash". No evidence of sheen or free phase product detected during the ground investigation at this location. The boreholes log records clay deposits (Glaciolacustrine Deposits) of 3.85m in thickness beneath the Made Ground and it is anticipated that the cohesive deposit is likely to prevent the movement of potential NAPL to controlled water receptors. In addition, the groundwater monitoring events undertaken at ML159-CP403 did not identify the presence of hydrocarbons in the samples tested. Therefore, the potential NAPL identify is considered unlikely to pose a risk to controlled waters near to the site.

It should be noted that the Made Ground soils associated with hydrocarbons will be removed to facilitate the development of the site, thus leading to source removal, further mitigating risks to controlled waters.

13 REFINED CONCEPTUAL SITE MODEL

As shown in **Error! Reference source not found.**6 the conceptual site model was refined to reflect the GQRA and DQRA outputs described in Section 10, 11 and 12.

Table 26 Refined conceptual site model following GQRA and DQRA

Source	Pathway	Receptor	Previous Risk Assessment Rating	Updated Risk Assessment	Remediation required?
S1a: Contaminated soils – on-Site (Source 1, 2, 3 and 4 - **Error! Reference source not found.**) S1b: Contaminated soils – off-Site (Sources 5, 6 and 7 - **Error! Reference source not found.**) S3: Contaminated Groundwater (Sources 1, 2, 3, 4, 5, 6 and 7 - **Error! Reference source not found.**)	P1: Direct contact, ingestion, inhalation of dust/vapour from contaminated soils P2: Inhalation of vapour with / from contaminated waters P3: Direct contact, ingestion from contaminated waters	R1: On-Site users – commercial/ public open space R2: Off-Site users – commercial/public open space	**S1a, S1b, S3 > P1, P2, P3 > R1, R2** Probability: Unlikely Consequence: Medium **Risk Rating: Low**	**S1a, S1b, S3 > P1, P2, P3 > R1, R2** Probability: Unlikely Consequence: Medium **Risk Rating: Low**	No remediation proposed
	P6: Direct Contact	R5: Property Receptors – buildings, foundations and services (on and off-Site)	**S1a, S1b, S3 > P6 > R5** Probability: Likely Consequence: Medium **Risk: Moderate**	**S1a, S1b, S3 > P6 > R5** Probability: Likely Consequence: Medium **Risk: Moderate**	Refer to durability report and GIR for sulphates
S1c: Asbestos Contaminated Soils	P1: Inhalation of contaminated soils	R1: On-Site users – commercial/ public open space R2: Off-Site users – commercial/public	**S1c > P1 > R1 & R2** Risk assessment provided by asbestos specialist	**S1c > P1 > R1 & R2** Risk assessment provided by asbestos specialist.	Although no asbestos was detected at the site, reference should be made to the sublot asbestos risk assessment report prepared by an asbestos risk assessment specialist (1MC09-BBV_MSD-EV-REP-NS04_NL10-100208).
S2: Ground Gases	P7: Inhalation of Ground Gases	R1: On-Site users – commercial/ public open space R2: Off-Site users – commercial/public open space	**S2, S2b > P7 > R1, R2** Probability: Unlikely Consequence: Medium **Risk Rating: Low**	**S2, S2b > P7 > R1, R2** Probability: Unlikely Consequence: Medium **Risk Rating: Low**	No remediation proposed.
	P4: Exposure to explosive ground gases	R5: Property Receptors – buildings, foundations	**S2a, S2b > P4 > R5** Probability: Unlikely Consequence: Medium **Risk Rating: Low**	**S2a, S2b > P4 > R5** Probability: Unlikely Consequence: Medium **Risk Rating: Low**	No remediation proposed.

Source	Pathway	Receptor	Previous Risk Assessment Rating	Updated Risk Assessment	Remediation required?
S1a: Contaminated soils – on-Site (Sources 1, 2, 3 and 4- **Error! Reference source not found.**)	P5a: Vertical and lateral migration via natural pathways P5b: Vertical and lateral migration via man-made created pathways	R3: Controlled waters on-Site Groundwater: Glaciofluvial – Secondary A; Mercia Mudstone Group – Secondary B R4: Controlled waters off-Site Groundwater: Alluvium and Glaciofluvial – Secondary A; Mercia Mudstone Group – Secondary B, Surface water: Coleshill Pools	**S1a > P5 > R3, R4** Probability: Likely Consequence: Medium **Risk: Moderate**	**S1a > P5 > R3, R4** Probability: Unlikely Consequence: Medium **Risk: Low** The ConSim model indicates that all inorganic and organic contaminants would take more than 1000 years to reach surface water compliance points. Due to the long-retarded travel times, soil exceedances are unlikely to pose risks to Coleshill Pools.	No remediation proposed.
S3a: Contaminated groundwater Contaminated Groundwater (Sources 1, 2, 3, 4, 5, 6 and 7 - **Error! Reference source not found.**)	P5a: Vertical and lateral migration via natural pathways P5b: Vertical and lateral migration via man-made created pathways	R3: Controlled waters on-Site Groundwater: Glaciofluvial – Secondary A; Mercia Mudstone Group – Secondary B R4: Controlled waters off-Site Groundwater: Alluvium and Glaciofluvial – Secondary A; Mercia Mudstone Group – Secondary B, Surface water: Coleshill Pools	**S3 > P5 > R3 & R4** Probability: Likely Consequence: Medium **Risk: Moderate**	**S3 > P5 > R3 & R4** Probability: Unlikely Consequence: Medium **Risk Rating: Low** The ConSim model indicates that hexavalent chromium would reach the 50m compliance point in less than 1000 years, however, is considered to pose a low risk due to the conservative ConSim model, such as geology, aquifer and distance from the Coleshill Pools. Also, ConSim model suggested that a compliance point of 115m travel times would be above 1000 years.	No remediation proposed.

14 LAND QUALITY MANAGEMENT

14.1 Overview

The culmination of the previous assessments, GQRA and DQRA concluded that contaminated soils and groundwater identified at the site are unlikely to present a risk to human health and controlled waters (including Coleshill Pools) and the need for specific targeted soil and groundwater remediation is not warranted.

Although the current assessments do not indicate the need for remediation, the following section provides guidance on land management as development progresses at the site.

14.2 Material re-use and disposal

14.2.1 Material Re-use

Reuse of excavated waste will be managed through the Contaminated Land Applications in Real Environments (CL:AIRE) definition of waste (DoW) code of practice (COP) (CL:AIRE DoWCOP)[xii] and the HS2 MMP Framework.

The Made Ground generated by the works and other material impacted by contamination may be recovered in accordance with CL:AIRE DoWCOP Development Route A; the use of waste as a material where contamination is suspected or known to be present. For uncontaminated natural materials, this may be re-used in the North Contract areas in accordance with the Development Route B Design Statement 1MC08-BBV_MSD-EV-RIA-N001-100002.

All Route A material generated that is to be re-used should be tested and screened according to the acceptability criteria (both chemical and physical) for the final placement of the material defined in the MMP Route A Remediation Strategy 1MC08-BBV_MSD-EV-REP-N001-100058. A material management plan (MMP) will be required to determine that material re-used has met the following criteria:

- Protection of human health and the environment
- Suitability for use, without further treatment
- Certainty of use
- Quantity of material

The MMP will require details of the volumes of material generated, volumes to be transferred, and specific testing requirements for this material prior to re-use. A verification report will be required to demonstrate that the MMP has been fully implemented.

It should be noted that the landscape bund will be partly constructed from remediated material originating from Middle Bickenhill Landfill south of the site (Ch. 157+125 to 157+375). The landfill materials are to be managed under a Permit for Waste Recovery. Various supporting assessments have been completed to support the permit application which have concluded a low risk associated with the reuse of landfill materials at the bund. The reader is encouraged to review the HS2 report entitled “Hydrogeological Risk Assessment and Material Acceptability Criteria Risk Assessment: Pool Wood Embankment Landscape Bund” (1MC09-BBV_MSD-EV-REP-NS04_NL10-100217).

14.2.2 Disposal of material

To determine the likely waste class of excavated soils, a waste categorisation exercise should be undertaken, if offsite disposal of material excavated will occur. Every effort should be taken within the design to minimise volumes of waste, or that material can be re-used in preference to landfill disposal. Where re-use is possible, Made Ground should be tested for contaminants and, where required, remediation/screening should be considered to enable re-use in preference of disposal.

Waste classification is a two-stage process, with the first step comprising a hazard assessment of the soil quality data in line with the guidance set out in the Environment Agency: Guidance on the Classification and Assessment of Waste Technical Guidance WM3 document[xiii], to provide the likely List of Waste (LoW) code. Once the hazardous nature of the materials is known, the second step is to assess the potential performance of the materials in a hazardous or inert landfill; this is undertaken by considering the results of Waste Acceptance Criteria (WAC) testing.

Generally, wastes that are classified as hazardous will need to be deposited in a hazardous waste landfill or within a stable non-reactive hazardous waste cell in a non-hazardous waste landfill (depending on the WAC test results). Wastes that are shown not to be hazardous may either be deposited in a non-hazardous waste landfill (for which no WAC tests are required) or as inert waste (which would require confirmation of suitability for this particular waste stream through WAC testing). A formal classification has not been undertaken, since this is beyond the scope of this report.

14.3 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) should be prepared in accordance with the Code of Construction Practice (CoCP)[xiv]. The following sections of the CoCP relevant to the management of contamination are as follows:

- 5.12: Pollution incident control and emergency procedures
- 7.2: Measures to reduce potential impacts on air quality
- 7.3: Monitoring of air quality
- 11.2: Measures to reduce potential impacts on geology and soils
- 11.3: Monitoring
- 16.2: Measures to reduce impacts to water resources
- 16.4: Monitoring

Given the proximity of the Site to the Colehill Pool, BBV s attention is drawn towards the CoCP sections relevant to pollution of watercourses. The CEMP should include measures to manage surface water run-off. The CEMP should include Site specific measures to manage surface water run-off, in particular, in relation to piling works (if deemed necessary), and to monitor controlled waters as necessary during the works. If any dewatering activities are proposed for construction, this will need to be completed under a permitted consent as per Section 16 of the CoCP.

14.4 Asbestos Management Plan

No asbestos was detected at the site, however, reference should be made to an asbestos risk assessment report completed by RSK (1MC09-BBV_MSD-EV-REP-NS04_NL10-100208). A copy of the report is included in Appendix F.

Prior to the commencement of excavation works an Asbestos Management Plan (AMP) should be provided by BBV. The AMP should also reference the asbestos risk assessment provided by the specialist and measures to be taken in the event it is encountered during ground works.

14.5 Unexpected contamination

In advance of construction works a protocol in the form of a 'Watching Brief' for dealing with unexpected contamination should be established and form part of the works method statement. The watching brief would provide guidance to construction workers on how to identify suspected contaminated soil and groundwater and how to respond to it in the immediate term. As part of the process, a contaminated land specialist should be engaged to advise on the requirement for assessment, remediation and/or revisions to the existing remedial approach and liaison with the regulatory authorities.

Any further assessment and revisions to this report will need to be agreed with all stakeholders and gain regulatory approval.

14.6 Stockpile Management

No stockpile management is anticipated on Site. However, if materials excavated from hotspots that may be removed off-Site (if ACs are not met for re-use without treatment) will need to be securely stockpiled to minimise the risk of fugitive emissions of leachates to groundwater and surface water. If soil stabilisation remediation is undertaken at the point of material deposition it will need to be preceded by laboratory or field trial data to demonstrate that the stabilisation techniques (cement and additive mixes) are capable of meeting the verification criteria prior to Site deployment. This must also be accompanied by use of chemical risk assessment in accordance with HS2 Technical Standards.

The mixing of hazardous wastes with non-hazardous waste is prohibited under the Hazardous Waste Regulations (2005), unless authorised by a waste permit or registered exemption. The Landfill Regulations 2002 (as amended) require the pre-treatment of waste prior to disposal off-Site to appropriately permitted landfills. Wastes should be strictly segregated into hazardous, hazardous non-reactive, non-hazardous, and inert waste streams. Sufficient laboratory testing should be undertaken to ensure that waste is classified correctly and is assigned the correct European Waste Catalogue (EWC) code.

14.7 Unexploded ordnance (UXO)

Any works undertaken at the Site must be undertaken following UXO guidance measures. The review of the regional Unexploded Bomb (UXB) Risk Map available interpreted the Zetica UXO Desk Study[xv], indicated the Site to be located within a Low risk area from unexploded ordnance. Low risk areas are defined as “Tolerable to the client as engineering activity need not alter if UXO related procedures and controls are strictly adhered to”. The report recommends a UXO Awareness Briefing to accompany the works.

14.8 Existing Utilities

During ground works caution should be taken to avoid damaging underground services on Site if present. A minimum safe working distance from services are required, and safe distances should be confirmed with the utility provides. As a standard the following should be taken into consideration:

- Excavations and drillings should not be undertaken within 15m to a gas main. However, it may be possible to minimize the safety distance to 3m of the pipeline if the owner/operator supervisor is present on-Site during earthworks.
- To avoid any unexpected risk when working near sewers (and water pipes), service plans from relevant water and sewer companies and the use of a pipe locator (where viable) should be considered. It is recommended that a safe distance of 4.0m should be considered. Normally, a low risk is anticipated for construction personnel working near sewers and water pipes, however, the disruption to services and the cost of the damage should be avoided.
- Live electrical cables should be made dead if possible. If there is not an alternative option, agreement of safe methods of excavation with the cable owners should be made. Excavation should not be carried out within 5.0m of a high voltage electricity cable without contacting the provider. Also, it is recommended that the provider company should be contacted when working within 10m of an overhead power lines, including pylons.
- Safe distance of work from railways are anticipated to be 4.0m with supervision.

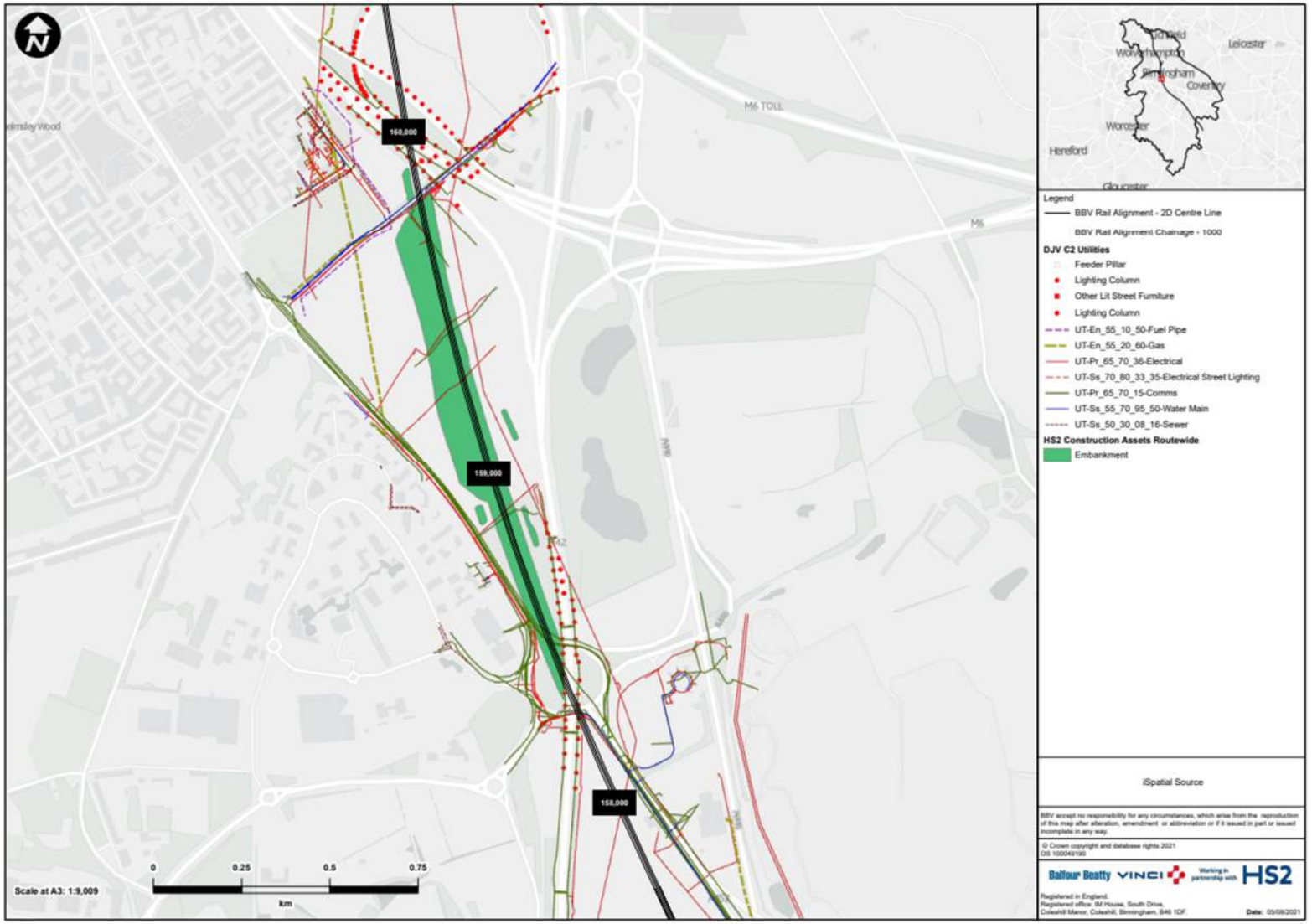
A report on utility services coordination requirements (Detailed Design – Utilities: 1MC09-BBV_MSD-UT-DMB-NS04_NL10-164400) has been produced to be used during the detailed design phase for HS2 Lot N1 and N2. Any utility service management on Site should also be undertaken with reference to the document.

A plan of the existing below ground utilities including telecommunications, sewers, water mains, electricity and gas present onsite are shown in Figure 26. However, this figure should not be relied upon for design or any intrusive works.

It should be noted that there could be unmanaged or undetected utilities present at the Site. Moreover, caution is required when designing intrusive investigation as the location of utilities and services may not be as indicated on plans.

To manage the risk associated with encountering services it is understood that BBV are currently in the process of completing utility surveys at all assets including the Site.

Figure 28 Utility services



14.9 Decommissioning of redundant boreholes

Boreholes completed as groundwater/gas monitoring wells will become redundant and unserviceable once the construction works are undertaken. As such, well installations will need to be decommissioned to ensure that they do not act as conduits for the movement of contamination. Decommissioning should be undertaken with reference to the following documents:

- Environment Agency (2006): Guidance on the design and installation of groundwater quality monitoring points. Science Report SC020093. Section 5.[xvi]Environment Agency (2012): Good practice for decommissioning redundant boreholes and wells. Reference: LIT 6478 / 657_12[xvii]. This document is located at 1MC09-BBV_MSD-EV-REP-NS04_NL10-100173.

14.10 Invasive species

No Invasive Non-Native Species (INNS) are anticipated to be present on Site and/or within close proximity to the Site boundary. If any INNS are encountered during ground works, it should be managed and removed in accordance with the EWC biosecurity Invasive Non-Native Species (INNS) Plan.

14.11 Foundation works risk assessment

A foundation works risk assessment (FWRA) was undertaken to assess the risks of piling at the site. The report concluded that piles associated with the Pool Wood Embankment area (incorporating the Coleshill Heath Road Underbridge and M42 Motorway Box Structures) will not pose any unacceptable risks to human health or water resource receptors. The FWRA is located at 1MC09-BBV_MSD-EV-REP-NS04_NL10-100049.

14.12 Redundant pipe work and tanks

The previous ground investigation did not encounter any underground storage tanks (USTs) or pipework. During future Site works if any unexpected USTs are encountered, a contaminated land specialist should be engaged to assess the potential risks associated with the USTs/pipework to human health and environment and, if required prepare a remediation strategy for the safe removal of the underground features to mitigate risk.

14.13 Verification reporting

As required, a summary of verification reporting requirements is provided in the Table 27.

Table 27: Verification reporting requirements

Verification Report Section	Content
Background information	Names, roles and responsibilities of personnel managing the groundworks.
Investigation	Pre-groundworks verification: • Exploratory holes (logged to BS5930). • Summary of visual and olfactory evidence of contamination (with supporting photographs). • Updated risk assessment produced by a contaminated land specialist to confirm that the CSM presented in this report is correct (if necessary). • Formation inspection.

Verification Report Section	Content
Remediation	Utilities • Plans showing the location of removed utilities and capping of redundant service trenches • Plans showing the location of underground storage tanks and redundant pipework. Records of tank contents chemical testing and tank removal/backfilling details
	Unexpected contamination (if present): • Location of unexpected contamination • Records of regulatory discussion • Ground investigation factual data for areas of unexpected contamination • Contamination conceptual models for unexpected contamination • Summary of updates to report to manage unexpected contamination • Summary of remediation programme
	Invasive Species: • Plan showing areas of any invasive species infestation identified as part of the construction works • Record of measures taken to removal Invasive Species
	Stakeholder Liaison and Health and Safety: • Summary of complaints • Summary of remediation-related environmental and H&S incidents and near misses, and actions taken to address these.
Material Management	Verification Reporting requirements to be determined in MMP.
Final Site condition	Status at completion: • Post remediation contamination conceptual model. • Written statement on post remediation contamination risks. • Health and Safety File including requirements for long term monitoring (if required by updated the report).

15 ASSUMPTIONS AND LIMITATIONS

This report is subject to the following limitations:

- Excludes assessment of the risks from asbestos, radioactive substances and toxic mould. Whilst the assessment has not identified the presence of asbestos at the site, the DJV does not provide a detailed assessment of asbestos risk, the DJV role is to report the presence of asbestos only. Reference should be made to the RSK report (1MC09-BBV_MSD-EV-REP-NS04_NL10-100208) that provides commentary on identified risks and how they should be managed should suspected asbestos to encountered during ground works.
- Where gaps in GI data are identified this precludes GQRA for certain contaminant linkages. For these linkages a preliminary qualitative risk assessment has been undertaken based on available desk-based information.
- In certain areas of the assessment we have relied upon information from draft and preliminary GI factual reports. A review has been conducted on this data to check its integrity, and where it contains errors and inconsistencies it has been excluded from analysis. Where it has been used in our assessment it should be noted that preliminary and draft data may be subject to change following finalisation of the factual reports. This may affect the data interpretation.
- The report should be reviewed following completion of pre-works verification ground investigation to ensure that the conclusions remain valid.
- Should the development proposals detailed in the Design Element Statement or the ground investigation data upon which the risk assessment in this report change then the conclusions and recommendations provided in this report should be reviewed to ensure that they remain valid.
- Responsibility for risk assessment and remediation/mitigation measures to address contamination risks specifically associated with temporary works rests with the temporary works designer, BBV and is outside the scope of this report.
- This report is based only on the existing available data. Further ground investigation is proposed to assess the ground conditions and potential risk posed to human health and to the environment. Ground investigation should collect additional soil, leachate and groundwater samples. A review and an update of this report should be carried out when new data is received in which the conclusion of the assessment presented in this report could change following further Site data interpretation.
- Please refer to our disclaimer in Appendix F for general limitations.

Appendix A Site Walkover Photographs

Site walkover (sheet 1-4)

Site walkover (sheet 2-4)

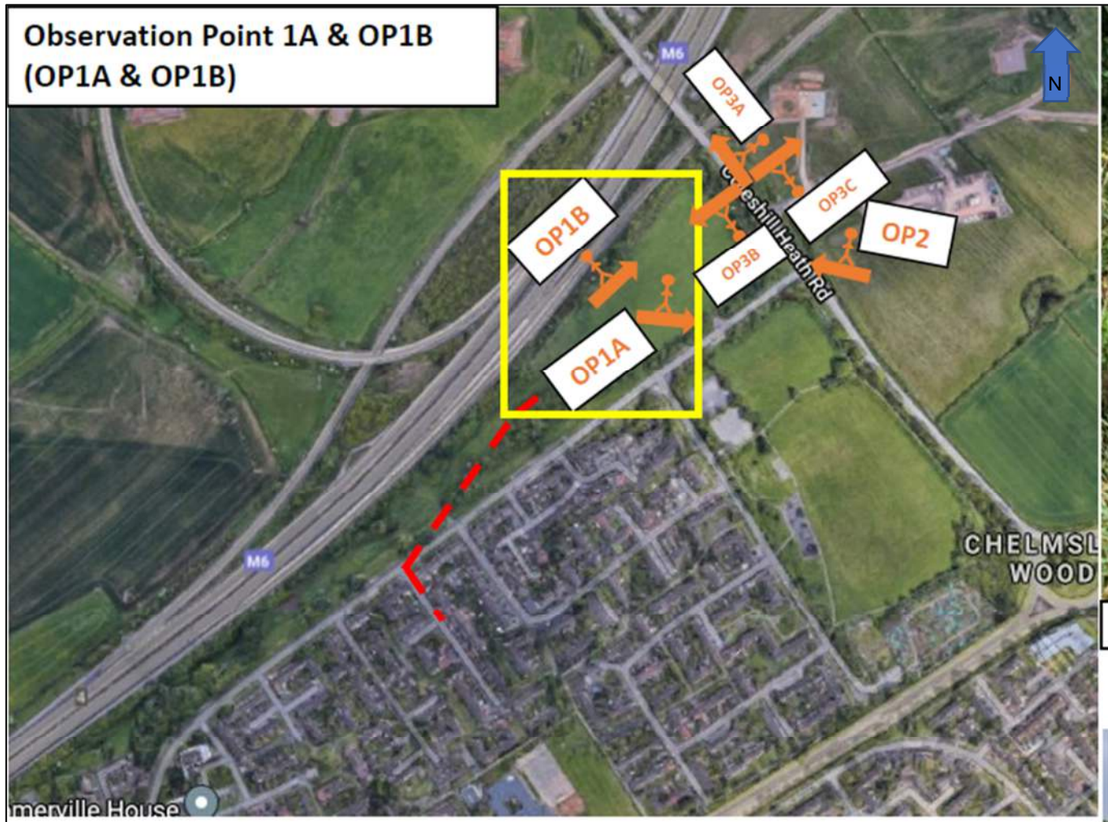


Photo OP1A.1

Photo OP1A.2

Observations:

OP1A.1: Esso HP Oil Pipeline (52.477758, -1.717745). Black arrow (indicated by a red circle) on marker post indicates pipeline is running West-South West (W-SW).
OP1A.2: Made ground exposed in a small bund running parallel to Yorkminster Drive (52.4782030, -1.7182030). Description - MADE GROUND: Reddish brown, gravelly, clayey SILT. Gravel is rounded of quartzite and mudstone. Fragments of brick and tarmacadam also present.

OP1B.1 and OP1B.2: Nearby field and highways embankment (Made Ground) (52.478160, -1.716503). OHL visible, assumed to be in new location due to EWC utilities diversion.

Photo OP1B.1

Photo OP1B.2

Site walkover (sheet 3-4)

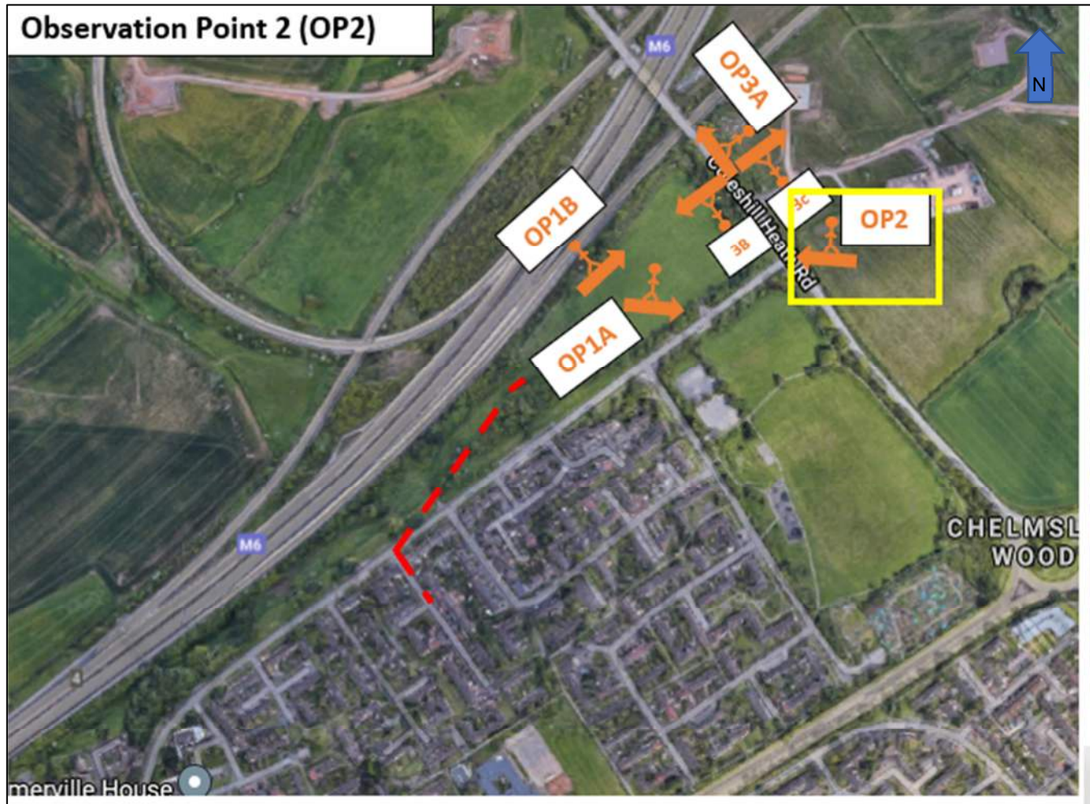



Photo OP2.1


Photo OP2.2


Photo OP2.3.


