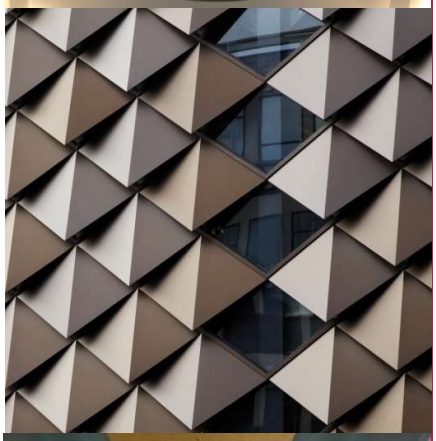

North Bierley WWTW, Bradford

Ground Investigation Report

Curtins Ref: 065646-CUR-00-XX-RP-GE-001

Revision: V01

Issue Date: 03 December 2019

Client Name: Opus North

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Rev	Description	Issued by	Checked	Date
V01	*Issue*	MB	ML	03 December 2019

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Executive Summary

Appointment	In September 2019, Curtins were instructed by Fox LLoyd Jones on behalf of Opus North to undertake a Phase 2 Site Investigation for a commercial re-development of the former North Bierley WWTW, Bradford. The site is centred on National Grid Reference SE 17984 27441.
Current Site Status	The site comprises a large rectangular plot of land to the east of the M606, and north of the M62. The site is predominantly occupied by the inactive sewage treatment works, with adjacent fields to the west within the site curtilage. The site topography generally slopes from approximately 112mAOD in the northwest the 91mAOD in the south, although with abrupt changes within the area of the WWTW.
Fieldworks	Fieldworks were carried out between 1st - 4th October 2019 and comprised 16 window sample holes advanced to a maximum depth of 5.00m bgl. A trial trench excavated to the west of the site to investigate the location of recorded historic mine shafts. Groundwater monitoring standpipes were installed in 6 window samples, in order to monitor groundwater levels for drainage design. Selected soil samples were scheduled for chemical and geotechnical analysis.
Ground Conditions	Made ground was encountered in each location to a maximum depth of 3.0m. It was generally encountered as a dark grey to brown sandy gravelly clay. Made ground was underlain by superficial deposits, generally recovered as a soft to firm dark grey to brown sandy gravelly clay. Bedrock was not encountered during this investigation
Geo-environmental Assessment	One exceedance of the adopted '*Commercial*' end use General Assessment Criteria was recorded in the soil samples tested, in the form of Cyanide. However, the exceedance is not considered to present a significant risk to future site occupiers. Overall the risk to end-users from this exceedance is considered to be low. The risk presented to controlled waters (Groundwater and Surface Waters) is assessed as Low. The site has previously been classified as CS-1. No formal remedial works are considered necessary A remedial strategy / development statement should be produced to consider imported soils and unexpected contamination.
Geotechnical Assessment	The ground conditions present at the site are noted to be highly variable. In particular the depth of made ground, the presence of soft natural soils and made ground also presents a geohazard for shallow foundations. Due to highly variable nature of the ground conditions encountered, it is anticipated that variable founding solutions may be required. It is advised that where poor ground conditions are present locally, options such as; Piled foundation; Ground improvement (Stone Columns, soil modification, surcharge). Excavation & re-compaction; are considered in an optioneering exercise. Optioneering of a suitable foundation solution should be furthered by production of a detailed specification for each plot. For shallow foundation solutions, the ground should be engineered in a manner to allow sufficient bearing capacity to be achieved whilst ensuring settlement remains within tolerable levels. The presence and removal of underground obstructions needs to be considered. The presence of an unrecorded 'landfill' will need to be considered within foundation design, with potential for further investigation and assessment.
Recommendations	The following recommendation are made for future works; - Geotechnical optioneering to consider the most efficient foundation solution for each plot; - Earthworks strategy, site wide and tailored to each plot; - Mine shaft treatment strategy and mine shaft cap design; - Remediation strategy / development strategy

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Appendices

1.0 Introduction

1.1 Project Background

In September 2019 Curtins were instructed by Fox Lloyd Jones on behalf of Opus North to undertake a Ground Investigation for the proposed developments at North Bierley WWTW, Bradford. This Ground Investigation Report (GIR) has been produced in support of the proposed development.

It is proposed that the site is re-developed for a commercial end use, comprising a series of units over the development area. It is understood that the site will undergo a package of enabling works comprising cut and fill to provide a level development platform across the site.

The site is located on approximate National Grid Reference (NGR) SE 17984 27441.

The current development plans are presented within *Appendix A* of this report.

A separate Coal Mining Risk Assessment (CMRA) has been prepared for the site (ref; 065646-CUR-00-XX-RP-GE-001). This report should be read in conjunction with the CMRA.

1.2 Scope of Works

This report includes a review of the readily available information for the site and the recent ground investigation undertaken by Curtins. This report will provide an assessment of the geo-environmental and geotechnical conditions across the site to present an account of the ground and groundwater conditions along with any anticipated limitations or constraints caused by contamination or geohazards. The Phase 2 report is intended to determine:

a) Presence of shallow site soil or groundwater contamination which would adversely impact the end-user;
b) Presence of contamination (soil or groundwater) which would adversely impact controlled waters;
c) Presence of ground gas which would adversely impact the end-user; and
d) Likelihood of the proposed works being adversely impacted by geo-hazards across the site.
e) Groundwater level monitoring for drainage design – REPORTED UNDER SEPARATE COVER

In addition, recommendations for potential foundation solutions for the proposed structures will be provided.
Detailed flood risk assessment, ecology and archaeological studies are outside of the scope of this report.

2.0 Site Setting

This section presents a summary of the current site setting, history, geology and hydrogeology/hydrology.

2.1 Available Sources

A Phase 1 and Phase 2 ground investigations have previously been undertaken for the site by Wardell Armstrong in 2017. The reports cover a wider area than the site in question. A review of the reports has been undertaken, with pertinent information included as part of this study.

Other sources of relevant information reviewed for this scheme comprise:

- British Geological Society (BGS) Map Sheet 77, Scale 1:50,000 Huddersfield Solid and Drift Geology (British Geological Society, 2003)
- BGS GeoIndex Online Map Viewer (British Geological Society, 2019)

2.2 Current Setting

The site is accessed down an unnamed road off Cliffe Hollins Lane, to the east of the M606.

Figure 2.2 shows the site location.

Figure 2.2 *Site Location Plan (approx. site boundary shown in red), centred on National Grid Reference SE 17984 27441.*

The site topography varies, with a slope down from the western side to the eastern side. Site levels range from approximately 112m AOD in the northwest to 91m AOD in the south.

Site topography is not uniform, with several slopes giving the majority of topographic change. The eastern site area (former WWTW) is generally flat.

The surrounding land use is presented in ***Table 2.2***.

Table 2.2 *Surrounding Land uses*

Surrounding Area	N	Fallow land with residential and commercial properties beyond.
	E	Fallow land.
	S	Fallow land with the M62 beyond.
	W	Fallow land with the M606 and residential properties beyond.

2.3 Previous Site Use

A review of the available historical maps has been undertaken, a summary of which is provided below:

- 1850s. The site is predominantly occupied by agricultural fields.
- 1890s. By the 1890s a sewage works is present at the northern end of the site. Valley Pit (coal and ironstone) is shown to the west, connected to a lower coal pit in the south by a tramway. Adjacent to where the Valley Pit is marked on maps is a triangular shaped area, recorded as a pit / surface depression.
- 1908. Valley Pit is recorded as an 'old coal pit'. Rope works, chemical works, mills and a pumping engine are all present directly to the south of the site. The majority of the surrounding area is still occupied by agricultural land.
- 1930s. The previous coal pits are no longer labelled but are still differentiated from regular land on the maps. The sewage works footprint has expanded to include filter beds to the southwest of the main plan area.
- 1960s. Tramways are no longer recorded on the site. Further expansion of the sewage works over to the west is recorded.
- The site has remained in this condition until present day.

The contaminants likely to be present from the historic site and surrounding area uses include, but are not limited to: asbestos within construction materials, petroleum hydrocarbons from localised fuel spillages, and inorganic compounds including metals & non-metals from historic industrial uses.

2.4 Geology and Hydrogeology

The geological sequence underlying the site, from a review of the British Geological Survey (BGS) borehole records and the GeoIndex Onshore map (British Geological Society, 2019) is summarised in

Table 2.4 *Geological/Hydrogeological Succession*

	Geology	Associated Hydrogeological Classification
Artificial	BGS maps record made ground to be present at the eastern side of the site, where the water treatment works are located. No made ground is recorded in the fields to the west of the site area.	N/A
Superficial	Alluvium is recorded to be present on the eastern edge of the site.	Secondary (A) Aquifer[2]
Bedrock	Pennine Lower Coal Measures[1]	Secondary (A) Aquifer[2]

Notes:

1. Pennine Lower Coal Measures comprise interbedded grey mudstones, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower parts and thicker coal seams in the upper part.
2. Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

2.4.1 Existing Ground Investigation/BGS Data

A previous site investigation has been conducted on the site by Wardell Armstrong, discussed in detail in Section 3.0.

2.5 Hydrology

The nearest surface water feature to the site is at the eastern border, Hunsworth Beck trends northwest to southeast.

The western part of the site lies in Flood Zone 1. The central part is mixed between Flood Zones 1 and 2 and the eastern boundary is in Flood Zone 3.

2.6 Mining

The site lies outside a coal mining development high risk area with the exception of the immediate vicinity around two mine shafts present on site, as such a separate Coal Mining Risk Assessment report has been prepared by Curtins (ref. 065646-CUR-00-XX-RP-GE-001) and is summarised in Section 3.0.

2.7 Unexploded Ordnance

The Hazard Screen asks two key questions:

Are there any indicators of former military uses on the site? No (no evidence on historical mapping and internet searches).

Are there indicators of historical bombing on the site? No, Bradford was subject to bombing during the Second World War (various online sources), however, there is no evidence of the site itself having received direct strikes from ordnance (no change in footprint on historical mapping and internet searches). No UXO have been discovered in previous investigations across the site.

Conclusion: No indicators of military land use or historical bombing are noted on site and therefore, no further risk assessment is recommended for ground investigation works.

Recommendations: It is recommended that a generic emergency response plan is put into place, for all planned activities, to deal with any unforeseen UXO encounters.

2.8 Ground Gas

There are no recorded historical or other landfill sites within 250 m of the site.

The UK Radon Mapping (UK Radon, 2019) confirms that the property is in a lower probability radon area, where 1-3% of properties are estimated to be above the radon action level. On this basis, basic radon protection measures are not considered necessary within the construction of new dwellings or extensions.

Ground gas monitoring has been previously undertaken by Wardell Armstrong. This information is presented in Section 3.0 and further considered in Section 7.3.

3.0 Summary of Existing Reporting

As noted in Section 1.1 several existing geo-environmental reports have been produced that relate, in part or fully, to the proposed development site. These reports have been reviewed in support of the design of this ground investigation and include, in chronological order:

- 'Phase 1 Environmental Assessment', Wardell Armstrong, original draft issue June 2012, re-issue November 2017 (ref. SH10534, RPT-004).
- 'Phase 2 Geo-Environmental Assessment', Wardell Armstrong, November 2017 (ref. SH10534, RPT-002c)
- 'Coal Mining Risk Assessment', Curtins, November 2019 (ref. B065646-CUR-00-XX-RP-GE-001)

It is assumed that the reader of the report has access to the reports listed above and therefore, for the purposes of this reporting, a summary of the key findings is presented in the table hereafter.

Where reference is made to 'the site' it should be noted that previous investigation (Wardell Armstrong reports) covered a larger site area than the illustrated in Figure 2.2. Curtins have considered the relevant factual and interpretive information of the previous reporting in subsequent Sections of this report.

Pertinent information from each of these reports is also included and referenced in the appropriate interpretive sections of this reporting.

Report Reference	Scope of Works	Summary of Ground Model	Summary of Geotechnical Testing	Summary of Environmental Testing and Monitoring	Conclusions and Recommendations
Phase 1 Environmental Report - Wardell Armstrong, 2017	Desk-based investigation prepared for an outline planning application for site redevelopment. Review of 2006 URS Corporation Ltd Phase 1 and Wardell Armstrong 2012 Phase 2 (see above).	N/A	N/A	N/A	Site presents a low to moderate risk from past use, adjacent operations and ground instability. 'There is no risk to human health from soils on site' and a low risk to controlled waters. Further shallow coal mining investigation is required. CS2 gas protection measures required in the extreme south of the site. CS1 And therefore no ground gas protection is required across the rest of the site. Asbestos survey recommended prior to building demolition. Flood Risk and Drainage Strategy to be consulted prior to redevelopment.
Phase 2 Geo-Environmental Report - Wardell Armstrong, 2017	Intrusive investigation to further identify contamination issues previously identified at the site (within Phase 1 report). Revised report from 2011 investigation.	The site geology comprises made ground up to 8.4m thick. Made ground was encountered within the majority of boreholes. Made ground was underlain by a 3.5m thick layer of sandy gravelly clay, locally cobbly with rare boulders and occasional layers of clayey sandy gravel of weathered coal measures. Bedrock was encountered as a weak to moderately strong sandstone and mudstone bedrock was encountered. Bedrock was proven to 30m bgl. Evidence of shallow mine workings in the south of the site, indicated to be in the Shertcliffe Bed. No intact coal was identified but broken/soft ground was recorded between 11.3m bgl and 16.7m bgl in BH6 at the south end of the site (off the current development site). Groundwater level has been encountered between 2m and 9m bgl, assumed to be natural groundwater level in the coal measures bedrock. Soakaway testing in five trial pits returned two infiltration rates of 2.708 x 10^{-4} m/s and 2.197 x 10^{-4} m/s, with no infiltration being observed in the other three trial pits.	SPTs ranged from 20 to refusal in natural soils, and 30 to refusal in the weathered coal measures bedrock. Sulphate testing indicates a worst-case design sulphate class of DS-2 and Aggressive Chemical for Concrete (ACEC) class of AC-2. The weathered coal measures are described as firm to very stiff. For cohesive natural soils, an undrained shear strength ranging 32kPa to 161kPa was identified in undrained triaxial testing. Natural soil moisture content testing returned results between 9.4% and 32%. Plasticity index between 9% and 25% was recorded in the natural soils.	No contaminants exceeded the commercial human health screening thresholds chosen for the proposed end use of site. An overall low to moderate risk was identified to controlled waters, as medium to long chain hydrocarbon values were elevated with respect to the UK DWS in the southern part of the site. Low quantities of methane and moderate concentrations of carbon dioxide were recorded. A CS1 classification was assigned. In the far south of the site outside the current development footprint one borehole recorded elevated gas concentrations leading to a CS2 classification for this area. Groundwater was monitored as fluctuating over the monitoring period. Groundwater flow direction analysis was inconclusive, with an overall groundwater flow to the southeast inferred.	No elevated concentrations of contaminants were identified with respect to the proposed end use (commercial) screening thresholds, therefore there is unlikely to be a risk to long term human health. Further investigation with respect to mining is proposed. Ground gas CS2 protection measures are likely to be required in the south of the site, with the remainder of the site having a CS1 classification, with no further action required.

Report Reference	Scope of Works	Compiled Information	Conclusions and Recommendations
Coal Mining Risk Assessment – Curtins, 2019	CMRA in support of redevelopment, to review and assess the site with respect to the potential impact of mining or mineral extraction activities.	Historic maps indicated mining activities on site from c. 1893. Shallow workings identified on site in southern area during Wardell Armstrong investigation (2011, see above). Topographically, the site lies within a valley. On BGS maps, the Shertcliffe seam outcrops to the east and west of the site, but is absent across the site, implying the seam has been eroded away in the production of the valley. The site is likely to be underlain by coal seams stratigraphically older than the Shertcliffe seam, namely the Black Bed and Better Bed seams. Historic BGS borehole data in the south east shows possible Shertcliffe coal seam at 11.1 – 12.0m bgl in the form of seatearth and siltstone. The Shertcliffe is determined to only be present on the south side of the site, outside of the current development area. Two mine entries are recorded on site by the Coal Authority, at depths of 66m (Bateman shaft) and 91.4m (Valley shaft) bgl, assumed to be targeting the Black Bed and Better Bed seams respectively. The Bateman shaft was identified in the Curtins 2019 intrusive investigation, but the location of the Valley Pit shaft was not. During this investigation, an informal landfill area was uncovered at the expected location of the Valley Pit shaft, comprising a loose sandy gravelly ash with lime overlying.	There are no records of surface coal mining on-site, therefore the risk is considered negligible. Geology and topography of the site indicate coal seams are not present beneath the site at shallow (<30m) depths. Coal extraction of the Black Bed and Better Bed seams has taken place at depths of 66m and 90m bgl respectively, presented in the two mine shafts recorded on site. Only one mine shaft was identified in the intrusive investigation, however, it is considered likely that the second pit is present on site. Mine shaft treatment is required, with the following recommendations: • A mine entry treatment plan or design should be completed for both shafts (Bateman and Valley Pit) • Further investigation to identify the Valley Pit shaft • Design of remedial works must account for the impacts of cut and or fill to achieve development levels. • Treatment design should consider the use of a soil founded shaft cap, with full grout treatment of the mine shaft.

4.0 Conceptual Site Model & Qualitative Risk Assessment

The Conceptual Site Model (CSM) and Qualitative Risk Assessment (QRA) are presented in the table within this section.

The CSM details the source-pathway-receptor linkages or potential contaminant linkages (PCLs) that have been identified for the site. The QRA details the associated level of risk relating to these PCLs.

The CSM and QRA concern the major risks to human health and controlled waters with additional, more specific risk assessment protocols contained within the main body of this reporting, as detailed in Section 4.1 below.

The QRA follows the framework outlined within CIRIA C552 which is summarised within Appendix C.

The 'risk rating' within the QRA refers to the risk that the source, pathway, receptor linkage or PCL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

4.1 Additional Risk Assessments

The following risk assessments, listed below, are not included within the main CSM and QRA but none-the-less can be of critical importance to the onward development of the site.

- The risk presented by **Mining and Mineral Extraction** is discussed and assessed in Sections 2.6 and 3.0, and in the separate Curtins 2019 Coal Mining Risk Assessment (ref. B065646-CUR-00-XX-RP-GE-001).
- The risk presented by **Radon** is discussed and assessed in Section 2.8.
- The risk presented by **Unexploded Ordnance** is discussed in Section 2.7.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements and therefore construction workers involved in the building works at the site have been discounted as a human receptor in the conceptual site model.

- The table below represents the first stage in the land quality risk assessment process; **the Qualitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be brought down to acceptable levels, i.e. low to negligible risk. The purpose of each stage of risk assessment is ultimately to establish if there is a requirement for additional levels of assessment to be made in order to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.

