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STADCO, Battlefield Way

Phase 2 Site Investigation Report

Veolia ES (UK) Ltd

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Revision 01

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Disclaimer: Please note that this report is based on specific information, instructions, and information from our Client and should not be relied upon by third parties.

Revision 01 has been prepared following the correction of a minor presentational error on a concrete core test result (in Appendix G) and the addition of ground-bearing slab assessment based on the core test results as Appendix H.

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Contents

1 Introduction

1.1 Background Information

ByrneLooby Ltd was commissioned by Veolia UK Ltd (the client) to carry out a ground investigation (GI) at the former STADCO Steel Works at STADCO, Battlefield Way, Shrewsbury. The GI was required for the preparation of design works associated with the proposed industrial development of the site.

The work was carried out in accordance with the proposal specification outlined in 14-K0273-TEN-000, dated 21st July 2022 and relevant standards (See Section 11, References). The fieldwork was carried out on 13th September 2022 to 16th September 2022, with gas and groundwater level monitoring completed on 13th October 2022, 26th October 2022, and 9th November 2022.

1.2 Development Proposals

ByrneLooby understands that the client is proposing the development and repurposing of the STADCO Steel Works for the constructions of a fire tank, silo's, a car park, and weighbridge/ kiosk. The proposed site layout shown on **Drawing K0273-BLA-D-001-00** which was supplied by the client.

1.3 Planning Status & Requirements

ByrneLooby have not been informed of specific planning permission requirements for the redevelopment. ByrneLooby understands that the information presented in this report is to be used by the client to inform the future construction of the proposed development.

1.4 Objectives

The purpose of this report is to provide a geo-environmental and geotechnical assessment of the site for the proposed development.

This report complies with the relevant principles and requirements of a range of guidance with regards to potentially contaminated land, including but not limited to:

- Part IIA of the Environment Protection Act, 1990;
- Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, April 2012);
- National Planning Policy Framework (HCA, February 2019);
- BS5930:2015: "Code of Practice for Site Investigations";

- BS10175: 2011 +A2:2017 "Investigation of Potentially Contaminated Sites - Code of Practice";
- The Building Regulations 2010. Part C (HM Government 2013);
- Environment Agency Online Guidance (October 2020): Land Contamination Risk Management Land Contamination (LCRM) (which replaced Report CLR11 (2004) Model Procedures for the Management of Land Contamination);
- Environment Agency (2011) Report GPLC1 "Guiding Principles for Land Contamination"; and
- Environment Agency (2017) "The Environment Agency's Approach to Groundwater Protection" November 2017 Version 1.1.

The 'Service Constraints, Report Limitations & Planning Requirements' are presented as **Appendix A**, and a description of Environmental Risk Assessment Methodology and Terminology is presented in **Appendix B**.

1.5 Previous Investigations

A Phase 1 Desk Study for the site was undertaken in July 2020 by Georisk Management Limited (Georisk), Report No. 20108/1 (dated July 2020), and is summarised below.

ByrneLooby understands that the desk study was completed on behalf of Stadco Limited for the former Stadco facility on Harlescott Lane in Shrewsbury, Shropshire. The study area covered was approximately 7.5 ha. The Georisk desk study mentions a previous Phase 1 & Phase 2 Environmental Site Assessment and Ground Investigation (ESA) having been undertaken at the site by AECOM Limited in 2014. These reports are not available to ByrneLooby, although the AECOM Phase 2 report was summarised within Georisk's desk study report.

<u>Anticipated Geology</u>

A study of 1:50,000 scale BGS digital mapping determined the site to be underlain by Glacial Till clay overlying gravelly sandstone of the Chester Formation and Wildmoor Sandstone Formation of the Sherwood Sandstone Group.

Ground conditions encountered by AECOM in 2014 at the site were summarised as follows:

- **Made Ground:** between 0.3m and 1.2m thick comprising concrete, asphalt, or gravel over subbase and sandy gravelly (brick, clinker, and coal) clay to 1.2m depth;
- **Superficial Deposits:** Glacial Till comprising sandy, gravelly clay to depths of between 2.0m and 5.6m bgl, but not fully penetrated at 6.4m bgl in one location (i.e. BH101); and
- **Bedrock:** Weathered sandstone of the Sherwood Sandstone Group.