Photo OP2.4

Observations:

OP2.1: Esso HP Oil Pipeline on the corner of Coleshill Heath Rd and Yorkminster Drive (52.4775295, -1.7174935). Black arrow on marker post indicates pipe is running WSW along tree line parallel to Yorkminster Drive.
OP2.2: Manhole (52.4775295, -1.7174935), potentially associated with sewage system.
OP2.3 and OP2.4: Nearby land- currently in use as a public football pitch.

: Site walkover (sheet 4-4)

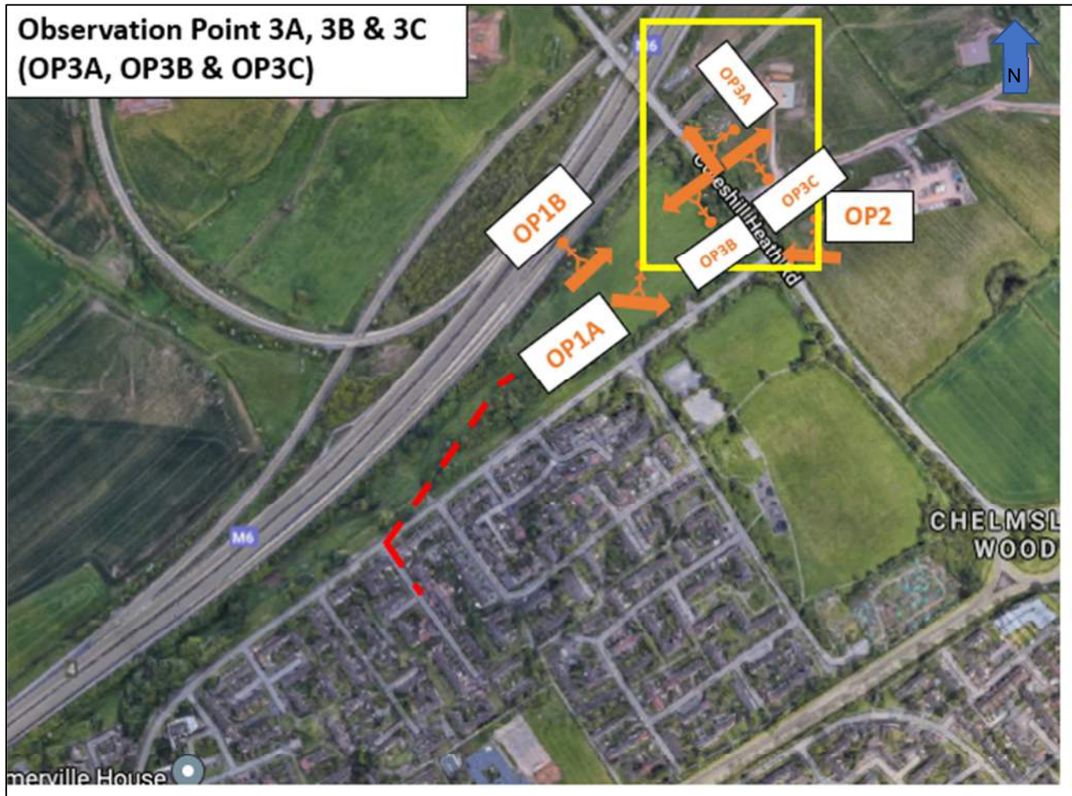



Photo OP3A.1


Photo OP3A.2

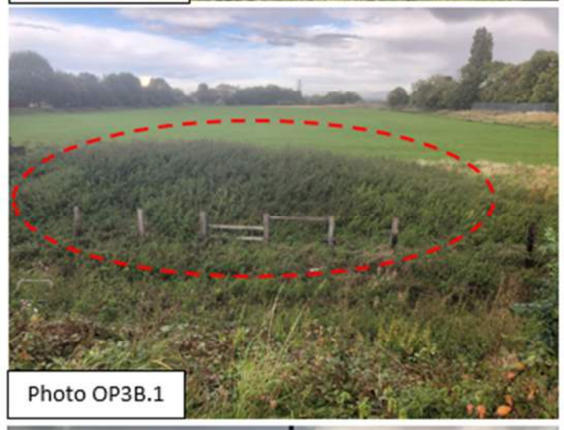


Photo OP3B.1

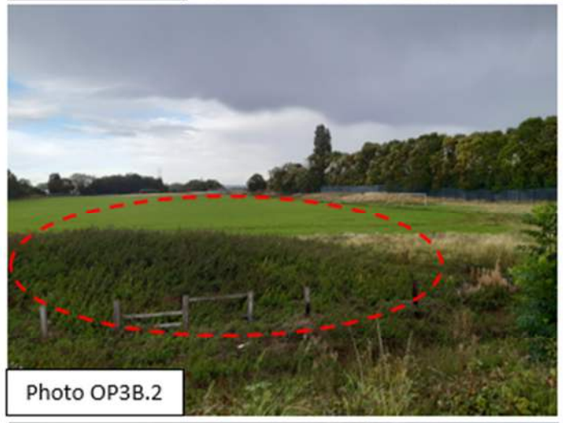


Photo OP3B.2


Photo OP3C.1


Photo OP3C.2

Observations:

OP3A.1 and OP3A.2: Coleshill Heath Road and its associated highways embankment (52.478002, -1.716320). Made ground, slopes are vegetated. Slope angle appears to be potentially greater than 1V:2H.
OP3B.1 and OP3B.2: Made Ground (vegetated, encircled in red on the photos), appears to be associated with Coleshill Heath Road.
OP3C.1 and OPC3.2: EWC work zone (Excalon), restricted access to Pool Wood Embankment area. OHL's visible and appear to be in new location following EWC utility diversions.

Appendix B Methodologies employed for risk assessment

Geo-environmental risk	Methodology employed
Risks from Non-Asbestos Soil Contaminants to On-Site Commercial / Public Open Space Receptors	Risks to human health were assessed using Generic Screening Criteria (GSC) using the SP1010[xviii] framework developed by Contaminated Land: Applications in Real Environments (CL:AIRE) on behalf of the Department for Environment, Food and Rural Affairs (DEFRA), and the Environment Agency Contaminated Land Exposure Assessment (CLEA)[xix,xx] Framework. The commercial and public open space park (PoS(park)) end uses have been used. Where available, the GSC are the Category 4 Screening Levels (C4SLs) published in the SP1010 policy companion document by DEFRA (2014). C4SLs are based on Low Level of Toxicological Concern "*which represents the estimated concentration of a contaminant [expressed as a daily intake] that poses a low risk to human health*". This is regarded as far below an intake level that would represent a Significant Possibility of Significant Harm (SPOSH) to human health. C4SLs have been published for a limited number of determinants. Where no C4SL exists, Suitable for Use Values (S4ULs) published by Land Quality Management Ltd (LQM)[xxi], were used as GSCs. These sets of GSCs are based on Health Criteria Values (HCVs) representing a minimal / tolerable level of risk. This is regarded as far below an intake level that would represent a SPOSH to human health. Organic GSCs have been developed by Mott MacDonald for the PoS(park) and commercial land uses using CLEA v1.071 adopting low level of toxicological concern (LLTCs) (where available) or published HCVs and pathway and receptor parameters approved by DEFRA under the SP1010 framework. All GSCs assume Soil Organic Matter (SOM) contents of 1% representing a typical lower bound for this parameter. The human health risk posed by the additive total petroleum hydrocarbons (TPH) concentrations in samples was assessed in accordance with Environment Agency guidelines[xxii] by calculating an individual Hazard Quotient (HQ) for each TPH fraction (TPH band concentration divided by the GSC) and then summing the HQ to derive a Hazard Index (HI).
Risks from Non-Asbestos Soil Contaminants to Construction and Maintenance Personnel	The GSC used to assess the risk to human health is designed to assess the risk from long term exposure rather than the acute risks which would typically be faced by construction and maintenance personnel. Risks have therefore been assessed on a qualitative basis.
Risks from Permanent Ground Gases to On-Site and Off-Site Receptors	To assess the risk from ground gas to building occupants, the gas monitoring results have been interpreted and assessed in accordance with British Standard (BS) 8485:2015 (+A1:2019)[xxiii] and Construction Industry Research and Information Association (CIRIA) C665[xxiv]. Radon risks were assessed using publicly accessible radon maps[xxv].
Risks from Ground Gases to Construction and Maintenance Workers	The gas monitoring results from the monitoring boreholes have been compared against the occupational exposure limits (OELs) published by the Health and Safety England (HSE)[xxvi].
Risks from Flammable/ Explosive Ground Gases to Property	To assess the risk from flammable/explosive ground gas to building occupants, the gas monitoring results have been interpreted and assessed in accordance with BS8485:2015 (+A1:2019)[xxvii].
Risks from Groundwater Vapours to On-Site and Off-Site Receptors	Risks from volatile contaminants in groundwater to on-Site commercial, public open spaces and off-Site commercial and residential receptors have been assessed using the generic acceptance criteria for groundwater vapour (GAC_{gwvap}) developed by the Society of Brownfield Risk Assessment (SoBRA)[xxviii].
Risks from Soils to Controlled Water Receptors	Risks from contaminants leached from soils to controlled water receptors (groundwater and surface water) were assessed following the procedures set out in, notably, Groundwater Protection Guidance[xxix], and Remedial Targets Methodology[xxx]. Risks from soils to on-Site and off-Site controlled water receptors comprise contaminants, whose concentrations exceed the relevant generic assessment criteria, entrained in water which has been leached from contaminated soils. Laboratory soil leachate data is compared with Drinking Water Standards (DWS) to protect groundwater (Principal and Secondary aquifers) and Environmental Quality Standards (EQS) for fresh water, to protect surface waters. The rivers and lakes metal bioavailability tool (M-BAT) has been used for determining Site specific $EQS_{bioavailable}$ for copper, zinc, manganese, lead, and nickel[xxxi]. This was done using a downstream surface water monitoring point. The cadmium EQS (which is based on hardness) was also determined from the downstream surface water monitoring point. Data was accessed from the Environment Agency's water quality data archive[xxxii], specifically point MD-64496050. A high-level assessment of the organic contaminants recorded in the soil data (both TPH and polycyclic aromatic hydrocarbons, PAH) has been performed to establish, on a semi-quantitative basis the risks from organic soils to controlled waters.
Risks from Existing Groundwater Pollution	Risks from existing groundwater pollution were assessed following the procedures set out in Groundwater Protection Guidance[xxix] and Remedial Targets Methodology Appendix B. Risks from existing groundwater pollution to on-Site and off-Site Controlled Water Receptors, includes both groundwaters and surface waters. For this assessment, groundwater pollution is defined as an exceedance of the generic assessment criteria by contaminant concentrations in groundwater samples. Laboratory groundwater data has been compared with Drinking Water Standards (DWS) to protect groundwater (Principal and Secondary aquifers) and Environmental Quality Standards (EQS) for fresh water, to protect surface waters. The rivers and lakes metal bioavailability tool (M-BAT) has been used for determining Site specific $EQS_{bioavailable}$ for copper, zinc, manganese, lead, and nickel[xxxi]. This was done using a downstream surface water monitoring point. The cadmium EQS (which is based on hardness) was also determined from the downstream surface water monitoring point. Data was accessed from the Environment Agency's water quality data archive[xxxii] specifically point MD-64496050.
Risk from Soils and Groundwater to Property	The aggressive chemical environmental for concrete (ACEC) and design sulphate class (DSC) for each strata type has been determined based on the guidance presented in BRE Special Digest 1:2005[xxxiii] Risks to modified water mains were assessed against United Kingdom Water Industry Research (UKWIR) guidance[xxxiv]
Risks from Soils and Groundwater to Ecological Sites	No ecological or geological designated Sites are recorded within the Site and therefore no pollutant linkages are considered to be present.

Appendix C Qualitative Risk Assessment Definitions

The qualitative risk summaries for non-controlled waters are derived from the Environmental Statement Volume 5, Technical Appendices, Scope and methodology Report Addendum (CT-001-000/2), Annex F, (HS2, 2013)

Table G.1: Classification of probability

Classification	Definition of the Probability of Harm/Pollution Occurring
High Likelihood	The contaminant linkage exists and it is very likely to occur in the short term, and/or will almost inevitably be realised in the long term, and/or there is current evidence of it being realised.
Likely	The source, pathway and receptor exist for the contaminant linkage and it is probable that this linkage will occur. Circumstances are such that realisation of the linkage is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	The source, pathway and receptor exist and it is possible that it could occur. Circumstances are such that realisation of the linkage is by no means certain in the long term and less likely in the short term.
Unlikely	The source, pathway and receptor exist for the contaminant linkage but it is improbable that it will be realised even in the long term.

Table D.2: Classification of consequence (non-controlled water receptors)

Classification	Definition of Consequence
Human Health Receptors – Site End Users	
Severe	Acute damage to human health based on the potential effects on the critical human health receptor.
Medium	Chronic damage to human health based on the potential effects on the critical human health receptor.
Minor	Minimal short- term effects on human health based on the potential effects on the critical human health receptor.
Negligible	No appreciable impact on human health based on the potential effects on the critical human health receptor.
Ecosystem Receptors	
Severe	For sites with designations as follows – Site of Special Scientific Interest, National Nature Reserve, Special Protection Area (and potential sites), Special Area of Conservation (and candidate sites) or Ramsar. Irreversible adverse change in the functioning of the ecological system or any species of special interest that forms part of that system.
Medium	For sites with designations as follows – Site of Special Scientific Interest, National Nature Reserve, Special Protection Area (and potential sites), Special Area of Conservation (and candidate sites) or Ramsar. Substantial adverse change in the functioning of the ecological system or any species of special interest that forms part of that system.
Minor	Harm to ecosystems of a low sensitivity such as sites of local importance. No appreciable harm to ecosystems with statutory designations.
Negligible	Limited harm to ecosystems of low sensitivity such as sites of local importance.
Property Receptors – Buildings, Foundations and Services including the operational HS2 scheme	
Severe	Collapse of a building or structure including the services infrastructure from explosion due to ground gasses.
Medium	Significant damage to a building or structure including the services infrastructure impairing their function.
Minor	Damage to buildings/structures and foundations but not resulting in them being unsafe for occupation. Damage to services but not sufficient to impair their function.
Negligible	No appreciable damage to buildings/structures, foundations and services.
Property Receptors – Grade 1 Agricultural land	
Severe	Substantial loss in the value of crops or domestically-grown produce resulting from disease, death or other physical damage. Death to livestock, domesticated animals or wild animals subject to shooting or fishing rights.
Medium	Substantial diminution in yield of crops or domestically-grown produce resulting from disease, death or other physical damage. Serious disease or other serious physical damage to livestock, domesticated animals or wild animals subject to shooting or fishing rights.
Minor	Harm to crops but not resulting in a substantial loss in value or diminution in yield. Limited harm in terms

Classification	Definition of Consequence
	of disease or other physical damage to livestock, domesticated animals or wild animals subject to shooting or fishing rights.
Negligible	No appreciable harm, or harm to a low sensitivity receptor.

The qualitative risk summaries for controlled waters are derived from HS2 Technical Standard – groundwater protection Document number HS2-HS2-EV-STD-000-000010.

Table D.1: Classification of Probability (Controlled Waters)

Classification	Definition
High likelihood	There is a linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a linkage and all the elements are present and in the right place, which means that it is probably that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table D.2: Classification of Consequence (Controlled Waters)

Classification	Criteria	Example
Major	Adverse: Loss of an attribute and /or quality and integrity of an attribute	Adverse: Increased flood risk to essential infrastructure, highly or more vulnerable developments; loss of a fishery; decrease in surface water ecological or chemical WFD status or groundwater qualitative or quantitative WFD status
	Beneficial: Creation of new attribute or major improvement in quality of an attribute	Beneficial: Creation of flood plain and decrease in flood risk; increase in productivity or size of fishery; increase in surface water ecological or chemical WFD status; increase in groundwater qualitative or quantitative WFD status.
Moderate	Adverse: Loss of part of an attribute or decrease in integrity of an attribute	Adverse: Increased flood risk to less vulnerable developments; Partial loss of fishery; measurable decrease in surface water ecological or chemical quality or reversible change in the yield or quality of an aquifer, affecting existing users, but not changing any WFD status
	Beneficial: Moderate improvement in quality of an attribute	Beneficial: Measurable increase in surface water quality or in the yield or quality of aquifer benefiting existing users but not changing any WFD status
Minor	Adverse: Some measurable change to the integrity of an attribute	Adverse: Increased flood risk to water compatible development or impact which does not affect existing or any possible future developments; measurable decrease in surface water ecological or chemical quality; decrease in yield or quality of aquifer not affecting existing users or changing any WFD status
	Beneficial: Measurable increase, or reduced risk of negative effect to an attribute	Beneficial: Measurable increase in surface water ecological or chemical quality; increase in yield or quality of aquifer not affecting existing users or changing any WFD status
Negligible	No change to integrity of attribute	Negligible change to flood risk; discharges to watercourse or changes to an aquifer which lead to no change in the attribute's integrity

Table D.3: Comparison of Magnitude of Effect (Consequence) Against Probability

	Consequence			
Probability	**Major**	**Moderate /Medium**	**Minor**	**Negligible**
High likelihood	Very high risk	High risk	Moderate risk	Moderate/low risk
Likely	High risk	Moderate risk	Moderate/low risk	Low risk
Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Table D.4: Estimation of Risk (All receptors)

Risk	Definition
6 (Very High risk)	There is a high probability that a contaminant linkage could exist between a source and a designated receptor resulting in detriment to the receptor. Investigation and remediation will be required prior to (or as part of) construction. During construction further mitigation and monitoring measures (in accordance with the draft Code of Construction Practice (CoCP)) are likely be required. Such Sites are considered significant.
5 (High Risk)	It is likely that a contaminant linkage exists with potentially a severe affect on designated receptors. Investigation and remediation is very likely to be required. Such Sites are considered significant.
4 (Moderate risk)	It is possible that an effect could arise to a designated receptor through a contaminant linkage. However, the effect is most likely to be moderate to minor. Further investigative work is likely to be required to clarify the risk. Some remediation works may be required. Such Sites may be considered significant.
3 (Moderate / Low Risk)	It is possible that a contaminant linkage could exist, but if it does, any effects would normally be minor. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.
2 (Low risk)	It is a low possibility that a contaminant linkage could exist. However, should there be a linkage the effect to the receptor (with regards to controlled waters) would normally be minor or negligible and the effect on human health would be negligible. No investigation or remedial works are likely to be required.
1 (Very Low risk)	It is unlikely that a contaminant linkage could exist between a source and a designated receptor.

Appendix D Contamination Data

1MC09-BBV_MSD-EV-CAL-NS04-100055

Appendix E ConSim input parameters

The physical and chemical input parameters for ConSim model

Parameter	Unit	Distribution	Value	Source of parameter value/ justification
Source				
Lithology	N/A	Made Ground - perched water horizons exist within the strata Typical description: Predominately granular but cohesive Made Ground is also present. Typically described as medium dense reddish brown mottled black and brown slightly silty fine to coarse SAND and subangular to rounded fine to coarse GRAVEL of mixed lithologies including flint and quartzite.		
Dry bulk density of source zone	g/cm^3	Triangular	1.52, 1.60, 1.70	Minimum, mean and maximum values of the dry bulk density values of Made Ground. Data taken from compaction tests in the Made Ground from BD162-TP003 (similar Made Ground description; dark brown, slightly gravelly, fine and medium SAND with some clay pockets. Gravel is subangular and subrounded of quartzite with occasional brick, plastic and timber fragments.). No compaction tests were carried out on boreholes within MG at the site. Also, the GIR Report E2, suggests that due to the large variety of MG across the area, specific site parameters should be considered.
Calculate porosities?	-	-	No	
Air filled soil porosity	fraction	Triangular	0.014, 0.12, 0.232	Minimum, mean, and maximum values calculated from the dry bulk density values and moisture content values of the Made Ground at BD162-TP003. No compaction tests were carried out from boreholes within the Site.
Water filled soil porosity	fraction	Triangular	0.195, 0.29, 0.382	Minimum, mean, and maximum values calculated from the dry bulk density values and moisture content values of the Made Ground at BD162-TP003. No compaction tests were carried out from boreholes within the Site.
Thickness of source	m	Triangular	0.20, 3.22, 5.65	Minimum and maximum thickness of Made Ground identified at the site within the brick works area.
Length source	m	Single	142.5	95% of the approximate length of the source (most contaminated part of the Site)
Width source	M	Single	133	95% of the approximate width of the source (most contaminated part of the Site)
Area source	m2	Single	18,952.5	Approximate area of the source (most contaminated part of the Site)
Fraction of organic carbon (in source soil)	%	Log triangular	1.46, 8.36, 14	Data taken the Made Ground deposits across Pool Wood Emb. Statistical analysis showed that 75% of data was <14%, therefore minimum, mean, and maximum values were calculated from this dataset.
Declining source?	-	No		Conservative approach
Pathway (unsaturated pathway) (level 2)				
Lithology	N/A	Glaciofluvial deposits - pathway and aquifer is the Glaciofluvial paleochannel which is hydraulically connected to Coleshill Pool (principal receptor). Typical description: mixture of granular and cohesive. For a more robust assessment granular pathway has been considered.		
Infiltration	mm/yr	Triangular	47, 69, 101	Minimum, arithmetic mean, and maximum of Rainfall – slope runoff coefficient - actual evaporation: Rainfall - determined from UK hydrometric register and CEH[xxxv] Actual evaporation - determined from Hess (2010)[xxxvi], Estimating green water footprints in a temperate environment As the contaminated areas will largely be located beneath landscaping bunds and embankments, it is considered appropriate to add a slope runoff factor. The highways slope runoff coefficient (as given in DMRB) is 16%. As a conservative measure 50% of this value (8%) will be applied to the minimum rainfall value, 16% to the maximum value and midpoint of 12% to the mean rainfall value. This is in line with slope rainfall coefficients from US sources.
Overall unsaturated zone thickness	m	Triangular	0.38, 1.52, 2.9	Average groundwater levels observed in the Glaciofluvial deposits minus the minimum and maximum Made Ground thickness. Unsaturated zone thickness calculated from the bottom of the Made Ground until the groundwater depths observed in the Glaciofluvial deposits.

Parameter	Unit	Distribution	Value	Source of parameter value/ justification
Fraction of organic carbon (in pathway soil)	%	Triangular	0.13, 0.68, 1.3	Data taken from Sublot 5 and 6 geo-environmental summaries to provide a representative data set. This is for the Glaciofluvial deposits within the Sublot 5 and 6 area.
Pathway				
Thickness of unsaturated zone	m	Triangular	0.38, 1.52, 2.9	Average groundwater levels observed in the Glaciofluvial deposits minus the minimum and maximum Made Ground thickness. Unsaturated zone thickness calculated from the bottom of the Made Ground until the groundwater depths observed in the Glaciofluvial deposits.
Water filled porosity	fraction	Triangular	0.006, 0.15, 0.448	Minimum, Mean, and Maximum values calculated from the dry bulk density values and moisture content values of the Glaciofluvial Deposits data from GIR Report E2.
Dry bulk density	g/cm^3	Triangular	1.99, 2.6, 2.94	Minimum, mean and maximum values of the dry bulk density values of GFD. Data taken the GIR Report E2.
Unsaturated hydraulic conductivity	m/s	Triangular	2.4x10-8, 3.7 x10-06, 2.5x10-5	In-situ permeability tests of the GFD. Taken from Permeability Statistics for HS2 N1/N2 (document number:1MC08-BBV_MSD-GT-CAL-N001-100209).
Vertical dispersivity	m	Triangular	0.038, 0.152, 0.290	10% of unconfined thickness
Retarded travel in the UZ?	-	-	Yes	Model due to retardation will happen within the aquifer itself
Biodegradation in the UZ?	-	-	Yes	Aquifer is unconfined and well aerated, allowing for biodegradation to occur
Flow model	-	-	Porous medium	Sandy gravel unsaturated zone - flow model will be porous medium
Aquifer Pathway (Level 3)				
Thickness	m	Single	8	Glaciofluvial deposits is around 9.5m thick, with the top 1.52m (average) being unsaturated, therefore a saturated thickness of 8.00m has been used.
Dry bulk density	g/cm^3	Triangular	1.99, 2.6, 2.94	Minimum, mean and maximum values of the dry bulk density taken the GIR Report E2.
Mixing Zone thickness	N/A	N/A	Calculated	
Hydraulic conductivity	m/s	Triangular	0.000000024, 3.71711111111111E-06, 0.000025	In-situ permeability tests of the GFD. Taken from Permeability Statistics for HS2 N1/N2 (document number:1MC08-BBV_MSD-GT-CAL-N001-100209).
Effective porosity	fraction	Uniform	0.18 - 0.43	Literature Rev
Hydraulic gradient	fraction	Single	0.019318182	Calculated from average groundwater levels around the brick works.
Groundwater flow direction	degrees	Single	90	South-east travel to Coleshill Pool
Longitudinal dispersivity	m	Single	5	10% of distance to 50m compliance point
Lateral dispersivity	m	Single	0.5	1% of distance to 50m compliance point
Retarded travel in the Aquifer?	N/A	N/A	Yes	Retardation is believed to occur within the aquifer
Fraction of organic carbon (in aquifer)	%	Triangular	0.13, 0.68, 1.3	Data taken from Sublot 5 and 6 geo-environmental summaries to provide a representative data set. This is for the Glaciofluvial deposits within the Sublot 5 and 6 area.