Conceptual Site Model			Qualitative Risk Assessment			Action
Source	**Pathway(s)**	**Receptor(s)**	**Consequence (Potential Severity)**	**Likelihood of Occurrence**	**Risk Rating**	
On-site sources of potential contamination: Made ground is the primary anticipated source of contamination on site. Contaminants expected within the made ground are include: Asbestos, hydrocarbons, solvents and heavy metals. On-site historic industrial processes which may give rise to gross contamination.	**Inhalation of vapours (Direct contact and ingestion of soils have been discounted due to no proposed soft landscaping areas)**	**End users of site** Future site occupiers	**Medium** Chronic health risk	**Low Likelihood** Made ground deposits are anticipated based on the identified phases of historic development and are recorded in the previous ground investigation by Wardell Armstrong. Although contamination is expected to be present at the site, the lower sensitivity use of the site as a commercial unit decreases the risk to development. The previous Wardell Armstrong investigation identified no contaminant exceedances against the relevant screening thresholds.	**Moderate / Low**	Intrusive ground investigation to inform a generic quantitative risk assessment (GQRA)
	Vertical migration through the made ground and residual soils) May occur due to processes including; capillary action, burrowing animals inducing soil mixing and downwards into the natural deposits through infiltration.	**Controlled waters (Groundwater)** Superficial and Bedrock – Secondary A No abstractions within 500m of the site.	**Medium** Pollution of sensitive water resources	**Low Likelihood** The nearest surface water receptor is Hunsworth Beck at the eastern perimeter of the site. The site is susceptible to flooding. The previous Wardell Armstrong investigation identified no contaminant exceedances against the relevant screening thresholds for the current development area. The underlying soils and bedrock are recorded in previous investigations as cohesive in nature. Overall the risk to controlled waters is assessed as low.	**Moderate / Low**	Confirm ground conditions as comparable to previous investigations and confirm absence of gross contamination.
		Controlled waters (Surface water) Unnamed stream at eastern site boundary.	**Medium** Pollution of non-sensitive water resources			
Off-site sources of potential contamination: Made ground is considered the primary source of contamination in the vicinity of the site, due to previous phases of development and historic industrial land uses in the surrounding area.	**Horizontal migration through the shallow soils and air (dust/particulates)** Followed by… Direct contact, ingestion, inhalation (dust)	**End users of site** Staff and visitors.	**Medium** Chronic health risk	**Low Likelihood** Although the surrounding areas of the site have experienced cycles of industrial development, the risk of off-site contamination is considered no worse than that anticipated to be present on site.	**Moderate / Low**	Intrusive ground investigation to inform a generic quantitative risk assessment (GQRA)
On-site and off-site sources of potential ground gas generation Made ground associated with historic site uses Coal mining history	**Vertical and horizontal migration through the superficial (incl. made ground) and bedrock deposits**	**End users of site** Residents and visitors	**Severe** Acute health risk, e.g. asphyxiation or risk from explosion	**Unlikely** With reference to BS8576 (2013) *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds,* organic inclusions within made ground & Natural sources are considered to have a Very Low to Low gassing potential. The Wardell Armstrong report identified a CS1 classification for ground gas measures across the footprint of the site, requiring no further measures.	**Moderate / Low**	**Qualitative Risk Assessment** to consider previous findings against current investigation.

5.0 Field and Laboratory Studies

5.1 Ground Investigations

Site investigation works were undertaken between 1st and 4th October 2019.

The scope of the ground investigation was designed in general accordance with current UK guidance including:

- CLR11 (Environment Agency, 2004)
- British Standard (BS) 10175 (British Standards Institution, 2011)
- BS5930:2015 (British Standards Institution, 2010)
- BSEN1997: Part 2:2007 Eurocode 7A (British Standards Institution, 2007)

A summary of the scope of the works and rationale is provided in ***Table 5.1***.

Table 5.1 *Scope and Rationale of Fieldwork Undertaken*

Exploratory Hole Type	Exploratory Hole Reference	Target Exploratory Hole Depth (m bgl)	Rationale
Window Sample Boreholes	WS101 to WS110	5.00	• Confirm ground conditions. • Collect soil samples for chemical analysis. • Undertake in-situ testing.
	WS111 – WS106	4.70	• Confirm ground conditions. • Collect soil samples for chemical analysis. • Undertake in-situ testing. Gas and groundwater level monitoring. Basin (Under separate cover)
Trial Trench	TP101	1.00	• Investigation to determine location of two recorded mine shafts

5.1.1 Trial Trenching

TP101 was excavated in the fields to the west of the WWTW, where the two mine shafts are recorded. A trench was excavated to a maximum depth of 1.0m bgl to determine the locations of the recorded shafts. The excavation was undertaken in accordance with the requirements of Coal Authority permit 18769.

The first identified shaft, at 2.2m in diameter with a double skinned brick lining, was encountered with the GPS tolerance of the recorded Bateman Shaft. The shaft was filled with a black cohesive soil backfill. The second mine shaft (the Valley Pit) was not positively identified, however an area of fill overlapping with the location of the valley pit was observed, which may be covering the shaft.

For the exploratory hole location plan refer to Curtins drawing Ref: 065646-CUR-00-XX-DR-GE-001-V01, *Appendix A*.

5.1.2 In-Situ Tests

In-situ testing has been undertaken during the ground investigation works. A summary is presented in ***Table 5.1.1***.

Table 5.1.1 *In-Situ Testing*

Activity	Rationale
SPT tests within Rotary and Window Sample boreholes	To obtain in-situ density

5.1.3 Laboratory Testing Summary

The exploratory holes were logged on site by a Curtins Engineer in accordance with the requirements of BS5930:2015, including recording of any observed visual and olfactory indications of contamination.

Copies of the exploratory hole logs are provided within Appendix B.

Representative soil samples were obtained for laboratory geotechnical and geochemical testing, based on the field observations.

Soil samples for geochemical analysis were placed in appropriate laboratory provided containers and stored in temperature-controlled conditions prior to being transported to a UKAS accredited laboratory under chain of custody documentation.

The representative soil and rock samples were collected and scheduled for laboratory geotechnical testing. Geotechnical samples were transported to a UKAS and MCerts accredited laboratory under chain of custody documentation for testing.

Geo-environmental - Soils

Soil samples were taken from shallow (<3.0m bgl) ground across the site, and the samples were tested for Curtins Suite B and D.

The contaminants of concern potentially present on the site were considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel/oils), heavy metals and asbestos the extent of which is captured by the environmental testing suites listed in ***Table 5.1.2***.

The presence of a former electrical substation had previously been investigated by Wardell Armstrong. Therefore, no further PCB testing was undertaken.

Table 5.1.2 *Environmental Chemistry Analysis Suite: Soils*

Suite Ref.	Analyte	LOD
Soils Suite B	Asbestos Screen, pH and Soil Organic Matter (SOM)	N/A
	Arsenic, Chromium, Chromium VI, Copper, Lead, Selenium, Zinc, Nickel	1 mg/kg
	Boron (water soluble)	0.2 mg/kg
	Cadmium	0.2 mg/kg
	Mercury	0.3 mg/kg
	Cyanide (total)	1 mg/kg
	Phenols (screen)	
	PAHs (USEPA 16)	0.05 mg/kg
	TPH (Aro/Ali Split)	0.01 to 10 mg/kg
Soils Suite D	Asbestos Screen, pH and Soil Organic Matter (SOM)	N/A
	Arsenic, Chromium, Chromium VI, Copper, Lead, Selenium, Zinc, Nickel	1 mg/kg
	Boron (water soluble)	0.2 mg/kg
	Cadmium	0.2 mg/kg
	Mercury	0.3 mg/kg
	Cyanide (total)	1 mg/kg
	PAHs (USEPA 16)	0.05 mg/kg

Copies of the environmental chemistry testing certificates are presented in *Appendix C*.

Geotechnical

Soil samples were prepared in accordance with BS1377 (British Standards Institution, 2016). The following geotechnical tests have been undertaken:

- 4 No. Particle Size Distribution (PSD) Tests;

- 8 No. Atterberg Tests;

Copies of the geotechnical testing certificates are presented within *Appendix D*.

5.1.4 Monitoring Well Installations

Consideration of groundwater level is specific to drainage considerations. The assessment of groundwater level is to be reported under separate cover. However, installations and boreholes were completed as part of this ground investigation.

Installations comprising 50mm diameter slotted standpipes were installed in WS111 to WS116 for groundwater monitoring.

A bentonite seal was placed above and below the screened section of the boreholes to minimise potential for downward migration of contaminants and the creation of a preferential migratory pathway. A gravel surround was installed in the annulus between the sides of the borehole and the slotted sections of pipe.

A summary of the response zones is presented in ***Table 5.1.3***.

Table 5.1.3 *Monitoring Well Response Zones*

Borehole Ref.	Piezotip Diameter (mm)	Response Zone (m bgl)	Strata Description(s)
WS111	50	1.0 – 4.7	Made ground
WS112	50	1.0 – 4.0	Made ground
WS113	50	1.0 – 4.0	Made ground
WS114	50	1.0 – 3.0	Superficial
WS115	50	1.0 – 4.5	Superficial
WS116	50	1.0 – 2.9	Superficial

Copies of borehole logs can be referred to in *Appendix B* of this report.

5.1.5 Post-Investigation Monitoring

Groundwater monitoring is proposed on a monthly basis over one year. The groundwater monitoring is still ongoing at the time of issue and will be re-assessed upon completion.

The groundwater level results are specific to drainage design and will be reported under separate cover.

6.0 Ground Conditions

6.1 General

A summary of the ground conditions encountered during the site investigation works, Curtins 2019, is presented in ***Table 6.1***, with detailed information presented on the exploratory hole logs, Appendix B.

Table 6.1 *Ground Conditions Summary*

Stratum	Depth to top of strata (m bgl)		Thickness (m)	
	Min	Max	Min	Max
Topsoil	0.0	0.0	0.0	0.3
Made Ground	0.0	0.3	0.45*	2.8*
Superficial Deposits	0.0	3.0	2.45	5.31**

*where present

**Depth to base not proven

Bedrock was not encountered as a part of this investigation.

The Wardell Armstrong 2011 data has been reviewed, but since the accuracy cannot be confirmed the depths of each strata have not been considered above. In addition, because of this the Wardell Armstrong data has been included as test results on graphs but not in parametric analysis. Only the Wardell Armstrong boreholes that fall within the current development boundary have been included.

6.2 General Commentary

In general, the ground conditions at the site are noted to be highly variable.

In general, made ground is noted to be deeper within the WWTW area, with the fields to the west having little to no made ground present.

Natural soils are also highly variable, although general trends are noted. The geomorphology of the site is that of the transition from valley side to valley floor. As such natural ground conditions reflect this change. The west of the site is typically comprised of a weathered bedrock deposit which grades into the underlying coal measures bedrock.

The east of the site, dominantly the former WWTW area is comprised of lower strength soils, with a softer strength profile, likely an influence of being closer to the valley bottom, increasing bedrock weathering due to the influence of alluvial soils / processes.

In general, the ground conditions are dominated by two ‘typical sections’;

- The west, being dominantly weathered bedrock (superficials) underlain by bedrock. Soil strengths are broadly more consistent and increase with depth from soft to stiff.
- The east of the site is more variable. A variable depth of made ground is underlain by lower strength soils. These soils are likely to be a combination of extremely weathered bedrock and the minor influence of alluvial deposits from the Hunsworth Beck to the east. Strengths do generally increase with depth, grading, as with the west of the site, into the bedrock.

Further detail and parametric analysis of ground conditions is presented within the following sections.

6.3 Made Ground

In the Wardell Armstrong investigation report, made ground was encountered in the majority of boreholes, with a maximum thickness of 76.0m where the base was proven. Four different made ground units were encountered. A cohesive unit of soft to firm orange to black locally cobble sandy gravelly clay. The other horizons were granular, being a loose to dense grey or brown clayey cobbly sandy gravel or gravelly sand, a medium dense grey to black clayey sandy gravel, and a loose black clayey sandy gravel to sand.

In the Curtins 2019 investigation, made ground deposits were encountered in 12 of the 16 exploratory boreholes, generally to the east of the site, to a maximum proven depth of 3.0 m bgl.

Made ground generally comprised a dark grey to brown sandy gravelly clay. Gravel comprised fine to coarse sub rounded to angular brick, coal, concrete, mudstone, sandstone and slag. Frequent rootlets and occasional ceramic and timber were recorded.

A summary of the in-situ geotechnical test results recorded within the cohesive made ground is presented in ***Table 6.3***. No geotechnical laboratory testing has been completed on made ground.

Table 6.3 *Summary of geotechnical test results –Made Ground*

Parameter	No. of tests	Results	
Wardell Armstrong 2011:			
SPT 'N'	3	Minimum	13
		Maximum	50
		Average	27
Curtins 2019:			
SPT 'N'	3	Minimum	4
		Maximum	12
		Average	9

6.3.1 Trial Pit Investigation of Mine Shafts

As highlighted the intention of TP101 was to investigate the presence and location of two recorded mine shafts at the site.

TP101 was excavated down to c. 1.0m bgl at its maximum and contained made ground similar to that highlighted in section 6.2 to the base. A mine shaft, expected to be the Bateman shaft, was evidenced by a double skinned brick shaft of 2.2m diameter, backfilled with a black cohesive soil.

The shaft was located within the tolerances of the GPS unit, based on the coordinates provided by the Coal Authority.

6.3.2 Unrecorded Historical Landfill

In the approximate location of the Valley Pit shaft, a fill area of loose brown red sandy gravelly ash with whole glass bottles was recorded in a triangular shape, similar to that seen on historic maps by the Valley Pit. This fill material is interpreted to be a potential unrecorded historical landfill. The soils overlying this potential landfill material were white and interpreted as lime.

A photograph of the infilled area is presented in plate 6.3.2.

Plate 6.3.2: Potential landfill.

6.4 Superficial Deposits

In the 2011 Wardell Armstrong investigation, the natural strata was encountered as a 3.5m thick soft to stiff orange-brown mottled grey locally cobbly with rare boulders sandy gravelly clay, with a gravel of sandstone, shale, mudstone and coal.

During the Curtins 2019 site works, superficial deposits were encountered underlying the made ground in all of the exploratory holes as a cohesive material, as a soft to firm dark grey or orange brown sometimes sandy gravelly clay. Gravel was fine to coarse rounded to angular coal, mudstone, sandstone and siltstone with occasional low sandstone and siltstone cobble content. One exception, WS113, where a clayey fine to coarse sub rounded to angular coal and mudstone gravel was encountered between 1.5 and 3.1m bgl.

The maximum depth to the base of the superficial deposits was not encountered within the window sample exploratory holes.

A summary of the geotechnical test results recorded within this layer is presented in ***Table 6.4a*** and ***6.4b***. The test result certificates are included within *Appendix D*.

Table 6.4a *Summary of Wardell Armstrong 2011 geotechnical test results – superficial deposits*

Test	No. of tests	Minimum	Maximum	Average
In-situ				
SPT 'N' Value	8	20	50	40.5
Laboratory				
Particle Size Distribution	6	See Wardell Armstrong Phase 2 Report (ref. SH10534, RPT-002c)		
Moisture Content (%)	15	7.4	32	16.7
Liquid Limit (%)	13	25	51	38.6
Plastic Limit (%)	13	16	26	21.1
Plasticity Index (%)	13	9	25	17.5

Table 6.4b *Summary of Curtins 2019 geotechnical test results – superficial deposits*

Test	No. of tests	Minimum	Maximum	Average
In-situ				
SPT 'N' Value	40	4	40	19.55
Laboratory				
Particle Size Distribution	4	See Appendix D		
Moisture Content (%)	8	15	37	22.88
Liquid Limit (%)	8	30	59	45.75

Test	No. of tests	Minimum	Maximum	Average
In-situ				
Plastic Limit (%)	8	17	34	24.38
Plasticity Index (%)	8	13	33	21.38

Overall 48 SPT 'N' values were recorded across both ground investigations, ranging from 4 to 50, although it is noted that the Wardell Armstrong logs do not include SPT 'N' values shallower than 4.5m bgl.

The SPT 'N' values are variable across the soil profile and site. Values typically increase with depth, becoming more consistent at 5m bgl, as shown in *Figure 6.4a*. *Figure 6.4b* shows the variation across the site in the shallow ground, with data taken only from the Curtins 2019 site works.

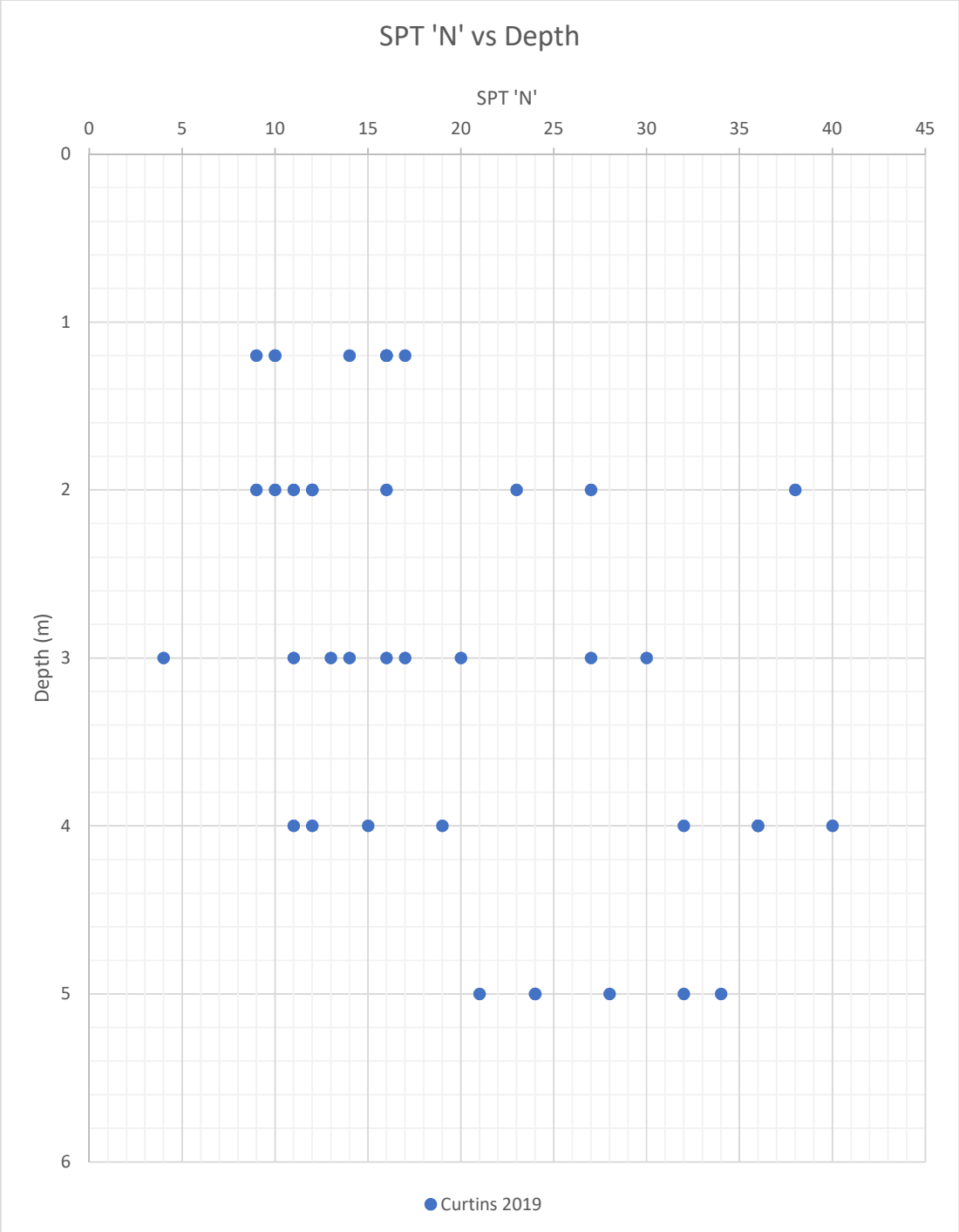

Figure 6.4a -Error! Use the Home tab to apply 0 to the text that you want to appear here.