Hydrology & Hydrogeology

The nearest surface watercourse (river/stream) is Battlefield Brook approximately 230m north of the site, flowing southeast to the River Severn. A pond is also present within an office car park approximately 20m southwest (150m south of the current site boundary).

The Glacial Till underlying the site is classified as a Secondary Undifferentiated Aquifer, while the Chester Formation and Wildmoor Sandstone Formation are classified as a Principal Aquifer.

In an investigation undertaken by AECOM in 2014 , perched groundwater was encountered at the top, or within, the Glacial Till at the site.

Conclusions of Desk Study by Georisk

Several potential on-site sources of contamination were identified. However, it was noted that no gross or widespread contamination was identified in historical intrusive ground investigations at the site. These investigations reported that the localised contamination encountered posed a very low to low risk to human health and controlled waters.

No potential off-site sources of contamination were identified that could affect the site.

Receptors considered for the site included site end-users, site workers during construction, buildings and foundations, the underlying bedrock Principal Aquifer, Battlefield Brook, and the pond mentioned 150m south of the site.

Relevant pathways considered included dermal contact and ingestion of soils and/or dust derived from any contaminated soil, direct contact with buildings/structures, and lateral migration of mobile contaminants into controlled water receptors.

The contaminant linkages assessment within the report concluded a very low risk to all receptors from any potential contamination on site.

1.6 Site Location

The site was located along Battlefield Way in Shrewsbury with access to the back of the warehouse off Vanguard Way. The site was bounded by industrial infrastructure to the north, east, and south with the road Battlefield Way beyond the western boundary. The approximate site location is shown in **Figure 1.1**.

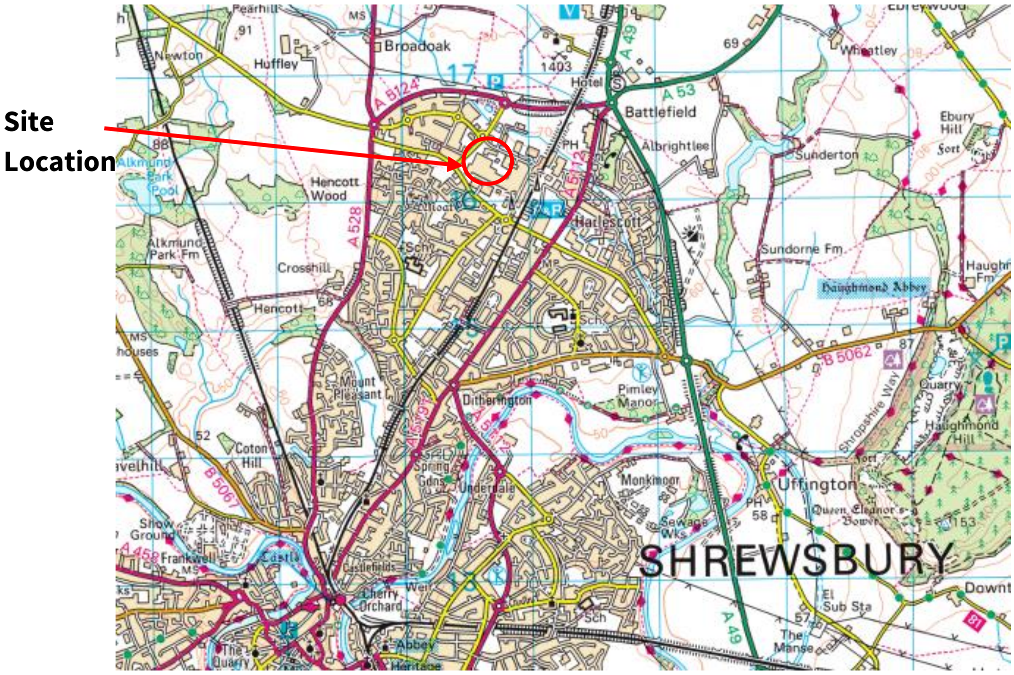

Figure 1.1: Approximate Site Location

Reproduced from Ordnance Survey 1:25,000 Map with the permission of Ordnance Survey ® on behalf of the Controller of Her Majesty's Stationary Office © Crown copyright (2008) All Rights Reserved Licence number 100035365.