Parameter	Unit	Distribution	Value	Source of parameter value/ justification
Biodegradation in the Aquifer?	N/A	N/A	Yes	Aquifer is unconfined and well aerated, allowing for biodegradation to occur
Receptors				
Base of the unsaturated zone	N/A	N/A	Base of the UZ	Automatic ConSim compliance point (Level 2 analysis)
Receptor 1	N/A	N/A	5m compliance point	Automatic ConSim compliance point
Receptor 2	N/A	N/A	10m compliance point	Receptor to highlight minimal risks to underlying Glaciofluvial deposits (Level 3 analysis)
Receptor 3	N/A	N/A	50m compliance point	Additional receptor to protect defined surface waters

Chemical input parameters for ConSim model 1 (soil source) and 2 (groundwater source)

Contaminant	Organic carbon to water partition coefficient/partition coefficient (m/lg)	Henry's Law Constant (unitless)	Max solubility (mg/l)	Max solubility (ug/l)	Half Life: (Source and USZ) (years)	Half Life: (Water) (years)
TPH and BTEX						
TPH Ali 5-6	794	33	3.60E+01	3.60E+04	0.04	0.96
TPH Ali 6-8	3981	50	5.4	5400	0.06	0.55
TPH Ali 8-10	31623	8	0.43	430	0.03	0.55
TPH Ali 10-12	251189	120	0.034	34	0.13	0.82
TPH Ali 12-16	5.01E+06	520	0.00076	0.76	2.05	4.11
TPH Ali 16-21	630957345	4900	0.0000025	0.0025	2.71	5.43
TPH Ali 21-35	630957345	4900	0.0000025	0.0025	2.71	5.43
TPH Ali 35-44	630957345.00	4900.00	0.00000250	0.0025	2.71	5.43
TPH Aro 5-7/ Benzene	68	0.23	1800	1800000	0.04	2
TPH Aro 7-8/ Toluene	204	0.115	590	590000	0.06	0.55
TPH Aro 8 -10	1585	0.48	65	65000	0.03	0.34
TPH Aro 10-12	2512	0.14	25	25000	0.13	0.55
TPH Aro 12-16	5012	0.053	5.8	5800	2.05	4.11
TPH Aro 16-21	15849	0.013	0.65	650	2.71	5.43
TPH Aro 21-35	125893	0.001	6.60E-03	6.60E+00	2.71	5.43
TPH Aro 35-44	125893	0.001	6.60E-03	6.60E+00	2.71	5.43
Ethylbenzene	447	0.139	1.80E+02	1.80E+05	0.027	0.62
Xylene	454	0.104	200	200000	0.08	1
PAH						
Anthracene	29512	1.60E-03	4.50E-02	4.50E+01	1.26	2.52
Acenaphthylene	5027	4.66E-03	1.61E+01	1.61E+04	0.164	0.329
Acenaphthene	5027	7.52E-03	3.9	3900	0.279	0.559
Benzo(a)anthracene	176900	4.91E-04	9.40E-03	9.40E+00	1.86	3.73
Benzo(a)pyrene	128825	0.00000176	0.0038	3.8	1.45	2.9
Benzo(b)fluoranthene	104713	0.00000205	0.002	2	1.67	3.34
Benzo(k)fluoranthene	147911	0.00000174	8.00E-04	8.00E-01	5.86	11.7
Benzo(g,h,i)perylene	416869	0.00000236	2.60E-04	2.60E-01	1.78	3.6
Chrysene	180500	2.14E-04	2.00E-03	2.00E+00	2.72	5.48
Di-benzo(a,h)anthracene	1912000	5.76E-06	2.49E-03	2.49E+00	2.58	5.15

Contaminant	Organic carbon to water partition coefficient/partition coefficient (m/lg)	Henry's Law Constant (unitless)	Max solubility (mg/l)	Max solubility (ug/l)	Half Life: (Source and USZ) (years)	Half Life: (Water) (years)
Fluorene	9160	3.93E-03	1.69	1690	0.164	0.329
Fluoranthene	18197	0.0000629	0.23	230	1.21	2.41
Indeno(1,2,3-cd)pyrene	87069	2.05E-06	2.00E-04	2.00E-01	2	4
Naphthalene	646	0.00662	19	19000	0.13	0.71
Phenanthrene	16690	1.73E-03	1.15	1150	0.548	1.1
Pyrene	16218	4.87E-04	1.35E-01	1.35E+02	5.2	10.4
Styrene	446	0.112	3.10E+02	3.10E+05	0.08	0.58
Metals						
Arsenic	500	0	10000000	10000000000	10000000	10000000
Antimony	45	0	10000000	10000000000	10000000	10000000
Boron	10	0	10000000	10000000000	10000000	10000000
Cadmium	100	0	10000000	10000000000	10000000	10000000
Chromium (III)	4800	0	10000000	10000000000	10000000	10000000
Chromium (VI)	19	0	10000000	10000000000	10000000	10000000
Copper	35	0	10000000	10000000000	10000000	10000000
Iron	25	0	10000000	10000000000	10000000	10000000
Mercury	500	0	10000000	10000000000	10000000	10000000
Nickel	500	0	10000000	10000000000	10000000	10000000
Lead	900	0	10000000	10000000000	10000000	10000000
Manganese	65	0	10000000	10000000000	10000000	10000000
Selenium	5	0	10000000	10000000000	10000000	10000000
Vanadium	12.6	0	10000000	10000000000	10000000	10000000
Zinc	38	0	10000000	10000000000	10000000	10000000
Other contaminants						
Ammoniacal Nitrogen	0.45		10000000	10000000000	10	10
Cresol	307	0.0000253	9.07E+03	9.07E+06	0.079	0.13
Phenol	83	0.00000835	8.41E+04	8.41E+07	0.027	0.27
Trichloroethene	141	0.187	1370	1370000	1	4.5
Tetrachloroethene	269	3.16E-01	2.25E+02	2.25E+05	1	2
1,4-Dichlorobenzene	708	0.047	5.12E+01	5.12E+04	0.5	1
1,2-Dichloroethene	39.6	0.167	3.50E+03	3.50E+06	0.5	7.91
1,2-Dichlorobenzene	692	0.0338	1.33E+02	1.33E+05	0.5	1
Hexachlorobutadiene	10965	0.155	4.80E+00	4.80E+03	0.5	1
Trichlorobenzenes (Koc, and H are avg for 123, 124 and 135 TCB)	2497	0.0307	4.14E+01	4.14E+04	0.5	1
Chloroform	50	7.65E-02	8.95E+03	8.95E+06	0.5	5
Bis(2-ethylhexyl)phthalate	120000	0.000011	0.003 & 0.27 (uniform)	3 & 270	-	0.82 & 12.8
Inorganics						
Sulphate	1	0	10000000	10000000000	10000000	10000000
Nitrate	1			0		

Environment Agency/Atkins, 2003. Review of the Fate and Transport of Selected Contaminants in the Soil Environment. Tables 2.4, 3.2 & 4.3.[xxxvii]

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RAIS database (Risk Assessment Information System, http://rais.ornl.gov/tools/)[xxxix]

Howard et al. 1991. Environmental Degradation Rates. Max values. [xl]

Buss *et al.*, 2004. A Review of Ammonium Attenuation in Soil and Groundwater. QJEGH v37. Mid point kd values chosen for clean sand and gravel. Half-life is maximum for strata with mean pore size of >1um assuming aerobic conditions[xli]

Environment Agency 2008. Compilation of data for priority organic pollutants for derivation of Soil Guideline Values [xlii]

Contaminant	Organic carbon to water partition coefficient/partition coefficient (m/lg)	Henry's Law Constant (unitless)	Max solubility (mg/l)	Max solubility (ug/l)	Half Life: (Source and USZ) (years)	Half Life: (Water) (years)
See table below						
Nathanail et al 2015: "The LQM / CIEH S4ULs for Human Health Risk Assessment ", Copyright Land Quality management Limited reproduced with permission: Publication No. S4UL3389[xliii]						
Agency for Toxic Substances and Disease Registry webSite[xliv]						
Environment Agency (2002): Research & Development technical Report P2-228/TR[xlv]						

Soil half-lives for Total Petroleum hydrocarbons

TPH fraction	***Soil half Lives***
Aliphatic C5-6	Maximum soil half-life for Benzene (C6): 16 days: Howard et al. 1991[xl]
Aliphatic C6-8	Maximum soil half-life for Toluene (C7): 22 days: Howard et al. 1991[xl]
Aliphatic C8-10	Maximum soil half live for Ethylbenzene (C8) and Xylene (C8): 10 days: Howard et al. 1991[xl]
Aliphatic C10-12	Maximum aerobic half live for Naphthalene (C10): 48 days: Howard et al. 1991[xl]
Aliphatic C12-16	Average of maximum soil half-lives for Pyrene (C16), Anthracene (C14), Phenanthrene (C14) and Fluoranthene (C16): 749 days (Howard *et al*, 1991)[xl]
Aliphatic C16-21	Average of maximum aerobic half-lives for Benzo(a)anthracene (C18), Chrysene (C18), Benzo(a)pyrene (C20), Benzo(k)Fluoranthene (C20) and Benzo(b)Fluoranthene (C20): 989 days (Howard *et al*, 1991)[xl]
Aromatic C8-10	Maximum soil half live for Ethylbenzene (C8) and Xylene (C8): 10 days: Howard et al. 1991[xl]
Aromatic C10-12	Maximum aerobic half live for Naphthalene (C10): 48 days: Howard et al. 1991[xl]
Aromatic C12-16	Average of maximum aerobic half-lives for Pyrene (C16), Anthracene (C14), Phenanthrene (C14) and Fluoranthene (C16): 749 days (Howard *et al*, 1991)[xl]
Aromatic C16-21	Average of maximum aerobic half-lives for Benzo(a)anthracene (C18), Chrysene (C18), Benzo(a)pyrene (C20), Benzo(k)Fluoranthene (C20) and Benzo(b)Fluoranthene (C20): 989 days (Howard *et al*, 1991)[xl]
Aromatic C21-35	Average of maximum aerobic half-lives for Benzo(a)anthracene (C18), Chrysene (C18), Benzo(a)pyrene (C20), Benzo(k)Fluoranthene (C20) and Benzo(b)Fluoranthene (C20): 989 days (Howard *et al*, 1991)[xl]

Appendix F HS2 Area North Asbestos Risk Assessment for Contaminated Land at Sub-Lots 5 & 6

Sub lot 5_6 RA Rv1 Final.pdf

Appendix G Disclaimer

This disclaimer should be read in accordance with the technical limitations in Section 15.

This report has been prepared solely for use by the party which commissioned it (the "client") in connection with the captioned project. It should not be used for any other purpose. No person other than the client may rely on the content, information or any views expressed in this report. We accept no duty of care, responsibility or liability to any other recipient of this report. This report is confidential and contains proprietary intellectual property.

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We disclaim all and any liability whether arising in tort or contract or otherwise which it might otherwise have to any party other than the client, in respect of this report, or any information attributed to it.

This report represents the technical findings and opinions of experienced geo-environmental specialists and does not constitute legal, insurance or financial advice, for which separate, independent advice should be consulted from qualified professionals if so required.

The findings and opinions of this report are based on information obtained from a variety of sources as detailed in this report. We cannot and do not guarantee the authenticity or reliability of the information from other sources upon which we have relied. To the extent that this document is based on information supplied by other parties, we accept no liability for any loss or damage suffered by the client due to an error or omission in this report which is (i) due to an error or omission data, information or statements supplied to us by other parties including the client ("Data") or (ii) which arises from any conclusions based on such Data. We have not independently verified such Data and have assumed it to be accurate, complete, reliable and current as of the date of such information.

To the extent that this report is based on information obtained from a ground investigation, any such investigation can examine only a small part of the subsurface conditions. Where we have been responsible for the design of a ground investigation, we shall have used reasonable skill and care. However, in any ground investigation there remains a risk that pockets or "hot-spots" of contamination may not be identified, because investigations are necessarily based on sampling at localised points. Not finding any indicators of contamination does not mean that hazardous substances do not exist at the Site.

Certain indicators or evidence of hazardous substances or conditions may have been outside the limited portion of the subsurface investigated or monitored and thus may not have been identified or their full significance appreciated. Such risks may be mitigated to a degree by carrying out further ground investigation, or during construction works, by on-Site visual observation and validation testing.

It is also possible that environmental monitoring has not identified certain conditions because of the relatively short monitoring period. Accordingly, it is possible that the ground investigation and monitoring failed to indicate the presence or significance of hazardous substances or conditions. If so, their presence could not have been considered in the formulation of our findings and opinions.

For the avoidance of doubt, where the words "remediation" or "remedial" actions / operations are used in this report, these words and phrases shall refer to actions to eliminate, control or reduce risks from relevant pollutant linkages associated with the Site. Unless explicitly stated, remediation shall NOT be assumed to refer to actions to eliminate contamination risks.

This report has been produced using due skill and care, in accordance with statute and best practice at the reporting date stated in the report. We accept no liability for any change in geo-environmental risk interpretation resulting from changes in guidance and/or statute after the reporting date.

We believe that providing information about limitations is essential to help the client identify and thereby manage its risks. These risks can be mitigated – but they cannot be eliminated - through additional research. We will, on request, advise the client of the additional research opportunities available, their impact on risk, and their cost.

Appendix H References[xlvi]

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[iv] Delta Junction Area A, WP-DJA-001. Factual Report for Ground Investigation Work Package. RPS. Document number: 1G026-RPS-GT-REP-000-000005. August 2017.
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[viii] United Kingdom (UK) Government: *Land contamination: risk management*: https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks [Accessed 14th July 2020].
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APPENDIX C
GROUND INVESTIGATION SPECIFICATION: POOL WOOD EMBANKMENT (1MC09-BBV_MSD-EV-REP-NS04_NL10-100218 REV. P01)

Balfour Beatty VINCI Working in partnership with HS2

Contract No. 1MC13

Ground Investigation Specification: Pool Wood Embankment

Document Number: 1MC09-BBV_MSD-EV-REP-NS04_NL10-100218

Current Revision	Author	Reviewed By	Approved By	Date Approved	Reason for Review
P01	J. Olsen	T. Hodges	Remant Doorgakant	07/02/2025	S3 – fit for Review and Comment

Stakeholder Review Required (SRR)	Purpose of SRR
☒ Yes – Please Specify Below	☒ Comment
☐ No	☐ Information
Click or tap here to enter text.	☒ Approval

HS2 Signature Required
☐ Yes – Please Specify Below
☐ No
Click or tap here to enter text.

Handling Instructions: Produced by BBV for project use only

Review Required

Team	Yes/No	Name	Position	Date
Quality				
Health & Safety				
Environment & Sustainability				
Other teams if required				

Revision History

Previous Revision	Author	Reviewed By	Approved By	Date Approved	Reason for Review
P01	J. Olsen	T. Hodges	Remant Doorgakant	07/02/2025	S3 – fit for Review and Comment

Revision Summary

Paragraph Modified	Details of Modification

Contents

1 SCOPE AND PURPOSE

This report is applicable to all activities undertaken by the Balfour Beatty VINCI Joint Venture (BBV) and its supply chain on the Main Works Civils Contracts (MWCC) for Sectors N1N2, project references [1MC08] and [1MC09] (referred to in this document as the Project) for the provision of Design and Construction services in accordance with the requirements of the Contract.

This report has been prepared by the Design Joint Venture (Systra and Mott MacDonald) on behalf of Balfour Beatty Vinci (BBV) for HS2 to provide ground investigation, sampling and monitoring requirements to support environmental assessment work and a Deposit for Waste Recovery Plan (DFWRP) for Pool Wood Embankment (PWE).

BBV plan to construct part of a landscape bund located to the west of the PWE trace using materials sourced from Middle Bickenhill Landfill (MBL) located at Chainage (Ch.) 157+200 to 157+300. The material generated from the landfill will be the subject of a Remediation Implementation Plan (RIP). Fundamentally, the RIP will involve the segregation of construction (rubble) type material from putrescible 'black bag' waste. The former will be processed for reuse and placement in a section of the bund, with the latter either to be landfilled and/or incinerated. It is estimated that up to approximately 90% (161,100m^3) of the estimated 179,000m^3 of material contained in the landfill will be used in the construction of the landscape bund.

As the material sourced in the part construction of the landscape bund will originate from a landfill, its reuse cannot be managed under the BBV contaminated and non-contaminated material management plans (MMP Route A Earthworks Contamination Risk Assessment and N1 and N2 Earthworks Risk Assessment and Design Statement for MMP Route B Materials). Consequently, the material must be managed under a Deposit for Waste Recovery permit that will be obtained by submitting a DFWRP and supporting application documentation. The application process is being managed by RSK Geosciences on behalf of BBV.

A range of assessments are required to support the DFWRP to demonstrate that the use and placement of landfill sourced materials post development will not present an unacceptable risk to human health and controlled waters. Accordingly, there is requirement to complete a Scenario 8 Hydrogeological Risk Assessment (with acceptability criteria derivation), a Preliminary Ground Gas Assessment and a H1 Risk Assessment. These assessments will be presented under separate cover.

To support these assessments there is a need to collect data (primarily groundwater and surface water) to establish baseline (background) pre-construction conditions and conditions during and following construction to determine if there has been a deterioration and departure from background water quality that could be reasonably attributed to the placement and landfill material in the landscape bund. Moreover, if required, the data will be used to support the identification of intervention and mitigation measures to address identified risks both during and following construction works. A robust dataset is also required to support the future surrender of the Deposit for Waste Recovery permit.

This report provides guidance to BBV and its sub-Contractors on the ground investigation/sampling/monitoring requirements to allow the DJV to complete its environmental assessment work specific to the Scenario 8 Hydrogeological Risk Assessment in support of the DFWRRP and future surrender works.

This report, together with the processes included in the BBV Way and any associated documents listed in section 2.3 meet the requirements of the Contract (as specified in the documents listed in section 2.1) and the standards listed in section 2.2. The report should be read in conjunction with the documents listed in section 2.3.

This report is written on the basis that BBV can undertake their business in the normal manner. Where significant disruption occurs that fundamentally affects the implementation of this report (e.g., health pandemic), an addendum will be prepared to describe how the requirements of this document shall be modified for the duration of the disruption. Once any period of disruption has ended, the addendum shall be withdrawn and BBV shall revert to the current version of this document.

2 REFERENCE DOCUMENTS

2.1 Contract

Document Title	Document Number
Specification for Civil Engineering Works – Contract Specific appendices – Series 0600 Earthworks: N1 and N2, 2021	1MC08-BBV_MSD-GT-SPE-N000-100001
MMP Route A Earthworks Contamination Risk Assessment, 2021 (C01)	MMP A 1MC08-BBV_MSD-EV-RIA-N001-100001
N1 and N2 Earthworks Risk Assessment and Design Statement for MMP Route B Materials, 2020	1MC08-BBV_MSD-EV-RIA-N001-100002
Materials Management Plan Route A Earthworks Remediation Strategy Report, 2023	1MC09-BBV_MSD-EV-REP-NS04_NL10-100218
Schedule 1 Specification for Ground Investigation, 2014	HS2-HS2-GT-SPE-000-000001
HS2 Technical Standards (Water Resources and Flood Risk Consents) HS2 *"Technical Standard – Water resources and flood risk consents and approvals"*, March 2019	HS2-HS2-EV-STD-000-000015
HS2, *"Technical Standard - Land Quality"*, April 2019	HS2-HS2-EV-STD-000-000027 P05
HS2 *"Technical Standard – Groundwater"*, November 2017	HS2-HS2-EV-STD-000-000010 P07
HS2 Geo-environmental Report for Sub Lots 5 and 6, February 2021	1MC09-BBV_MSD-EV-REP-N002-100002
Pool Wood Embankment – Land Quality Management Report, November 2024	1MC09-BBV_MSD-EV-REP-NS04_NL10-100218
Hydrogeological Risk Assessment and Material Acceptability Criteria Risk Assessment: Pool Wood Embankment Landscape Bund	1MC09-BBV_MSD-EV-REP-NS04_NL10-100217

2.2 Standards and Information Sources

This report has been produced in accordance with the following regulatory guidance documents and data sources:

- ISO 9001: 2015 Quality Management System
- ISO 14001: 2015 Environmental Management System
- ISO 45001: 2018 Occupational Health and Safety
- Environment Agency "Land Contamination: Risk Management (LCRM)", April 2021, www.gov.uk

- UK Government: Groundwater protection. https://www.gov.uk/government/collections/groundwater-protection
- Environment Agency (2009): "Human Health Toxicological assessment of contaminants in soil", Science Report. SC050021/SR2
- DEFRA (2010): "SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document"
- Contaminated Land: Applications in Real Environments (CL:AIRE), Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration, 2020
- Balfour Beatty Vinci joint venture *"iSpatial"* Ordnance Survey online mapping platform combining information gathered from multiple sources as part of the HS2 project, 2021.

2.3 Associated BBV Procedures

Document Title	Document Number
N/A	

2.4 The BBV Way

The BBV Way is the Balfour Beatty VINCI Integrated Management System for the project. It contains the processes that we will use to manage the project – it is held in the following location:

The BBV Way

3 RESPONSIBILITIES

Role	Main Responsibilities
John Olsen (MM/Systra DJV)	Report Author
Tim Hodges (MM/Systra DJV)	DJV Land Quality Lead, Report Checker
Remant Doorgakant (MM/Systra DJV)	DJV Environment coordinator, Report Approver
Stephen Phipps (BBV)	BBV Materials Manager, BBV Reviewer
Paul Sandall (BBV)	BBV Contaminated Land Specialist, BBV Reviewer

4 SCHEDULE 1: INFORMATION AND SITE SPECIFIC REQUIRMENTS

This report has been prepared with general reference to the HS2 reported entitled “Schedule 1 – Specification for Ground Investigation”, October 2014 (HS2-HS2-GT-SPE-000-000001) and the Institute of Civil Engineers (ICE) report entitled “UK Specification for Ground Investigation, 2nd Edition”, 2012. This report should be read in conjunction with the aforementioned documents. Where not otherwise specified in the current document, the clauses in HS2-HS2-GT-SPE-000-000001 shall apply.

4.1 Name of Contract

Ground investigation specification to support the development of a PFWRP, associated environmental assessments and future surrender report for the construction of a landscape bund at PWE.

4.2 Investigation supervisor

The Investigation Supervisor will be a representative of BBV.

4.3 Description of site

4.3.1.1. Location

PWE is located ~10km south-east of Birmingham City Centre. The M42 motorway and a roundabout is situated at its southern boundary and the M6 motorway is present at its northern boundary. The main element of the asset is located between approximately Ch. 158+500 and 159+915.

The landscape bund that is to receive material from MBL is located to the adjacent west of the PWE trace, which is designed to act as a visual/noise barrier for residents located to the west of the alignment. The landscape bund is proposed to be ~850m long (~Ch. 158+900 to 159+750), ~50 to 70m wide and up to 14m in height above existing ground level.

The area of the landscape bund to be constructed using material sourced from MBL is located at approximate Ch. 159+225 and 159+700. The location of PWE and the area subject to the conditions of the PFWRP are shown on Figure 1 and 2 respectively.

Figure 1: Location of Pool Wood Embankment

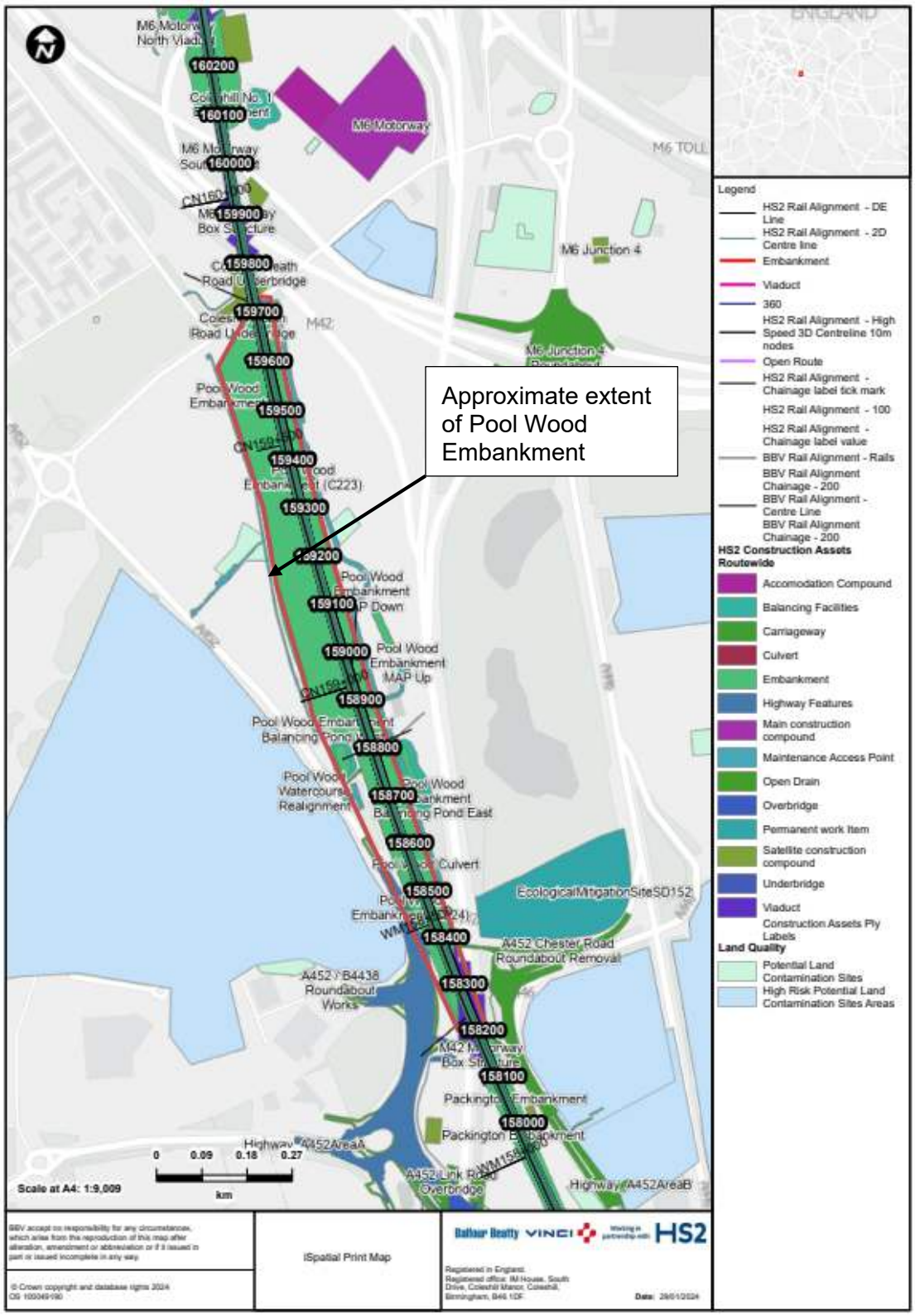
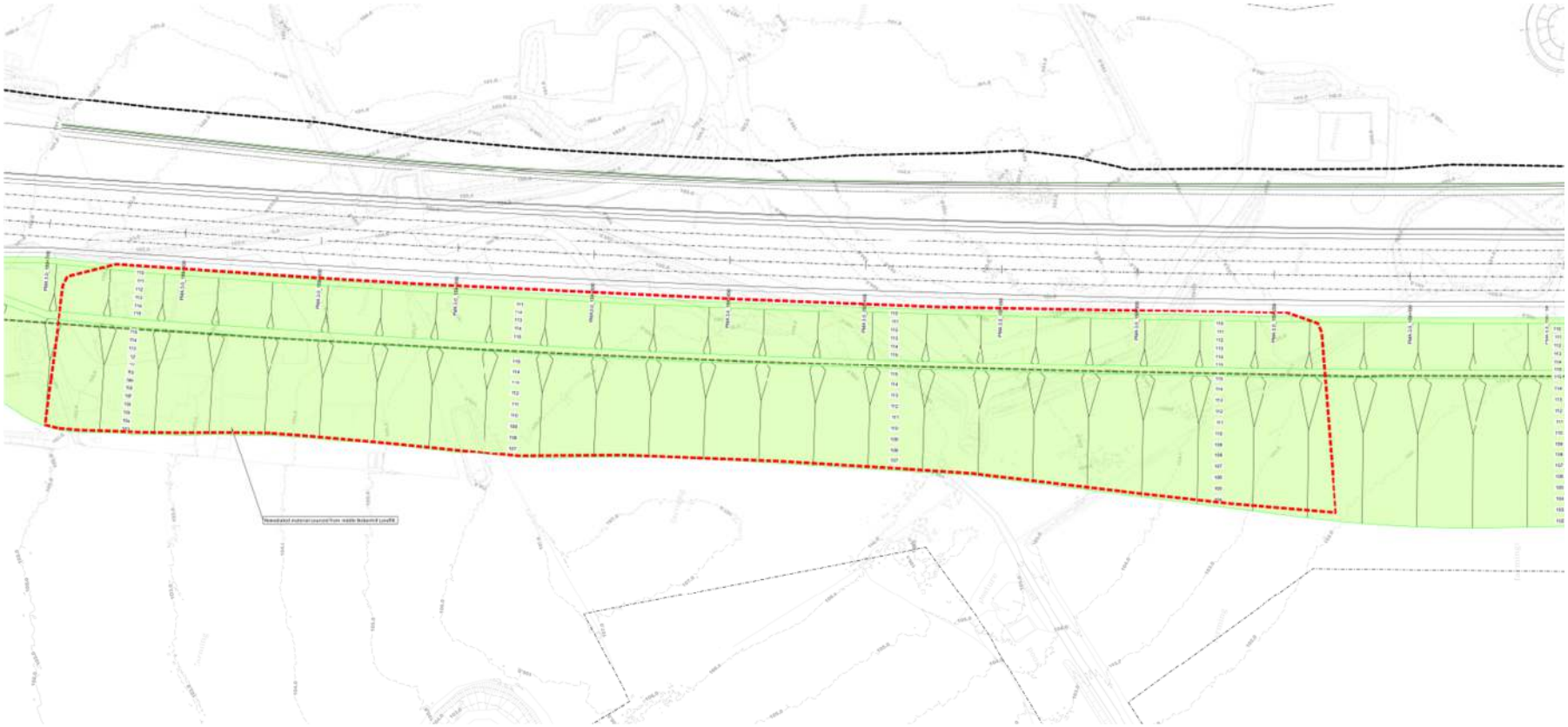


Figure 2: Extent of area subject to the Permit for Waste Recovery Plan



4.3.1.2. Topography

Under pre-construction conditions elevation ranged from ~99mAoD in the south raising to 106mAoD in the northern third from Ch. 159+100. Elevations fall to about 100mAoD at the northern extreme of the asset (~Ch. 159+800). The northern third of the asset represents an area of mounding associated with geological superficial deposit with elevations falling in all directions. Elevations in the neighbouring areas are around 100mAoD with the lowest elevations recorded to the east of the asset at around 97mAoD associated with Coleshill Pools.