SPT 'N' Value vs Depth

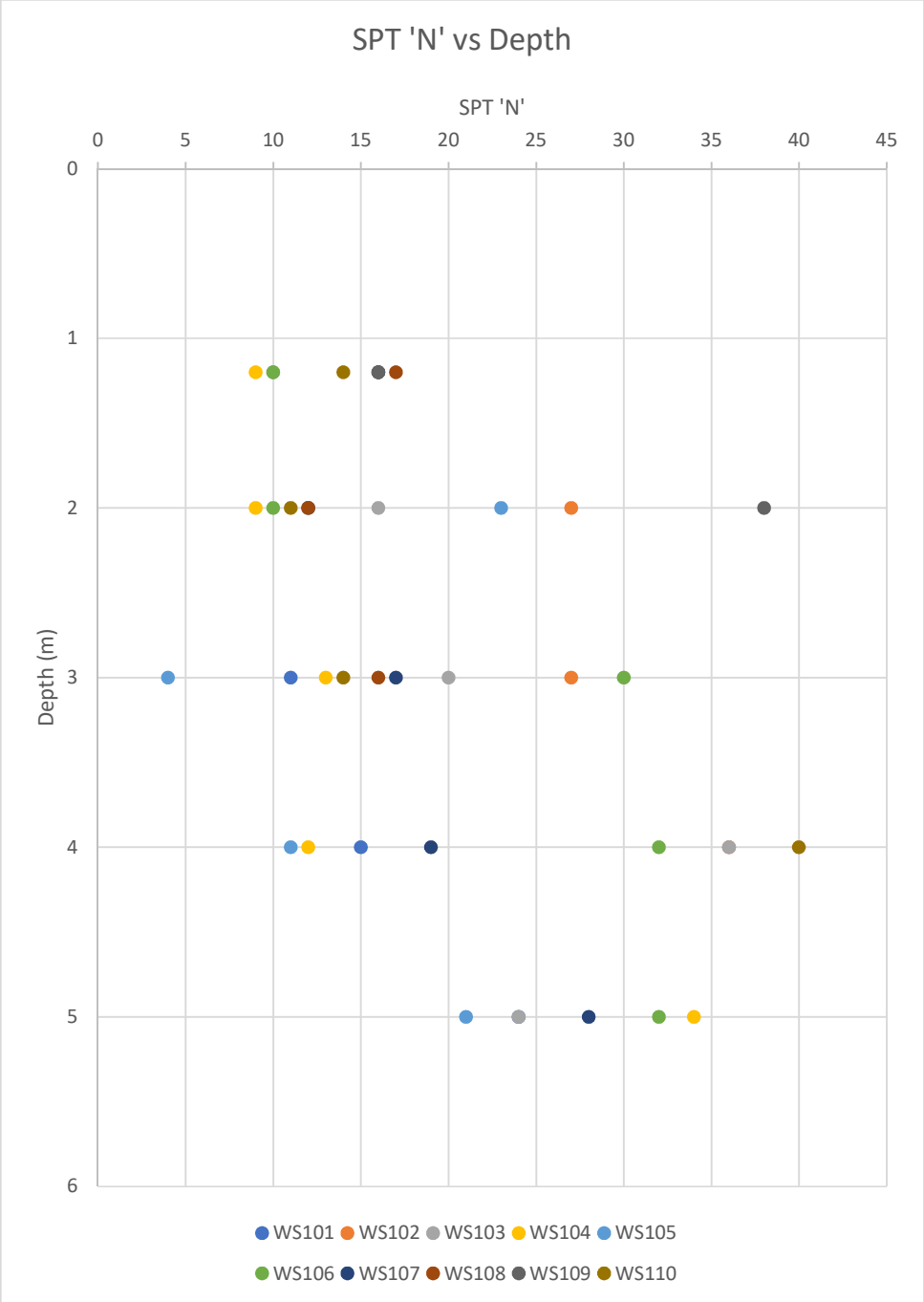

Figure 6.4b - *SPT 'N' Value vs. Depth - Superficial Deposits, Curtins 2019*

It is noted that as highlighted within section 6.2 variability across the natural strata is identified. This is reflected within figure 6.4b, where it can be seen that a wide range of SPT values are recorded for the same depths.

The Undrained Shear Strength (Cu) of the cohesive superficial deposits has been determined from the relationship between SPT 'N' values and the Plasticity Indices (PI), after Stroud, 1975, as presented in Equation 1:

$Cu = SPT\ N.F_1$ **[Equation 1]**

Where:
Cu is the Undrained Shear Strength
N is SPT 'N' *value*
F_1 is the Stroud Factor

For the Curtins 2019 investigation, a conservative F_1 value of 5 is deemed suitable for the range of PI, determined from the Atterberg test results. Therefore, Undrained Shear Strength values typically between 45 kPa and 200 kPa are calculated. One value of 20 kPa is estimated at 3.0m bgl, which is likely to demonstrate a localised low strength deposit or area of increased weathering. The Undrained Shear Strength results are presented against depth, *Figure 6.4c,* demonstrates a general increase in strength with depth. As demonstrated, the results are shown to be reflective of a medium to high strength clay.

As with all parameters, it is observed that although general, conservative, trends have been applied, variation within the results exists and should be proportionately accounted for.

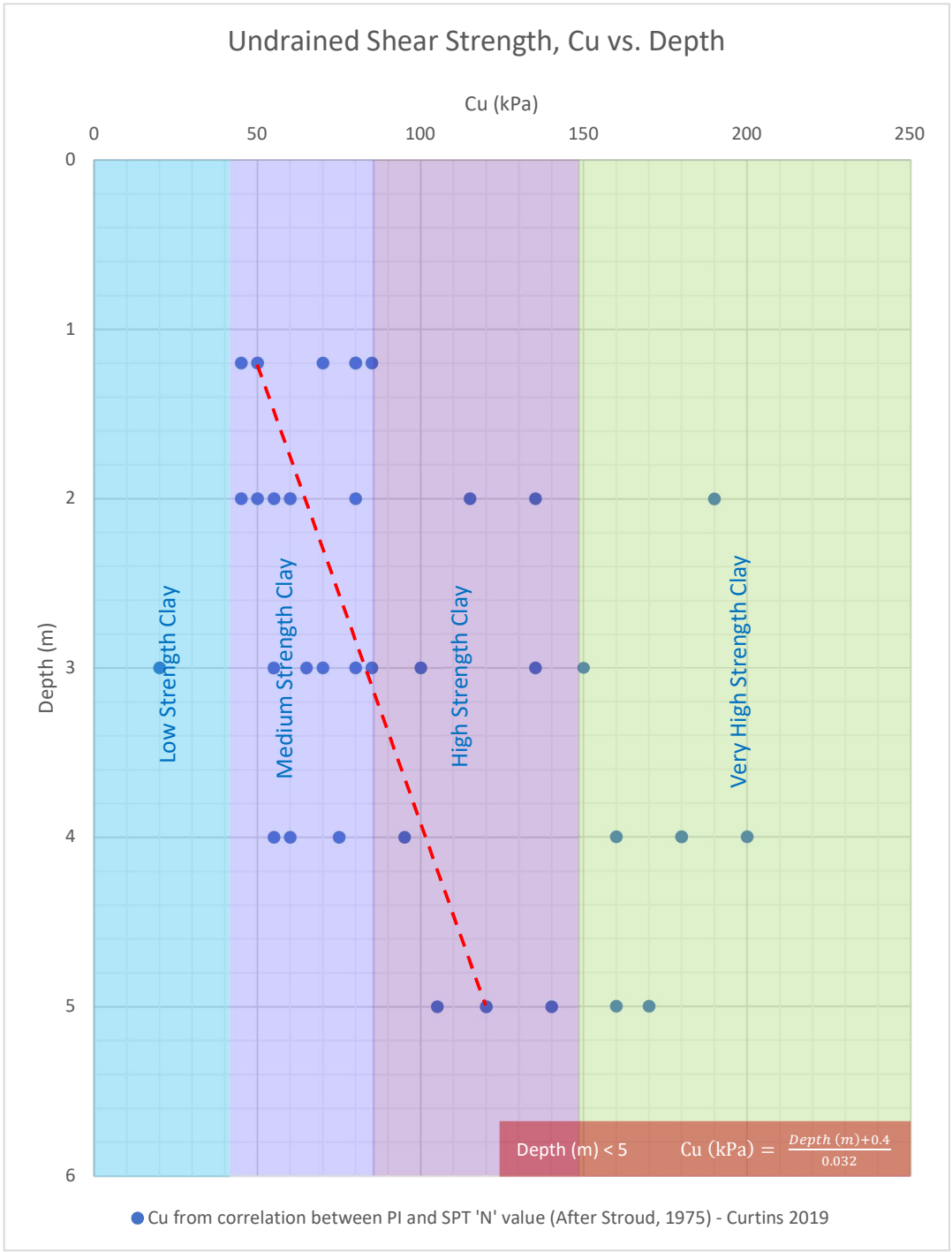

Figure 6.4c - *Undrained Shear Strength, Cu vs Depth*

The Coefficient of Volume Compressibility (Mv) has been determined from the relationship between SPT 'N' values and the Plasticity Indices (PI), after Stroud, 1975, as presented in Equation 2:

$Mv = 1/(SPT\ N.f_2)$ **[Equation 2]**

Where:
Mv is Coefficient of Volume Compressibility
N is SPT 'N' values
F_2 is the Stroud factor

For the Curtins 2019 investigation, a F_2 value of 0.5 is deemed suitable for the range of PI values.

Therefore, Mv values typically range between 0.05 m^2/MN and 0.22m^2/MN are determined. One value of 0.5m2/MN has been determined at 3.0m bgl, likely to indicate a localised very soft layer or increased weathering. The results are plotted against depth, *Figure 6.4d*. As demonstrated the results are predominantly of low to medium compressibility. The compressibility of the soils appears to decrease with depth. The equations demonstrating the relationship for determination of a moderately conservative value is demonstrated on *Figure 6.4d*.

As with all parameters, it is observed that although general, conservative, trends have been applied, variation within the results exists and should be proportionately accounted for.

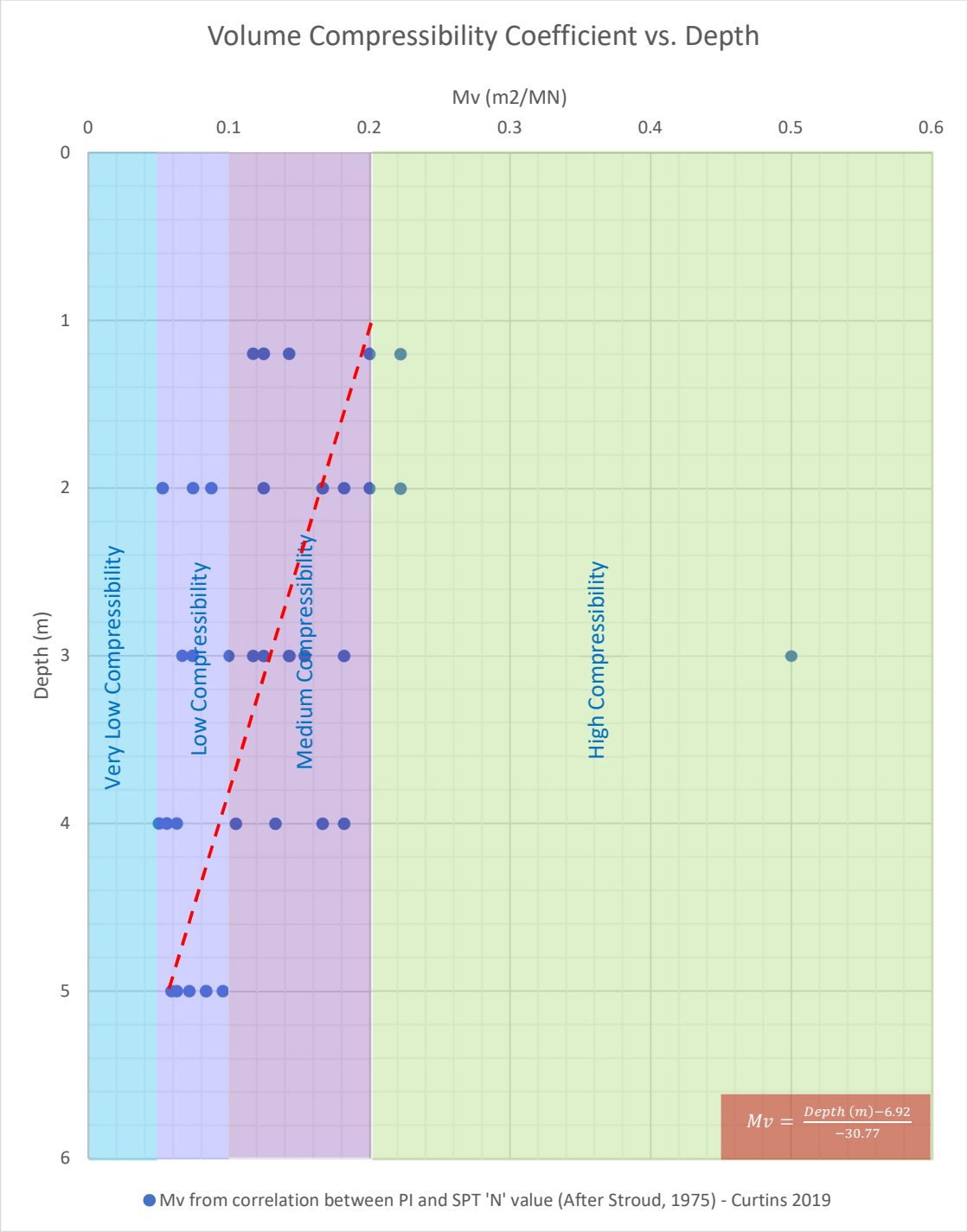

Figure 6.4d - *Coefficient of Compressibility, Mv vs Depth*

The Angle of Internal Friction (ϕ') for cohesive soils has been derived from the correlation with Plasticity Indices, after Gibson, 1953. An Angle of Internal Friction of 24.8° is deemed suitable for this stratum.

The Undrained Stiffness Modulus has been derived from the relationship with SPT 'N' values, after CIRIA 143, as presented in Equation 3:

$$E = SPT\ N \times 1.2 \qquad \textbf{[Equation 3]}$$

Where:
Eu is the Undrained Stiffness Modulus
N is SPT 'N' *values*

The results are plotted against depth, *Figure 6.4e*. The stiffness of the soils appears to increase with depth. The equations demonstrating the linear relationship for determination of a moderately conservative value is presented on *Figure 6.4*e.

A wide variation is recorded for undrained stiffness across the site. This is considered to reflect the changes in natural soils as highlighted within section 6.2. As with all parameters, it is observed that although general, conservative, trends have been applied, variation within the results exists and should be proportionately accounted for.

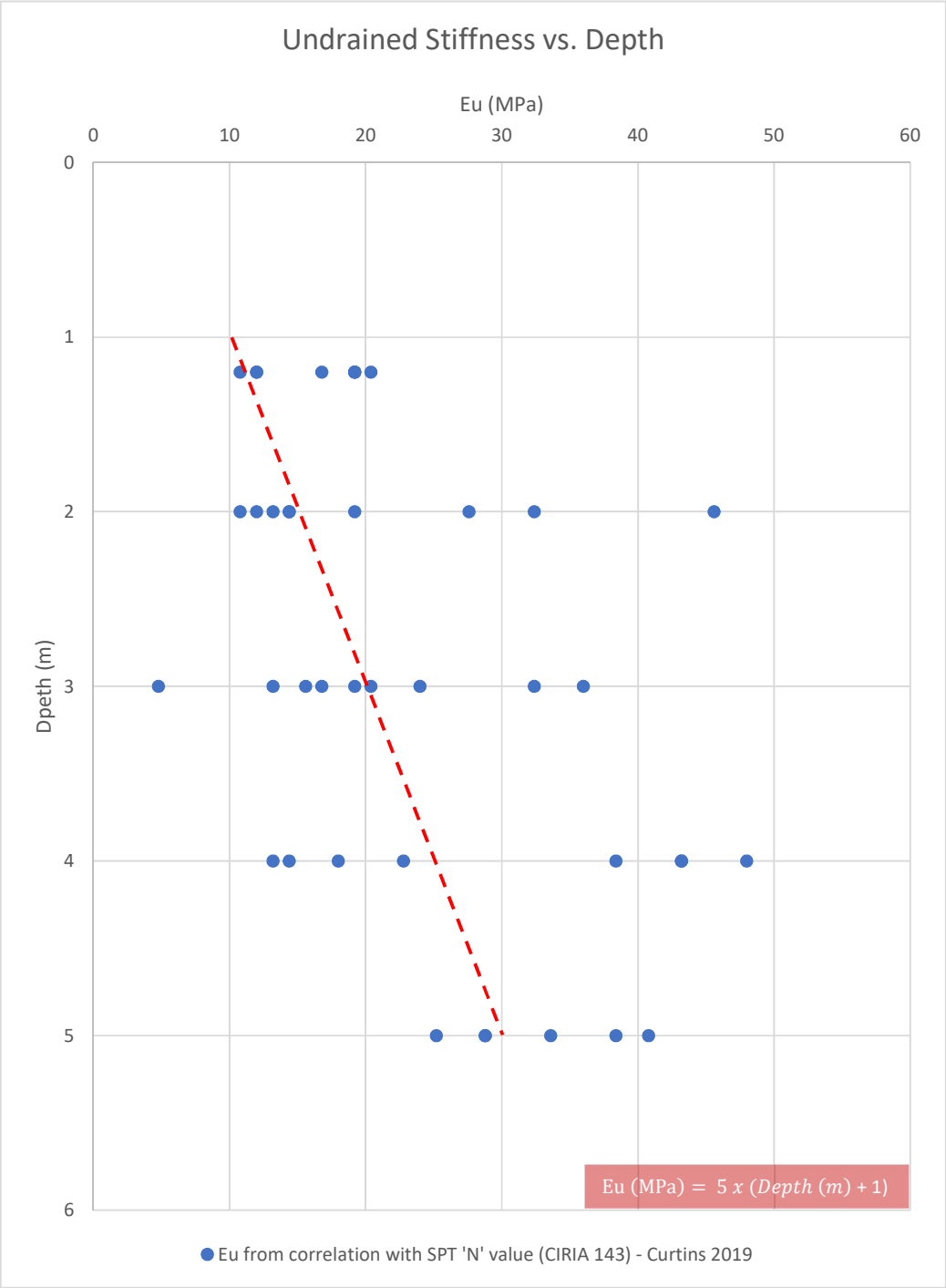

Figure 6.4e *Undrained Stiffness, Eu vs Depth*

The Drained Stiffness Modulus has been determined from the relationship with SPT 'N' values, after CIRIA 143, as presented in Equation 4:

$$E' = \mathrm{Eu} \times 0.73 \quad \textbf{[Equation 4]}$$

Where:
E' is the Drained Stiffness Modulus
Eu is the Undrained Stiffness

The results are plotted against depth, *Figure 6.4f*. The stiffness of the soils appears to increase with depth. The equations demonstrating the linear relationship for determination of a moderately conservative value is presented on *Figure 6.4f*.

A wide variation is recorded for drained stiffness across the site. This is considered to reflect the changes in natural soils as highlighted within section 6.2. As with all parameters, it is observed that although general, conservative, trends have been applied, variation within the results exists and should be proportionately accounted for.