The approximate boundaries of the site area are shown on the proposed site layout plan, **Drawing No. K0273-BLA-D-001-00**. A summary of the site location is presented in **Table 1.1**.

Table 1.1 – Summary of the Site Location and its Environs

Location	STADCO, Battlefield Way, Battlefield Way, Shrewsbury
Grid Reference	521076 224095
Post Code	SY1 3EQ
Site Area	1.97 ha (approximately)
Topography	The site is flat with no ostensible topographic changes other than a grass verge along the northern site boundary.

1.7 Site Description

The site was approximately 1.97 ha in area and approximately rectangular in shape. At the time of writing, the site was not in use, with the main warehouse being vacant with only minute amounts of scrap aluminium sheeting left within one of the sections of the warehouse. In the main loading area in the western section of the site, a vacant security kiosk can be found along with some potentially empty gas canisters, scrap metal and wooden pallets found scattered around the area. The eastern area outside the warehouse is vacant of any materials with one blue tarped building currently being used as storage for IBC’s.

The site surface comprised hardstanding concrete on the outside of the warehouse to the east, south and west with a grass clayey, sandy, gravelly verge to the north of the warehouse. The surface within the warehouse was entirely a concrete slab. Site boundaries were demarcated by steel palisade fencing along the northern and western boundaries. The southern boundary is bound by the warehouse’s southern wall. The eastern boundary was an open boundary with industrial warehouses located beyond it.

According to regional unexploded ordnance (UXO) mapping published by Zetica, the site is located within a low UXO risk.

1.8 Limitations

Whilst every attempt is made to record full details of the strata encountered in the exploratory holes, techniques of exploratory hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks.

All information given in this report is based on the ground conditions encountered during the site work and on the results of laboratory and field tests performed during the investigation. However, there may be conditions at the site that have not been considered, such as unpredictable soil strata, contaminant concentrations and water conditions between or below exploratory holes. It should be noted that groundwater levels, gas concentrations and gas flows usually vary due to seasonal, atmospheric and/or other effects and may at times differ to those measured during the investigation.

ByrneLooby’s service constraints and report limitations are presented in **Appendix A** and a description of environmental risk assessment methodology and terminology is presented in **Appendix B**.

2 Site Investigation Scope and Methodology

2.1 General Observations

ByrneLooby personnel were present on site, supervised all work, described the ground encountered, and retrieved soil samples where required. A services search was carried out prior to the site work and a Cable Avoidance Tool (CAT) and Genny scan performed at the location of each exploratory hole location. Each exploratory hole location was also cleared of utilities by a service clearance survey and the GPS locations were recorded. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- British Drilling Association “Guidance for Safe Intrusive Activities on Contaminated or Potentially Contaminated Land” (2008);
- BS5930:2015 "Code of Practice for Site Investigations"; and,
- BS10175:2011 + A2:2017 “Investigation of Potentially Contaminated Sites – Code of Practice.”

2.2 Investigation Scope Summary

The scope of the investigation was considered by ByrneLooby and expressed to the client in the letter 14-K0273-TEN-000, dated July 2022.

A broad scope of the investigation is as follows:

- 2 No. rotary cored boreholes (Geobore) to a maximum depth of 10.00m below ground level (m bgl) with associated in situ testing and sampling;
- Up to 5No. dynamic (window) sampling boreholes to a maximum depth of 5.00m bgl with Standard Penetration Testing (SPTs) at 1m intervals;
- Up to 28No. concrete cores to the base of the concrete slab together with the description of the cores in laboratory;
- Up to 2No. hand-dug trial pits to a maximum depth of 1.20m bgl with associated sampling for geo-environmental and geotechnical purposes;
- Installation of 2No. groundwater monitoring wells within the rotary cored boreholes;
- Installation of 4No. ground gas and groundwater monitoring wells within the dynamic sampling boreholes;
- Logging of ground conditions encountered in accordance with BS5930:2015 "Code of Practice for Site Investigations”;

- Geo-environmental soil sampling of the Made Ground encountered and of the underlying natural strata; and
- 3No. return site visits to monitor ground gas concentrations and groundwater levels.