4.3.1.3. Previous and Current use

Pre-construction land use at the asset appears to have been predominantly agricultural in nature. Current aerial imagery indicates that enabling/earthworks works associated with the construction of the asset have commenced.

4.3.1.4. Site classification

The following potentially contaminated areas were identified in the Environmental Statement

- A former brick works with kiln and infilled pond located at Ch. 159+300 (associated with ML159-CP403 to 406. At the time of the original design a RED classification was assigned to this area due to the potential for asbestos, hazardous chemicals, and flammable gases.
- An area around Ch. 158-800 to 158+850 associated with ML158-TP414 and TP415 to the south of all proposed exploratory hole locations. At the time of the original design a YELLOW classification was assigned to the area, however it is unclear what led to this classification. Upon investigation, the holes did not encounter any made ground.

With respect to the RED and YELLOW classification, in line with comments made in Section 5.3.1.5, subsequent assessment in the respective areas did not identify the presence of soil or groundwater contamination or elevated gas concentrations. Based on subsequent ground investigations, sample analysis and contaminated land assessment, future ground investigation specially involving the completion of exploratory holes should be undertaken assuming a precautionary BDA classification of YELLOW for all areas

4.3.1.5. Known or suspected contamination

Various phases of contaminated land assessment have been completed at the asset, the culmination of these assessments have been presented in the HS2 report entitled “Pool Wood Embankment – Land Quality Management Report”, March 2023 (1MC09-BBV_MSD-EV-REP-NS04_NL10-100218). From a post development perspective, through the development of a conceptual site model (source, pathway, and receptor), the referenced report concluded that the asset is unlikely to present a significant risk to human health or controlled waters, and no specific targeted soil/groundwater remediation is needed. However, from a Contractor perspective, a range of locations, source materials and contaminants have been identified that Contractors could be exposed to during ground works, as discussed below:

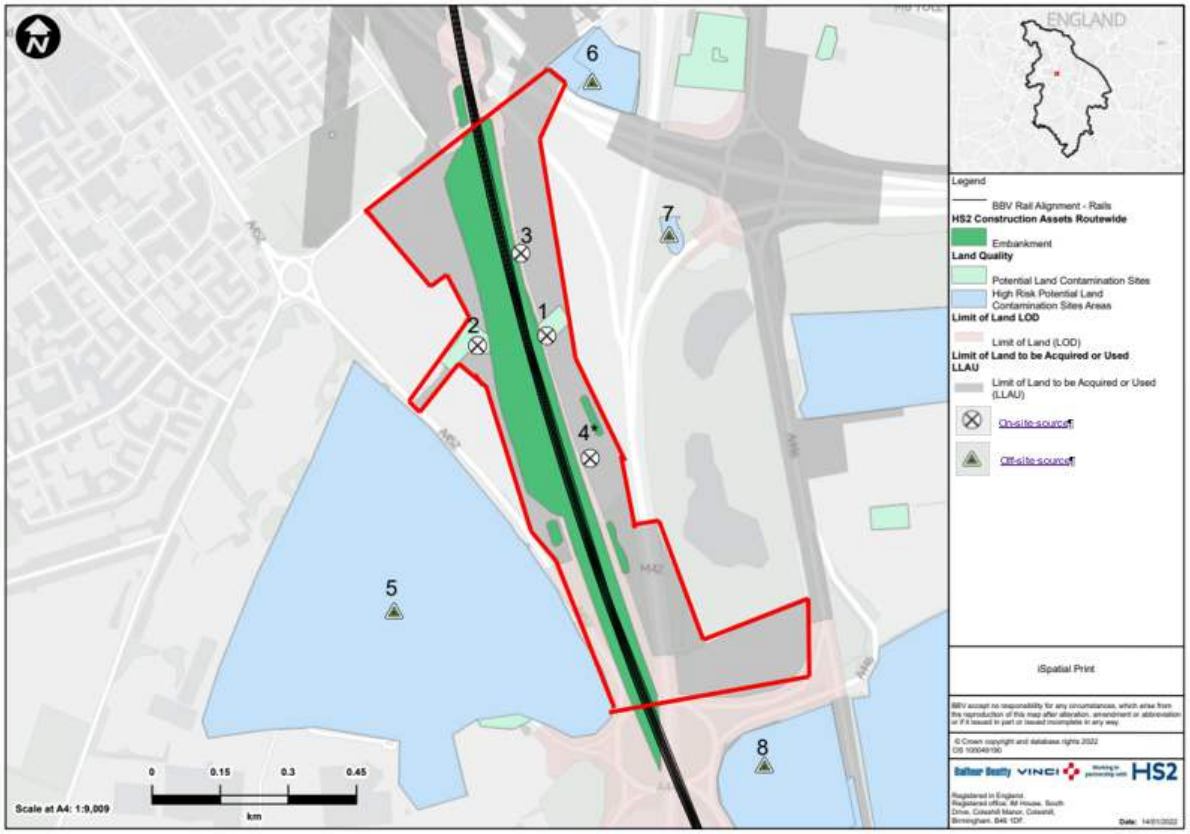
Potential source locations

Table 1 and Figure 3 summarise the source locations and nature of the potential contaminants of concern.

Table 1: Potential contaminant source locations at Pool Wood Embankment

Sources	Source ID	Location and Potential Contaminants of Concern
On-Site		
Brick Works with kiln and infilled pond	1	Located on-site. Potential contaminants include organics, metals, asbestos, sulphates and herbicides, pesticides and ground gas
Brickfield Farm and Brickfields Cottage	2	Located on-site to the west of the asset. Contaminants includes organics, solvents, metals, asbestos, herbicides and pesticides
Abandoned Well	3	Located in the northeast of the site. Potential contaminants include metals, organics, sulphates, asbestos and ground gases
Fly-tipping	4	Fly-tipping observed during site walkover. Potential contaminants include organics, metals and asbestos
Off-Site		
Birmingham Business Park	5	Located off-site to the west the asset. Contaminants includes organics, metals, inorganics, asbestos and solvents
Depot and Motorway Maintenance Compound	6	Located off-site to the north-east of the asset. Contaminants include organics, metals, solvents and inorganics
Gravel Pit	7	Located off-site to the northwest of the asset. Potential contaminants include metals, organics, sulphates, asbestos and ground gases
Brackenlands Farm Landfill	8	Located off-site to the south-west of the asset. Potential contaminants include organics, metals, asbestos, sulphates and herbicides, pesticides and ground gas

Figure 3: Location of potential contaminant sources at Pool Wood Embankment



Source materials

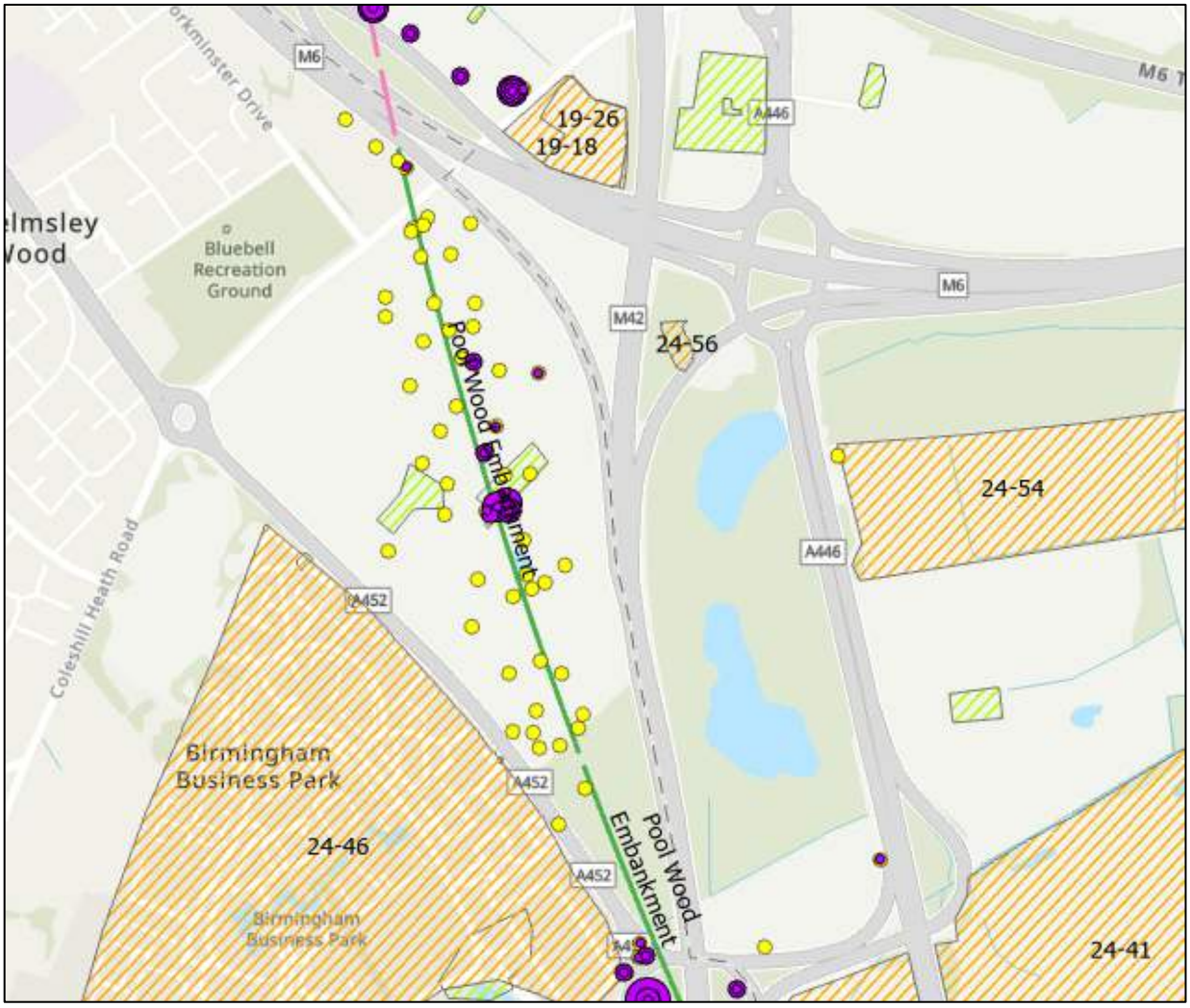
Any location that contains Made Ground or suspected Made Ground that has either identified contaminants through sample analysis or not will remain a potential source of contaminant exposure. Table 2 and Figure 4 summarise the source locations where Made Ground has been encountered during various phases of ground investigation.

Table 2: Detail on specific exploratory hole locations where visual/olfactory evidence of contamination has been identified

Hole ID	Top (m bgl)	Base (m bgl)	Geological Formation	Description
ML159-CR018	3.3	4	Made Ground	Dense, orangish brown, clayey, fine and medium SAND and angular to subrounded, fine to coarse GRAVEL of sandstone, quartzite and roadstone. Strong odour (undefined).
ML159-TP015	1.1	1.8	Glaciofluvial Deposits	Dark brown, mottled black, very gravelly, fine and medium SAND with low cobble content and decomposing organic odour (undefined). Gravel is subrounded and rounded, medium and coarse of quartzite. Cobbles are subrounded and rounded of quartzite.
ML159-TP015	1.8	2.1	Glacial Till	Firm and stiff, friable, dark brown mottled black, slightly sandy, very gravelly CLAY with moderate organic odour (undefined). Gravel is subrounded and rounded, medium and coarse of quartzite.
ML159-CP003	0	1.10	Made Ground	Turf over dark brown slightly gravelly clayey fine to coarse SAND. Gravel is angular to subrounded fine to coarse of mixed lithologies

				including flint and quartzite with occasional glass, metal, pottery fragments, ash, slag, brick, rope plastic wood
ML159-CP403	0.7	5.3	Made Ground	Dark brown to black sandy subangular to subrounded fine to coarse gravel sized fragments of brick, glass, sandstone, wood and quartzite. Sand sized fragments are fine to coarse of ash.
ML159-CP403	5.3	5.65	Made Ground	Dark grey to black slightly gravelly sandy clay. Sand is fine to coarse. Gravel is angular to subangular fine to medium of sandstone and siltstone. Slight sewage odour
ML159-CP405	0	0.20	Made Ground	Black sandy angular to subangular fine to medium gravel sized fragments of bituminous material. Sand sized fragments are fine to coarse of bituminous material.
ML158-WS015	0	0.20	Made Ground	Firm dark brown sandy very gravelly SILT. Sand is fine to medium. Gravel is angular to rounded fine to coarse of mixed lithologies including flint, quartzite, slag and charcoal.

Figure 3: Location of Made Ground (purple spots) identified at Pool Wood Embankment



Reported contaminants

A range of soil, leachate, and groundwater samples have been collected from the asset and submitted for laboratory analysis. Ground gas monitoring has also been undertaken across the asset. A summary of the main contaminants identified during previous assessment is as follows:

- Soil lead and nickel above PoS Park and commercial acceptable criteria at ML159-CP403 ranging from 3 to 4mbgl (see Figure 4).
- Using semi-quantitative methods, moderate (between 100 and <1000mg/kg) soil total petroleum hydrocarbons (aliphatic and aromatic) were reported at multiple locations primarily in Made Ground ranging from approximately 0.05 to 4.0mbgl (see Figure 5).
- Soil leachate (copper, hexavalent chromium, cadmium, nickel, chromium III, arsenic, and zinc) were reported above water quality standards at multiple locations primarily in Made ground from 0.05 to 5mbgl (see Figure 5).
- Groundwater determinands (range of inorganics, metals, and hydrocarbons) were reported above water quality standards at multiple locations in wells screened across superficial, bedrock and Made Ground deposits (see Figure 6).

- Several rounds of ground gas monitoring have been undertaken at five exploratory holes located within and close to the asset footprint. Maximum carbon dioxide, methane, carbon monoxide and hydrogen sulphide concentrations were 4.3%v/v, 0.8%v/v, 2ppm and 0ppm respectively. Comparison with the Health and Safety Executive Occupational Exposure Limits (OEL) indicated that carbon dioxide concentrations were above the short (1.5%v/v) and long term (0.5%v/v) OEL (see Figure 7).

Figure 4: Location of soil lead and nickel exceedances above human health assessment criteria at Pool Wood Embankment

Figure 5: Location of moderate soil petroleum hydrocarbons and leachate exceedances recorded at Pool Wood Embankment

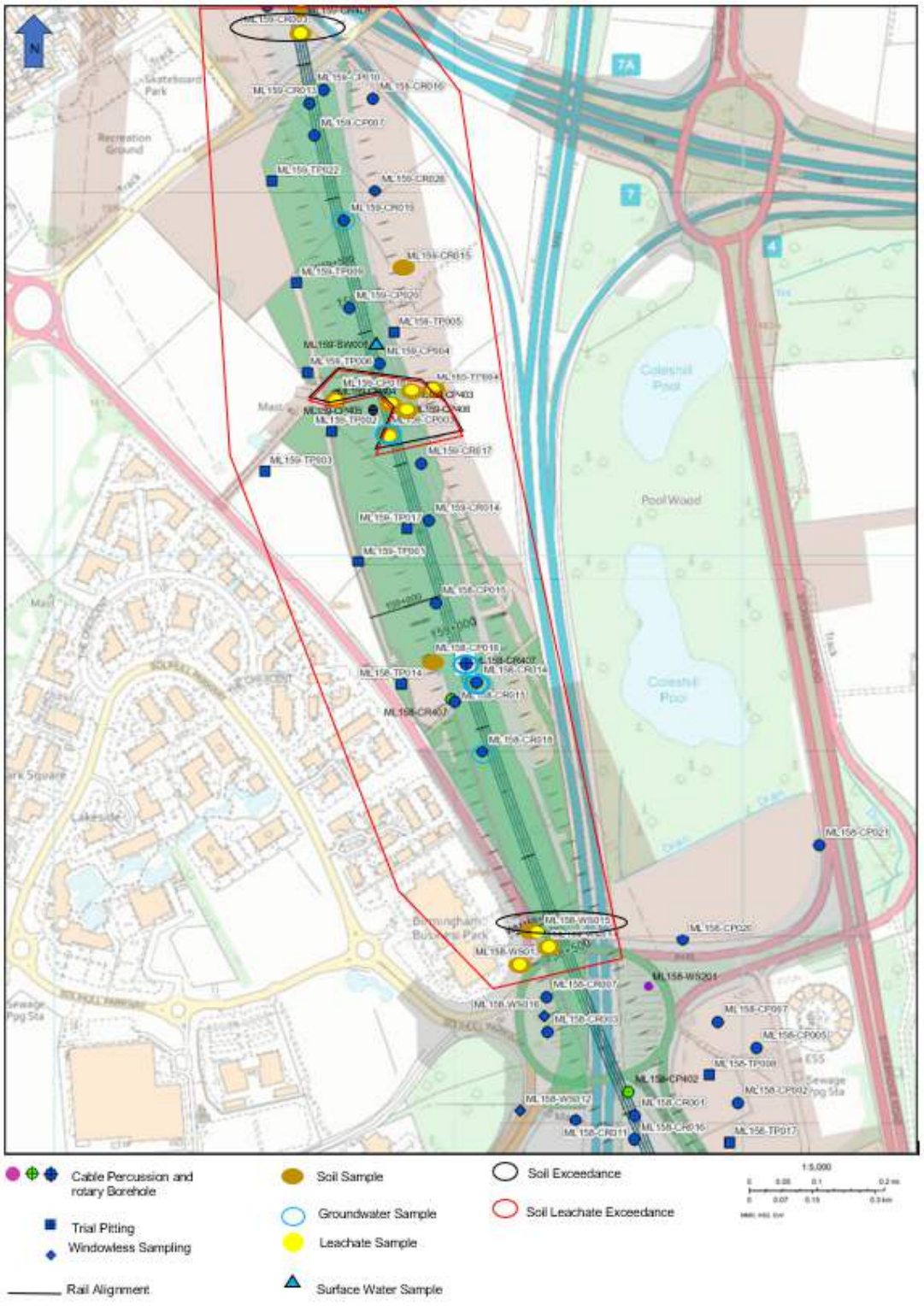


Figure 6: Location of groundwater exceedances above water quality standards at Pool Wood Embankment

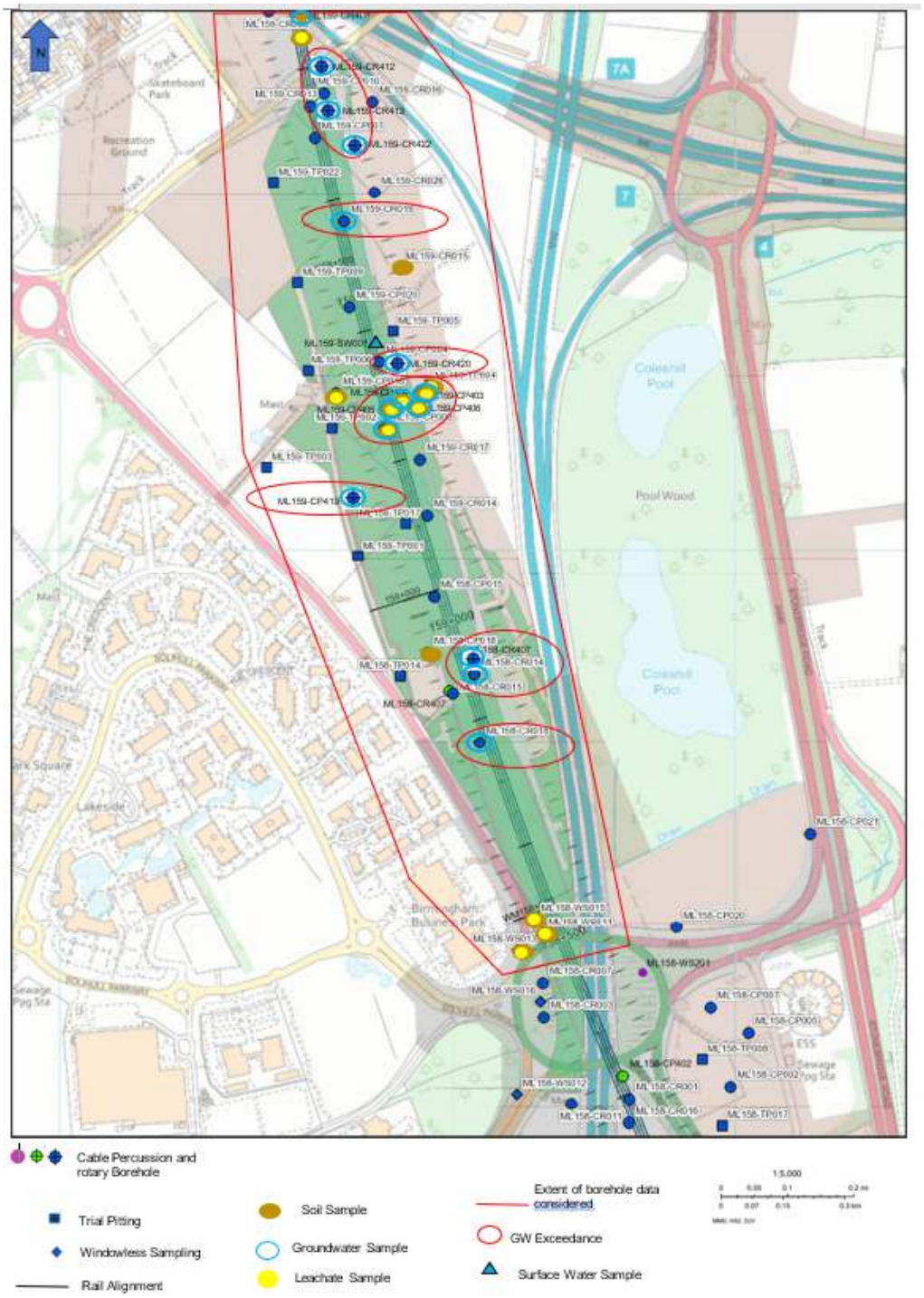


Figure 7: Location of ground gas monitoring locations at Pool Wood Embankment

Note: Estimated AoC shown by the red polygon

Construction Design Management (CDM)

The potential risks to Contractors have been documented in an online CDM risk database (Safetibase) which identifies the hazard, risk, and design mitigation measures. From a land quality perspective, the main risks are associated with the following CDM risk entries:

- Exposure to Made Ground or similar materials containing contaminants exceedances and/or the potential for contaminant exceedances.
- Exposure to dusts associated with Made Ground or similar materials containing contaminants exceedances and/or the potential for contaminant exceedances.
- Exposure to ground gases originating from the decay of organic material.

- Exposure to asbestos or asbestos containing materials. It should be noted that chrysotile (0.0011%) was reported at ML158-WS016 in Made Ground. However, this sample location is located to the south and outside the area of ground investigation.

In all cases, it is the responsibility of BBV, and its Contractors managing and directly involved in ground investigation works to ensure that all works are undertaken in accordance with the appropriate standards/guidance and that risk assessments and methods statements have been prepared, approved, circulated, and communicated to all appropriate parties in advance of ground works. The reader is encouraged to review the "Pool Wood Embankment – Land Quality Management Report", November 2024 (1MC09-BBV_MSD-EV-REP-NS04_NL10-100218) report for more detailed information. Similarly, the reader should review the CDM risk entries specific to PWE contained in Safetibase.

4.3.1.6. Notifiable or invasive weeds

No Invasive Non-Native Species (INNS) (including giant hogweed or Japanese) are anticipated at or near to the asset. If any INNS encountered during ground works should be managed and removed in accordance with the Enabling Works Contractor (EWC) biosecurity Invasive Non-Native Species (INNS) Plan.

4.3.1.7. Access restrictions

The Contractor responsible for managing and completing the ground investigation will be required to fully assess the accessibility of proposed/existing exploratory holes and advise in a timely manner how access will be achieved, if there are constraints, and present the associated method of works for the review and acceptance by the Investigation Supervisor. The following is brought to the Contractor's attention:

- As most of the asset has been used for agricultural purposes, soft ground may be encountered.
- Vegetation clearance might be needed at some of the exploratory hole locations.
- The asset has been subject to enabling works and some earthworks which may restrict access to some exploratory holes location from a physical, and programme perspective.
- The citing of exploratory holes should allow for potential restrictions and changes in work activities that may be experienced over the lifetime of the project i.e., during enabling, construction works and post construction). Restrictions will need to consider the ground investigation and subsequent monitoring/sampling programme phases of the project.
- If undertaking ground investigation and monitoring where access to third party and/or private land is required, permissions and agreements will be required in advance of ground works.

4.3.1.8. Unexploded ordnance

A review of the regional Unexploded Bomb (UXB) Risk Map contained in the Zetica UXO Desk Study, indicated the asset to be located within a 'Low' risk area from unexploded ordnance. Low risk areas are defined as "Tolerable to the client as engineering activity need not alter if UXO related procedures and controls are strictly adhered to". Any works undertaken at the asset must be undertaken following UXO guidance measures and include a UXO awareness briefing before ground works are commenced.

4.3.1.9. Pre-construction information required by CDM (2015)

The Investigation Supervisor is to provide Design Risk Registers, Pre-Construction, Permit to Dig and all other pertinent documentation that will ensure the safe execution of the ground investigation and monitoring programme. The Permit to Dig is to be formulated and managed by a suitably qualified person within BBV.

4.4 Main works proposed and purpose of this Contract

The main construction works proposed at the asset is an embankment to support the main alignment (trace) and a landscape bund to the adjacent west of the alignment embankment to provide a visual and noise screening barrier. This Contract is to target ground investigation (including long-term monitoring and sampling) at and near landscape bund located at PWE. The scope of the ground investigation works is detailed in Section 5.5.

The main purpose of the ground investigation and monitoring/sampling programme will be to provide geoenvironmental information to enable the safe and cost-effective design and construction of the landscape bund, specifically associated with the reuse and placement of MBL sourced material in a large section of the bund. The ground investigation and subsequent monitoring shall focus primarily on the groundwater and surface water quality, as follows:

- Allow the establishment of a robust groundwater monitoring network (using existing and new installations) that will be present for the duration of the scheme (pre, during and post construction).
- To characterise the pre-construction baseline contamination status of the area, to provide a dataset against which future variations in groundwater quality may be determined.
- Allow for the installation of additional strategically positioned groundwater monitoring wells in the Glaciofluvial Deposits underlying the site. In relative terms these deposits are deemed more productive than the other units in the area and likely to be the main transport mechanism for contaminants and more likely to be hydraulically connected with sensitive receptors
- The collection of groundwater and surface water samples to establish background water quality conditions and monitor the effects (if any) on water quality associated with the placement of MBL sourced materials in the landscape bund.
- Provide supplementary information on the hydrogeological regime, e.g., groundwater/surface water levels, connectivity, flow, and seasonal variations at and around the asset.
- Provide supplementary information on the description and classification of the superficial and bedrock deposits at and around the asset.
- Provide further information on the nature, thickness, and distribution of the geological deposits across and around the asset footprint.
- The information will be used to inform assessment work to support the production of a Waste Recovery Plan, allow assessment on the potential effects on water quality (if any) and provide a long term and robust data set to support the future surrender to the Permit for Waste Recovery

4.5 Scope of investigation

The ground investigation and subsequent monitoring/sampling programme should be undertaken in three primary phases as described below.

4.5.1.1. Phase 1 – land based non-intrusive mapping

The position and the nature of any services (above and below ground) at or near the proposed exploratory hole locations shall be identified as accurately as possible by means of a utility survey or review of existing plans by the Contractor. This should include obtaining utility records, working with the utility provider as needed and completing geophysical surveys. Utility plans held on iSpatial for the asset are presented in Appendix A.

Once plans have been reviewed a PAS128 Type B2 survey should be completed to inform the Permit to Dig and signed off by the Contractor prior to ground works.

The Contractor should confirm that access and the serviceability of the proposed and existing exploratory holes will not be constrained/compromised during and following the life of the development programme, i.e., pre, during and post construction.

The Contractor will ensure that the appropriate agreements are in place should access be required to third party lands not under the control or ownership of HS2 to access and/or cite exploratory holes.

Any constraints associated with utility and/or programme conflicts should be reported back to the Investigation Supervisor, to advise on alternative exploratory hole positioning.

4.5.1.2. Phase 2 – intrusive ground investigation exploratory holes

The information gathered from the land based (non-intrusive) mapping should enable confirmation of the intrusive ground investigation exploratory hole locations in this report. The information obtained from Phase 1 survey may result in the repositioning of exploratory holes. As indicated, any repositioning will need to be confirmed by the Investigation Supervisor.