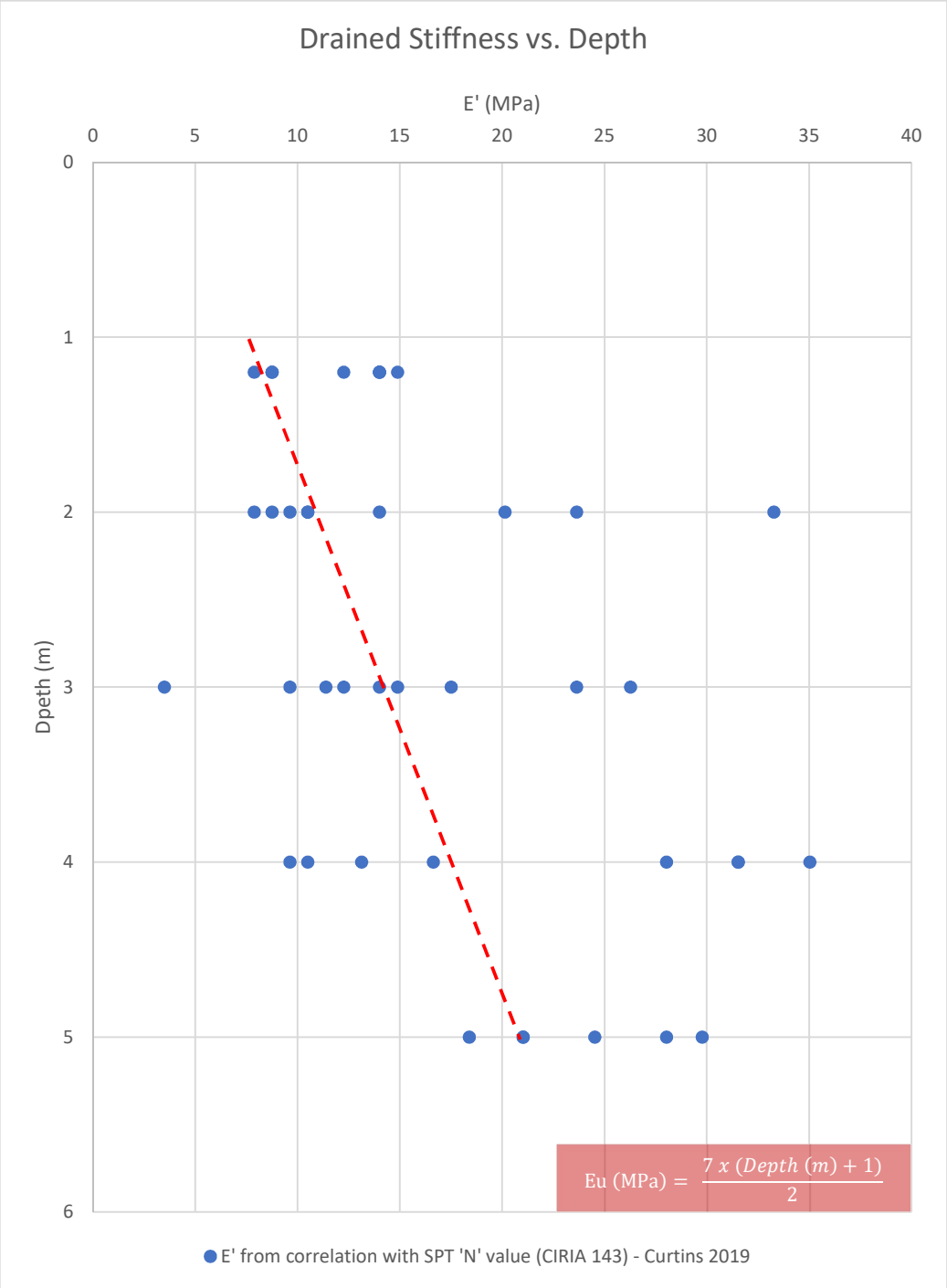

Figure 6.4f *Drained Stiffness, E' vs Depth*

Atterberg tests generally indicate a medium plasticity clay, with individual Casagrande chart test results in the low plasticity clay, high plasticity clay and high plasticity silt categories.

Following a review of published values, a moderately conservative unit weight, ɣ', of 19 kN/m^3 has been deemed suitable.

Table 6.4c *Characteristic Parameters – Superficial Deposits*

Parameter	Characteristic Values	Reference
Unit Weight, ɣ' (kN/m^3)	19	Barnes, 2000
Angle of Internal Friction, ϕ' (°)	24.8	Correlation with Plasticity Index (Gibson, 1953)
Undrained Shear Strength, Cu (kPa)	Depth (m) <5 $Cu = \frac{Depth\ (m)+0.4}{0.032}$	SPT 'N' correlation with Plasticity Index (Stroud 1997)
Coefficient of Volume Compressibility, Mv (m^2/MN)	Depth (m) <5 $Mv = \frac{Depth\ (m)-6.92}{-30.77}$	SPT 'N' correlation with Plasticity Index (Stroud 1997)
Undrained Stiffness, Eu (MPa)	Depth (m)<5 Eu = 5 (Depth (m) + 1)	SPT 'N' correlation (CIRIA 143)
Drained Stiffness, E' (MPa)	Depth (m)<5 $E' = \frac{7\,x\,(Depth\ (m)+1)}{2}$	SPT 'N' correlation (CIRIA 143)
Drained Cohesion, c' (kPa)	0	Based on engineering judgement

A wide variation is recorded for geotechnical parameters across the site. This is considered to reflect the changes in natural soils as highlighted within section 6.2. The use of general trends for future design is advised with caution, and the designer should ensure that the information utilised for future design is specific to their requirements.

It is noted in particular for this site, that variation between proposed development plots is large and hence, the use of general trends for future design is not recommended in this instance.

6.5 Bedrock

In the 2011 Wardell Armstrong bedrock was typically encountered at a depth of c. 6m – 8m bgl, with variation noted. Bedrock was identified to comprise both sandstone and mudstone, with respective strength descriptions on encountering being weak to strong.

Five SPT 'N' values were obtained, all of which were a refusal at 50 blows.

Bedrock was not encountered in any of the exploratory holes during the 2019 Curtins investigation.

6.6 Observed Potential Contamination

No observations of potential gross contamination was noted within the soils/groundwater during the Curtins investigation.

6.7 Groundwater Level

6.7.1 Historic Investigation

The Wardell Armstrong Investigation (2011) monitored groundwater level in nine boreholes over the course of a year. Monitoring was only undertaken in the Spring/Summer months. Levels varied from being consistently dry (BH1 and WS104) to fluctuating 3 – 5m (BH2, WS102, WS107).

6.7.2 Recent Investigation

The groundwater levels and strikes recorded during the Curtins siteworks is summarised in ***Table 6.7.2***.

T***able 6.7.2*** *Groundwater Levels and Strikes - Site Investigation*

Borehole Ref.	Water Strikes		
	Strike Depth (m bgl)	Strata	Notes
WS101	3.67	Superficial Deposits	No rise in 20 minutes
WS102	2.4	Superficial Deposits	No rise in 20 minutes
WS104	4.61	Superficial Deposits	No rise in 20 minutes
WS105	2.4	Superficial Deposits	No rise in 20 minutes
WS106	2.85	Superficial Deposits	No rise in 20 minutes
WS107	2.38	Superficial Deposits	No rise in 20 minutes
WS111	3.1	Superficial Deposits	No rise in 20 minutes
WS113	3.15	Superficial Deposits	No rise in 20 minutes
WS114	2.18	Superficial Deposits	No rise in 20 minutes
WS115	2.14	Superficial Deposits	No rise in 20 minutes
WS116	2.5	Superficial Deposits	No rise in 20 minutes

Groundwater level monitoring for drainage design is, at the time of writing, ongoing and is to be reported under separate cover.

6.8 Aggressive Ground Conditions

The classification of the site in terms of concrete in aggressive ground is based on the guidance provided in Table C2 of the Building Research Establishment (BRE) Special Digest 1, third edition of 2005 (Building Research Establishment, 2005). ***Table 6.8*** details the classification.

Table 6.8 *Aggressive Chemical Environment for Concrete (ACEC) Site Classification*

Stratum	Design Sulphate Class	ACEC Class *
Made Ground	DS-1	AC-1
Cohesive Deposits	DS-1	AC-1

* ACEC assessment was based on the mobile groundwater condition for the scheme area

It is noted that the Wardell Armstrong report identifies a worst case concrete classification of DS-2 AC-2.

7.0 Ground and Groundwater Contamination Assessment

This section of the report includes the assessment of the potential contamination, solid, liquid and gas, identified on the subject site which may present a risk to the proposed end users, associated utilities and the wider environment.

In guidance published by the Environment Agency, the risk to human health or controlled waters is determined through an assessment of pollutant linkages between a source of contamination (within the ground or groundwater either on or off site) and a sensitive receptor such as end users of the site, building materials, edible plants grown in gardens or groundwater abstracted for drinking. This is termed a source-pathway-receptor relationship. The same model is applied to the assessment of risk arising from ground gases as detailed within BS8576:2013 (British Standards Institution, 2013).

These models have a common approach, which is one of a tiered assessment. At each stage of the assessment further detail can be applied to the conceptual site model to provide a detailed interpretation on a site by site basis. As part of the planning process this approach is adopted to establish either if the site is 'suitable for use' or whether additional work or else remedial work is required for the site to be deemed so.

The sub-sections hereafter therefore incorporate the first tier (Tier 1) of this approach otherwise referred to as the Generic Quantitative Risk Assessment (GQRA). The GQRA builds on the qualitative risk assessment presented in the Phase 1 Desk Study in conjunction with observations made during the ground investigation and is based solely on the results of the chemical and other testing data obtained as part of Curtins ground investigation. The GQRA is used to build/refine the Conceptual Site Model (CSM) for the site as detailed and presented in *Section 8.0* of this report.

The following sections present more detail on the risk assessment methodology rationale for the main receptors.

7.1 Human Health GQRA

Detailed guidance on human health risk assessment is available within several documents, published by both the Environment Agency and Defra. Guidance includes Contaminated Land Exposure Assessment (CLEA) v1.071 model (Environment Agency, 2014), Science Report 2 (Environment Agency, 2009) and Science Report 3 (Environment Agency, 2009).

A generic quantitative risk assessment (GQRA) has been carried out for the Potential Contaminant Linkages (PCLs) investigated by screening of soil contamination data against relevant Generic Assessment Criteria (GAC) where available, including:

i) **Soil Guideline Values (SGVs):** These have been published by the Environment Agency and are trigger values for screening out low risk areas of land contamination. SGV's give an indication of representative average concentrations of chemicals in soil, below which long-term health risks are likely to be minimal. SGVs have been published for several contaminants including arsenic, cadmium, mercury, nickel, selenium, BTEX, phenols and dioxins, furans and

dioxin-like PCB substances for land uses including residential, allotments and commercial. The SGVs have been developed for a sandy loam soil with 6% soil organic matter (SOM) content;

ii) **Supplementary Screening Values (SSVs):** In addition to the SGVs developed by the EA, other third-party organisations have derived SSVs for a wider range of contaminants and land uses using the CLEA Model. Curtins have adopted these numbers where applicable, including those developed by Atkins AtriskSoil™, the LQM/CIEH Suitable for Use Levels (S4UL) and EIC/AGS/CL:AIRE published thresholds;

iii) **Category 4 Screening Levels (C4SLs):** In March 2014 DEFRA published C4SLs for arsenic, benzene, benzo(a)pyrene, cadmium, hexavalent chromium and lead. These values were derived to support the revised Part 2A Statutory Guidance issued in 2012 (Department of Environment Food and Rural Affairs (DEFRA) , 2012) in which four categories of contaminated land are included, ranging from Category 1 (significant/high risk) to Category 4 (low risk). C4SLs are not representative of significant possibility of significant harm (SPoSH) and are low risk levels which, and therefore where the C4SLs are not exceeded, land can be demonstrated to be in Category 4 and cannot be determined as contaminated land.

The development plans are noted as commercial buildings. An initial conservative assessment has been completed using '*Commercial'* criteria.

Details of the GAC's or 'Tier 1 Thresholds' adopted for the GQRA are provided in Appendix F.

7.1.1 Soils

Representative samples of made ground and natural soils were taken from exploratory holes across the site and tested for either Soil Suite B or Soil Suite D with a total of 8 No. samples tested.

As discussed within the previous section, comparison of the soil analysis results has been undertaken against Generic Assessment Criteria (GAC) or 'Tier 1 Threshold' for '*Commercial'* land use scenario.

Soil Organic Matter (SOM) has a strong bearing on the availability of potential contaminants and therefore influences the Tier 1 Thresholds. The SOM typically ranged from 0.4% to 8.6%, with an average of 2.6%. As such, the comparison has been made against GACs developed for a sandy soil with a SOM of 2.5%.

The results of the environmental testing can be referred to in Appendix D2. Copies of the Tier 1 Thresholds are contained within Appendix F.

A single exceedance has been identified in WS101 at 1.30 m bgl, for total Cyanide. The value identified in testing is 4.2 mg/kg, above the GAC screening value of 3.4 mg/kg. No

further exceedances are identified. The results of the GQRA also align with previous reports which do not identify contaminants above adopted threshold values.

In general, with the exception of cyanide as further discussed in section 7.1.2, soil contamination at the site is considered to present a very low risk to future site occupiers.

7.1.2 Discussion of Cyanide

Considering the soil matrix from which the sample (WS101, 1.30 m bgl) was derived (soft dark grey to black sandy gravelly clay) and the generally higher concentrations of heavy metals within the same sample, it is considered this material may represent dried sewage sludge, a waste product from the former sewage works.

The testing of cyanide has considered the total cyanide present, rather than free cyanide, with no sources of free cyanide (e.g gas works) noted in the development of the conceptual site model. As such, the threshold of 34 mg/kg is considered conservative for a total cyanide comparison with the threshold representative of the acute risk posed by free cyanide.

Considering the exceedance of 37 mg/kg within this single sample, and the low concentrations of cyanide elsewhere on the site, this exceedance is considered isolated.

The commercial GAC thresholds utilised within the GQRA are based upon a working life span for employees of 49 years. It is considered unlikely that an adult would remain as an employee for this time period.

Furthermore, the GAC thresholds used are for a sandy loam utilising an SOM of 2.5%. The material encountered at this depth is not fully comparable to the threshold criteria assumptions. The material is generally cohesive in nature with an organic matter of 8.2%. The geo-chemical interactions of cyanide, if present as a free cyanide ion, would more readily adsorb into a cohesive organic matrix (due to the chemical charges involved). Overall this would decrease the likelihood of free cyanide impacting future site users.

The exceedance was observed within WS101 in the north east area of the site, is expected to have c. 2 - 4m of additional fill placed in this area as part of cut and fill operations. This extra 2 - 4m of soil, assuming it is of suitable imported composition, will provide a further barrier for the contaminant pathway.

Overall, the exceedance of the cyanide threshold in WS101 is considered to present a low risk only to future end users. The additional placement of material further reduces this to a negligible risk.

7.2 Controlled Waters GQRA

In consideration of the proposed development, the on-site made ground is anticipated to be the main potential source of groundwater contamination. No specific point sources of contamination are noted from a review of historical information and previous reporting.

In consideration of contaminant sources, the identified concentrations of contaminants in soils are noted to be *low*. Although contaminant concentrations in soil are not directly related to the groundwater limits, the low concentrations of soil contaminants is considered unlikely to give rise to contamination of controlled water via leaching.

In consideration of groundwater receptors and pathways, the underlying superficial deposits and bedrock are classified as Secondary A Aquifers, with a lower sensitivity. An absence of groundwater abstractions within the site vicinity indicates a lower potential for contaminants to reach human receptors. A small stream (Hunsworth Beck) flows along the eastern boundary of the site. it is expected that the development would reduce infiltration and potential for leaching of contaminants via placement of structures alongside hardstanding.

In summary, the underlying aquifer is noted to be of lower sensitivity, however, the absence of any contaminant concentrations in made ground or gross contamination, identifies that a source, pathway, receptor linkage is not present at the site. As such, the risk to controlled waters is assessed as very low, with no mitigation proposed.

7.3 Ground Gas GQRA

Qualitatively the presence of made ground indicates that gas may be produced, however, the Wardell Armstrong investigation classified the current development site as a CS1, with no further ground gas protection measures required. The Wardell Armstrong investigation did identify an area that would require CS2 protection measures, but this was to the south, outside of the current proposed development site. The presence of elevated ground gas is likely associated with the shallow workings of the Shertcliffe seam identified at this end of the site only.

During the Curtins investigation, the composition of the made ground did not comprise substantially organic or putrescible materials, confirming a low gassing potential. In addition, coal seams present at the site are noted to lie at a considerable depth, within bedrock and or overlain by cohesive soils.

An unrecorded historical landfill has been identified at the site. The composition of the material indicates a low organic content with no visual evidence of organic inclusions. The anticipated age of infilling with minimal observed organic content, indicates a low gassing potential of this material.

Overall the gassing potential of the site is considered to be low, confirming the CS1 classification.

8.0 Revised Conceptual Site Model

The Preliminary Conceptual Site Model (PCSM) presented in *Section 4.0* of this report has been revised following the GQRA in *Section 7.0* above. The Revised Conceptual Site Model (CSM) is summarised in the table overleaf.

The CSM details the source-pathway-receptor linkages or potential pollutant linkages (PPL) that have been identified as relevant for the site. The GQRA details the associated level of risk relating to these potential pollutant linkages.

The CSM follows the framework outlined within CIRIA C552 (CIRIA, 2001) which is summarised within *Appendix G*.

The 'risk rating' within the CSM refers to the risk that the source, pathway, receptor linkage or PPL is complete. Unless specifically stated it does not necessarily refer to an immediate risk and is intended to be used as a tool to assess the necessity for further assessment/investigation.

Under current health and safety legislation, employers are required to carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015 (CITB, 2015) which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. It has been assumed that any future construction works on site will be undertaken in compliance with these requirements and therefore construction workers involved in the building works at the site have been discounted as a human receptor in the conceptual site model. Reference should be given to the environmental testing results discussed within *Section 7.0* and presented within *Appendix C*.

- The table below represents the Second stage in the land quality risk assessment process; the Revised Conceptual Site Model following the Quantitative Risk Assessment.
- For a development site to be deemed 'suitable for use' the level of risk needs to be brought down to acceptable levels, i.e. low to very low risk. The purpose of each stage of risk assessment is ultimately to establish if there is a requirement for additional levels of assessment to be made to have sufficient confidence to support a risk characterisation or management decision, e.g. remedial action.
- In the absence of specific site data, a Generic Quantitative Risk Assessment is invariably recommended.

Conceptual Site Model			Generic Qualitative Risk Assessment			Action
Identified Source	**Pathway(s)**	**Receptor(s)**	**Consequence**	**Likelihood of Occurrence**	**Risk Rating**	
On-site sources of potential contamination: Made ground is the primary source of contamination on site. Contaminants expected within the made ground include: Asbestos, hydrocarbons and heavy metals. On-site historic industrial processes which may give rise to gross contamination.	**Direct contact, ingestion and inhalation (soil, dust and vapours)**	**Future site users** Staff and visitors	**Medium** Chronic health risk	**Unlikely** Elevated concentrations of Cyanide were encountered in one exploratory hole at the site, with respect to the selected screening thresholds. The chosen commercial end-use and sandy loam GACs are broad and likely to be over-conservative in this case. Considering the site conditions and development proposals, the concentration of cyanide identified is considered to present a low risk to future site occupiers.	**Low**	No further action required.
	Vertical migration of contaminants May occur due to processes including; capillary action, burrowing animals inducing soil mixing and downwards migration into the natural deposits through infiltration.	**Controlled waters (Groundwater and Surface Water)** Secondary A aquifer in the bedrock No local sensitive surface waters	**Medium** Pollution of lower sensitivity water resources	**Unlikely** The underlying aquifer is noted to be sensitive, however the absence of any substantial contamination in the made ground, being the only identified on-site source of contamination, identifies that a source, pathway, receptor linkage is not present at the site.	**Low**	No further action required.
On-site and off-site sources of potential contamination: Ground gases from made ground and coal mining legacy.	**Horizontal migration through the shallow soils and air (dust/particulates)** Followed by… Direct contact, ingestion, inhalation (dust)	**End users of site** Staff and visitors.	**Medium** Chronic health risk	**Unlikely** Previous investigations on site classified the future development sections as a Characteristic Situation 1, with no further ground gas protection measures required. No further ground gas sources were identified during the Curtins site investigation.	**Low**	No further action required.
Off-site sources of potential contamination: Made ground is considered the primary source of contamination, due to previous phases of development and historic industrial land uses in the surrounding area.	**Horizontal migration through the shallow soils and air (dust/particulates)** Followed by direct contact, ingestion and inhalation (dust and vapours)	**Future site users** Visitors and staff	**Medium** Chronic health risk	**Unlikely** There is a low potential for mobile phase contamination to migrate onto the subject site, due to the cohesive condition of the ground. Overall the potential off-site sources of contamination in the close surrounding area are considered no greater than the subject site.	**Low**	No further action required.