2.3 Investigation Strategy

The purpose of the various exploratory holes is presented in **Table 2.1**:

Table 2.1 Site Investigation Rationale

Exploratory Holes	Rationale
Boreholes carried out using rotary coring methods. (RC01 – RC02)	2 No. rotary cored (Geobore) boreholes, one of which is located on the proposed fire tank location and the other one in the proposed silos area. The boreholes were drilled using clean drilling techniques, to a target depth of 10.00m bgl and any rock encountered was cored and logged to the BS5930 (2015) similar to the overlaying soils. 2No. deeper boreholes were installed for groundwater monitoring purposes to a maximum depth of 10.00m bgl.
Trial pits carried out by hand (HP01 – HP02)	2No. hand dug trial pits to a maximum depth of 1.20m bgl, located on the embankment in the northeast of the site were excavated and soil samples for geochemical testing were obtained as part of the geo-environmental assessment of the site.
Boreholes carried out by dynamic sampling methods (WS01-WS05)	5No. Window (Dynamic) sampling probeholes to a maximum depth of 5.45m bgl were excavated. One of the probeholes was located on the embankment in the northeast of the site (proposed car park area formed by retaining walls). Soil samples were obtained for geochemical and geotechnical data from both Made Ground and natural deposits. 4No. Window (Dynamic) Sampling probeholes were installed to a maximum depth of 5.45m bgl for the purpose of groundwater level and gas monitoring.
Coring of concrete slab using concrete coring methods (CC1 – CC26)	Concrete coring (100mm internal diameter) across the existing floor slab.

2.4 Chemical and Geotechnical Testing Strategy

Geotechnical samples consisted of disturbed samples stored in plastics tubs and granular material stored in bulk bags.

Samples for geotechnical testing and strata description were taken during the drilling of the exploratory holes in general accordance with the specification, BS5930:2015, BS10175:2011 and BS EN ISO 22475-1:2006. Soil samples for geotechnical laboratory testing were despatched to Murray Rix.

Adopted Assessment Guidelines Screening of soil analysis data against published assessment guidelines (C4SLs and S4ULs) was undertaken assuming a commercial / industrial land use. A soil organic matter content of 1% was conservatively assumed.

2.5 Monitoring Strategy

Following review of the previous investigations, groundwater chemical assessment is not deemed to be required unless new potentially contaminative sources were identified during this investigation. The previous site investigation conducted by AECOM and reviewed by Argyll Environmental, concluded that no gross or widespread contamination was identified, and that the localised contamination recorded, posed a very low to low risk to human health or controlled waters. Therefore, no further action is required, unless new sources are identified during the subject investigation.

Ground gas monitoring was carried out in accordance with BS 8576: 2013 and comprised three visits over 6 weeks, using a GFM gas monitor and testing for; flow rate, atmospheric pressure, differential pressure, oxygen, carbon dioxide, carbon monoxide, methane and hydrogen sulphide.

3 Fieldwork

3.1 General

The fieldwork was carried out between 13th and 16th September 2022, with the subsequent groundwater level and ground gas monitoring visits completed between September 2022 and November 2022. The scope of the works comprised:

- 2 No. rotary cored boreholes (Geobore) to a maximum depth of 10.00m below ground level (m bgl) with associated in situ testing and sampling;
- 5No. dynamic (window) sampling boreholes to a maximum depth of 5.00m bgl with Standard Penetration Testing (SPTs) at 1m intervals;
- 26 No. concrete cores to the base of the concrete slab which are to be photographed and sampled for geotechnical testing, (2 of the proposed 28 concrete cores in the southwestern part of the building could not be accessed);
- 2No. hand-dug trial pits to a maximum depth of 1.20m bgl with associated sampling for geo-environmental and geotechnical purposes.