Inspection pits shall be undertaken at each exploratory hole formed as an additional precaution against possible service strikes. The information obtained from these inspection pits may result in the repositioning of exploratory holes, which shall be agreed with the Investigation Supervisor. Given the nature of ground conditions and depths to the underlying Glaciofluvial Deposits it is envisaged that cable percussive drilling methods will be adopted. As shown in Appendix A, on the assumption that the existing groundwater monitoring well identified as ML158-CP419 remains part of the network, it is proposed that an additional ten boreholes (identified as ML159-CP603, CP604, CP607 to CP610, CP613, CP616, CP619 and CP620) completed as groundwater monitoring wells will be installed at and near to the asset. If there are constraints associated with the use of existing monitoring wells this should be communicated to the Investigation Supervisor to agree on the use of alternative wells or the need to drill additional wells to maintain network coverage.

It should be noted that seventeen of the boreholes will be completed at the nearest opportunity. A second point of note, it will be the responsibility of the Contractor to ensure that the existing and newly installed monitoring wells are visible and will be protected for the duration of the programme. These protection measures shall ensure that accidental or intentional removal of standpipes does not occur. Placement of concrete manhole rings around standpipes along with warning signage shall be employed where access permits.

Although details on the ground investigation activities and follow-on monitoring programme are included in the body of this report, a summary of the key design elements is presented as a Schedule 2 in Appendix B.

The Contractor shall be responsible for all temporary works, if any required. Where the Contractor is designing any part of the temporary works, the Investigation Supervisor shall review and comment where required.

As an overview the Contractor will undertake the following works as part of Phase 2. Specific details are provided from Section 4.7 an onwards.

- Boreholes completed as monitoring wells with screens (single installations) designed to isolate the Glaciofluvial Deposits from the other overlying and underlying deposits.
- Soil sampling, screening, and logging.
- Groundwater and surface water elevations
- Groundwater and surface water sampling.
- Submission of samples for laboratory analysis.
- Capturing the results in a Factual Ground Investigation Report to include methods, exploratory locations, exploratory hole logs, field monitoring and laboratory analytical results. Borehole and laboratory data should also be provided in electronic and AGS format.

4.5.1.3. Phase 3 – monitoring and sampling programme

On completion of the ground investigation, the Contractor will engage in a long-term monitoring programme to generate a robust water quality dataset. This will also include the collection of surface water samples from one existing (ML158-SW601) and four new (ML159-SW601, SW602, SW605 and SW606) locations. Commentary on the frequency and duration of the programme is provided in this report and will be managed by the Investigation Supervisor. Monitoring will commence immediately following the installation of groundwater monitoring wells and extend beyond the construction of the asset. As data becomes available for review and once regulatory agreements are in place, the Investigation Supervisor will provide direction on the duration of monitoring.

As an overview the Contractor will undertake the following works as part of Phase 3. Specific details are provided from Section 4.7 and onwards.

- On a routine basis monitor groundwater and surface water elevations at existing and newly installed monitoring wells and designated surface water locations.
- During monitoring collect groundwater and surface water samples
- Submission of water samples for laboratory analysis
- Provision of monitoring and analytical results to the Investigation Supervisor to compile and manage for review and assessment purposes. Data should be provided in a report format and electronically.

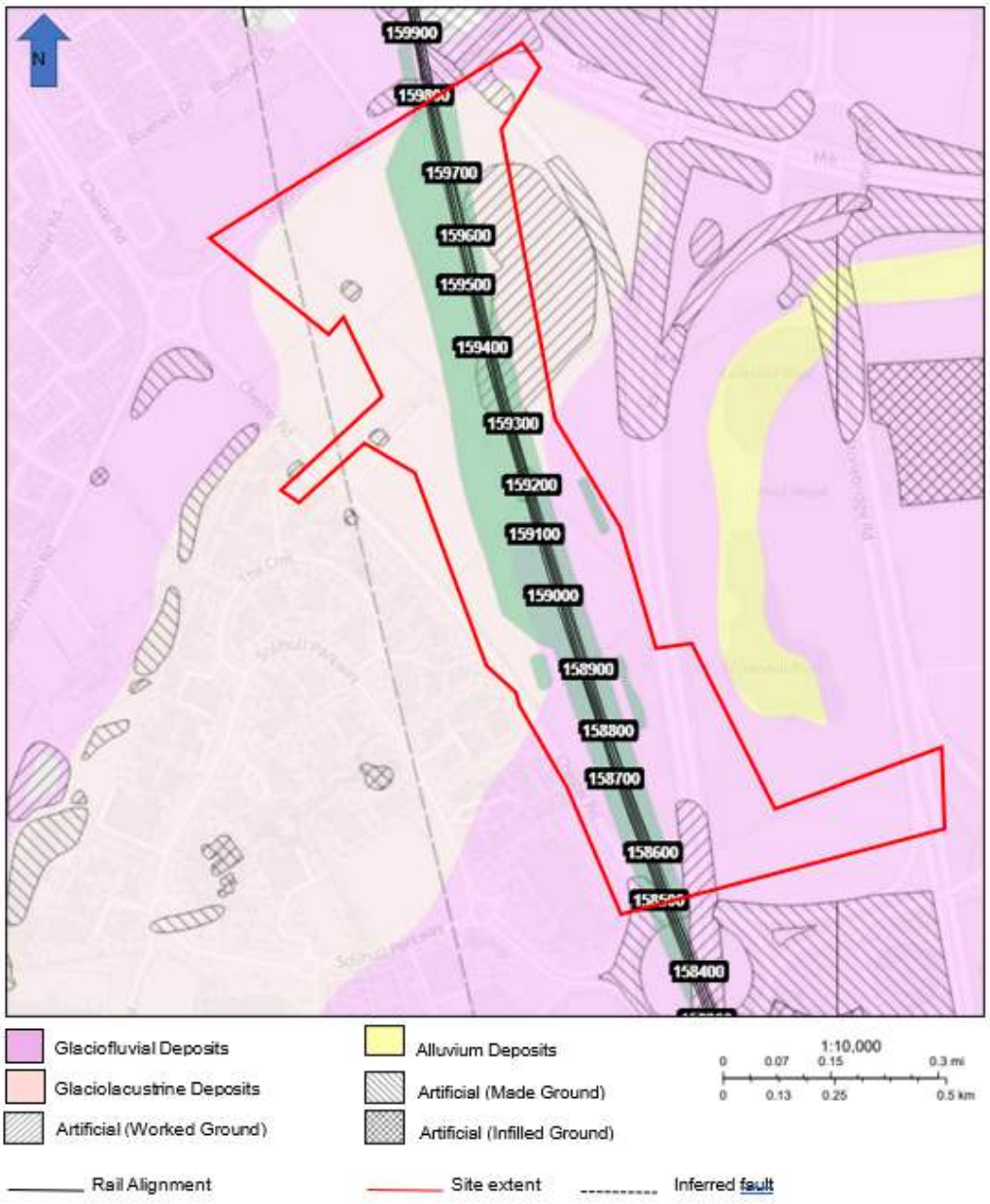
4.6 Baseline conditions

4.6.1.1. Geology

British Geological Survey records indicate that the asset and local area is underlain by Glaciolacusterine Deposits from the approximate centre to the northern boundary of the asset (between Ch 159+125 to 159+750), which are in turn underlain by Glaciofluvial Deposits, likely to be present beneath the whole asset. Alluvial deposits are present about 200m to the east of the asset.

The superficial deposits are underlain by the bedrock geology of the Mercia Mudstone Group. Figure 8 shows the location of asset geology.

Figure 8: Location of Superficial Geology at Pool Wood Embankment

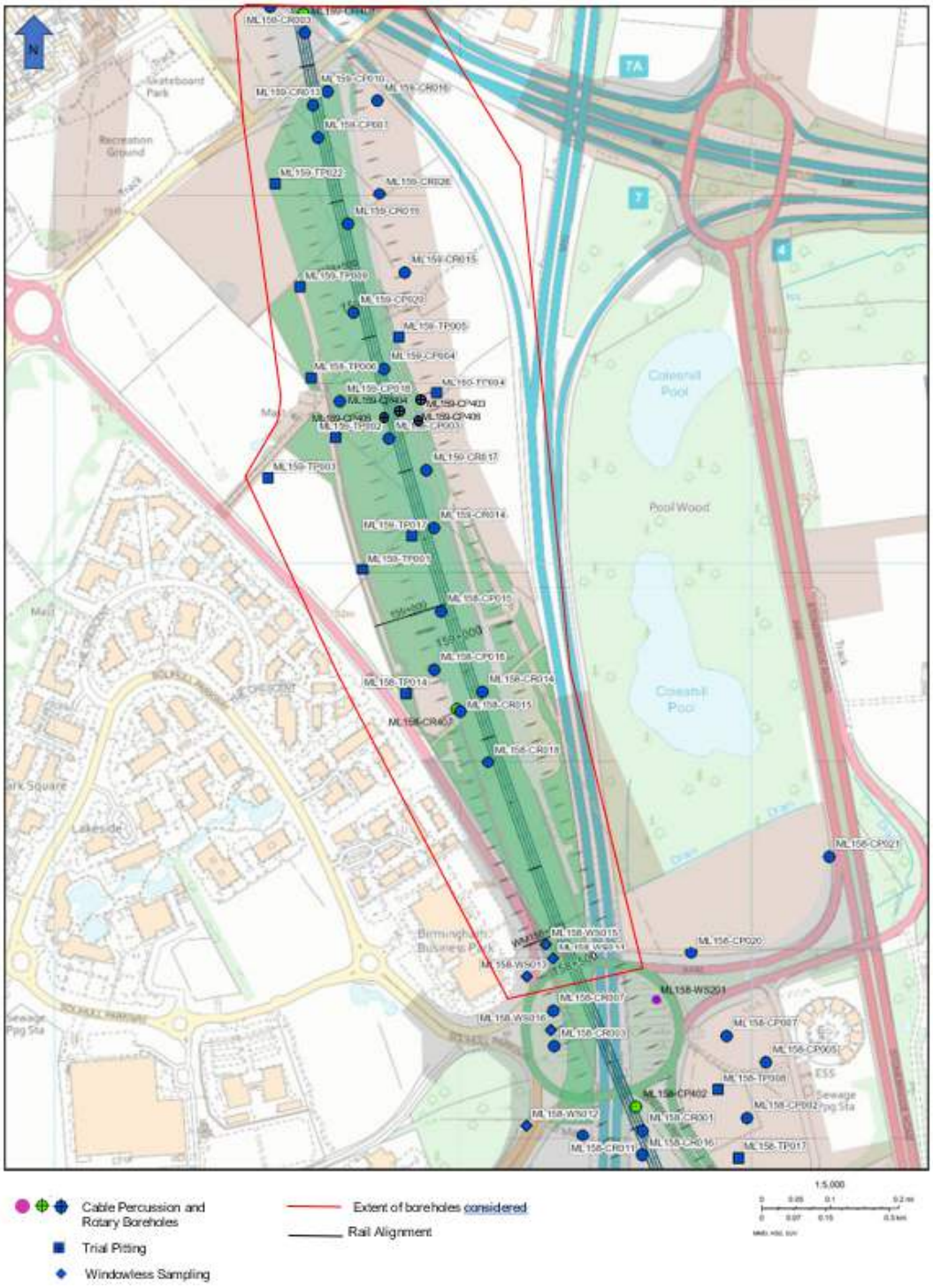


The asset has been subject to various phases of ground investigation. A summary of the ground conditions encountered during the previous ground investigations is presented in Table 1. The location of exploratory holes completed during the ground investigations are shown in Figure 9.

Table 1: Encountered geology at and in the vicinity of the asset

Strata	Distribution	Typical depth range (m bgl)	Description
Topsoil	Encountered across the asset at all exploratory locations (see Figure 10)	0 to 0.50	Mixture of granular and cohesive. Mostly recorded as agriculturally reworked deposits. Generally recorded as clay or sand.
Made Ground	ML158-WS013, ML158-WS014 ML159-CP004, ML159-CP003 ML158-WS013, ML159-CR003 ML159-TP005, ML158-WS015 ML159-CP403, ML159-CP404 ML159-CP405, ML159-CP406 (encountered at the southern and northern boundary and the centre of the asset)	0 to 5.65	Mixture of granular and cohesive materials. Mostly described as sand and gravel and clay. Gravel includes ash, flint, brick, concrete, glass, and charcoal
Glaciolacustrine Deposits	ML159-CP018, ML159-CP004 ML159-CR014, ML159-CR015 ML159-CR019, ML159-CP403 ML159-CP405, ML159-CP406 (encountered in the centre and northern part of the asset)	0.20 to 9.50	Mostly cohesive described as sandy silty or sandy clay.
Glaciofluvial Deposits	Encountered across the asset at all exploratory locations (see Figure 10)	0 to 12.60	Mixture of granular and cohesive. Granular materials mostly described as fine to coarse sand and cohesive as sandy clay.
Weathered Mercia Mudstone Group (Grade III/IV)	Encountered across the asset at all exploratory locations (see Figure 10)	0.50 to 15.00	Very high strength reddish orange, brown silty CLAY
Unweathered Mercia Mudstone Group (Grade I/II)	Encountered across the asset at all exploratory locations (see Figure 10)	8.61 to 35.60 (depth not proven)	Very weak, medium to thickly bedded, reddish brown MUDSTONE. Bedding is horizontal, undulating, smooth and clean

Figure 9: Location of exploratory holes at Pool Wood Embankment



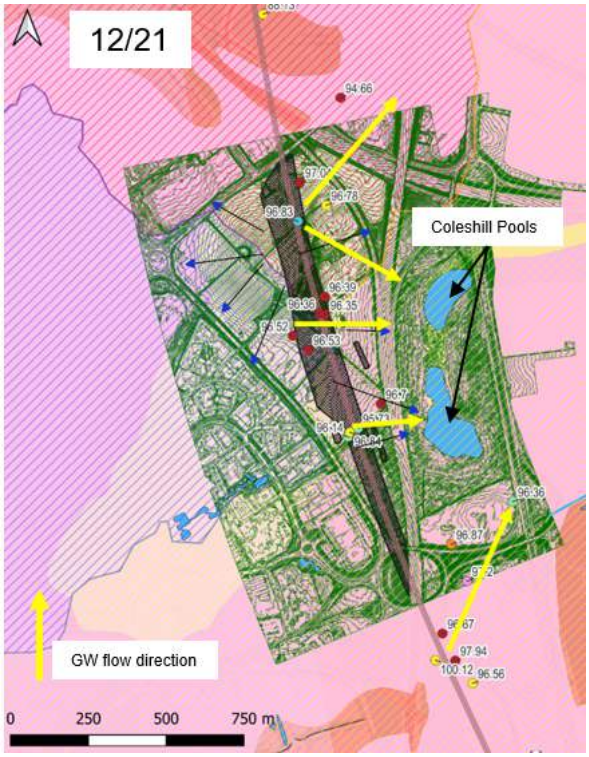
4.6.1.2. Hydrogeology

Published Environment Agency records describe the aquifer characteristics associated with the geological units as follows:

- Glaciofluvial and Alluvial deposits – Secondary A aquifers, which contain permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers.
- Glaciolacustrine deposit – Non-productive.
- Mercia Mudstone Group – Secondary B aquifer, which contain predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering.

The monitoring wells located at and near the asset have been subject to groundwater monitoring between 2016 and 2022. Groundwater elevations between this period ranged from approximately 86 to 103mAoD. Based on long-term monitoring data, the dominant groundwater flow direction is anticipated to be easterly as shown in Figure 10.

Figure 10: Groundwater flow directions recorded at and near Pool Wood Embankment (Dec 2021)



4.6.1.3. Hydrology

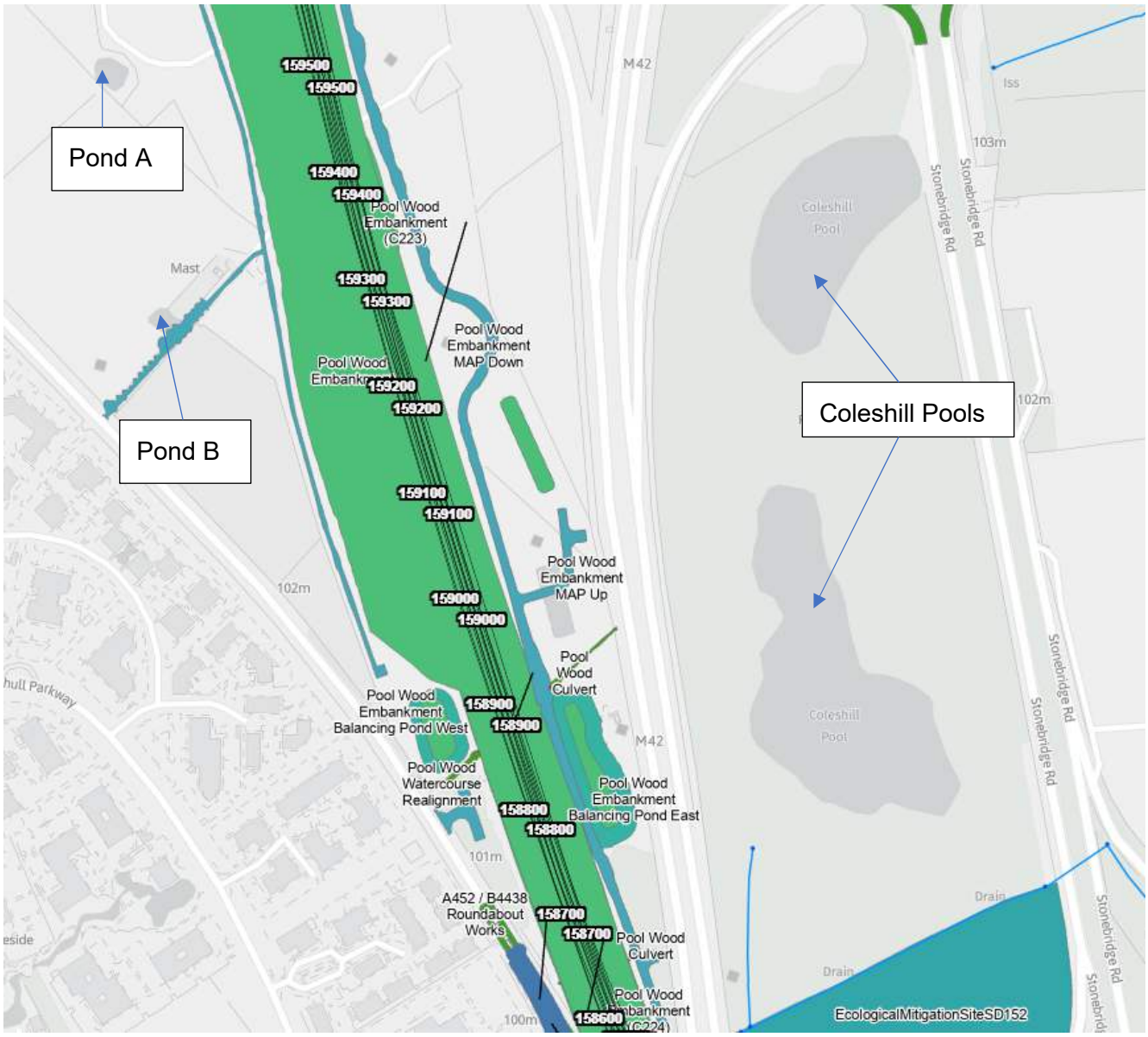
Several surface water features at located at and near to the asset, these features are listed below and shown in Figure 11.

- Land drains to the east of the asset, nearest ~630m. The drains flow easterly, eventually discharging into River Blyth.
- Two small surface water/runoff fed two ponds (A and B) located ~90 and 200m west of the asset.
- Coleshill/Bannerly Pools, Sites of Special Scientific Interest, located ~350m east of the asset. The pools are groundwater dependent terrestrial ecosystems (alluvium and GFD). Assessment indicates that due to the presence of Glaciolacusterine Deposits the asset is not

considered a major recharge area, although some runoff (recharge)/infiltration into the Glaciofluvial Deposits at the margins of the Glaciolacusterine Deposits is possible.

- Assessment indicates that surface runoff from the site is unlikely to discharge into the Pools.

Figure 11: Surface water features located at and near Pool Wood Embankment



4.7 Schedule of drawings and documents

4.7.1.1. Documents

- Zetica, “Unexploded Ordnance Desk Study”, (0615-ZET-GT-REP-000-000001).
- HS2/BBV Contract No. 1MC13, “Pool Wood Embankment Land Quality Management Report”, March 2022 (1MC09-BBV_MSD-EV-REP-NS04_NL10-100218)

- HS2 Schedule 1 Specification for Ground Investigation, October 2014 (HS2-HS2-GT-SPE-000-00001)
- Schedule 2, presented in Appendix B.

4.7.1.2. Drawings

- Exploratory Hole Location Plan (Appendix A).

4.8 General requirements (Specification Section 3). Particular restrictions/relaxations

4.8.1.1. Quality management system (S1.8.1 & Clause 3.3)

As specified.

4.8.1.2. Professional Attendance (S1.8.2 & Clause 3.5.2)

As specified.

The requirement for professional attendance to be provided by the Contractor are indicated in Table S1.8.2. It is anticipated that on-site staff duties shall primarily relate to the operations indicated in Table 2, however, in cases where these operations do not require a full-time role, they shall also undertake other duties as appropriate.

Table 2: Requirements for Professional Attendance

Category	Operation	Personnel Required	Qualification
1	Office-based Engineer during the mobilisation period for preparation of the necessary documents for BBV approval prior to commencement of fieldwork. During the life-time of the Contract, the Contractor shall maintain its presence in BBV offices on an ad hoc basis to attend meetings as required by the BBV delivery team for ground investigation.	1 No.	Engineering Geologist or Geotechnical Engineer with appropriate post-graduate experience.
2	Technical superintendence and agent on site for the duration of the Contract with responsibility for the Contractor's on-site co-ordination of Permissions and Access, Environmental Management, Environmental Consents and Community Liaison [excluding liaison with land-owners].	1 No. Minimum	Engineering Geologist or Geotechnical Engineer with appropriate post-graduate experience in geotechnical and contaminated land investigations. Relevant experience in the environmental disciplines included within the accepted Environmental Management Plan. Appropriately experienced with proven communication and/or community relations skills. Reporting to BBV's Head of Engagement.

Category	Operation	Personnel Required	Qualification
3	Health and safety co-ordinator for the duration of the site operations, including responsibility for utilities coordination.	1 No. Minimum	Appropriately experienced and trained full time staff member with proven communication skills, and who shall have a prescribed qualification under the New Road and Street Works Act 1991.
4	Sampling and logging Supervisor to ensure technical consistency and accuracy for chemical sampling, preservation, storage, dispatching and in-situ testing, and logs of boreholes.	1 No.	Engineering Geologist and/or Environmental scientist/hydrogeologist as applicable with appropriate post-graduate experience.
5	Supervision of operating rig including sampling and logging as required (in addition to staff provided in 2, 3, 4 and 6).	Each professional to supervise no more than two operating rigs on the same site or one pitting operation at any one time.	Graduate Engineer with appropriate post-graduate geotechnical experience.
6	Chemical sampling of boring operations and on-site analysis (in addition to staff provided in 2, 3, 4 and 6).	Each professional to undertake sampling at one site of no more than two operating rigs or one pitting operation at any one time.	Graduate environmental scientist(s)/hydrogeologist(s) with appropriate post-graduate chemical field sampling experience.
7	Nominated Database Manager.	1 No.	Graduate engineer/scientist or Assistant engineer/scientist with appropriate post-graduate experience.

4.8.1.3. Provision of ground practitioners and other personnel (S1.8.3, Clause 3.6.1 & Clause 3.6.2)

As specified.

4.8.1.4. Hazardous ground, land affected by contamination and notifiable and invasive weeds (S1.8.4, Clause 3.7.1 & Clause 3.22)

As specified.

Land affected by contamination as detailed in Section 5.3. All site works are to be planned and undertaken in accordance with the Guidance for Safe Intrusive Activities on Contaminated or Potentially Contaminated Land (British Drilling Association, 2008).

No invasive species were identified during previous assessments as detailed in Section 5.3.

4.8.1.5. Additional information on services not shown on Contract drawings (S1.8.5 & Clause 3.7.2)

As specified.

All plans to be obtained and reviewed by the Contractor in advance of ground investigation works. Constraints to be communicated with the Investigation Supervisor to agree on alternative locations. The Contractor is to conduct PAS128 Type B2 survey prior to ground investigation to confirm location of above and underground utilities. The latest Type C plans are located within iSpatial and presented in Appendix A.

4.8.1.6. Known/suspected mine workings, mineral extractions etc. (S1.8.6 & Clause 3.7.3)

The asset does not appear to have been subject to surface mining and/or located in a Mineral Safeguarding Area. There is a Land Quality site ("Former Brick works with kiln and infilled pond") located around Ch.159+300 and an area of infilled ground (artificial deposit) located to the adjacent east of the asset between approximate Ch. 159+300 and 159+700. The Contractor should take the appropriate measures to ensure the safe execution if completing ground investigation and sampling in these areas. Further details on the locations of these features are included in the HS2/BBV Contract No. 1MC13, "Pool Wood Embankment Land Quality Management Report", November 2024 (1MC09-BBV_MSD-EV-REP-NS04_NL10-100218).

4.8.1.7. Protected species (S1.8.7 & Clause 3.7.4)

None identified.

4.8.1.8. Archaeological remains (S1.8.8 & Clause 3.7.5)

None identified.

4.8.1.9. Security of site (S1.8.9 & Clause 3.11)

As specified.

The Contractor shall ensure that all equipment, plant, and materials left onsite, when unattended, are secure and all plant are immobilised.

4.8.1.10. Traffic management measures (S1.8.10 & Clause 3.12)

As specified.

As part of the Phase 1 element of works, the Contractor is to ensure all measures are in place to ensure safe access and that any required measures to accommodate constraints are also in place in advance of ground investigation and monitoring for the duration of the programme.

4.8.1.11. Restricted working hours (S1.8.11 & Clause 3.13)

Restrictions on working hours shall be agreed prior to commencement on site; it is currently assumed these hours shall be 8.00 a.m. to 6.00 p.m., Monday to Friday for all works.

4.8.1.12. Trainee site operatives (S1.8.12 & Clause 3.14.1)

As specified.

4.8.1.13. Contamination avoidance and/or aquifer protection measures required (S1.8.13, Clause 3.15.2 & Clause 3.15.3)

On the assumption that the asset has a BDA YELLOW (and RED when working in the former brickworks area) classification, aquifer protection measures would be required when completing ground investigation, specifically where boreholes will be drilled through low permeability deposits into underlying Glaciofluvial Secondary A aquifer deposits.

Should unexpected ground conditions be encountered during site works, such as gross contamination and the presence of cohesive geology providing a low permeability layer (as is the case with the presence of Glaciolacusterine Deposits at the asset) to retard the downward natural migration of contamination, then further aquifer protection measures may be required. This is to minimise the creation of new pathways for the downward migration of contamination into an underlying aquifer.

Measures to prevent cross contamination can include the use of dual casing and sealing casing with bentonite when at the interface between the low permeability and higher permeability geological units.

To prevent cross contamination during drilling, vegetable-based oils shall be used to lubricate drilling equipment (e.g., casing and drill stems) coming into contact with the ground and groundwater. The Contractor shall provide samples of the vegetable oils for analysis.

The purging or pumping of groundwater from boreholes and standpipes is exempt from permitting if the volume is <20 m^3 per day. The Environment Agency will allow such water to be discharged to the ground adjacent to the borehole or standpipe. If any potentially contaminated groundwater is to be purged, then this will need to be collected at the point of discharge from the ground into a suitable container and disposed of under a Discharge Consent or transferred to a licenced waste management facility.

Records of all permits, consents and water disposed of, are required.

4.8.1.14. Maximum period for boring, pitting or trenching through hard material, hard stratum or obstruction (S1.8.14, Clauses 2.8,4.3 & 6.4)

As specified.

As indicated in Section 5.5, the suggested method of drilling is cable percussion. As the geology indicates the presence of cohesive Glaciolacusterine and Glaciofluvial superficial deposits with holes terminating at the superficial/bedrock interface, obstructions are not anticipated.

4.8.1.15. Reinstatement requirements (S1.8.15 & Clause 3.16)

As specified.

On completion of works all fieldwork locations shall be fully re-instated to their original condition to the satisfaction of the Investigation Supervisor. Any breaking out of hardcover (including any disturbance and disruption) shall be kept to the minimum.

As there is a need to maintain access and serviceability to the monitoring well network, it is advised that protection (e.g., fencing, barriers/guard) are installed to prevent damage and future access restrictions.