9.0 Geotechnical Conclusions and Recommendations

The recommendations provided within this section are based on a review of the historical and recent records of ground conditions encountered across the site, considering the geotechnical and geo-environmental limitations and hazards identified.

In addition, the recommendations presented here have considered the proposed cut and fill model, as presented in Appendix A.

9.1 Foundation Recommendations

The ground conditions present at the site are noted to be highly variable. In particular the depth of made ground. The presence of soft natural soils and made ground also presents a geohazard for shallow foundations. Due to highly variable nature of the ground conditions encountered, it is anticipated that variable founding solutions may be required.

The intention of substantial cut and fill indicates the risk for intolerable ground movements. It is anticipated that intolerable ground movements may be locally present associated with poor ground conditions. In addition, however, the opportunity to found on soils with suitable structural properties may present as a result of cut activities. As such the ground conditions at each development plot should be considered individually and further assessment of suitable founding solutions is undertaken.

It is advised that where poor ground conditions are present locally, options such as;

- Piled foundation;
- Ground improvement (Stone Columns, soil modification, surcharge).
- Excavation & re-compaction.

are considered. These solutions are proposed to reduce associated risks with intolerable ground movements and to improve the ground bearing capacities.

Optioneering of a suitable foundation solution (outside the scope of this report) should be furthered by production of a detailed specification for each plot, and in consideration of the wider site. For shallow foundation solutions, the ground should be engineered in a manner to allow sufficient bearing capacity to be achieved whilst ensuring settlement remains within tolerable levels.

The presence and removal of underground obstructions needs to be considered.

The presence of an unrecorded ‘landfill’ will need to be considered within foundation design, with potential for further investigation and assessment.

Due to presence of made ground, it is advised that suspended slabs are adopted unless engineering of the made ground is completed to a suitable specification. All areas of soft/loose compressible material and made ground from sub-grade should be removed and replaced with suitably compacted granular deposits, in accordance with Series 600 Specification for Highways Works (SHW).

In accordance to BS8004:2015, foundations, pile caps and slabs are to be taken to a minimum 450mm depth, to avoid Heave/Frost (NHBC Guidance Chapter 4.2).

9.2 Excavations

It is anticipated that excavations will be required during the construction phase. These are likely to be for achieving required founding levels or localised services and dig & replacement works.

Due to the presence of a variable thickness of made ground, stability of unsupported excavations <1.2m bgl is considered a hazard.

It is anticipated that any deep excavation which may be required will necessitate suitable stabilisation methods. However, some localised excavations e.g. for services (shallower than 1.0m) may be able to achieve stability, utilising appropriate batters, to be decided by the temporary works designer.

Groundwater present at relatively shallow depths must be taken into consideration, for the purposes of design of the temporary excavation works. De-watering may pose a risk and may be required dependant on depths of excavation.

The presence of underground obstructions should be considered likely.

Advice from a temporary works designer and a de-watering specialist must be sought prior to commencement of the works. A de-watering Strategy may be required.

9.3 Re-use of Site Soils

It is assumed that re-use of soils will be considered as a part of the development works.

The re-use of site soils is considered viable due to the presence of contamination levels below screening values.

In addition to quality, the re-use of site-won soils is governed by the following principles:

- The geotechnical suitability of the material needs to be confirmed;
- The re-use of the material needs to be covered as part of the planning approval, e.g. site levels maintained within agreed limits;
- The volume of the material being re-used needs to be confirmed and traceable
- Regulatory approval from the relevant authorities should be sought.

These principles are outlined within the CL:AIRE Code of Practice (v2) (Contaminated Land: Applications In Real Environments (CL:AIRE), 2011) and if and where the re-use of site-won soils is proposed as part of the development works, it is recommended that a Materials Management Plan is produced in line with the Code of Practice to detail and document the process.

9.4 Waste Classification of Soils

It is the responsibility of the contractor and/or their appointed groundworks contractor to confirm waste classifications of soils requiring disposal off site.

Where any site soils are to be disposed of off-site guidance on the disposal of contaminated soils is provided within the following documents published by the Environment Agency.

a) Guidance on the Classification and Assessment of Waste Technical Guidance WM3 (1st Edition 2015) (Environment Agency, May 2015).

Guidance states that the principal contractor (or any other sub-contractor undertaking excavations) should, in conjunction with the proposed disposal facility, use where possible the relevant environmental chemistry analyses results to classify any surplus material identified for off-site disposal. However, it should be noted that this information is for guidance only, based on soils selected for sampling. All material identified for disposal should be tested and assessed in accordance with WM3 to enable classification prior to and during the works.

An initial assessment for the waste classification of the made ground encountered on site has been carried out through a comparison of the soil testing results using the Waste Soils Characterisation Assessment Tool, Cat-Waste^{Soil}, developed by M^{c}Ardle and Atkins. This online tool gives a rapid assessment of contaminated soils and their classification as either hazardous or non-hazardous waste.

The initial CAT Waste assessment has identified that the made ground soils tested are classified as non-hazardous waste for off-site disposal. As such, the waste code for these soils is 17-05-04, mirror non-hazardous.

Following the CATWaste assessment, consideration of landfill acceptance is also given. The waste code of non-hazardous identifies that the material may potentially be accepted at a non-hazardous or inert landfill dependant on the results of Waste Acceptance Criteria tests. A total of three WAC tests have been completed. The results of the WAC testing indicate that the made ground soils would be accepted as a non-hazardous waste, but unlikely to be accepted as inert waste due to exceedances in antimony, total PAH and loss on ignition.

As discussed, preliminary waste classification and discussion of landfill acceptance is undertaken to offer indicative advice only with respect to disposal requirements. Furthermore, landfill operators are

not obligated to accept waste and, if they were to do so, may have specific requirements beyond those outlined above prior to acceptance. It is noted that it is the responsibility of the contractor to ascertain and apportion the soils at the site for disposal.

9.5 Geotechnical Risk Assessment

The risk rating is derived from Risk Rating = Risk Likelihood x Risk Severity. Where risk likelihood and risk severity are defined as:

RISK LIKELIHOOD	RISK SEVERITY
1. LOW (unlikely)	1. LOW
2. MEDIUM (Possible)	2. MEDIUM
3. HIGH (Probable)	3. HIGH

The result in a risk that can be described as MINIMAL (0-3), RESIDUAL (4) or SIGNIFICANT (6-9) as per the risk matrix in ***Table 9.5***.

Table 9.5*; Risk Matrix.*

		Severity		
		1	2	3
Likelihood	1	• Minimal	• Minimal	• Minimal
	2	• Minimal	• Residual	• High
	3	• Minimal	• High	• High

Ref No.	Hazard/Activity	Risk/Potential Outcome	Design Measures to Remove/Reduce the Risk	Risk Likelihood	Risk Severity	Risk	Residual Risk
1	Unsuitable ground conditions	Intolerable ground movements for ground bearing slabs	Suitable foundation design – likely to be variable across the site on a unit by unit basis. Detailed Review of the provided ground information within this report by the designer and the contractors. Designer and the contractor must satisfy themselves with the ground conditions across the site.	2	1		Where soft/loose compressible material is encountered, it must be removed and replaced with suitably compacted granular material in accordance with Series 600 SHW.
2	Fluctuating shallow Groundwater	Flooding in excavations	Dewatering is advised, however due to presence of adjacent structures, it may be complex.	2	2		Dewatering strategy undertaken by a de-watering specialist
3	Structural loading, earthworks & compressible soils	Excessive settlement	Design of appropriate ground improvement of foundation option to limit settlement to tolerable levels	3	3		

Ref No.	Hazard/Activity	Risk/Potential Outcome	Design Measures to Remove/Reduce the Risk	Risk Likelihood	Risk Severity	Risk	Residual Risk
4	Area of unrecorded historical landfill	Lower bearing capacity, settlement	Further investigation and or consideration of foundations in this area	3	3		Further consideration / investigation
5	Aggressive ground/groundwater conditions	Degradation on the buried concrete	Adoption of suitable concrete design based on the assessment undertaken to BRE Digest 1. DS-2, AC-2.	1	1		N/A
6	Unforeseen ground conditions	Unexpected ground conditions encountered during construction	N/A	2 Former WWTW & previously unidentified potential landfill area	2		N/A
7	~Mine Shafts	Collapse / settlement / impact on works	Treat & cap mine shaft	3	3		

9.6 Recommendations

The following recommendation are made for future works;

- Geotechnical optioneering to consider the most efficient foundation solution for each plot;
- Earthworks strategy, site wide and tailored to each plot;
- Mine shaft treatment strategy and mine shaft cap design;

10.0 Geo-Environmental Conclusions and Recommendations

A revised tabulated Conceptual Site Model has been derived following the findings of the Generic Quantitative Risk Assessment and is presented in Section 8.0.

10.1 Conclusions

The environmental chemistry soil results have been compared with the Generic Assessment Criteria (GAC) for soils with respect to human health against a '*Commercial'* threshold.

With respect to the proposed end-uses of the site, the risk to human health is considered **low**.

This investigation confirms the CS1 ground gas classification.

The BGS Radon Mapping confirms that the site is situated in a lower probability radon area where 1 - 3% of homes are above the radon action level. On this basis radon protection measures are not considered necessary for the proposed development on the site.

10.2 Recommendations

The following further works are recommended;

- Remediation strategy / development statement for imported soils & unexpected contamination.

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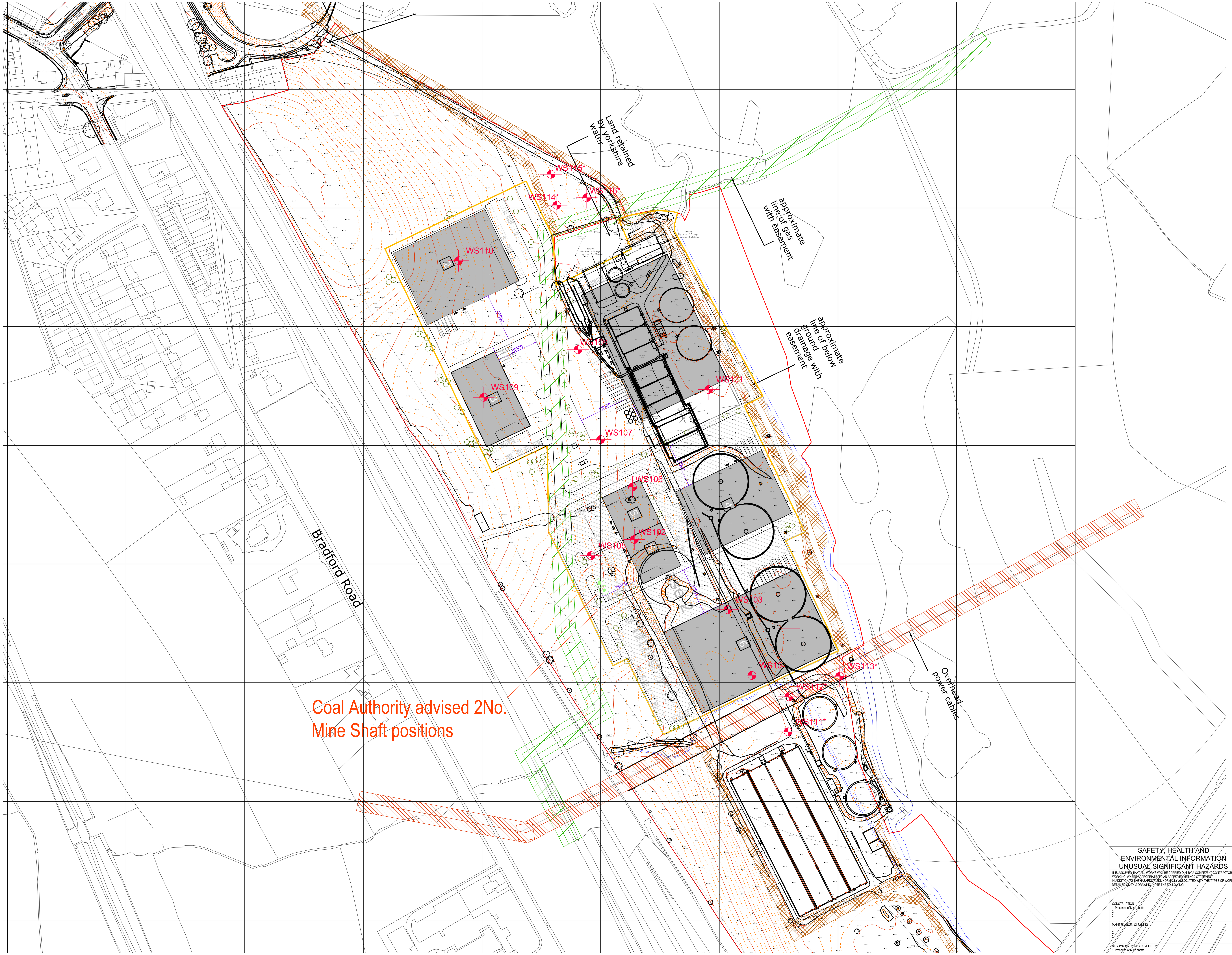
Appendix A – Drawings

- Curtins Drawing Ref. 065646-CUR-00-XX-DR-GE-001-V01 Exploratory Hole Location Plan.
- Curtins cut & fill model.



GENERAL NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. FOR GENERAL NOTES REFER TO DRAWING.

GROUND INVESTIGATIONS KEY

Curtins Ground Investigation

WS Window sample borehole
* (asterisk) denotes monitoring well

Mine Shafts
Dashed line indicates 8m departure zone from shafts

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION UNUSUAL SIGNIFICANT HAZARDS

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING:

CONSTRUCTION
1. Presence of Mine shafts
2.
3.

MAINTENANCE / CLEANING
1.
2.
3.

DECOMMISSIONING / DEMOLITION
1. Presence of Mine shafts
2.
3.

Rev:	Description:	Date:	By:	Chkd:
V04	Updated locations following GI	01/11/19	MB	MB
P03	Added Further WS locations	02/10/19	MB	MB
P02	Amended	01/10/19	KE	MB
P01	ISSUE	30/09/19	MB	MB

curtins
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Email
Web

Civils & Structures • Transport Planning • Environmental • Infrastructure • Geotechnical • Conservation & Heritage • Principal Designer
Birmingham • Bristol • Cambridge • Cardiff • Douglas • Dublin • Edinburgh • Glasgow • Kendal • Leeds • Liverpool • London • Manchester • Nottingham

Status: FINAL

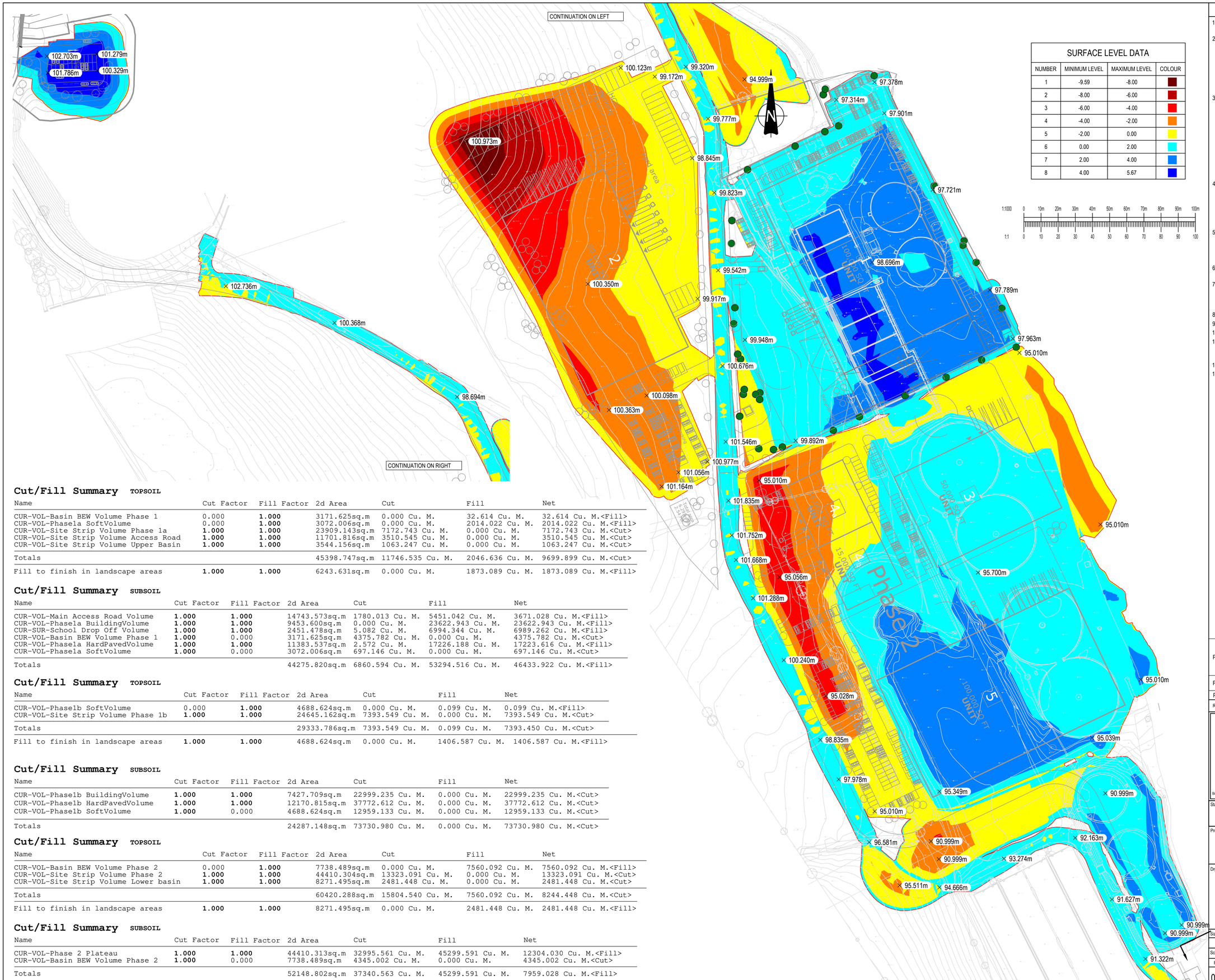
Project: NORTH BIERLEY

Drg Title: EXPLORATORY HOLE LOCATION PLAN

Size:	Date:	Drawn By:	Designed By:	Checked By:
A0	01/11/2019	MB	MB	MB
Scale: 1:1000				