3.2 Exploratory Holes

The exploratory holes were logged by an experienced ByrneLooby specialist in accordance with the recommendations of BS5930:2015 +A1:2020, which incorporates the requirements of BS EN ISO 14688-1, 14688-2:2018 and 14689:2018. Methods of formation and geological descriptions, together with sample records, in situ test results and observations made during formation of the exploratory hole are given in the logs presented in **Appendix D** and should be read in conjunction with the key included therein. Final installations and trial pit photographs are presented in **Appendix C**.

The positions of the exploratory holes are shown on the Exploratory Hole Location Plan presented as **K0273-BLA-D-002-00**.

The positions of the concrete cores are shown on the Concrete Core Location Plan presented as K0273-BLA-D-003-00

A summary of the exploratory holes formed is listed in the following table.

Table 3.1 Summary of the exploratory holes/locations.

Location ID	Type	Start Date	End Date	Easting	Northing	Ground Level (mOD)	Final Depth (m)
HP01	HP	14/09/2022	14/09/2022	350722.09	316335.847	72.45	1.20
HP02	HP	14/09/2022	14/09/2022	350743.147	316337.711	72.23	1.20
RC01	RC	15/09/2022	15/09/2022	350718.206	316314.824	71.691	11.0
RC02	RC	16/09/2022	16/09/2022	350570.347	316372.006	71.493	11.0

Location ID	Type	Start Date	End Date	Easting	Northing	Ground Level (mOD)	Final Depth (m)
WS01	WS	14/09/2022	14/09/2022	350729.881	316338.627	71.628	3.42
WS02	WS	14/09/2022	14/09/2022	350735.898	316322.494	71.617	2.40
WS03	WS	14/09/2022	14/09/2022	350711.304	316300.031	71.639	2.42
WS04	WS	14/09/2022	14/09/2022	350536.862	316371.081	71.551	4.42
WS05	WS	14/09/2022	14/09/2022	350530.515	316331.053	71.569	3.37

Key; RC- Rotary Core ; WS – Windowless sampler ; HP – Hand Pits; m OD – metres above Ordnance Datum.

3.3 Sampling

Soil samples for chemical analysis comprised a plastic tub for metals and inorganics and two amber glass jars for organics. The soil samples were stored in a cool box with ice and were collected directly to Eurofins Chemtest Ltd. Samples for geo-environmental and geotechnical testing and strata description were taken during the formation of the exploratory holes in general accordance with the specification, BS5930:2015, BS10175:2011 and BS EN ISO 22475-1:2006.

Soil samples for laboratory geotechnical testing were despatched directly to Murray Rix.

Groundwater levels measured in the monitoring installations are presented in **Appendix E**.

3.4 In Situ Testing

In situ testing was carried in accordance with BS 5930:2015 and BS 1377-9 (1990) unless otherwise stated. SPT results are presented on individual exploratory hole logs as uncorrected N values.

3.5 Installations and Monitoring

Details of borehole installations are presented on the exploratory hole logs. A summary of the installations for each bore are summarised in the following table.

Table 4.3 Summary of Instrumentation

Location ID	Instrument Type	Installation Date	Top of Response Zone (m bgl)	Base of Response Zone (m bgl)	Top of Response Zone (mOD)	Base of Response Zone (mOD)
RC01	SP	15/09/2022	1.0	11.0	70.691	60.691
RC02	SP	16/09/2022	4.0	11.0	67.493	60.493
WS01	SP	14/09/2022	1.0	3.0	70.617	68.617
WS03	SP	14/09/2022	1.0	2.0	70.639	69.639
WS04	SP	14/09/2022	1.0	4.0	70.639	67.639
WS05	SP	14/09/2022	1.0	3.0	70.551	68.551

Key: SP – Standpipe; m bgl – metres below ground level, mOD – metres above ordnance datum.

Records of ground gas and groundwater level monitoring carried out after the fieldwork period to the date of issue of this report are presented in **Appendix E.**

4 Laboratory Analysis

4.1 Geo-environmental Testing

The testing was scheduled by ByrneLooby and carried out by Eurofins Chemtest Ltd.