4.8.1.16. Hygiene facilities required (S1.8.16 & Clauses 2.20 and 3.16.1)

As specified.

4.8.1.17. Unavoidable damage to be reinstated by Contractor (S1.8.17 & Clause 3.16.1)

As specified.

If using 3rd party lands for access or citing exploratory holes, the Contractor should ensure that all reasonable conditions imposed by the landowner are addressed.

4.8.1.18. Accuracy of exploratory hole locations (S1.8.18, Clause 3.19 & 3.20)

As specified.

The Contractor shall capture HS2 Snakegrid and National OS Grid coordinates after hole completion to a horizontal and vertically accuracy of +/- 0.1m.

4.8.1.19. Photography requirements (S1.8.19 & Clause 3.25)

As specified.

4.8.1.20. Rail Management and Safety

As specified.

Any Contractor carrying out work on Network Rail infrastructure shall have all appropriate documentation from the respective infrastructure controller approving the work on their infrastructure. The Contractor, as the approved competent authority, shall be solely responsible for ensuring that he complies with all relevant standards, processes and guidance when working on Network Rail infrastructure.

4.9 Percussion Boring (Specification Section 4). Particular restrictions/relaxations

4.9.1.1. Permitted methods and restrictions (S1.9.1 & Clauses 4.1 to 4.4)

As specified.

4.9.1.2. Backfilling (S1.9.2 & Clause 4.5)

As specified.

4.9.1.3. Dynamic sampling (S1.9.3 & Clause 4.6)

As specified.

Access constraints are not envisaged, therefore cable percussive drilling (shell and auger) methods are anticipated, however the Contractor may choose to use window sampling drilling methods if they can ensure that the design depths can be reached, i.e., wells can be installed and screened within the Glaciofluvial Deposits. Details of anticipated geology are shown in Table 1. Schedule 2 provides a target drill depth (10mbgl) for installation in the Glaciofluvial Deposits; however, it is the responsibility of the Contractor to ensure that all boreholes reach the base of the Glaciofluvial Deposits even if a greater or shallower drill depth is required. This would be especially the case for post construction drilling in the landscape bund when targeting the base of the fill material (top of the drainage blanket) that may be up to 14 metres below the surface of the bund.

4.10 Rotary drilling (Specification Section 5). Particular restrictions/relaxations

Based on ground conditions the use of rotary, rotary follow-on and/or open hole (with casing) drilling methods is not envisaged. On this basis Schedule S1.10.1 to S1.10.13 and the associated clauses are not applicable.

4.11 Pitting and trenching (Specification Section 6). Particular restrictions/relaxations

Based on the requirement to install groundwater monitoring wells the use of pitting methods is not anticipated. On this basis Schedule S1.11.1 to S1.11.9 and the associated clauses are not applicable.

4.12 Sampling and monitoring during intrusive investigation (Specification Section 7) Particular restrictions/relaxations

4.12.1.1. Address for delivery of selected geotechnical samples (S1.12.1 & Clause 7.6.1)

Not required.

4.12.1.2. Retention and disposal of geotechnical samples (S1.12.2 & Clause 7.6.2)

Not required.

4.12.1.3. Frequency of sampling for geotechnical purposes (S1.12.3 & Clauses 7.6.3-7.6.11)

Not required.

4.12.1.4. Open-tube and piston sample diameters (S1.12.4 & Clause 7.6.5)

Not required.

4.12.1.5. Retention of cutting shoe samples (S1.12.5 & Clause 7.6.5)

Not required.

4.12.1.6. Delft and Mostap sampling (S1.12.6 & Clause 7.6.12)

Not required.

4.12.1.7. Groundwater level measurements during exploratory hole construction (S1.12.7 & Clause 7.7)

As specified.

During the advancement of boreholes, if encountered the depth of water strikes and the water levels at 20 minutes (rise level) are to be recorded and included on borehole logs.

4.12.1.8. Special geotechnical sampling (S1.12.8 & Clause 7.8)

Not required.

4.12.1.9. Address for delivery of selected samples (S1.12.9 & Clause 7.9.2)

To be notified.

4.12.1.10. Retention and disposal of contamination/WAC samples (S1.12.10 & Clause 7.9.3)

As specified.

All environmental samples should be sent to an accredited laboratory for analysis. Once samples have expired (exceed holding times), the laboratory will be responsible for safe disposal of sample material (soil and water).

4.12.1.11. Frequency of sampling (S1.12.11 & Clause 7.9.4)

Representative samples of debris (fragments) of suspected asbestos-containing material are to be taken as Environmental Samples. Such samples are to be double-contained and labelled as “suspected asbestos”. A note is to be added to the exploratory hole log to record such samples,

possible type of material (rope, cement-bonded tile, insulation board etc), quantity and size(s) of debris present.

Environmental samples are to be taken where there is Made Ground, visual or olfactory evidence of contamination.

Environmental soil samples shall be taken from 0.05 mbgl, or immediately below hard standing, and then at 1.00m intervals to the base of Made Ground or soils with evidence of visual or olfactory evidence of contamination. A minimum of one sample of Made Ground should be collected. Environmental soil samples shall then be taken at the top of each change of strata in addition to any material with visual or olfactory suspected contamination.

Any material with visual or olfactory suspected contamination is to be taken as an Environmental sample and the details of this noted on the exploratory hole log.

Environmental samples of groundwater are not required during exploratory holes formation.

4.12.1.12. Sampling method (S1.12.12 & Clause 7.9.5)

As specified.

All soil samples for geoenvironmental analysis are to be immediately placed in a cool box and to be kept at a temperature of below 4° Celsius, but not frozen, and transported in this condition under Chain-of-Custody to the accredited laboratory for testing to commence within 48 hours of the sample being taken and/or within the period determined by the laboratory for sampling preparation and analysis to be completed within the determinand hold time.

4.12.1.13. Headspace testing (S1.12.13 & Clause 7.9.8)

For screening purposes, headspace testing using PID is required at the depth of each environmental soil sample. The results shall be included on the relevant exploratory hole log. The Contractor is to use the PID to aid in the selection of samples for laboratory analysis. Alternatively, if needed, the Contractor can seek advice from the Investigation Supervisor on scheduling and decision making.

A copy of the Correction Factors manual for the PID used is required to be submitted to the Investigation Supervisor at the commencement of site works. This information is also to be included in the Factual Ground Investigation Report.

4.13 Probing and cone penetration testing (Specification Section 8). Particular restrictions/relaxations

Not a requirement of the proposed ground investigation. On this basis Schedule S1.13.1 to S1.13.6 and the associated clauses are not applicable.

4.14 Geophysical testing (Specification Section 9) Particular restrictions/relaxations

4.14.1.1. Geophysical survey objectives (S1.14.1 & Clause 9.1.1)

Utility identification

In accordance with Schedule 4 (clause 3.8.3) the position and the nature of any services at or near the proposed exploratory hole locations shall be identified as accurately as possible by means of an underground utility survey. The proposed location of new/existing groundwater monitoring locations

does not account for the rerouting/changes in location of utilities/services. It is up to the Contractor to ensure there are no associated constraints for the duration f the programme.

Each exploratory hole has been defined as Category B – Detection in accordance with PAS 128 and therefore the survey work shall comprise of a minimum of two types of non-intrusive geophysical mapping in addition to a desk top review, liaison with utility providers and site reconnaissance.

The Contractor shall ensure that the geophysical mapping survey covers a minimum squared area of 25m^2 centred at every exploratory hole location. Where an obstruction, such as buildings or a road falls into this minimum survey area, the survey shall be extended towards the obstruction as far as reasonably practical. Any restrictions will need to be confirmed by the Investigation Supervisor.

This mapping shall be completed prior to forming any asset exploratory holes. The information obtained from this survey and review of desk study information may result in the repositioning of an exploratory hole. Any repositioning will need to be discussed and agreed by the Investigation Supervisor.

4.14.1.2. Requirement for Ground Specialist geophysicist (S1.14.2 & Clause 9.1.1)

As specified.

4.14.1.3. Trials of geophysical methods (S1.14.3 & Clause 9.1.1)

Not required.

4.14.1.4. Types of geophysics required (S1.14.4 & Clause 9.1.1)

As specified.

A Ground Penetrating Radar (GPR) survey shall be undertaken at each fieldwork location in accordance with PAS128. Alternative techniques that meet the PAS128 requirements can be proposed by the Contractor and agreed with the Investigation Supervisor.

4.14.1.5. Information provided (S1.14.5 & Clause 9.2)

As specified.

4.14.1.6. Horizontal data density (S1.14.6 & Clause 9.3)

Not required.

4.14.1.7. Level datum (S1.14.7 & Clause 9.4)

Not required.

4.14.1.8. Geophysical survey report (S1.14.8 & Clause 9.7)

Not required.

4.14.1.9. Review and Approvals (S1.14.9)

As specified.

4.15 In situ testing (Specification Section 10) Particular restrictions/relaxations

4.15.1.1. Tests in accordance with British Standards (S1.15.1 & Clause 10.3)

Not required.

4.15.1.2. Hand penetrometer and hand vane for shear strength (S1.15.2 & Clause 10.4.1)

As specified.

4.15.1.3. Self-boring pressuremeter (SBP) and high-pressure dilatometer (HPD) testing and reporting (S1.15.3 & Clause 10.5.1)

Not required.

4.15.1.4. Driven or push-in pressuremeter testing and reporting requirements (S1.15.4 & Clause 10.5.2)

Not required.

4.15.1.5. Menard pressuremeter tests (S1.15.5 & Clause 10.5.3)

Not required.

4.15.1.6. Soil infiltration test (S1.15.6 & Clause 10.6)

Not required.

4.15.1.7. Special in situ testing and reporting requirements (S1.15.7 & Clause 10.7)

Not required.

4.15.1.8. Interface probes (S1.15.8 & Clause 10.8)

As specified.

The presence of light non-aqueous phase liquids (LNAPL) or sheens is not anticipated at the asset, however, as a precaution, the Contractor will use an interface probe (depth sounder) that can measure LNAPL thickness and groundwater depths.

4.15.1.9. Contamination screening tests (S1.15.9 & Clause 10.9)

As specified.

All soil samples are to be screened for the presence of hydrocarbons using a calibrated hand-held PID. As part of the screening process, samples are to be visually inspected for the presence of contaminants. At the Contractor's discretion, screening results are to be used to inform decisions on sample submission for laboratory analysis. All PID results along with sample information is to be included on exploratory hole logs.

4.15.1.10. Metal detection (S1.15.10 & Clause 10.10)

Not required.

4.16 Instrumentation (Specification Section 11) Particular restrictions/relaxations

4.16.1.1. Protective covers for installations (S1.16.1 & Clause 11.2)

As specified.

No plastic covers shall be used in remote/vegetated locations.

Where possible, the Contractor should use raised covers as a visual aid to deter damage and allow easier detection when completing monitoring/sampling rounds. If there are constraints associated with the use of raised covers, the Contractor can opt to use flush mounted covers.

4.16.1.2. Protective fencing (S1.16.2 & Clause 11.3)

As specified.

It will be the Contractors responsible to determine the need for fencing, for example to protect the exploratory hole locations during and following drilling, to maintain the serviceability of the installations or as required to meet the conditions imposed by 3rd party private landowners.

4.16.1.3. Standpipe and standpipe piezometer installations (S1.16.3 & Clauses 11.4.1 and 11.4.2)

As specified.

The installation (standpipe) design (length of HDPE solid and slotted section) will be dictated by ground conditions encountered at the time of ground investigation. However, it is important that the screen crosses the Glaciofluvial Deposits only to isolate it from underlying and overlying geological unis that may contain groundwater.

The standpipe slotted section shall be wrapped with a filter fabric, unless directed otherwise by the Investigation Supervisor.

Standpipe response zones to be surrounded by pea gravel or clean washed sand (with a geotextile sock), depending on the geology, with adequate bentonite seal above and below the response zone.

4.16.1.4. Other piezometer installations (S1.16.4 & Clause 11.4.3)

Not required.

4.16.1.5. Development of standpipes and standpipe piezometers (S1.16.5 & Clause 11.4.5)

As specified.

Well development will be required following installation to remove suspended solids, flush the screen and remove possible introduced influences from drilling to ensure that more representative water samples can be collected during future monitoring/sampling rounds.

4.16.1.6. Ground gas standpipes (S1.16.6 & Clause 11.5)

Not required.

4.16.1.7. Inclinometer installations (S1.16.7 & Clause 11.6)

Not required.

4.16.1.8. Slip indicators (S1.16.8 & Clause 11.7)

Not required.

4.16.1.9. Extensometers and settlement gauges (S1.16.9 & Clause 11.8)

Not required.

4.16.1.10. Settlement monuments (S1.16.10 & Clause 11.9)

Not required.

4.16.1.11. Removal of installations (S1.16.11 & Clause 11.10)

Not required.

4.16.1.12. Other instrumentation (S1.16.12 & Clause 11.11)

As specified.

To enable the collection of surface waters levels (mAoD) when collecting surface water samples, a crest gauge(s) should be installed by the Contractor in the Coleshill Pools area. The purpose of the crest gauge will be to record surface water levels in the ponds on the same day when recording groundwater levels to allow a direct comparison of levels to calculate groundwater flow direction. The Contractor will identify a safe and suitable location(s) to cite the crest gauge(s) but must ensure that they will remain accessible and serviceable for the duration of the monitoring programme. Where required, the Contractor will seek the necessary permissions to install and access the instruments.

4.17 Installation monitoring and sampling (Specification Section 12) Particular restrictions/relaxations

4.17.1.1. Groundwater level readings in installations (S1.17.1 & Clause 12.2)

As specified.

Routine monitoring of groundwater levels will be undertaken at all newly installed (ML159-CP603, CP604, CP607 to CP610, CP613, CP616, CP619 and CP620) and the existing (ML158-CP419) monitoring well standpipes, as shown in Appendix A. The borehole log associated with ML158-CP419 is presented in Appendix C.

Similarly, water levels within designated ponds and a channel to the west of the asset and Coleshill Pools to the east of the asset will be recorded using crest gauges (depth gauges). To allow for the calculation of hydraulic gradients, level readings of the entire monitoring network should be taken on the same day.

As indicated previously if the existing wells or newly installed wells are no longer serviceable/accessible or are unlikely to remain for the duration of the programme, the Contractor will engage with the Investigation Supervisor to agree on alternative locations. The Contractor is to ensure that groundwater monitoring locations are checked for safe access and approaches in place if required The Contractor will also advise on access constraints to surface water monitoring points and seek direction from the Investigation Supervisor. The Contractor should ensure that safe access can be achieved to all surface water sample locations.

Unless otherwise instructed by the Investigation Supervisor, readings shall be taken from groundwater and surface water locations presented in Appendix A at the following intervals:

- Within 1 week of well completion.
- Weekly to the point when MBL sourced materials start to be placed at the asset (min 8 weeks)
- Monthly during the placement of MBL sourced material.
- Monthly on completion of MBL material placement for 12 months

- After 12 months, reduce to every two months for the duration of the monitoring programme.

The Contractor will seek direction from the Investigation Supervisor on when the frequency of monitoring is to be adjusted to reflect changes in programme. The Investigation Supervisor will also advise if a change in frequency is required and when the monitoring is to end.

All monitoring results should be issued to the Investigation Supervisor within a week of being undertaken. Due to the size of the data set to be generated, the Contractor shall provide this data electronically in AGS4 format.

4.17.1.2. Groundwater sampling from installations (S1.17.2 & Clause 12.3.1)

As specified.

Groundwater and surface water samples will be collected as part of the monitoring programme. Sampling frequency and timeframe are described in S1.17.1.

The Contractor will seek direction from the Investigation Supervisor on when the frequency of sampling is to be adjusted to reflect changes in programme. The Investigation Supervisor will also advise if a change in frequency is required and when the sampling is to end.

All monitoring results should be issued to the Investigation Supervisor within a week of being undertaken. Due to the size of the data set to be generated, the Contractor should provide this data electronically in Excel or similar.

4.17.1.3. Purging/micro-purging (S1.17.3 & Clause 12.3.2)

As specified.

Low-flow sampling as appropriate when taking groundwater samples from every standpipe. Field measurements should also be recorded and presented in reporting to the Investigation Supervisor as per Table S1.17.1.

If present, the standing water level and thickness of free-phase product in standpipes shall be recorded before and after purging using an interface probe. If free-product is still present further instructions should be sought from the Investigation Supervisor.

4.17.1.4. Ground gas monitoring (S1.17.4 & Clause 12.4)

Not required.

4.17.1.5. Sampling from ground gas installations (S1.17.5 & Clause 12.5)

Not required.

4.17.1.6. Other monitoring (S1.17.6 & Clause 12.8)

As specified.

4.17.1.7. Sampling and testing of surface water bodies (S1.17.7 & Clause 12.9)

Surface water samples shall be taken at the same frequency and timeframe as described in S1.17.1/2.

4.18 Daily records (Specification Section 13) Particular restrictions/relaxations

4.18.1.1. Information for daily records (S1.18.1 & Clause 13.1)

As specified.

Field records should be compiled and provided to the Investigation Supervisor daily.

4.18.1.2. Special in situ tests and instrumentation records (S1.18.2 & Clause 13.4)

Not required.

4.19 Geotechnical laboratory testing (Specification Section 14) Particular restrictions/relaxations

Not a requirement of the proposed ground investigation. On this basis Schedule S1.19.1 to S1.19.8 and the associated clauses are not applicable.

4.20 Geoenvironmental laboratory testing (Specification Section 15) Particular restrictions/relaxations

4.20.1.1. Investigation Supervisor or Contractor to schedule testing (S1.20.1 & Clause 15.1)

As specified.

Although the Contractor will be responsible for selecting and scheduling soil samples for laboratory submission based on their observations made during the ground investigation, they are encouraged to contact the Investigation Supervisor and DJV to seek direction of soil scheduling. Groundwater and surface water samples will be submitted on a routine basis for a range of determinands as per S1.17.1/2 and S1.20.3.

4.20.1.2. Accreditation required (S1.20.2 & Clause 15.2)

As specified.

4.20.1.3. Chemical testing for contamination (S1.20.3 & Clause 15.3)

Soil and water samples are to be submitted for the following laboratory chemical testing suites:

- Suite E: BTEX, TPH, PAH, metals, pH, %SOM
- Suite E9: VOC, SVOC
- Suite E6: TPHCWG
- Suite E12: PCBs
- Suite F: Leachable metals
- Suite H: asbestos screen
- Suite H1: asbestos quantification
- Suite I: groundwater suite
- Suite I1: groundwater TPHCWG
- Suite I2: groundwater VOC & SVOC

Surface water samples will also be submitted for the range of laboratory analysis specified in Suite I, I1 and I2.

Leachate samples shall be prepared in accordance with BS EN 12457-1 with a 2:1 ratio prior to testing accordance with Suite F.

The scheduling of Suite H1 asbestos quantification shall only be required if asbestos-containing material is found (Suite H). All samples of debris of suspected asbestos-containing materials will be scheduled for asbestos ID.

The Investigation Supervisor will advise on changes or deviations to the suites specified during the monitoring programme.

4.20.1.4. Waste characterisation (S1.20.4 & Clause 15.4)

As required to determine the reuse of soil material under the MMP Route A

4.20.1.5. Waste Acceptance criteria testing (S1.20.5 & Clause 15.5)

It is envisaged that arisings generated from drilling will be managed under the MMP Route A. The MMP provides appropriate guidance on testing requirements.

4.20.1.6. Laboratory testing (S1.20.6 & Clause 15.6)

Not required.

4.20.1.7. Special laboratory testing (S1.20.7 & Clause 15.7)

Not required.

4.21 Reporting (Specification Section 16) Particular restrictions/relaxations

4.21.1.1. Form of exploratory hole logs (S1.21.1 & Clauses 16.1 and 16.2.1)

As specified.

4.21.1.2. Information on exploratory hole logs (S1.21.2 & Clause 16.2.2)

As specified.

4.21.1.3. Variations to final digital data supply requirements (S1.21.3 & Clause 16.5.1)

As specified.

Data to be in AGS 4.0 format.

The Contractor shall use the geology codes as provided by the Investigation Supervisor.

4.21.1.4. Preliminary digital data (S1.21.4 & Clause 16.5.3)

As specified.

The Contractor shall deliver preliminary digital data to BBV in AGS 4.0 Data format on a weekly basis for progress tracking purposes.

4.21.1.5. Type(s) of report required (S1.21.5 & Clause 16.6)

As specified.

The Ground Investigation (Factual) Report should include exploratory borehole logs, figures and all field and laboratory data collected during the ground investigation component of the works (Phase 1 and Phase 2). Logs, field, and laboratory data should also be provided electronically, where appropriate in AGS and Excel format. The report should be provided no more than 6 weeks following the completion of the ground investigation.

Field and laboratory data collected during the long-term groundwater and surface water monitoring/sampling programme will be provided electronically in Excel format once received from the laboratory. Every 6 months the Contractor should also provide a Factual Long-Term Monitoring report, containing all field and laboratory data and observation notes pertinent to the monitoring programme, e.g., the condition of monitoring wells and sampling locations, constraints to monitoring/sampling, and QA/QC issues that may affect sample quality.

The Contractor should provide all reports and data to the Investigation Supervisor for review and onward circulation.

4.21.1.6. Electronic report requirements (S1.21.6 & Clauses 16.6.3)

As specified.

4.21.1.7. Format and contents of Desk Study Report (S1.21.7 & Clause 16.2.2)

Not required.

4.21.1.8. Contents of Ground Investigation Report (or specified part thereof) (S1.21.8 & Clause 16.8)

As specified.

4.21.1.9. Contents of Geotechnical Design Report (or specified part thereof) (S1.21.9 & Clause 16.9)

Not required.

4.21.1.10. Times for supply of electronic information (S1.21.10 & Clause 16.10.1)

As specified.

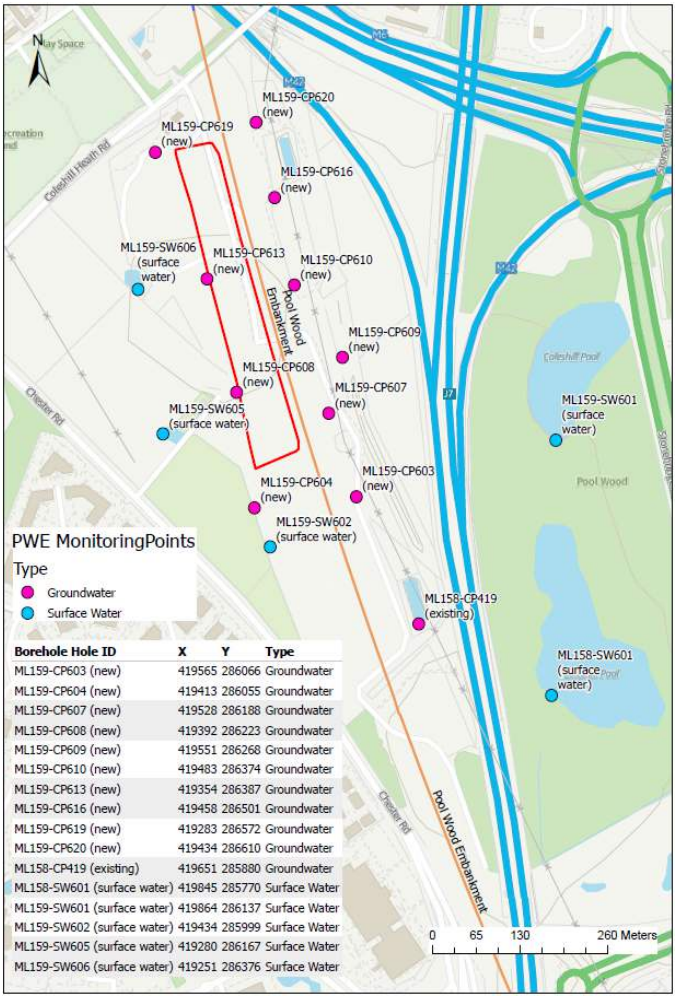
4.21.1.11. Electronic information transmission (S1.21.11 & Clause 16.10.2)

As specified.

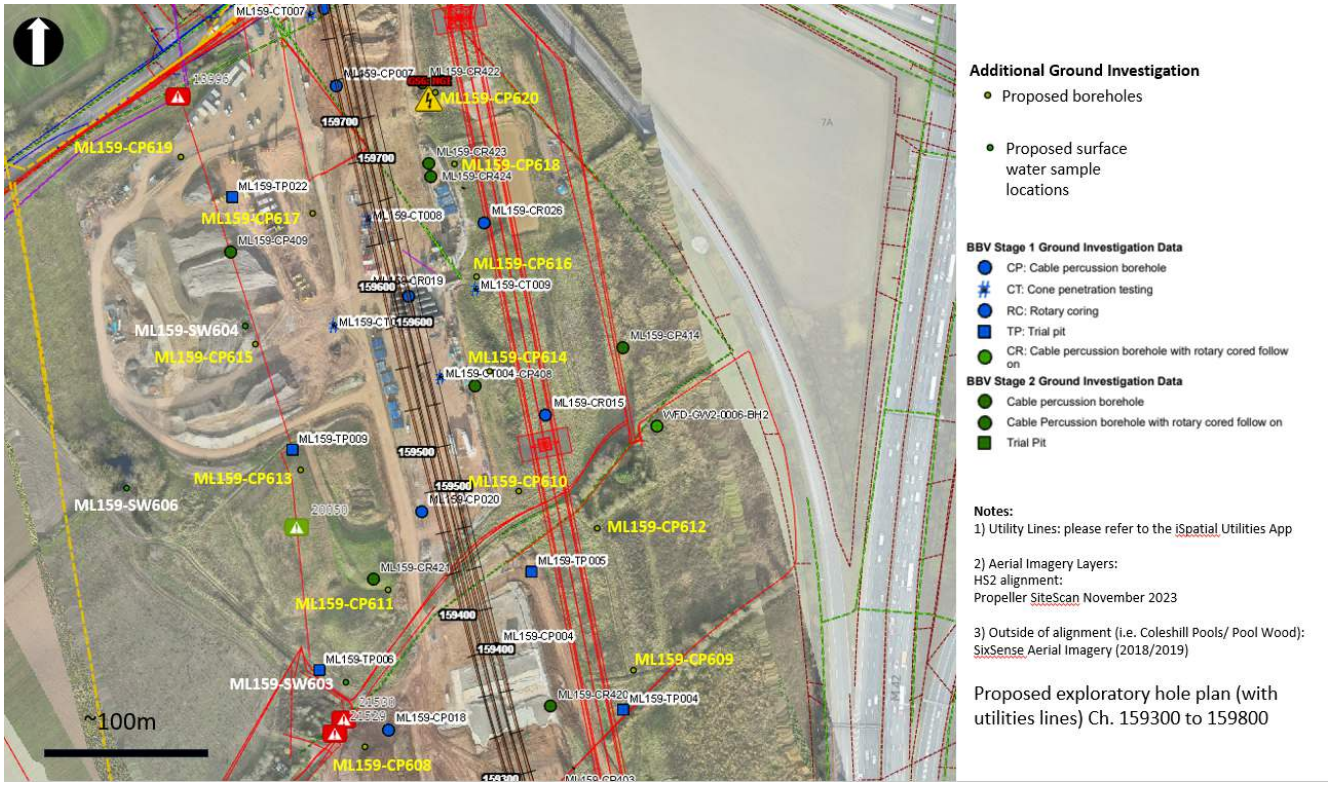
4.21.1.12. Report approval (S1.21.12 & Clause 16.11)

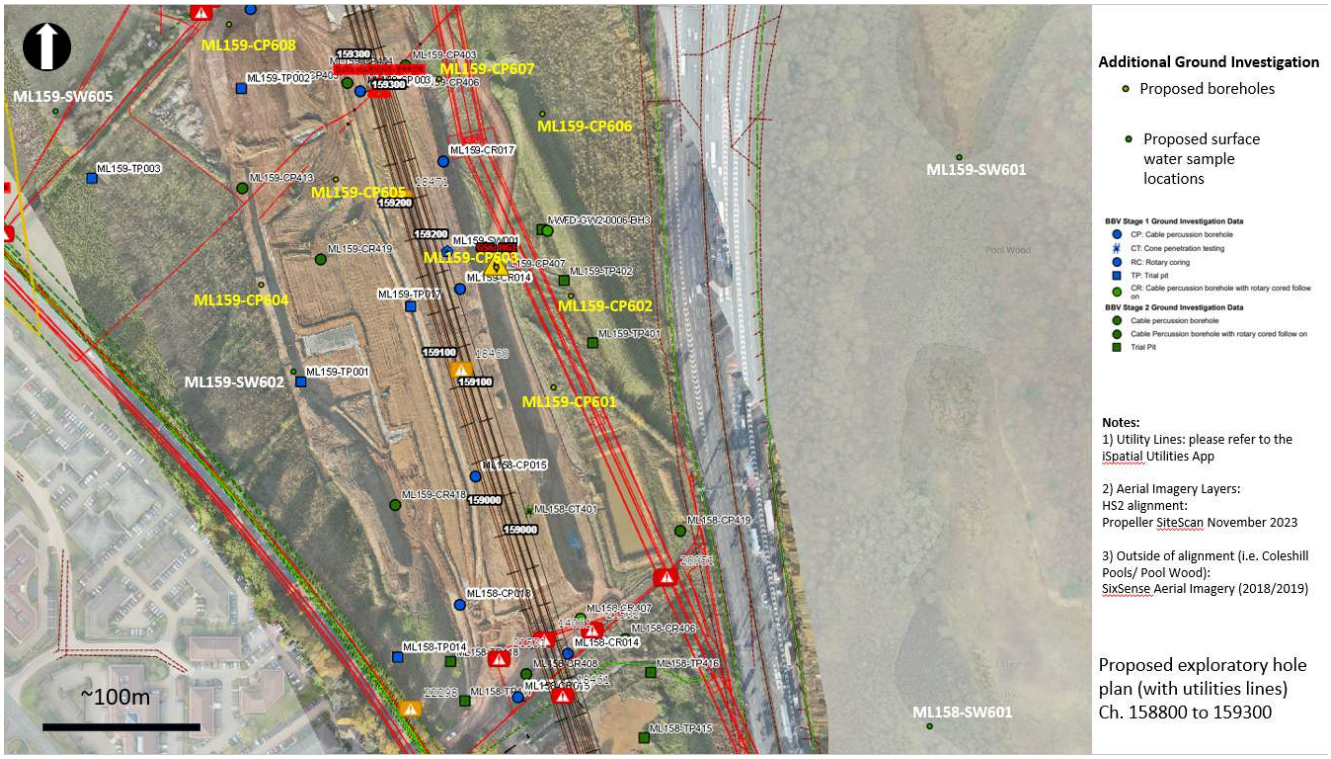
As specified.