Project No:	Originator:	Volume:	Level:	Type:	Role:	Category / Number:	Rev:
065646	CUR	00	XX	DR	GE	001	V04

\\efs02\Projects\065646 FRA Addendum N Bierley WWTW\QMS 4 Production\4B Models & Drawings_Enviromental-Z\CAD\



SURFACE LEVEL DATA			
NUMBER	MINIMUM LEVEL	MAXIMUM LEVEL	COLOUR
1	-9.59	-8.00	
2	-8.00	-6.00	
3	-6.00	-4.00	
4	-4.00	-2.00	
5	-2.00	0.00	
6	0.00	2.00	
7	2.00	4.00	
8	4.00	5.67	

1:1000 0 10m 20m 30m 40m 50m 60m 70m 80m 90m 100m
1:1 0 10 20 30 40 50 60 70 80 90 100

GENERAL NOTES:

1. THIS BULK EARTHWORKS ANALYSIS IS A COMPARISON BETWEEN THE STRIPPED ORIGINAL GROUND SURFACE, AND THE FORMATION SURFACE.
2. THE ANALYSIS IS BASED ON:
   - WARDELL ARMSTRONG, 2D TOPOGRAPHICAL SURVEY, DRAWING REF: SH10534-004, DATED 18/03/2014.
   - ELLIS HEALEY ARCHITECTURE PROPOSED SITE LAYOUT, DRAWING REF: 1856 SK14A, RECEIVED 01/10/2019.
   - 2m RESOLUTION DTM LIDAR DATA FROM THE ENVIRONMENT AGENCY
   - 30m RESOLUTION SRTMGL1 DATA
3. ITEMS EXCLUDED FROM THIS ANALYSIS INCLUDE:
   - BULKING FACTORS
   - DEMOLITION ARISINGS FROM EXISTING BUILDINGS ABOVE GROUND LEVEL
   - EXCAVATIONS ARISING FROM THE DRAINAGE SYSTEM
   - SURFACE WATER ATTENUATION
   - BUILDING FOUNDATION EDGE BEAMS, PILES AND PILE CAPS
   - RETAINING AND NON-RETAINING WALL FOUNDATIONS
   - ADDITIONAL CAPPING REQUIREMENTS FOR PLANTING AREAS, IF REQUIRED.
4. ASSUMPTIONS:
   - ALL SITE MATERIAL IS ASSUMED TO BE REUSABLE
   - 300mm DEPTH OF TOPSOIL STRIP HAS BEEN ASSUMED, PENDING THE OUTCOME OF THE GROUND INVESTIGATION. THE CUT & FILL IS A COMPARISON BETWEEN THE TOPSOIL STRIPPED EXISTING SURFACE AND THE FORMATION SURFACE
5. ASSUMED FORMATION DEPTHS ARE:
   - 500mm BUILDING FOOTPRINTS
   - 450mm HARDSTANDING AREAS
   - 300mm LANDSCAPING AREAS
6. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
7. DO NOT SCALE FROM THIS DRAWING. ANY AMBIGUITIES, ERRORS OR OMISSIONS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
8. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
9. ALL AREAS ARE EXPRESSED IN SQUARE METRES.
10. ALL VOLUMES ARE EXPRESSED IN CUBIC METRES.
11. SOME BATTER SLOPES ARE LOCATED OUTSIDE THE FENCE LINE AND LIMITS OF TOPOGRAPHICAL SURVEY, RETAINING STRUCTURE MAY BE REQUIRED OR A REVISION TO THE EXTENTS OF THE WORKS
12. ALL BATTER SLOPES TO THE PLOTS ARE MODELED AT 1:2
13. BASINS HAVE BEEN DESIGNED IN ACCORDANCE WITH THE YORKSHIRE WATER GUIDANCE FOR ADOPTABLE BASINS, SUBJECT TO DETAILED DRAINAGE DESIGN AND HYDRAULIC MODELLING

Cut/Fill Summary TOPSOIL

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUR-VOL-Basin BEW Volume Phase 1	0.000	**1.000**	3171.625sq.m	0.000 Cu. M.	32.614 Cu. M.	32.614 Cu. M.<Fill>
CUR-VOL-Phase1a SoftVolume	0.000	**1.000**	3072.006sq.m	0.000 Cu. M.	2014.022 Cu. M.	2014.022 Cu. M.<Fill>
CUR-VOL-Site Strip Volume Phase 1a	**1.000**	**1.000**	23909.143sq.m	7172.743 Cu. M.	0.000 Cu. M.	7172.743 Cu. M.<Cut>
CUR-VOL-Site Strip Volume Access Road	**1.000**	**1.000**	11701.816sq.m	3510.545 Cu. M.	0.000 Cu. M.	3510.545 Cu. M.<Cut>
CUR-VOL-Site Strip Volume Upper Basin	**1.000**	**1.000**	3544.156sq.m	1063.247 Cu. M.	0.000 Cu. M.	1063.247 Cu. M.<Cut>
Totals			45398.747sq.m	11746.535 Cu. M.	2046.636 Cu. M.	9699.899 Cu. M.<Cut>
Fill to finish in landscape areas	**1.000**	**1.000**	6243.631sq.m	0.000 Cu. M.	1873.089 Cu. M.	1873.089 Cu. M.<Fill>

Cut/Fill Summary SUBSOIL

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUR-VOL-Main Access Road Volume	**1.000**	**1.000**	14743.573sq.m	1780.013 Cu. M.	5451.042 Cu. M.	3671.028 Cu. M.<Fill>
CUR-VOL-Phase1a BuildingVolume	**1.000**	**1.000**	9453.600sq.m	0.000 Cu. M.	23622.943 Cu. M.	23622.943 Cu. M.<Fill>
CUR-SUR-School Drop Off Volume	**1.000**	**1.000**	2451.478sq.m	5.082 Cu. M.	6994.344 Cu. M.	6989.262 Cu. M.<Fill>
CUR-VOL-Basin BEW Volume Phase 1	**1.000**	0.000	3171.625sq.m	4375.782 Cu. M.	0.000 Cu. M.	4375.782 Cu. M.<Cut>
CUR-VOL-Phase1a HardPavedVolume	**1.000**	**1.000**	11383.537sq.m	2.572 Cu. M.	17226.188 Cu. M.	17223.616 Cu. M.<Fill>
CUR-VOL-Phase1a SoftVolume	**1.000**	0.000	3072.006sq.m	697.146 Cu. M.	0.000 Cu. M.	697.146 Cu. M.<Cut>
Totals			44275.820sq.m	6860.594 Cu. M.	53294.516 Cu. M.	46433.922 Cu. M.<Fill>

Cut/Fill Summary TOPSOIL

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUR-VOL-Phase1b SoftVolume	0.000	**1.000**	4688.624sq.m	0.000 Cu. M.	0.099 Cu. M.	0.099 Cu. M.<Fill>
CUR-VOL-Site Strip Volume Phase 1b	**1.000**	**1.000**	24645.162sq.m	7393.549 Cu. M.	0.000 Cu. M.	7393.549 Cu. M.<Cut>
Totals			29333.786sq.m	7393.549 Cu. M.	0.099 Cu. M.	7393.450 Cu. M.<Cut>
Fill to finish in landscape areas	**1.000**	**1.000**	4688.624sq.m	0.000 Cu. M.	1406.587 Cu. M.	1406.587 Cu. M.<Fill>

Cut/Fill Summary SUBSOIL

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUR-VOL-Phase1b BuildingVolume	**1.000**	**1.000**	7427.709sq.m	22999.235 Cu. M.	0.000 Cu. M.	22999.235 Cu. M.<Cut>
CUR-VOL-Phase1b HardPavedVolume	**1.000**	**1.000**	12170.815sq.m	37772.612 Cu. M.	0.000 Cu. M.	37772.612 Cu. M.<Cut>
CUR-VOL-Phase1b SoftVolume	**1.000**	0.000	4688.624sq.m	12959.133 Cu. M.	0.000 Cu. M.	12959.133 Cu. M.<Cut>
Totals			24287.148sq.m	73730.980 Cu. M.	0.000 Cu. M.	73730.980 Cu. M.<Cut>

Cut/Fill Summary TOPSOIL

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUR-VOL-Basin BEW Volume Phase 2	0.000	**1.000**	7738.489sq.m	0.000 Cu. M.	7560.092 Cu. M.	7560.092 Cu. M.<Fill>
CUR-VOL-Site Strip Volume Phase 2	**1.000**	**1.000**	44410.304sq.m	13323.091 Cu. M.	0.000 Cu. M.	13323.091 Cu. M.<Cut>
CUR-VOL-Site Strip Volume Lower basin	**1.000**	**1.000**	8271.495sq.m	2481.448 Cu. M.	0.000 Cu. M.	2481.448 Cu. M.<Cut>
Totals			60420.288sq.m	15804.540 Cu. M.	7560.092 Cu. M.	8244.448 Cu. M.<Cut>
Fill to finish in landscape areas	**1.000**	**1.000**	8271.495sq.m	0.000 Cu. M.	2481.448 Cu. M.	2481.448 Cu. M.<Fill>

Cut/Fill Summary SUBSOIL

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUR-VOL-Phase 2 Plateau	**1.000**	**1.000**	44410.313sq.m	32995.561 Cu. M.	45299.591 Cu. M.	12304.030 Cu. M.<Fill>
CUR-VOL-Basin BEW Volume Phase 2	**1.000**	0.000	7738.489sq.m	4345.002 Cu. M.	0.000 Cu. M.	4345.002 Cu. M.<Cut>
Totals			52148.802sq.m	37340.563 Cu. M.	45299.591 Cu. M.	7959.028 Cu. M.<Fill>

Rev:	Description:	Date:	By:	Chkd:
P03	REVISED TO INDICATE A SINGLE PLATEAU TO PHASE 1B AND PHASE 2, INCLUDED ADOPTABLE BASINS, MODIFIES HIGHWAYS DESIGN IN LINE WITH ACCESS ARRANGEMENTS, INTEGRATED SCHOLL DROP OFF AREA	09/10/19	OT	VW
P02	AMENDED TO SUITE REVISED LAYOUT, ADDED PHASE 1 ONLY VOLUMES	20/06/19	OT	AMB
P01	ISSUED FOR INFORMATION.	22/01/19	AMB	OT

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Status: SUITABLE FOR INFORMATION — S2

Project: NORTH BIERLEY WWTW REDEVELOPMENT

Drg Title: BULK EARTHWORKS ANALYSIS

Size:	Date:	Drawn By:	Designed By:	Checked By:
A1	22/01/19	AMB	AMB	OT

Scale: 1:1000

Project No:	Originator:	Volume:	Level:	Type:	Role:	Category / Number:	Rev:
065646	CUR	00	ZZ	DR	C	91001	P03

\\afs02\Projects\065646 RFA Addendum N Bierley WWTW\QMS 4 Production\4B Models & Drawings_Civil\C\CAD\S1\

Appendix B – Exploratory Hole Logs

- Window Sample Borehole Logs, WS101 – WS116.

Borehole Log

Borehole No. **WS101**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 02/10/2019 - 02/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			Soft dark grey brown slightly sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, coal, concrete, mudstone, sandstone and slag. Low brick and concrete cobble content. Frequent rootlets.
		1.20		N=11 (1,1/2,3,3,3)	1.20			MADE GROUND: Soft to firm dark brown mottled orange and black gravelly CLAY. Gravel is fine to coarse sub angular to angular brick, coal, concrete, mudstone and sandstone.
		1.30	ES					
					1.50			MADE GROUND: Soft dark grey to black sandy slightly gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick and sandstone. Frequent rootlets.
		1.90	D					
		1.90	ES					
		2.00		N=4 (1,0/1,1,1,1)	2.20			MADE GROUND: Soft dark grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, mudstone and sandstone.
					2.60			MADE GROUND: Soft dark grey to black sandy slightly gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick and sandstone. Frequent rootlets.
		3.00		N=11 (1,2/2,2,4,3)	3.00			MADE GROUND: Soft dark grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, mudstone and sandstone.
		3.20	D					
	▼				3.50			Soft orangey brown slightly gravelly CLAY. Gravel is fine to coarse sub rounded to sub angular sandstone.
		4.00		N=15 (3,5/3,4,4,4)	4.00			Soft dark grey very gravelly CLAY. Gravel is fine to coarse sub rounded to angular mudstone.
								Firm grey brown slightly sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular mudstone.
		5.00		N=24 (5,5/3,6,7,8)				
					5.45			End of borehole at 5.45 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

AGS

Borehole Log

Borehole No. **WS102**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 02/10/2019 - 02/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10			Soft brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, concrete, mudstone and sandstone. Frequent rootlets.
					0.40			MADE GROUND: Soft dark grey brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, concrete, mudstone, sandstone and slag. Rare timber.
		0.70	ES					
		1.20	D		1.10			MADE GROUND: Soft dark grey slightly sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, coal, concrete, mudstone, sandstone and slag.
		1.20		N=16 (2,2/3,4,4,5)				
		1.40	D					
					1.80			Soft to firm brown sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
		2.00		N=27 (2,3/4,4,4,15)	2.00			Soft black sandy CLAY.
	▼							Soft brown very gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone.
		2.60	D					
					2.80			Soft brown mottled orange and dark grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular mudstone and sandstone.
		3.00		N=27 (3,4/6,6,7,8)				
					3.50			Firm dark grey gravelly CLAY. Gravel is fine to coarse sub angular to angular mudstone.
		4.00		36 (10,14/36 for 190mm)				
					4.42			End of borehole at 4.42 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to sinking rig.

Borehole Log

Borehole No. **WS103**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 02/10/2019 - 02/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.10			Soft brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
		0.50	ES					MADE GROUND: Soft light to dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, concrete, mudstone and sandstone. Occasional plastic, tile and timber. Low concrete cobble content.
		1.20		N=10 (1,2/2,2,3,3)	1.10			Dark greeny grey slightly gravelly CLAY. Gravel is fine to coarse sub angular to angular coal and mudstone.
		1.30	D		1.20			Firm orangey brown mottled grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
		2.00		N=16 (1,2/2,3,5,6)				
		3.00		N=20 (2,4/3,5,5,7)	3.10			Firm to stiff dark grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
		4.00		N=36 (4,5/5,7,10,14)				
		5.00		24 (11,15/24 for 95mm)	5.25			End of borehole at 5.25 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

Borehole Log

Borehole No. **WS104**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 02/10/2019 - 02/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			Soft brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
		0.90	ES					MADE GROUND: Soft dark browny grey sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
		1.20		N=9 (2,2/3,2,2,2)	1.20			Soft dark grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, and mudstone. Rare timber.
		2.00		N=9 (1,0/2,2,2,3)	1.70			Soft to firm grey slightly gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Low sandstone cobble content.
								Becoming firmer with depth.
		3.00		N=13 (2,2/3,3,3,4)				
		4.00		N=12 (2,2/2,3,3,4)				
	▼							
		5.00		34 (6,10/34 for 125mm)				
					5.29			End of borehole at 5.29 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

Borehole Log

Borehole No. **WS105**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 03/10/2019 - 03/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15			Soft brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
		0.40	ES		0.60			MADE GROUND: Soft brown slightly sandy gravelly CLAY. Gravel is fine to coarse sub angular to angular brick, coal, concrete, mudstone and sandstone. Rare ceramic. Frequent rootlets.
		1.20		N=12 (2,2/2,2,3,5)	1.30			MADE GROUND: Black clayey fine to coarse sub angular to angular coal and mudstone GRAVEL. Rare ceramics and rootlets.
		2.00		N=23 (9,13/9,5,4,5)				Firm orange brown mottled grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
	▼				2.70			Soft brown mottled black slightly sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular mudstone and sandstone.
		3.00		N=4 (1,1/1,0,1,2)				
		4.00		N=11 (1,2/1,3,3,4)				
		5.00		N=21 (2,5/6,5,5,5)				
					5.45			End of borehole at 5.45 m

1 2 3 4 5 6 7 8 9 10

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

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Borehole Log

Borehole No. **WS106**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 03/10/2019 - 03/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.50 0.50	D ES		0.25			Soft brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular sandstone. Frequent rootlets.
		1.20		N=10 (2,2/2,3,2,3)				Soft orangey brown mottled grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone.
		2.00		N=10 (3,6/3,1,3,3)	1.50			Firm brown slightly sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Low sandstone cobble content.
	▼	3.00		N=30 (6,5/6,6,8,10)	3.00			Firm brown slightly sandy very gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Low sandstone cobble content.
		4.00		N=32 (5,5/6,8,8,10)				
		5.00		32 (9,9/32 for 155mm)	5.31			End of borehole at 5.31 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

Borehole Log

Borehole No. **WS107**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 03/10/2019 - 03/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, ceramic, coal, mudstone and sandstone.
		1.20		N=16 (2,3/4,4,4,4)				Soft to firm brown mottled orange and grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
	▼	2.00		N=12 (3,2/2,3,3,4)	2.00			Soft to firm brown slightly sandy gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
		3.00		N=17 (1,2/3,4,5,5)				
		4.00		N=19 (2,2/4,5,5,5)				
		5.00		N=28 (4,7/7,7,7,7)				
					5.45			End of borehole at 5.45 m

1 2 3 4 5 6 7 8 9 10

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

AGS

Borehole Log

Borehole No. **WS108**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 03/10/2019 - 03/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, ceramic, coal, mudstone and sandstone.
		0.40	ES		0.60			MADE GROUND: Soft dark grey to black gravelly CLAY. Gravel is fine to coarse sub angular to angular brick, ceramic, coal, mudstone and sandstone. Low brick and ceramic cobble content.
		1.20		N=17 (2,4/5,4,4,4)				Soft light brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Moderate sandstone cobble content.
		2.00		N=12 (2,3/3,3,3,3)				
		3.00		N=16 (3,10/4,4,4,4)				
					3.50			End of borehole at 3.50 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3.

Borehole Log

Borehole No. **WS109**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 03/10/2019 - 03/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
		0.30	D					Soft light brown slightly sandy very gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
		1.20		N=16 (2,3/3,3,5,5)				
		2.00		38 (4,8/38 for 160mm)				
					2.31			End of borehole at 2.31 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to target depth being achieved.

Borehole Log

Borehole No. **WS110**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 03/10/2019 - 03/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.20 0.20	D ES		0.15			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
		1.20		N=14 (2,3/3,3,4,4)				Soft light brown mottled orange and grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Moderate sandstone cobble content.
		2.00		N=11 (1,1/2,2,3,4)	1.70			Firm brown slightly sandy gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
		3.00		N=14 (1,2/3,3,3,5)	3.20			Firm orange brown mottled grey sandy gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
		4.00		N=40 (8,10/40 for 235mm)	4.39			End of borehole at 4.39 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to refusal.

Borehole Log

Borehole No.
WS111
Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 04/10/2019 - 04/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.15			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
								Soft to firm grey brown mottled orange gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
					2.20			Soft orange brown mottled grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone.
					3.00			Soft to firm grey mottled orange gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone, sandstone and siltstone. Low sandstone and siltstone cobble content.
					4.70			End of borehole at 4.70 m

Remarks
1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to refusal. 4. Hole installed with 50mm stand pipe with response zone indicated on logs. 5. Reinstated at surface with flush cover.

Borehole Log

Borehole No.
WS112
Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 04/10/2019 - 04/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30	ES		0.15			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
								MADE GROUND: Dark browny grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, ceramic, coal, mudstone and sandstone. Rare timber and rootlets. Low brick, ceramic and sandstone cobble content.
					1.30			*Very poor recovery (~10%)*
								Soft grey sandy gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone.
					3.25			Soft dark grey to black gravelly CLAY. Gravel is fine to coarse sub angular to angular coal and mudstone.
					4.00			End of borehole at 4.00 m

Remarks
1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to collapse. 4. Hole installed with 50mm stand pipe with response zone indicated on logs. 5. Reinstated at surface with flush cover.

Borehole Log

Borehole No. **WS113**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 04/10/2019 - 04/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.60	ES		0.15			Soft dark brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular concrete, mudstone and sandstone. Frequent rootlets.
								MADE GROUND: Soft browny grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular brick, ceramic, coal, mudstone and sandstone. Rare plastic and timber. Low brick, mudstone and sandstone cobble content.
					1.50			Dark grey to black clayey fine to coarse sub angular to angular coal and mudstone GRAVEL.
					3.10			Soft to firm orange brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone.
					4.50			End of borehole at 4.50 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to refusal. 4. Hole installed with 50mm stand pipe with response zone indicated on logs. 5. Reinstated at surface with flush cover.

Borehole Log

Borehole No. **WS114**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 04/10/2019 - 04/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30	D		0.20			Soft dark brown CLAY. Frequent rootlets.
					0.40			Soft browny grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone.
								Soft to firm orange brown mottled grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
					3.00			End of borehole at 3.00 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to sinking rig. 4. Hole installed with 50mm stand pipe with response zone indicated on logs. 5. Reinstated at surface with flush cover.

Borehole Log

Borehole No. **WS115**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 04/10/2019 - 04/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.25	ES		0.20			Soft dark brown CLAY. Frequent rootlets.
					0.60			Soft browny grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone.
					1.40			Soft to firm orange brown mottled grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone and sandstone. Low sandstone cobble content.
					3.20			Firm brown grey gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone, sandstone and siltstone. Low sandstone and siltstone cobble content.
					4.50			Soft grey sandy gravelly CLAY. Gravel is fine to coarse sub angular to angular coal, mudstone, sandstone and siltstone.
								End of borehole at 4.50 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to refusal. 4. Hole installed with 50mm stand pipe with response zone indicated on logs. 5. Reinstated at surface with flush cover.

Borehole Log

Borehole No. **WS116**

Sheet 1 of 1

Project Name: North Bierley	Project No. B065646.300	Co-ords: -	Hole Type WS
Location: Bradford		Level:	Scale 1:50
Client: Opus North		Dates: 04/10/2019 - 04/10/2019	Logged By ES

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.30 0.30	D ES		0.10			Soft dark brown CLAY. Frequent rootlets.
					0.60			Soft light brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Low sandstone cobble content.
					1.30			Soft brown mottled orange and black gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Low sandstone cobble content.
					2.10			Firm browny grey mottled orange and light grey gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Low sandstone cobble content.
					2.90			Firm brown gravelly CLAY. Gravel is fine to coarse sub rounded to angular coal, mudstone and sandstone. Moderate sandstone cobble content.
								End of borehole at 2.90 m

Remarks

1. Hole location scanned with CAT4+ prior to breaking ground. 2. Hand excavated pit 1.2m prior to drilling. 3. Terminated due to refusal. 4. Hole installed with 50mm stand pipe with response zone indicated on logs. 5. Reinstated at surface with flush cover.

Appendix C – Chemical Laboratory Testing Results

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Analytical Report Number : 19-66475

Project / Site name:	North Bierley	**Samples received on:**	07/10/2019
Your job number:	65646	**Samples instructed on:**	17/10/2019
Your order number:	EBLE820	**Analysis completed by:**	28/10/2019
Report Issue Number:	1	**Report issued on:**	28/10/2019
Samples Analysed:	13 soil samples		

Signed:

Zina Abdul Razzak
Senior Quality Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 19-66475

Project / Site name: North Bierley

Your Order No: EBLE820

Lab Sample Number				1333707	1333708	1333709	1333710	1333711
Sample Reference				TP101	WS101	WS104	WS108	WS113
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.60	1.30	0.90	0.40	0.60
Date Sampled				02/10/2019	02/10/2019	02/10/2019	03/10/2019	04/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	20	36	13	15	11
Total mass of sample received	kg	0.001	NONE	0.86	1.2	1.1	1.4	1.4
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.7	7.7	7.6	7.3	8.0
Total Cyanide	mg/kg	1	MCERTS	11	42	2	2	18
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	-	-	-	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.26	0.36	0.13	0.047	0.027
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	265	365	134	46.6	27.0
Organic Matter	%	0.1	MCERTS	5.7	8.6	2.5	4.2	3.2
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	1.0	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	0.33	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	1.6	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	1.4	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	2.5	13	0.36	1.3	1.4
Anthracene	mg/kg	0.05	MCERTS	< 0.05	3.6	< 0.05	0.25	1.2
Fluoranthene	mg/kg	0.05	MCERTS	3.1	26	0.44	1.3	0.70
Pyrene	mg/kg	0.05	MCERTS	2.9	24	0.38	1.2	0.66
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.5	15	0.20	0.70	0.38
Chrysene	mg/kg	0.05	MCERTS	1.6	10	0.30	0.79	0.71
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.7	15	0.25	0.76	0.60
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	1.6	9.4	0.20	0.67	0.49
Benzo(a)pyrene	mg/kg	0.05	MCERTS	2.1	16	0.25	0.80	0.56
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.95	11	< 0.05	0.56	0.48
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	3.5	< 0.05	0.20	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.0	13	< 0.05	0.59	0.58
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	18.9	163	2.38	9.17	7.79
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	92	40	21	110	34
Boron (water soluble)	mg/kg	0.2	MCERTS	0.9	4.5	1.2	0.4	0.7
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.6	7.4	< 0.2	< 0.2	0.4
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	68	2100	32	130	150
Copper (aqua regia extractable)	mg/kg	1	MCERTS	190	880	34	120	120
Lead (aqua regia extractable)	mg/kg	1	MCERTS	480	540	31	140	68
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.6	2.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	42	59	25	29	29
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	4.8	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	350	1200	67	110	140

Analytical Report Number: 19-66475

Project / Site name: North Bierley

Your Order No: EBLE820

Lab Sample Number				1333707	1333708	1333709	1333710	1333711
Sample Reference				TP101	WS101	WS104	WS108	WS113
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.60	1.30	0.90	0.40	0.60
Date Sampled				02/10/2019	02/10/2019	02/10/2019	03/10/2019	04/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	3.2	< 1.0	1.1	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	17	< 2.0	7.2	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	200	< 8.0	15	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	1300	< 8.0	72	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	1500	< 10	95	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	9.8	8.3	< 2.0	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	52	110	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	130	740	< 10	19	19
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	190	860	< 10	25	27

Analytical Report Number: 19-66475

Project / Site name: North Bierley

Your Order No: EBLE820

Lab Sample Number				1333712	1333713	1333714	1333715	1333716
Sample Reference				WS116	WS101	WS102	WS103	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.30	1.90	0.70	0.50	0.50
Date Sampled				04/10/2019	02/10/2019	02/10/2019	02/10/2019	03/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	25	19	16	13	13
Total mass of sample received	kg	0.001	NONE	1.4	1.4	1.4	1.4	1.3
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.7	7.8	8.0	7.8	7.8
Total Cyanide	mg/kg	1	MCERTS	2	-	-	-	-
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	450	120	79	19
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.030	0.23	0.062	0.040	0.0095
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	29.7	227	62.4	39.7	9.5
Organic Matter	%	0.1	MCERTS	1.2	0.4	0.8	1.8	2.6
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	-	-	-	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.76	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.74	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.66	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	1.9	5.5	0.54	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	0.54	1.4	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	3.1	7.2	0.54	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	2.8	6.4	0.49	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	1.7	3.1	0.35	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	1.8	2.8	0.35	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	2.6	2.6	0.40	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	1.4	1.3	0.16	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	2.3	2.2	0.29	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	2.0	1.5	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.61	0.46	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	2.3	1.8	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	23.1	38.3	3.12	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	35	41	66	20	13
Boron (water soluble)	mg/kg	0.2	MCERTS	0.4	1.4	1.0	0.7	0.5
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	1.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	48	360	91	39	23
Copper (aqua regia extractable)	mg/kg	1	MCERTS	33	150	88	37	21
Lead (aqua regia extractable)	mg/kg	1	MCERTS	73	110	440	42	22
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	16	30	28	29	22
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	72	220	120	77	61

Analytical Report Number: 19-66475

Project / Site name: North Bierley

Your Order No: EBLE820

Lab Sample Number				1333712	1333713	1333714	1333715	1333716
Sample Reference				WS116	WS101	WS102	WS103	WS106
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.30	1.90	0.70	0.50	0.50
Date Sampled				04/10/2019	02/10/2019	02/10/2019	02/10/2019	03/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	5.3	< 2.0	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	77	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	500	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	580	< 10	< 10	< 10

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	3.4	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	36	20	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	< 10	230	44	12	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	270	68	19	< 10

Analytical Report Number: 19-66475

Project / Site name: North Bierley

Your Order No: EBLE820

Lab Sample Number				1333717	1333718	1333719		
Sample Reference				WS110	WS112	WS115		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.20	0.30	0.25		
Date Sampled				03/10/2019	04/10/2019	04/10/2019		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1		
Moisture Content	%	N/A	NONE	19	13	24		
Total mass of sample received	kg	0.001	NONE	1.3	1.3	1.5		
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected		
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.4	7.8	7.4		
Total Cyanide	mg/kg	1	MCERTS	-	-	-		
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	44	54	35		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.022	0.027	0.018		
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	22.2	26.9	17.5		
Organic Matter	%	0.1	MCERTS	0.8	1.1	0.8		
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	-	-	-		
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Phenanthrene	mg/kg	0.05	MCERTS	0.43	1.1	0.29		
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Fluoranthene	mg/kg	0.05	MCERTS	0.68	0.86	0.52		
Pyrene	mg/kg	0.05	MCERTS	0.60	0.83	0.33		
Benzo(a)anthracene	mg/kg	0.05	MCERTS	0.23	0.45	0.28		
Chrysene	mg/kg	0.05	MCERTS	0.47	0.77	0.37		
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	0.41	0.67	0.33		
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.25	0.59	0.24		
Benzo(a)pyrene	mg/kg	0.05	MCERTS	0.41	0.60	0.25		
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.22	0.41	2.8		
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05		
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.26	0.57	2.2		
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	3.96	6.88	7.60		
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	12	23	11		
Boron (water soluble)	mg/kg	0.2	MCERTS	0.2	0.7	0.8		
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	0.5	< 0.2		
Chromium (hexavalent)	mg/kg	1.2	MCERTS	< 1.2	< 1.2	< 1.2		
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	57	160	42		
Copper (aqua regia extractable)	mg/kg	1	MCERTS	44	120	37		
Lead (aqua regia extractable)	mg/kg	1	MCERTS	53	94	52		
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3		
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	24	36	19		
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	78	160	89		

Analytical Report Number: 19-66475

Project / Site name: North Bierley

Your Order No: EBLE820

Lab Sample Number				1333717	1333718	1333719		
Sample Reference				WS110	WS112	WS115		
Sample Number				None Supplied	None Supplied	None Supplied		
Depth (m)				0.20	0.30	0.25		
Date Sampled				03/10/2019	04/10/2019	04/10/2019		
Time Taken				None Supplied	None Supplied	None Supplied		
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001		
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001		
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001		
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	11	< 1.0		
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	19	< 2.0		
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	26	< 8.0		
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	< 8.0	96	< 8.0		
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	< 10	150	< 10		

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001		
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001		
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001		
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0		
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0	< 2.0	< 2.0		
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	< 10	< 10	< 10		
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	12	26	< 10		
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	18	33	< 10		

Analytical Report Number : 19-66475

Project / Site name: North Bierley

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1333707	TP101	None Supplied	0.60	Brown clay and sand with gravel.
1333708	WS101	None Supplied	1.30	Brown clay and sand.
1333709	WS104	None Supplied	0.90	Brown clay and sand with gravel.
1333710	WS108	None Supplied	0.40	Brown clay and sand with gravel and brick.
1333711	WS113	None Supplied	0.60	Brown clay and sand with gravel.
1333712	WS116	None Supplied	0.30	Brown loam and clay with gravel and vegetation.
1333713	WS101	None Supplied	1.90	Brown clay with gravel.
1333714	WS102	None Supplied	0.70	Brown clay and sand with gravel and vegetation.
1333715	WS103	None Supplied	0.50	Brown clay and sand with gravel and brick.
1333716	WS106	None Supplied	0.50	Brown clay and sand.
1333717	WS110	None Supplied	0.20	Brown clay and loam with gravel and vegetation.
1333718	WS112	None Supplied	0.30	Brown loam and clay with gravel and vegetation.
1333719	WS115	None Supplied	0.25	Brown loam and clay with gravel and vegetation.

Analytical Report Number : 19-66475

Project / Site name: North Bierley

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Hexavalent chromium in soil (Lower Level)	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
TP101		S	19-66475	1333707	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	bc
TP101		S	19-66475	1333707	bc	TPHCWG (Soil)	L088/76-PL	b
TP101		S	19-66475	1333707	bc	Total cyanide in soil	L080-PL	c
WS101		S	19-66475	1333708	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	bc
WS101		S	19-66475	1333708	bc	TPHCWG (Soil)	L088/76-PL	b
WS101		S	19-66475	1333708	bc	Total cyanide in soil	L080-PL	c
WS101		S	19-66475	1333713	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	bc
WS101		S	19-66475	1333713	bc	TPHCWG (Soil)	L088/76-PL	b
WS102		S	19-66475	1333714	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	bc
WS102		S	19-66475	1333714	bc	TPHCWG (Soil)	L088/76-PL	b
WS103		S	19-66475	1333715	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	bc
WS103		S	19-66475	1333715	bc	TPHCWG (Soil)	L088/76-PL	b
WS104		S	19-66475	1333709	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	bc
WS104		S	19-66475	1333709	bc	TPHCWG (Soil)	L088/76-PL	b
WS104		S	19-66475	1333709	bc	Total cyanide in soil	L080-PL	c
WS106		S	19-66475	1333716	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS106		S	19-66475	1333716	b	TPHCWG (Soil)	L088/76-PL	b
WS108		S	19-66475	1333710	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS108		S	19-66475	1333710	bc	TPHCWG (Soil)	L088/76-PL	b
WS108		S	19-66475	1333710	bc	Total cyanide in soil	L080-PL	c
WS110		S	19-66475	1333717	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS110		S	19-66475	1333717	b	TPHCWG (Soil)	L088/76-PL	b
WS112		S	19-66475	1333718	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS112		S	19-66475	1333718	b	TPHCWG (Soil)	L088/76-PL	b
WS113		S	19-66475	1333711	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS113		S	19-66475	1333711	bc	TPHCWG (Soil)	L088/76-PL	b
WS113		S	19-66475	1333711	bc	Total cyanide in soil	L080-PL	c
WS115		S	19-66475	1333719	b	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS115		S	19-66475	1333719	b	TPHCWG (Soil)	L088/76-PL	b
WS116		S	19-66475	1333712	bc	BTEX and MTBE in soil (Monoaromatics)	L073B-PL	b
WS116		S	19-66475	1333712	bc	TPHCWG (Soil)	L088/76-PL	b
WS116		S	19-66475	1333712	bc	Total cyanide in soil	L080-PL	c

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

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Analytical Report Number : 19-66482

Project / Site name:	North Bierley	**Samples received on:**	07/10/2019
Your job number:	65646	**Samples instructed on:**	17/10/2019
Your order number:	EBLE820	**Analysis completed by:**	28/10/2019
Report Issue Number:	1	**Report issued on:**	28/10/2019
Samples Analysed:	3 10:1 WAC samples		

Signed:

Zina Abdul Razzak
Senior Quality Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.

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Waste Acceptance Criteria Analytical Results

Report No:	**19-66482**							
					Client:	**CURTINS**		
Location	**North Bierley**							
Lab Reference (Sample Number)	1333750 / 1333751				**Landfill Waste Acceptance Criteria Limits**			
Sampling Date	02/10/2019				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	WS102						
Depth (m)	0.70						
Solid Waste Analysis							
TOC (%)**	2.0				3%	5%	6%
Loss on Ignition (%) **	6.5				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.007				1	--	--
Mineral Oil (mg/kg)	130				500	--	--
Total PAH (WAC-17) (mg/kg)	38				100	--	--
pH (units)**	8.0				--	>6	--
Acid Neutralisation Capacity (mol / kg)	15				--	To be evaluated	To be evaluated
Eluate Analysis	10:1			10:1	Limit values for compliance leaching test		
(BS EN 12457 - 2 preparation utilising end over end leaching procedure)	mg/l			mg/kg	using BS EN 12457-2 at L/S 10 l/kg (mg/kg)		
Arsenic *	0.0090			0.0800	0.5	2	25
Barium *	0.0135			0.120	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0067			0.059	0.5	10	70
Copper *	0.0082			0.073	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0045			0.0395	0.5	10	30
Nickel *	< 0.0003			< 0.0030	0.4	10	40
Lead *	0.0034			0.030	0.5	10	50
Antimony *	0.014			0.13	0.06	0.7	5
Selenium *	< 0.0040			< 0.040	0.1	0.5	7
Zinc *	0.0028			0.025	4	50	200
Chloride *	1.1			9.8	800	4000	25000
Fluoride	0.61			5.4	10	150	500
Sulphate *	5.7			51	1000	20000	50000
TDS*	89			790	4000	60000	100000
Phenol Index (Monohydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	6.82			60.4	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	1.3						
Dry Matter (%)	84						
Moisture (%)	16						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.
*= UKAS accredited (liquid eluate analysis only)
Stated limits are for guidance only and i2 cannot be held responsible for any discrepancies with current legislation
** = MCERTS accredited

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes as defined by the Waste (England and Wales) Regulations 2011 (as amended) and EA Guidance WM3.
This analysis is only applicable for landfill acceptance criteria (The Environmental Permitting (England and Wales) Regulations) and does not give any indication as to whether a waste may be hazardous or non-hazardous.

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Waste Acceptance Criteria Analytical Results

Report No:	**19-66482**							
					Client:	**CURTINS**		
Location	**North Bierley**							
Lab Reference (Sample Number)	1333752 / 1333753				**Landfill Waste Acceptance Criteria Limits**			
Sampling Date	02/10/2019				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	WS103						
Depth (m)	0.50						
Solid Waste Analysis							
TOC (%)**	1.3				3%	5%	6%
Loss on Ignition (%) **	5.6				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.007				1	--	--
Mineral Oil (mg/kg)	< 10				500	--	--
Total PAH (WAC-17) (mg/kg)	3.1				100	--	--
pH (units)**	7.6				--	>6	--
Acid Neutralisation Capacity (mol / kg)	2.8				--	To be evaluated	To be evaluated
Eluate Analysis	10:1			10:1	Limit values for compliance leaching test		
(BS EN 12457 - 2 preparation utilising end over end leaching procedure)	mg/l			mg/kg	using BS EN 12457-2 at L/S 10 l/kg (mg/kg)		
Arsenic *	< 0.0011			< 0.0110	0.5	2	25
Barium *	0.0110			0.0971	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0012			0.011	0.5	10	70
Copper *	0.0031			0.028	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0009			0.0080	0.5	10	30
Nickel *	< 0.0003			< 0.0030	0.4	10	40
Lead *	0.0011			< 0.010	0.5	10	50
Antimony *	< 0.0017			< 0.017	0.06	0.7	5
Selenium *	< 0.0040			< 0.040	0.1	0.5	7
Zinc *	0.0035			0.031	4	50	200
Chloride *	0.92			8.1	800	4000	25000
Fluoride	0.59			5.2	10	150	500
Sulphate *	5.8			52	1000	20000	50000
TDS*	55			490	4000	60000	100000
Phenol Index (Monhydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	4.75			42.0	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	1.3						
Dry Matter (%)	87						
Moisture (%)	13						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.
*= UKAS accredited (liquid eluate analysis only)
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** = MCERTS accrediited

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This analysis is only applicable for landfill acceptance criteria (The Environmental Permitting (England and Wales) Regulations) and does not give any indication as to whether a waste may be hazardous or non-hazardous.