Appendix A Groundwater and Surface Water Monitoring Locations



Borehole Hole ID	X	Y	Type
ML159-CP603 (new)	419565	286066	Groundwater
ML159-CP604 (new)	419413	286055	Groundwater
ML159-CP607 (new)	419528	286188	Groundwater
ML159-CP608 (new)	419392	286223	Groundwater
ML159-CP609 (new)	419551	286268	Groundwater
ML159-CP610 (new)	419483	286374	Groundwater
ML159-CP613 (new)	419354	286387	Groundwater
ML159-CP616 (new)	419458	286501	Groundwater
ML159-CP619 (new)	419283	286572	Groundwater
ML159-CP620 (new)	419434	286610	Groundwater
ML158-CP419 (existing)	419651	285880	Groundwater
ML158-SW601 (surface water)	419845	285770	Surface Water
ML159-SW601 (surface water)	419864	286137	Surface Water
ML159-SW602 (surface water)	419434	285999	Surface Water
ML159-SW605 (surface water)	419280	286167	Surface Water
ML159-SW606 (surface water)	419251	286376	Surface Water


Additional Ground Investigation
Proposed boreholes
Proposed surface water sample locations
BBV Stage 1 Ground Investigation Data
CP: Cable percussion borehole
CT: Cone penetration testing
RC: Rotary coring
TP: Trial pit
CR: Cable percussion borehole with rotary cored follow on
BBV Stage 2 Ground Investigation Data
Cable percussion borehole
Cable Percussion borehole with rotary cored follow on
Trial Pit
Notes:
1) Utility Lines: please refer to the iSpatial Utilities App
2) Aerial Imagery Layers:
HS2 alignment:
Propeller SiteScan November 2023
3) Outside of alignment (i.e. Coleshill Pools/ Pool Wood):
SixSense Aerial Imagery (2018/2019)
Proposed exploratory hole plan (with utilities lines) Ch. 159300 to 159800
~100m


Additional Ground Investigation
Proposed boreholes
Proposed surface water sample locations
Notes:
1) Utility Lines: please refer to the iSpatial Utilities App
2) Aerial Imagery Layers:
HS2 alignment:
Propeller SiteScan November 2023
3) Outside of alignment (i.e. Coleshill Pools/ Pool Wood):
SixSense Aerial Imagery (2018/2019)
Proposed exploratory hole plan (with utilities lines) Ch. 158800 to 159300
~100m

Appendix B Schedule 2 – Summary of Work Package Details

Borehole Hole ID	OS Coordinates (eastings/ northings)	Drill Method	BDA	Scheduled depth	Installations	In-situ testing	Soil Analysis	Ground/ Surface Water monitoring	Groundwater Analysis	Surface Water Analysis	Monitoring sampling programme
ML159-CP603 (new)	419564.673, 286066.212										
ML159-CP604 (new)	419412.72, 286055.486										
ML159-CP607 (new)	419527.728,286187.77										
ML159-CP608 (new)	419391.883,286222.629										
ML159-CP609 (new)	419550.968,286267.618										
ML159-CP610 (new)	419482.942,286374.091										
ML159-CP613 (new)	419353.598,286387.34										
ML159-CP616 (new)	419458.033,286500.883										
ML159-CP619 (new)	419283.026,286572.22										
ML159-CP620 (new)	419434.308,286610.173										
ML158-CP419 (existing)	419651, 285880	NA	NA	NA	NA	NA	NA				
ML158-SW601 (surface water)	419844.694,285770.323	NA	NA	NA	NA	NA	NA	Surface water elevation reported in mAoD, to tie in with specific groundwater monitoring dates)	NA	Suite I: groundwater suite Suite I1: groundwater TPH Suite I2: groundwater VOC & SVOC	
ML159-SW601 (surface water)	419863.762,286137.382										
ML159-SW602 (surface water)	419434.135,285998.543							NA			
ML159-SW605 (surface water)	419280.399,286166.58										
ML159-SW606 (surface water)	419250.606,286375.733										

Appendix C Exploratory Hole Logs (existing monitoring wells)

Project Name	BBV Phase 2 GI Area North	Exploratory Hole Log	Hole ID
Project No.	TE8296		ML158-CP419
Engineer	Balfour Beatty Vinci		
Employer	High Speed Two (HS2) Limited		Sheet 1 of 2

Ground Level	+99.09mOD	Coordinates	419651.48E, 285880.81N	Grid	National Grid
Date Started	19/10/2021	Date Completed	20/10/2021	Inclination	90

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit Used	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	**1.20**	IP	19/10/2021 **13:30**	19/10/2021 **14:30**	IT	OC	NA	NA	**Insulated Hand Tools**	None	Stable	
1.20	**10.00**	CP	19/10/2021 **14:30**	20/10/2021 18:00	IT	OC	NA	NA	**Dando 3000**			

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

WATER STRIKE- GENERAL

Date Time	Depth Strike	Depth Casing	Depth Sealed

WATER STRIKE- DETAILS

Depth Water	Time Elapsed	Remarks

HOLE DIAMETER

Depth	Diameter	Remarks
10.00	200	

CASING DIAMETER

Depth	Diameter	Remarks
7.60	200	

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

DYNAMIC SAMPLING

Top	Base	Diameter	Duration	Recovery	Remarks

INSTALLATION DETAILS						PIPE CONSTRUCTION					BACKFILL DETAILS			
Distance	ID	Type	ResponseTop	ResponseBase	Pipe Ref	Pipe	Top	Base	Diamete	Pipe Type	DepthTop	DepthBase	Description	Remarks
7.00	01	SP	2.00	10.00	01	01 01	0.00 2.00	2.00 7.00	50 50	PLAIN SLOTTED	-0.30 0.00 0.50 2.00	0.00 0.50 2.00 10.00	Upstanding cover Concrete Bentonite Gravel	

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

C1.0 Print date and time 26/10/2021 16:50 Log checked by Emily Birch

Form No. SIEXPHOLEHDRP1 Issue.Revision No.2.00 Issue Date 08/10/2014 Partof the BachySoletancheGroup

Project Name	BBV Phase 2 GI Area North			Exploratory Hole Log	Hole ID ML158-CP419
Project No.	TE8296				Sheet 2 of 2
Engineer	Balfour Beatty Vinci				
Employer	High Speed Two (HS2) Limited				
Ground Level	+99.09mOD	Coordinates	419651.48E, 285880.81N	Grid	National Grid
Date Started	19/10/2021	Date Completed	20/10/2021	Inclination	90

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
19/10/2021 18:00	6.00	6.00	5.20	End of Shift
20/10/2021 07:30	6.00	6.00	4.70	Start of Shift
20/10/2021 18:00	10.00	7.60	7.85	End of Hole

SPT DETAILS

Depth	Type	Reported Result		Hammer Energy (%)	Casing Depth	Water Depth
2.00 3.00	S	N=17 (2,3,4,4,4,5)	AR3532	62 62	1.40 3.00	Dry 2.70
4.00 5.00	C	N=39 (4,7,7,10,10,12)	AR3532	62 62	3.95 5.00	3.00
	C	N=48 (6,8,8,12,12,16) N=31	AR3532			3.50
	C	(3,6,6,8,8,9)	AR3532			4.70
	C	N=89(25,0/0,19,21,22,27)	AR3532			6.10
		N=10 (5,4,3,3,2,2)	AR3532			
		N=49 (6,8,8,11,14,16)				

DEPTH RELATED REMARKS

Top Depth	Base Depth	Remarks
0.00	1.20	Position CAT s c anned before and during excavation.
0.00	10.00	No groundwater strikes observed during borehole formation.

GENERAL NOTES	6.00 7.00 8.50 9.50	C S S	N=63 (7,9,13,16,16,18)	AR3532 AR3532	62 62 62 62	6.00 7.00 7.45 7.60	7.20 7.85
1. PAS 128 Type B survey conducted over position.							

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water. For details of abbreviations see key.

C1.0 Print date and time 26/10/2021 16:50 Log checked by Emily Birch

Form No. SIEXPHOLEHDRP2 Issue.Revision No. 2.00 Issue Date 09/10/2014 Partof the BachySoletancheGroup

Project Name	BBV Phase 2 GI Area North			Exploratory Hole Log	Hole ID ML158-CP419
Project No.	TE8296				Sheet 1 of 2
Engineer	Balfour Beatty Vinci				
Employer	High Speed Two (HS2) Limited				
Ground Level	+99.09mOD	Coordinates	419651.48E, 285880.81N	Grid	National Grid
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Greyish black slightly gravelly sandy organic clay and occasional rootlets (<2mm). (TOP) [Topsoil]			(0.30)			B 2 0.10 D 1 0.10							
Light grey gravelly slightly clayey fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of quartzite. (GFDUD) [Glacio>uvial Deposits, Devensian]			0.30 (0.55)	98.79		B 4 0.40 0.80 D 3 0.40							
Firm greyish brown slightly silty slightly gravelly sandy CLAY . Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of quartzite. (GFDUD) [Glacio>uvial Deposits, Devensian]			0. 85 (0.35)	98. 24		D 5 0.90							
Stiff reddish brown locally greenish grey sandy CLAY . Sand is fine to coarse. (GFDUD) [Glacio>uvial Deposits, Devensian]			1.20	97.89		B 7 1.20 1.50 D 6 1.20							
						U 8 1.50 1.95	100	100	80				
			(1.65)			B 11 2.00 2.50 D 10 2.00-2.45 D 9 2.00						SPT(S) N=17 (2,3,4,4,4,5) 2.00	
						U 12 2.50-2.95	100	100	120				
Dense multicoloured sandy slightly silty subangular to subrounded fine to coarse GRAVEL of quartzite. Sand is fine to coarse. (GFDUD) [Glacio>uvial Deposits, Devensian]			2.85	96.24		B 15 3.00 3.50 D 13 3.00 D 14 3.00						SPT(C) N=39 (4,7,7,10,10,12) 3.00	
						D 16 3.75							
			(3.15)			B 17 4.00 4.50						SPT(C) N=48 (6,8,8,12,12,16) 4.00	

								D 18 4.75											
								B 19 5.00 5.50									N=31		
																	SPT(C) (3,6,6,8,8,9) 5.00		

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

C1.0 Print date and time 26/10/2021 16:51 Log checked by Emily Birch

Form No. SIEXPHOLELOG Issue.Revision No. 2.03 Issue Date 12/10/2016 Part of the Bac hy Soletanche Group

Project Name	BBV Phase 2 GI Area North			Exploratory Hole Log	Hole ID
Project No.	TE8296				ML158-CP419
Engineer	Balfour Beatty Vinci				
Employer	High Speed Two (HS2) Limited				Sheet 2 of 2
Ground Level	*99.09mOD	Coordinates	419651.48E, 285880.81N	Grid	National Grid
Hole Type	IP*CP	Inclination	90 ° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Water-strike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Dense multicoloured sandy slightly silty subangular to subrounded fine to coarse GRAVEL of quartzite. Sand is fine to coarse. (GFDUD) [Glacio>uvial Deposits, Devensian]						**D 20 5.75**							
			6.00	**93.09**		**B 22 6.00 6.50** **D 21 6.00**						**SPT(C) N=89 (25,0/0,19,21,22,27) 6.00**	
Very dense multicoloured sandy slightly silty subangular to subrounded fine to coarse GRAVEL of quartzite. Sand is fine to coarse. (GFDUD) [Glacio>uvial Deposits, Devensian]			**(1.00)**			**D 23 6.75**							
			7.00	**92.09**		**B 24 7.00 7.15**						**SPT(C) N=10 (5,4,3,3,2,2) 7.00**	
Medium dense multicoloured sandy slightly silty subangular to subrounded fine to coarse GRAVEL of quartzite. Sand is fine to coarse. (GFDUD) [Glacio>uvial Deposits, Devensian]						**D 25 7.25**							
			(1.00)			**B 26 7.50 8.00** **U NR 7.50 7.95**	**100**	**0**	**60**				
			8.00	**91.09**		**D 27 8.00** **U 28 8.00 8.45**	**100**	**100**	**120**				
Very stiff reddish brown locally greenish grey slightly gravelly sandy CLAY . Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mudstone lithorelicts and siltstone. (BCMU) [Branscombe Mudstone Formation]	≡					**B 31 8.50 9.00** **D 29 8.50** **D 30 8.50 8.95**						**SPT(S) N=49 (6,8,8,11,14,16) 8.50**	
			(2.00)			**D 32 9.00** **U 33 9.00 9.45**	**100**	**100**	**120**				
						D 34 9.50 **D 35 9.50 9.95**						**SPT(S) N=63 (7,9,13,16,16,18)**	

													9.50	
			10.00	89.09		D36 10.00							
End of borehole at 10.00m. Termination Reason: Acheived Scheduled Depth														

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

C1.0 Print date and time 26/10/2021 16:51 Log checked by Emily Birch

Form No. SIEXPHOLELOG Issue.Revision No. 2.03 Issue Date 12/10/2016 Part of the Bachy Soletanche Group

Appendix D Disclaimer

This report has been prepared solely for use by the party which commissioned it (the "client") in connection with the captioned project. It should not be used for any other purpose. No person other than the client may rely on the content, information or any views expressed in this report. We accept no duty of care, responsibility or liability to any other recipient of this report. This report is confidential and contains proprietary intellectual property.

No representation, warranty or undertaking, express or implied, is made and no responsibility or liability is accepted by us to any party other than the client, as to the accuracy or completeness of the information contained in this report.

We disclaim all and any liability whether arising in tort or Contract or otherwise which it might otherwise have to any party other than the client, in respect of this report, or any information attributed to it.

This report represents the technical findings and opinions of experienced geo-environmental specialists and does not constitute legal, insurance or financial advice, for which separate, independent advice should be consulted from qualified professionals if so required.

The findings and opinions of this report are based on information obtained from a variety of sources as detailed in this report. We cannot and do not guarantee the authenticity or reliability of the information from other sources upon which we have relied. To the extent that this document is based on information supplied by other parties, we accept no liability for any loss or damage suffered by the client due to an error or omission in this report which is (i) due to an error or omission data, information or statements supplied to us by other parties including the client ("Data") or (ii) which arises from any conclusions based on such Data. We have not independently verified such Data and have assumed it to be accurate, complete, reliable and current as of the date of such information.

To the extent that this report is based on information obtained from a ground investigation, any such investigation can examine only a small part of the subsurface conditions. Where we have been responsible for the design of a ground investigation, we shall have used reasonable skill and care. However, in any ground investigation there remains a risk that pockets or "hot-spots" of contamination may not be identified, because investigations are necessarily based on sampling at localised points. Not finding any indicators of contamination does not mean that hazardous substances do not exist at the Site.

Certain indicators or evidence of hazardous substances or conditions may have been outside the limited portion of the subsurface investigated or monitored and thus may not have been identified or their full significance appreciated. Such risks may be mitigated to a degree by carrying out further ground investigation, or during construction works, by on-Site visual observation and validation testing.

It is also possible that environmental monitoring has not identified certain conditions because of the relatively short monitoring period. Accordingly, it is possible that the ground investigation and monitoring failed to indicate the presence or significance of hazardous substances or conditions. If so, their presence could not have been considered in the formulation of our findings and opinions.

For the avoidance of doubt, where the words "remediation" or "remedial" actions / operations are used in this report, these words and phrases shall refer to actions to eliminate, control or reduce risks from relevant pollutant linkages associated with the Site. Unless explicitly stated, remediation shall NOT be assumed to refer to actions to eliminate contamination risks.

This report has been produced using due skill and care, in accordance with statute and best practice at the reporting date stated in the report. We accept no liability for any change in geo-environmental risk interpretation resulting from changes in guidance and/or statute after the reporting date.

We believe that providing information about limitations is essential to help the client identify and thereby manage its risks. These risks can be mitigated – but they cannot be eliminated - through additional research. We will, on request, advise the client of the additional research opportunities available, their impact on risk, and their cost.

APPENDIX D
GROUND GAS RISK ASSESSMENT (1MC09-BBV_MSD-EV-RIA-NS04_NL10-100006 REV. P01)

Balfour Beatty VINCI Working in partnership with HS2

Contract No. 1MC13

Pool Wood Embankment: Ground Gas Risk Assessment – Sub Lot 5 South

Document Number: 1MC09-BBV_MSD-EV-RIA-NS04_NL10-100006

Current Revision	Author	Reviewed By	Approved By	Date Approved	Reason for Review
P01	David Dray	Tim Hodges	Remant Doorgakant	15/11/2024	S3 – For Review and Comments

Stakeholder Review Required (SRR)
☐ Yes – Please Specify Below
☒ No
Click or tap here to enter text.

Purpose of SRR
☐ Comment
☐ Information
☐ Approval

HS2 Signature Required
☐ Yes – Please Specify Below
☒ No
Click or tap here to enter text.

Handling Instructions: Produced by BBV for project use only

Review Required

Team	Yes/No	Name	Position	Date
Quality				
Health & Safety				
Environment & Sustainability				
Other teams if required				

Revision History

Previous Revision	Author	Reviewed By	Approved By	Date Approved	Reason for Review
P01	David Dray	Tim Hodges	Remant Doorgakant	15/11/2024	S3 – For Review and Comments

Revision Summary

Paragraph Modified	Details of Modification

Contents

1 Introduction

An 850m long landscape bund will be formed alongside the 1,414m long Pool Wood Embankment that will be constructed as part of the HS2 rail link from London to Birmingham. Of the landscaped bund, 475m will comprise material placed under a permit for waste recovery. The material, placed under this permit, will be derived from the excavation of the Middle Bickenhill landfill, which comprised inert, industrial, commercial, household, and special wastes.

This document provides a qualitative assessment of the risks posed by the gas generated through the biodegradation of the organic materials derived from the former landfill to human health and surrounding properties.

This assessment identifies that the design of the landscape bund, the age of the wastes and the remediation practices that will be put in place during the excavation, material management and waste recovery plan, mean that the risk from landfill gas arising and impacting on human health and property should be very low.

1.1 Purpose of the report

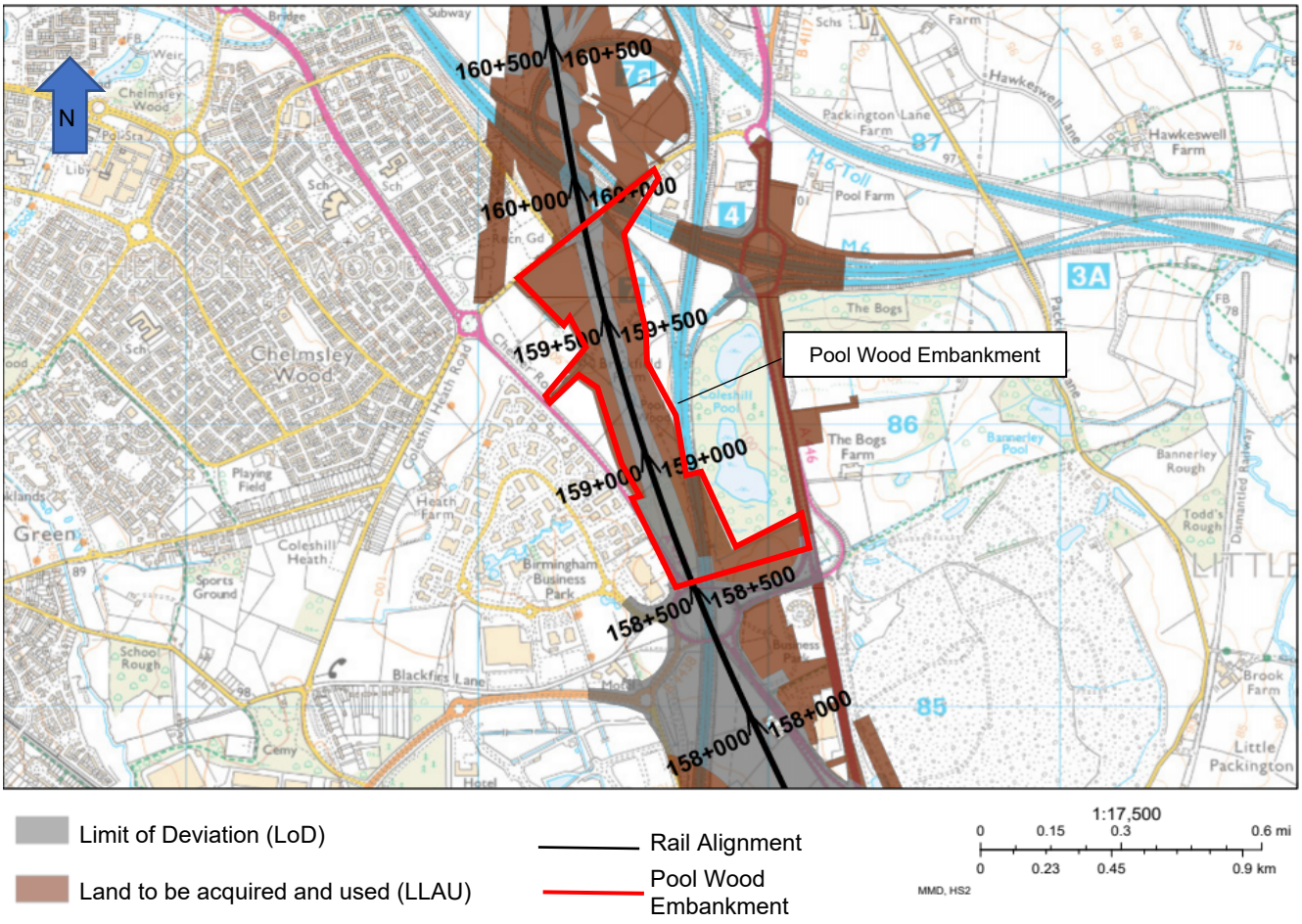
The DJV has been appointed to undertake a gas risk assessment relating to the import and placement of potentially gas-producing waste materials for reuse in the construction of a landscape bund which is part of Pool Wood Embankment, to the immediate west of HS2.

1.2 Background

Pool Wood Embankment is located ~10km to the south-east of Birmingham City Centre and just south-east of the town of Chelmsley Wood. The embankment is approximately 1.5km long and mostly crosses an area of existing farmland and woodland. In the north at chainage 159+805 of the HS2 scheme, a new underbridge will be constructed where the embankment meets Coleshill Heath Road. Where the embankment ends in the south, the HS2 alignment intersects the M42, to the south of Junction 7. A box structure will be constructed to take the HS2 alignment from the embankment and over the M42 carriageway. The box structure ties in with Packington Embankment in the south.

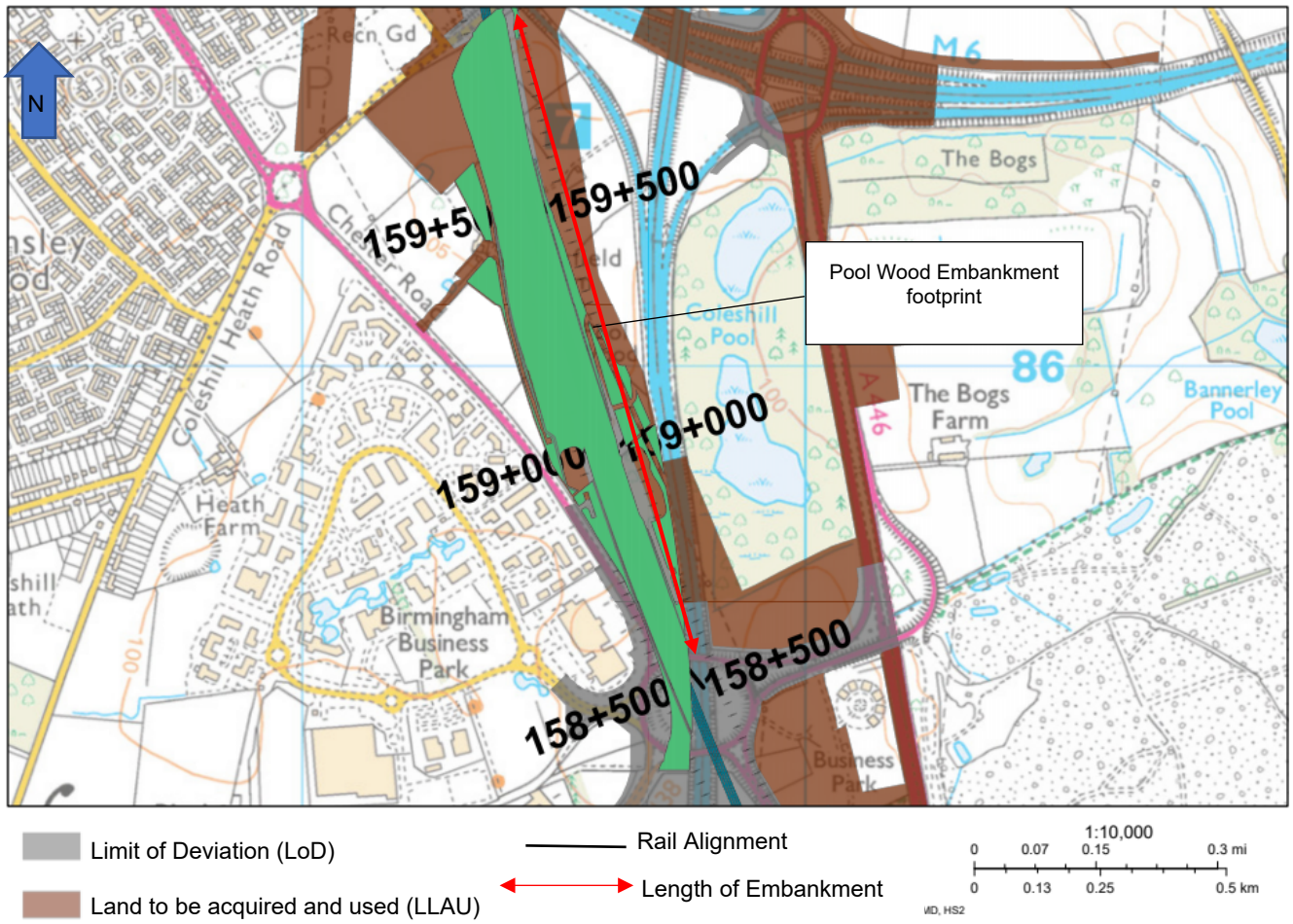
The location of Pool Wood Embankment and the extent considered in this report is shown on Figure 1, which comprises the land within the Limit of Deviation (LoD) and the Land to be Acquired and Used (LLAU). Figure 2 shows the footprint of the embankment (highlighted in green) and Figure 3 shows an aerial image of the area. The section of the landscape bund (hereafter referred to as the Site) subject to the placement of material sourced from Middle Bickenhill landfill is shown in Figure 4 and Figure 5.

Figure 1: Extent of Pool Wood Embankment



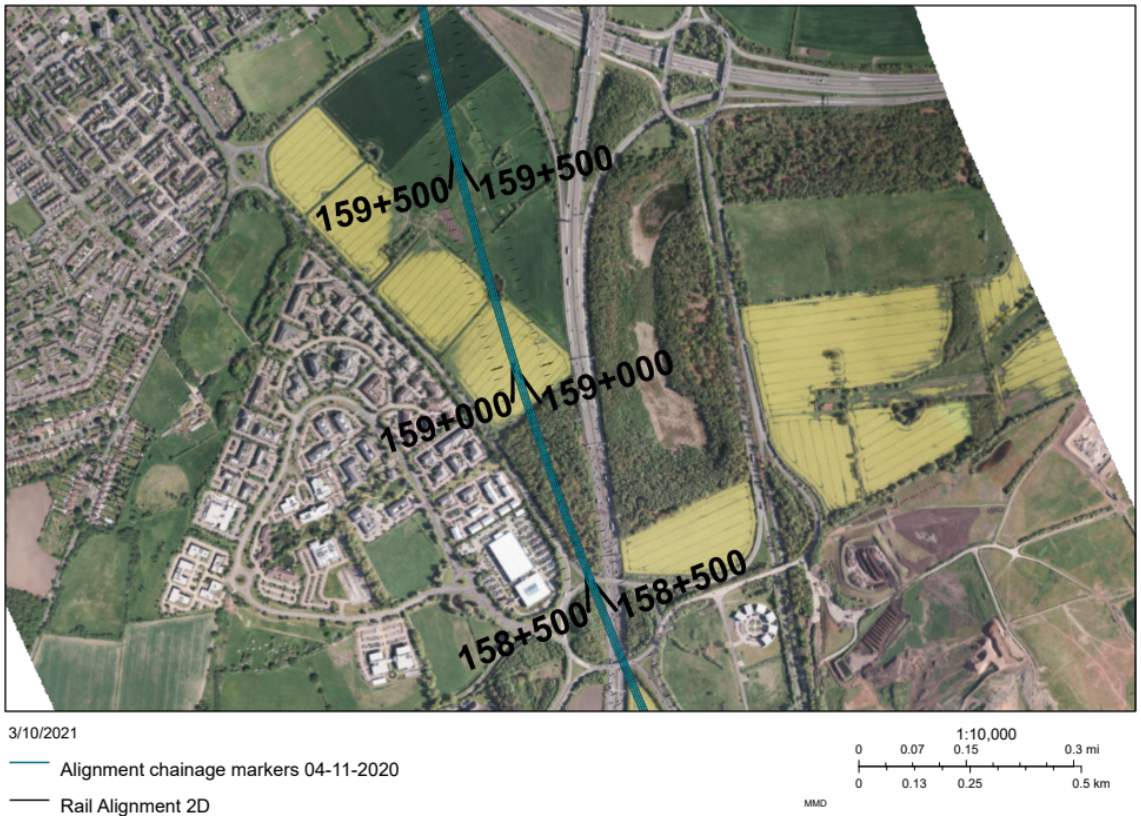
Source: HS2 Phase 1 MWCC web interface MOATA

Figure 2: Pool Wood Embankment (embankment footprint shown in green)



Source: HS2 Phase 1 MWCC web interface MOATA

Figure 3: Aerial imagery (2012) of Pool Wood Embankment extent

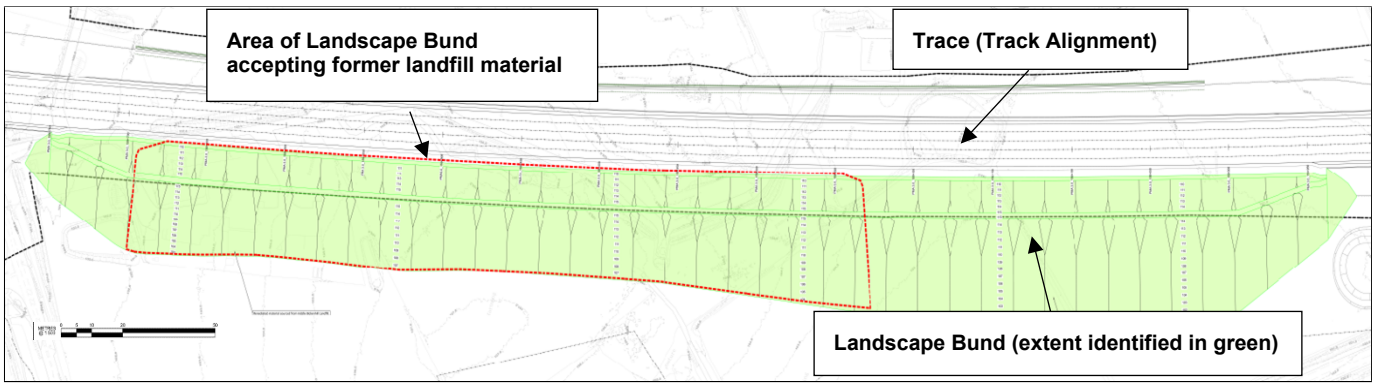


Source: HS2 Phase 1 MWCC web interface MOATA

The LoD specify the limits where the scheduled works may be constructed, and LLAU, is the area that outlines the additional limits for other works (e.g., ancillary works such as the provision of environmental mitigation), as well as the limits of land required in connection with the construction and future maintenance of the project.

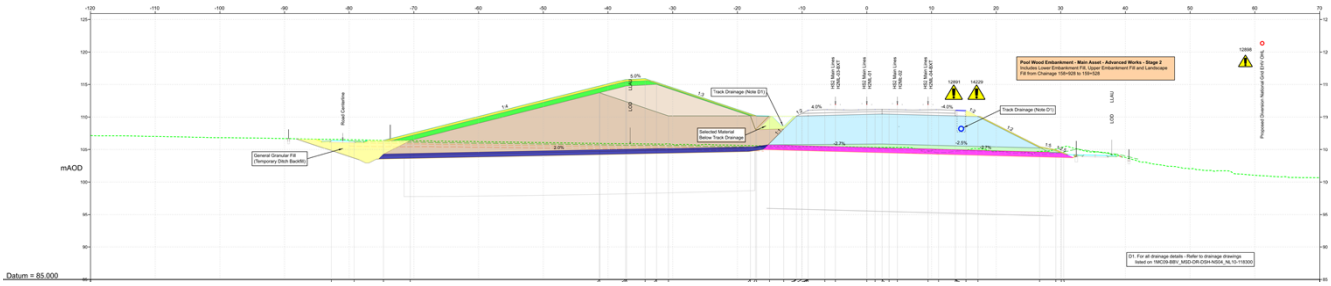
For the purposes of this report, contamination sources associated with material placement in the area to be permitted and receive landfill material will be considered.

Figure 4: Location of Site Boundary



Source: extract from HS2 drawing entitled "Pool Wood Embankment, Approximate Extent of Permitted Boundary", January 2024 (1MC09-BBV_MSD-CV-DPP-NS04_NL10-219402)

Figure 5: Cross-Section through Pool Wood Embankment Chainage 159 +500



Source: Balfour Beatty VINCI – drawing 1MC09-BBV_MSD-CV-DSE-NS04_NL10-218329 Rev P02 24/03/23

1.3 Report Context

This report is a qualitative gas risk assessment, based on a source, pathway, receptor approach. This report covers the gas risks resulting from the placement of material to form the section of the landscape bund to receive material from the landfill.

1.4 Reference Documents

Document Title	Document Number
WP 053(A) – BIS - Enabling Works - North Contract - Remediation Strategy Report - 29 October 2019[i].	1EW04-LMJ-EV-REP-NS07-053013 C02
Foundation Works Risk Assessment: Pool Wood Embankment - 24 August 2021[ii].	1MC09-BBV_MSD-EV-REP-NS04_NL10-100049 C01
Pool Wood Embankment Land Quality Management Report - 29 March 2022[iii].	1MC09-BBV_MSD-EV-REP-NS04_NL10-100167 C01,

2 SITE SETTING

2.1 Site location and description

The total length of Pool Wood Embankment will be approximately 1,414m. The length of the landscape bund is approximately 850m and runs from Ch. 158+920 to 159+775 on the west side of the Pool Wood Embankment trace. The red line boundary of the waste recovery permit within the landscape bund is 475m running from Ch 159+225 to Ch 159+700.

The height of the embankment associated with the trace varies along its length up to a maximum height from ground level to the top of the protection layer of approximately 11m (without considering the landscape bund). The width for the mainline embankment track bed is approximately 31m. The asset has a maximum side slope of 1:2. The maximum height of the site (and wider landscape bund) is 14m above existing ground elevations. The internal slope of the site and (and wider landscape bund) is 1:3 and the external slope is 1:4.

Historically, the site mostly comprised farmland. Aerial photos show that there is some construction taking place near the north of the site, adjacent to Coleshill Heath Road. This is likely to be associated with temporary works for HS2.

2.2 Geology

The published geology shows the following:

British Geological Society records were reviewed to assess geology at and near the site. Made Ground is recorded on or immediately to the east of the Site at approximate Ch 159+280 to 159+680.

Glaciolacustrine deposits (comprising of clay and silt) are present below the entire site, which are in turn underlain by Glaciofluvial deposits (comprising sand and gravel). Alluvial deposits (comprising clay, silt sand and gravel) are recorded approximately 300m to the east of the Site.

The site is underlain by up to approximately 10.0m of Glaciolacustrine Deposits and then 2.0 to 5.0m of Glaciofluvial Deposits.

The superficial deposits are underlain by the bedrock geology of the Mercia Mudstone Group, described as structureless with blocky weathering mudstone and siltstone.

The underlying bedrock is interpreted as Grade I / II Mercia Mudstone. There is an upper weathered horizon of Grade IV/V mudstone that is approximately 2.0m thick. There are limited groundwater strikes recorded at the site. Information indicates that groundwater lies at around 92mAOD in the mudstone and at the boundary between the Glaciolacustrine and Glaciofluvial Deposits (~96.0 and 102.0mAOD).

Table 1 provides a summary of the geology recorded during ground investigations at and near Pool Wood Embankment.

Table 1: Geology

Strata	Distribution	Typical depth range (m bgl)	Description
Topsoil	Located across the Site	0 to 0.50	Mixture of granular and cohesive. Mostly recorded as agriculturally reworked deposits. Generally described as clay or sand.
Made Ground	3 of 3 window samples 6 of 11 cable percussion boreholes 1 of 13 rotary drilled boreholes 1 of 10 trial pits (encountered at the southern and northern boundary and the centre of the Site)	0 to 5.65	Mixture of granular and cohesive materials. Mostly described as sand and gravel and clay. Gravel includes ash, flint, brick, concrete, glass, and charcoal
Glaciolacustrine Deposits	5 of 11 cable percussion boreholes 3 of 13 rotary drilled boreholes (encountered in the centre and northern part of the Site)	0.50 to 11.1	Mostly cohesive described as sandy silty or sandy clay.
Glaciofluvial Deposits	Encountered across the Site in all boreholes	3.2 to 12.60	Mixture of granular and cohesive. Granular materials mostly described as fine to coarse sand and cohesive as sandy clay.
Weathered Mercia Mudstone Group (Grade III/IV)	Encountered across the Site in all boreholes	0.80 to 15.00	Very high strength reddish orange, brown silty CLAY
Unweathered Mercia Mudstone Group (Grade I/II)	Encountered across the Site in all boreholes	8.61 to 35.60 (depth not proven)	Very weak, medium to thickly bedded, reddish brown MUDSTONE. Bedding is horizontal, undulating, smooth and clean

2.3 Published hydrogeology

The published geological units identified at the Site and surrounding area have the following aquifer characteristics, as determined by the Environment Agency (EA):

- Glaciofluvial and Alluvial deposits – Secondary A aquifers, which contain permeable layers capable of supporting water supplies at a local scale, and in some cases forming an important source of base flow to rivers.
- Glaciolacustrine deposits – Non-productive.
- Mercia Mudstone Group – Secondary B aquifer, which contain predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering.

3 SITE CONCEPTUAL MODEL REVIEW

3.1 Overview

For the purposes of this study, contamination and environmental considerations are studied by developing a conceptual model of the Site that describes the environmental features of the Site together with the expected interaction of potential contamination sources and the wider environment. There are three components to any site conceptual model, as summarised below:

- Source – Potentially gas generating components of the material placed
- Pathways – Routes linking the source with the receptors
- Receptors – Aspects (human health and property) that could be impacted by the presence of gas

Risks are defined qualitatively using the probability x consequence ratings summarised in Appendix A

3.2 Source

The material that is to be used in the construction of the Site will arise from the Middle Bickenhill landfill. It is expected that up to 90% of ~178,800m^3 to be excavated from the landfill (up to ~161,920m^3) will be used at the Site.

The Middle Bickenhill landfill was operational between 1962 and 1985. It accepted inert, industrial, commercial, household, and special wastes.

A ground investigation was undertaken, which showed the widespread presence of asbestos in fill materials (16 out of 50 samples analysed). In addition, there were locally elevated hydrocarbons, polyaromatic hydrocarbons (PAHs) and metals recorded in fill in excess of the Generic Assessment Criteria (GAC) for parks / open spaces.

According to the BIS Remediation Strategy[i] there were elevated ground gas concentrations recorded with peaks of 26% v/v carbon dioxide and 56% v/v methane within Middle Bickenhill Landfill. Depleted oxygen was also recorded (down to 0.1% v/v). Maximum peak flow rates of 12.7 l/hr and 10.2 l/hr were recorded from a specific location; however, steady flow rates from this location were much lower at between 0.0 and 0.1l/hr. Steady state flow rates recorded from all wells installed in the fill material ranged from 0 to 2.1 l/hr. The raw data supplied for the site casts some soubt on the detailed conclusions with the highest flow rates occurring at the end of monitoring periods or during single spot monitoring events. However, the general trends across the site are consistent with peak flow rates from other holes not exceeding 6.3l/lr and typically <2.5l/hr across the landfill.

Water was observed in seven of the 24 exploratory holes where Made Ground was encountered. These water strikes were located either near the base of the landfill in granular soils (and so potentially in continuity with groundwater) or at shallower depths and recorded as “seepages” only. Both inorganic and organic contaminants were recorded in shallow groundwater exceeding the Environmental Quality Standards and Drinking Water Standards (including total petroleum hydrocarbons, boron, hexavalent chromium, zinc, cyanide, ammoniacal nitrogen, PAHs and phenol). A subsequent Detailed Quantitative Risk Assessment (DQRA)[iv] was undertaken in advance of the Remediation Strategy to assess the risks from these contaminants in the Secondary A Aquifer to the eastern (down gradient) HS2 site boundary (LOD). Exceedance of the derived site-specific assessment criteria (SSAC) were recorded for inorganic

and organic contaminants (including boron, zinc, hexavalent chromium, ammoniacal nitrogen and phenol).

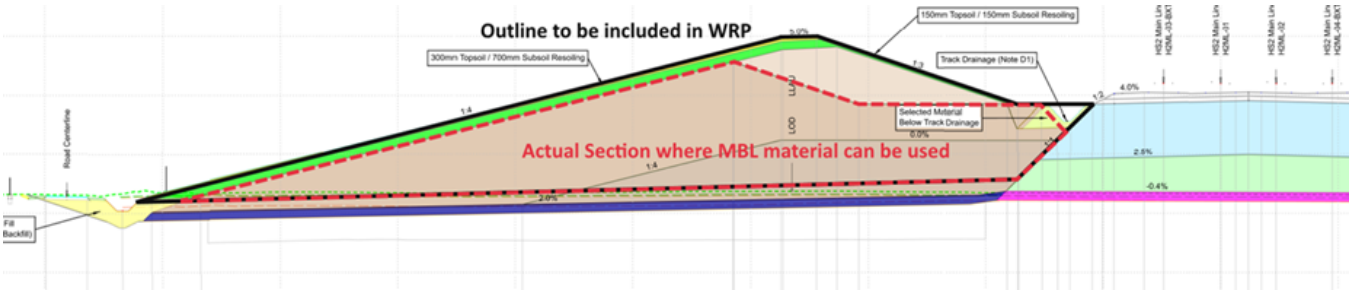
Japanese Knotweed is present across a wide area of the landfill.

A Remediation Implementation Plan is being developed that will ensure that the wastes with the greatest concentration of potentially polluting organic wastes are removed for incineration, together with measures to manage the Japanese Knotweed. It is expected that the remediation strategy will be based on screening to remove oversize materials (for future crushing) and to improve the quality of the fill for reuse and compaction. This operation will be undertaken in accordance with an Asbestos Management Plan. Following screening, the material will be subject to chemical and geotechnical testing to determine the materials suitability for use. The remaining material following recovery operation is largely expected to comprise crushed / suitable fills meeting a landscape specification.

3.3 Pathways

Figure 6 shows that the material sourced from the Middle Bickenhill Landfill will form a central core of the bund and will be covered by a one metre thick soil cover layer.

Figure 6: Cross-section through the Pool Embankment landscape bund



There are two principal pathways whereby gas resulting from the degradation of organic matter has the potential to affect on-site and off-site receptors. These include:

- Fugitive emissions of gas from the surface of the deposited material into the atmosphere where they will be diluted and dispersed; and
- Lateral migration of gas through the subsurface soils.

Human exposure to landfill gas emissions in the atmosphere may arise via a number of pathways as follows:

- Direct inhalation of airborne contaminants and particles, including airborne contaminants that may arise from lateral migration of landfill gas;
- Deposition of contaminants onto soils, vegetation and surfaces and subsequent ingestion of soils, vegetation and deposited dust;
- Dermal contact with contaminated soils and dust; and
- Contamination of vegetation via deposition and uptake through leaves and roots.

A further, and typically negligible pathway is human exposure to contaminants that are present in the gas. This can occur from the ingestion of other food products such as locally grown dairy products and meat (exposure occurs by the animal ingesting contaminated soils and vegetation). However, this is not applicable as HS2 will retain ownership and the bund will be used for landscaping. It will not be transferred over for agricultural uses and public access will be prohibited.

Lateral gas migration is unlikely, as firstly the materials used in the construction of the Site will form an above-ground feature, but also as shown in Figure 6 will be underlain with a 350mm thick drainage blanket that will form a preferential pathway for any gas generation. The permeability of the drainage layer will be significantly greater than the underlying Glaciolacusterine Deposits. These deposits have a relatively low hydraulic conductivity varying between 1.8 x 10^{-9}m/s to 3.6 x 10^{-6}m/s.

Atmospheric pollution is possible, as the placed material will not be covered by an impermeable barrier. Therefore, the main migration pathway for gas will be the emission to atmosphere through the surface of the deposited materials.

Other trace gases, such as hydrogen sulphide and other odorous gases could be generated.

3.4 Receptors

There are several properties within 250 metres of the Site. The closest properties are part of the Waterside Centre Business Park to the south and west of the embankment.

The closest residential properties are those on Bluebell Drive, which are approximately 320m to the northwest of the Site. There are no properties within a relevant distance to the east of the Site, as it is bordered by the M42 and beyond, the A446 roads.

The global environment (atmosphere) could also be considered to be a potential receptor for gases generated through organic material degradation.

3.5 Risk assessment

For there to be a major risk to the potentially sensitive receptors each part of the source, pathway, receptor approach has to be in place. In reality, the risk to sensitive receptors through lateral migration is very low because the material is placed above ground and any potential lateral movement would be collected in the granular base layer, which connects to a drainage layer along the western extremity of the Site (and wider landscape bund).

The only potential impacts are, therefore, through global atmospheric pollution and odour from trace elements. In reality, measures will be taken to limit the extent of atmospheric emissions and odour impacts through the use of the waste recovery plan. The material imported will be screened to remove oversized materials and “black bag waste” and other visible degradable inclusions such as timber, and will restrict the organic nature of the material placed. In addition, the waste is relatively old as the Middle Bickenhill landfill last received waste in 1985. Therefore, much of the biodegradation of the waste matter will already have occurred. It is possible that movement of this material may encourage some aerobic degradation to occur, but this should be short-lived and would not result in the more harmful organic compounds being developed.

Overall, the impact to the environment resulting from gas generated from the biodegradation of the waste should be very low.

4 CONCLUSIONS

4.1 Gas management requirements

Gas management requirements will essentially be covered during the construction. Measures will be taken to screen the most potentially contaminating materials from the source for disposal off-site. In addition, the material will be placed on a granular drainage blanket and be filled above ground level, thus removing the potential for lateral migration of gases.

The gas generation resulting from the material placed is unlikely to cause significant impacts and the risks to human health and property post development are considered to be very low. Assuming that good practices are adopted, and risk assessments and method statements are followed, the risk to construction workers should also be very low. It is, therefore, proposed that no further gas protection measures are required.

Appendix A Qualitative Risk Assessment Definitions

The qualitative risk summaries for non-controlled waters are derived from the Environmental Statement Volume 5, Technical Appendices, Scope and methodology Report Addendum (CT-001-000/2), Annex F, (HS2, 2013)

Table A.1: Classification of probability

Classification	Definition of the Probability of Harm/Pollution Occurring
High Likelihood	The contaminant linkage exists and it is very likely to occur in the short term, and/or will almost inevitably be realised in the long term, and/or there is current evidence of it being realised.
Likely	The source, pathway and receptor exist for the contaminant linkage and it is probable that this linkage will occur. Circumstances are such that realisation of the linkage is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	The source, pathway and receptor exist and it is possible that it could occur. Circumstances are such that realisation of the linkage is by no means certain in the long term and less likely in the short term.
Unlikely	The source, pathway and receptor exist for the contaminant linkage but it is improbable that it will be realised even in the long term.

Table A.2: Classification of consequence (non-controlled water receptors)

Classification	Definition of Consequence
Human Health Receptors – Site End Users	
Severe	Acute damage to human health based on the potential effects on the critical human health receptor.
Medium	Chronic damage to human health based on the potential effects on the critical human health receptor.
Minor	Minimal short- term effects on human health based on the potential effects on the critical human health receptor.
Negligible	No appreciable impact on human health based on the potential effects on the critical human health receptor.
Ecosystem Receptors	
Severe	For sites with designations as follows – Site of Special Scientific Interest, National Nature Reserve, Special Protection Area (and potential sites), Special Area of Conservation (and candidate sites) or Ramsar. Irreversible adverse change in the functioning of the ecological system or any species of special interest that forms part of that system.
Medium	For sites with designations as follows – Site of Special Scientific Interest, National Nature Reserve, Special Protection Area (and potential sites), Special Area of Conservation (and candidate sites) or Ramsar. Substantial adverse change in the functioning of the ecological system or any species of special interest that forms part of that system.
Minor	Harm to ecosystems of a low sensitivity such as sites of local importance. No appreciable harm to ecosystems with statutory designations.
Negligible	Limited harm to ecosystems of low sensitivity such as sites of local importance.
Property Receptors – Buildings, Foundations and Services including the operational HS2 scheme	
Severe	Collapse of a building or structure including the services infrastructure from explosion due to ground gasses.
Medium	Significant damage to a building or structure including the services infrastructure impairing their function.
Minor	Damage to buildings/structures and foundations but not resulting in them being unsafe for occupation. Damage to services but not sufficient to impair their function.
Negligible	No appreciable damage to buildings/structures, foundations and services.
Property Receptors – Grade 1 Agricultural land	
Severe	Substantial loss in the value of crops or domestically-grown produce resulting from disease, death or other physical damage. Death to livestock, domesticated animals or wild animals subject to shooting or fishing rights.
Medium	Substantial diminution in yield of crops or domestically-grown produce resulting from disease, death or other physical damage. Serious disease or other serious physical damage to livestock, domesticated animals or wild animals subject to shooting or fishing rights.
Minor	Harm to crops but not resulting in a substantial loss in value or diminution in yield. Limited harm in terms

Classification	Definition of Consequence
	of disease or other physical damage to livestock, domesticated animals or wild animals subject to shooting or fishing rights.
Negligible	No appreciable harm, or harm to a low sensitivity receptor.

The qualitative risk summaries for controlled waters are derived from HS2 Technical Standard – groundwater protection Document number HS2-HS2-EV-STD-000-000010.

Table A.3: Classification of Probability (Controlled Waters)

Classification	Definition
High likelihood	There is a linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a linkage and all the elements are present and in the right place, which means that it is probably that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table A.4: Classification of Consequence (Controlled Waters)

Classification	Criteria	Example
Major	Adverse: Loss of an attribute and /or quality and integrity of an attribute	Adverse: Increased flood risk to essential infrastructure, highly or more vulnerable developments; loss of a fishery; decrease in surface water ecological or chemical WFD status or groundwater qualitative or quantitative WFD status
	Beneficial: Creation of new attribute or major improvement in quality of an attribute	Beneficial: Creation of flood plain and decrease in flood risk; increase in productivity or size of fishery; increase in surface water ecological or chemical WFD status; increase in groundwater qualitative or quantitative WFD status.
Moderate	Adverse: Loss of part of an attribute or decrease in integrity of an attribute	Adverse: Increased flood risk to less vulnerable developments; Partial loss of fishery; measurable decrease in surface water ecological or chemical quality or reversible change in the yield or quality of an aquifer, affecting existing users, but not changing any WFD status
	Beneficial: Moderate improvement in quality of an attribute	Beneficial: Measurable increase in surface water quality or in the yield or quality of aquifer benefiting existing users but not changing any WFD status
Minor	Adverse: Some measurable change to the integrity of an attribute	Adverse: Increased flood risk to water compatible development or impact which does not affect existing or any possible future developments; measurable decrease in surface water ecological or chemical quality; decrease in yield or quality of aquifer not affecting existing users or changing any WFD status
	Beneficial: Measurable increase, or reduced risk of negative effect to an attribute	Beneficial: Measurable increase in surface water ecological or chemical quality; increase in yield or quality of aquifer not affecting existing users or changing any WFD status

Negligible	No change to integrity of attribute	Negligible change to flood risk; discharges to watercourse or changes to an aquifer which lead to no change in the attribute's integrity

Table A.5: Comparison of Magnitude of Effect (Consequence) Against Probability

	Consequence			
Probability	**Major**	**Moderate /Medium**	**Minor**	**Negligible**
High likelihood	Very high risk	High risk	Moderate risk	Moderate/low risk
Likely	High risk	Moderate risk	Moderate/low risk	Low risk
Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Table A.6: Estimation of Risk (All receptors)

Risk	Definition
6 (Very High risk)	There is a high probability that a contaminant linkage could exist between a source and a designated receptor resulting in detriment to the receptor. Investigation and remediation will be required prior to (or as part of) construction. During construction further mitigation and monitoring measures (in accordance with the draft Code of Construction Practice (CoCP)) are likely be required. Such sites are considered significant.
5 (High Risk)	It is likely that a contaminant linkage exists with potentially a severe affect on designated receptors. Investigation and remediation is very likely to be required. Such sites are considered significant.
4 (Moderate risk)	It is possible that an effect could arise to a designated receptor through a contaminant linkage. However, the effect is most likely to be moderate to minor. Further investigative work is likely to be required to clarify the risk. Some remediation works may be required. Such sites may be considered significant.
3 (Moderate / Low Risk)	It is possible that a contaminant linkage could exist, but if it does, any effects would normally be minor. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.
2 (Low risk)	It is a low possibility that a contaminant linkage could exist. However, should there be a linkage the effect to the receptor (with regards to controlled waters) would normally be minor or negligible and the effect on human health would be negligible. No investigation or remedial works are likely to be required.
1 (Very Low risk)	It is unlikely that a contaminant linkage could exist between a source and a designated receptor.

Appendix B References

[i] Laing Murphey (2019): WP 053(A) – *BIS - Enabling Works - North Contract - Remediation Strategy Report* - Document no.: 1EW04-LMJ-EV-REP-NS07-053013 C02, 29 October 2019

[ii] Mott MacDonald / Systra (2021): *Foundation Works Risk Assessment: Pool Wood Embankment* - Document Number: 1MC09-BBV_MSD-EV-REP-NS04_NL10-100049 C01, 24 August 2021

[iii] Mott MacDonald / Systra (2022): *Pool Wood Embankment Land Quality Management Report* - Document Number: 1MC09-BBV_MSD-EV-REP-NS04_NL10-100167 C01, 29 March 2022

[iv] Laing Murphey (2019): WP 053(A) – *BIS - Enabling Works - North Contract – Land Quality Assessment Report* – Document number 1EW04-LMJ-EV-REP-NS07-053011