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Waste Acceptance Criteria Analytical Results

Report No:	**19-66482**						
					Client: CURTINS		
Location	**North Bierley**						
Lab Reference (Sample Number)	1333754 / 1333755				**Landfill Waste Acceptance Criteria Limits**		
Sampling Date	03/10/2019				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Sample ID	WS105						
Depth (m)	0.40						
Solid Waste Analysis							
TOC (%)**	2.5				3%	5%	6%
Loss on Ignition (%) **	11.5				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.007				1	--	--
Mineral Oil (mg/kg)	86				500	--	--
Total PAH (WAC-17) (mg/kg)	1400				100	--	--
pH (units)**	7.7				--	>6	--
Acid Neutralisation Capacity (mol / kg)	4.0				--	To be evaluated	To be evaluated
Eluate Analysis	10:1			10:1	Limit values for compliance leaching test		
(BS EN 12457 - 2 preparation utilising end over end leaching procedure)	mg/l			mg/kg	using BS EN 12457-2 at L/S 10 l/kg (mg/kg)		
Arsenic *	0.0096			0.0785	0.5	2	25
Barium *	0.0338			0.277	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0062			0.051	0.5	10	70
Copper *	0.016			0.13	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0036			0.0294	0.5	10	30
Nickel *	0.0012			0.0095	0.4	10	40
Lead *	0.014			0.11	0.5	10	50
Antimony *	0.034			0.28	0.06	0.7	5
Selenium *	< 0.0040			< 0.040	0.1	0.5	7
Zinc *	0.0078			0.064	4	50	200
Chloride *	1.0			8.5	800	4000	25000
Fluoride	1.0			8.3	10	150	500
Sulphate *	3.2			26	1000	20000	50000
TDS*	61			500	4000	60000	100000
Phenol Index (Monhydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	7.63			62.5	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	1.2						
Dry Matter (%)	86						
Moisture (%)	14						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.
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** = MCERTS accrediited

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes as defined by the Waste (England and Wales) Regulations 2011 (as amended) and EA Guidance WM3.
This analysis is only applicable for landfill acceptance criteria (The Environmental Permitting (England and Wales) Regulations) and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Analytical Report Number : 19-66482

Project / Site name: North Bierley

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1333750	WS102	None Supplied	0.70	Brown clay and sand with gravel and vegetation.
1333752	WS103	None Supplied	0.50	Brown clay and sand with gravel and brick.
1333754	WS105	None Supplied	0.40	Brown sandy loam with gravel and vegetation.

Analytical Report Number : 19-66482

Project / Site name: North Bierley

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Acid neutralisation capacity of soil	Determination of acid neutralisation capacity by addition of acid or alkali followed by electronic probe.	In-house method based on Guidance an Sampling and Testing of Wastes to Meet Landfill Waste Acceptance""	L046-PL	W	NONE
BS EN 12457-2 (10:1) Leachate Prep	10:1 (as recieved, moisture adjusted) end over end extraction with water for 24 hours. Eluate filtered prior to analysis.	In-house method based on BSEN12457-2.	L043-PL	W	NONE
BTEX in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Chloride 10:1 WAC	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260.	L082-PL	W	ISO 17025
Dissolved organic carbon 10:1 WAC	Determination of dissolved inorganic carbon in leachate by TOC/DOC NDIR Analyser.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L037-PL	W	NONE
Fluoride 10:1 WAC	Determination of fluoride in leachate by 1:1ratio with a buffer solution followed by Ion Selective Electrode.	In-house method based on Use of Total Ionic Strength Adjustment Buffer for Electrode Determination"	L033B-PL	W	ISO 17025
Loss on ignition of soil @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L047-PL	D	MCERTS
Metals in leachate by ICP-OES	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Mineral Oil (Soil) C10 - C40	Determination of mineral oil fraction extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L076-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols 10:1 WAC	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080-PL	W	ISO 17025
PCB's By GC-MS in soil	Determination of PCB by extraction with acetone and hexane followed by GC-MS.	In-house method based on USEPA 8082	L027-PL	D	MCERTS
pH in soil	Determination of pH in soil by addition of water followed by electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L005-PL	W	MCERTS
Speciated WAC-17 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270. MCERTS accredited except Coronene.	L064-PL	D	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate 10:1 WAC	Determination of sulphate in leachate by ICP-OES	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Total dissolved solids 10:1 WAC	Determination of total dissolved solids in water by electrometric measurement.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L004-PL	W	NONE

Analytical Report Number : 19-66482

Project / Site name: North Bierley

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Total organic carbon (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Sample ID	Other_ID	Sample Type	Job	Sample Number	Sample Deviation Code	test_name	test_ref	Test Deviation code
WS102		S	19-66482	1333750	bc	BTEX in soil (Monoaromatics)	L073B-PL	bc
WS102		S	19-66482	1333750	bc	Total BTEX in soil (Poland)	L073-PL	bc
WS103		S	19-66482	1333752	bc	BTEX in soil (Monoaromatics)	L073B-PL	bc
WS103		S	19-66482	1333752	bc	Total BTEX in soil (Poland)	L073-PL	bc
WS105		S	19-66482	1333754	b	BTEX in soil (Monoaromatics)	L073B-PL	b
WS105		S	19-66482	1333754	b	Total BTEX in soil (Poland)	L073-PL	b

Key: a - No sampling date b - Incorrect container
c - Holding time d - Headspace e - Temperature

Appendix D – Geotechnical Laboratory Testing Results

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

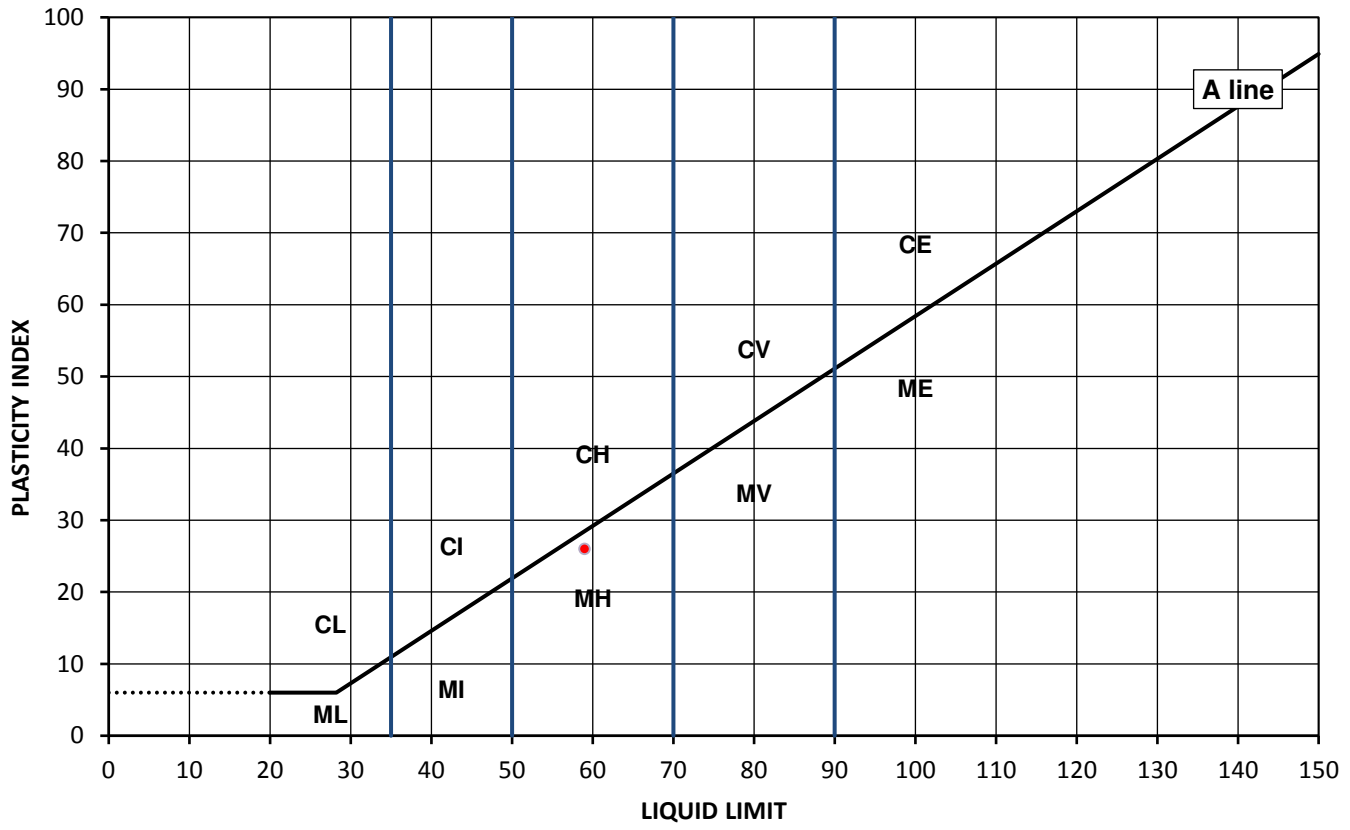
Client:	CURTINS	Client Reference:	65646
Client Address:	Rose Wharf, Ground Floor, 78-80 East Street, Leeds, LS9 8EE	Job Number:	19-66815
		Date Sampled:	02/10/2019
		Date Received:	07/10/2019
Contact:	Emma Scholes	Date Tested:	23/10/2019
Site Name:	North Bierley	Sampled By:	Not Given
Site Address:	Not Given		

Test Results:

Laboratory Reference:	1335546	Depth Top [m]:	1.90
Hole No.:	WS101	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Dark brown slightly gravelly slightly sandy CLAY		

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
25	59	33	26	72



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager

Signed: Darren Berrill
Geotechnical General Manager

Date Reported: 30/10/2019

for and on behalf of i2 Analytical Ltd **GF 236.5**

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

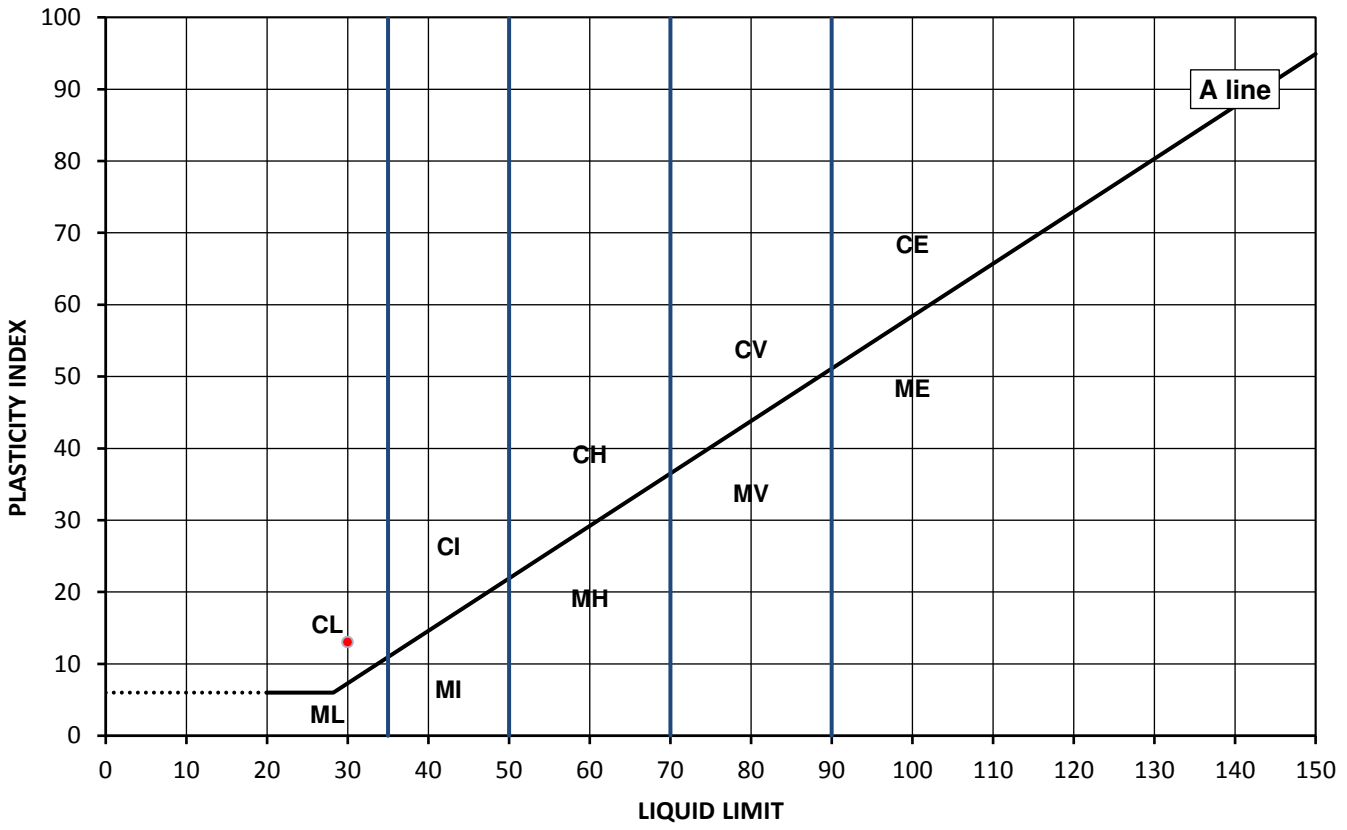
Client:	CURTINS	Client Reference:	65646
Client Address:	Rose Wharf, Ground Floor, 78-80 East Street, Leeds, LS9 8EE	Job Number:	19-66815
		Date Sampled:	02/10/2019
		Date Received:	07/10/2019
Contact:	Emma Scholes	Date Tested:	23/10/2019
Site Name:	North Bierley	Sampled By:	Not Given
Site Address:	Not Given		

Test Results:

Laboratory Reference:	1335549	Depth Top [m]:	1.40
Hole No.:	WS102	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Orangish brown slightly gravelly very sandy CLAY		

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
15	30	17	13	78



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
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M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Note: Moisture Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Dariusz Piotrowski
PL Geotechnical Laboratory Manager

Signed: Darren Berrill
Geotechnical General Manager

Date Reported: 30/10/2019

for and on behalf of i2 Analytical Ltd **GF 236.5**

TEST CERTIFICATE

Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

4041

Tested in Accordance with: BS 1377-2: 1990: Clause 4.3 and 5

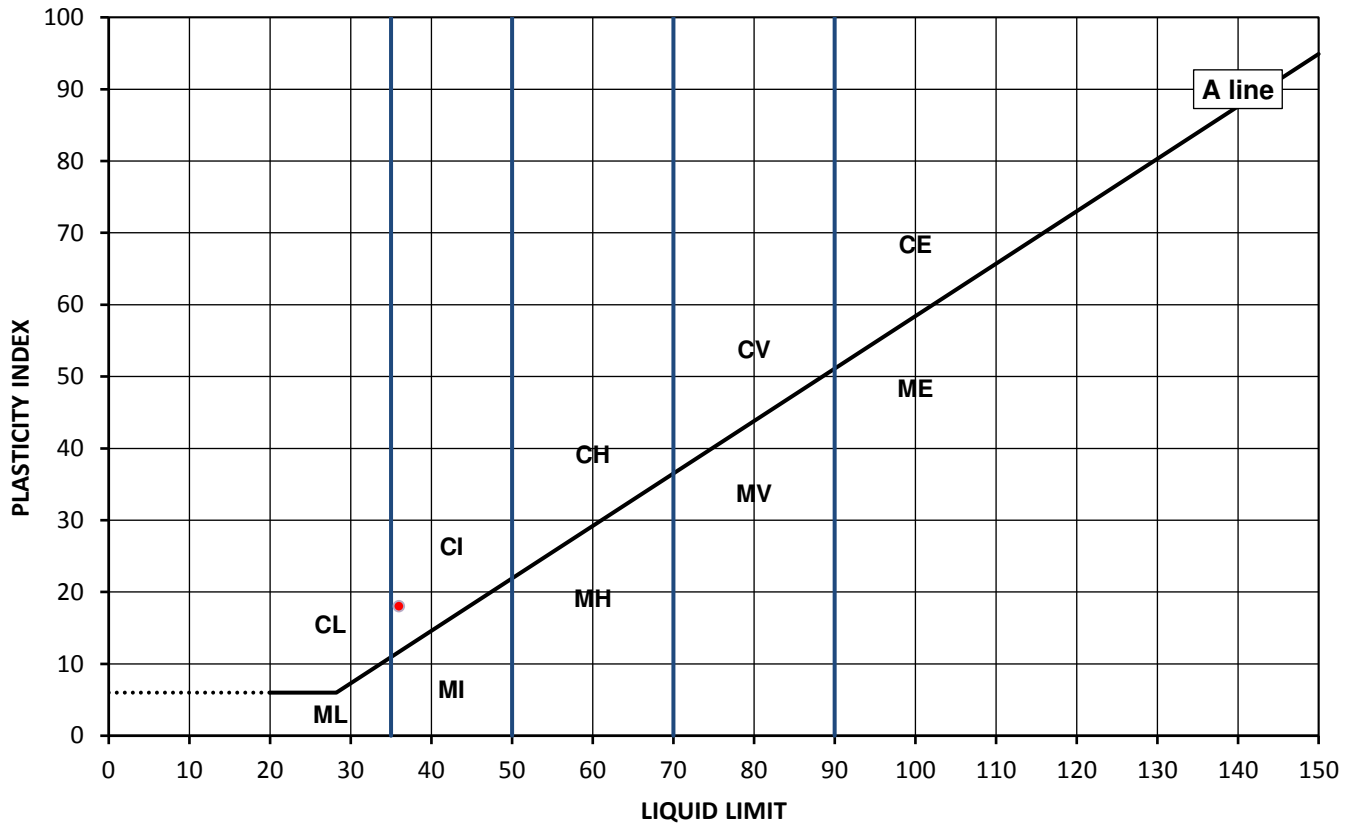
Client:	CURTINS	Client Reference:	65646
Client Address:	Rose Wharf, Ground Floor, 78-80 East Street, Leeds, LS9 8EE	Job Number:	19-66815
		Date Sampled:	02/10/2019
		Date Received:	07/10/2019
Contact:	Emma Scholes	Date Tested:	23/10/2019
Site Name:	North Bierley	Sampled By:	Not Given
Site Address:	Not Given		

Test Results:

Laboratory Reference:	1335550	Depth Top [m]:	2.60
Hole No.:	WS102	Depth Base [m]:	Not Given
Sample Reference:	Not Given	Sample Type:	D
Soil Description:	Orangish brown very gravelly sandy CLAY		

Sample Preparation: Tested after washing to remove >425um

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
16	36	18	18	43



Legend, based on BS 5930:2015 Code of practice for site investigations

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Remarks:

Approved: Dariusz Piotrowski
PL Geotechnical Laboratory Manager

Signed: Darren Berrill
Geotechnical General Manager

Date Reported: 30/10/2019

for and on behalf of i2 Analytical Ltd **GF 236.5**