Scheduled analysis and number of samples tested is summarised in **Table 4.1 and Table 4.2**. The laboratory certificates are presented in **Appendix F.**

Table 4.1 – Summary of Scheduled Chemical Analysis

Laboratory Test	Number of soil samples analysed
Metals	14
TCN	14
Moisture	14
pH	14
TOC	14
Stones	14
WSS04	14
BTEX	14
TPH CWG	14
Spec PAH (17)	14
Phenols	14
Chloride water soluble	14
Total Sulphates	14
Asbestos	8
WAC	1

4.2 Geotechnical Testing

The testing was scheduled by ByrneLooby and was carried out by Murray Rix. in accordance with the relevant British Standards. The testing is summarised below in **Table 4.2** and the results are presented in **Appendix G.**

Table 4.2 – Summary of Scheduled Geotechnical Analysis

Laboratory Test	Number of soil samples analysed
Dry density/ moisture content relationship using 2.5kg rammer	4
Liquid limit, plastic limit, and plasticity index	4
Particle size distribution	4
pH	4
Sulphate content of water extract from soil	4
Uniaxial Compressive Strength (UCS) of rock cores	4
Point Load (Index) Test of rock cores	6

5 Ground Conditions

The encountered ground conditions, groundwater and other observations are summarised and discussed below.

5.1 Encountered Ground Conditions

The ground conditions encountered are summarised in **Table 5.1** and discussed below.

Table 5.1 – Summary of Encountered Ground Conditions

Stratum	Location	Surface Depth (m bgl)	Proven Base Depth (m bgl)	Proven Thickness (m)
Made Ground	All Locations	0.00	1.00 to 2.00	1.00 to 2.00
Devensian Till	RC01, RC02, WS01, WS02, WS03, WS04, WS05.	1.00 to 2.00	3.00 to 4.00	1.00 to 3.00
Chester Formation	RC01, RC02	2.00	Base not proven	>11

5.1.1 Made Ground

Made Ground was encountered in all exploratory locations to depths of between 1.00 m bgl at WS01 and WS05 to 1.70 m bgl at WS02. This stratum broadly comprised an initial layer of concrete which varied in thickness between 0.25m and 0.30m. This was underlain by a loose, sandy gravel of various lithologies including concrete, sandstone, and flint, with a thickness between 0.35m and 0.75m. Below the gravel layer was a slightly gravelly very sandy clay in WS04 and WS03 between 0.40m and 0.70m thick. A slightly gravelly clayey sand was encountered in WS01 and WS02 with a thickness of 0.40m. In both RC01 and RC02, Made Ground has been recorded in the top 1.5m of the boreholes which has been described as sand and gravel.

5.1.2 Devensian Till

Superficial Deposits of Devensian Till were encountered underlying the Made Ground at WS01, WS02, WS03, WS04 and WS05 to depths of between 2.00m bgl at WS02 and WS03 to a maximum of 4.00m bgl in WS04, with stratum thickness varying between 0.30m and 2.50m at these locations. This stratum broadly comprised a medium dense to dense, reddish brown, slightly gravelly clayey sand with the gravel component consisting of angular to rounded, fine to coarse sandstone encountered in RC01, RC02, WS01, WS02, WS03, WS04 and WS05. A layer of firm reddish brown slightly gravelly sandy clay was encountered in WS04 and WS05.

WS01, WS02, WS03, WS04 and WS05 were terminated within Devensian Till due to SPT hammer refusal at 2.00m bgl in WS02, 3.00m bgl in WS01, WS03 and WS05 and at 4.00m bgl in WS04.

5.1.3 Chester Formation - Sandstone

Sandstone was encountered in both RC01 and RC02 at depths of 2.00m bgl underlying the Made Ground (sand & gravel) and superficial (sand) deposits. In both locations, a weak partially weathered sandstone (recovered as gravelly clayey sand) was observed leading into extremely weak to weak sandstone. This stratum has a thickness of 9.00m at both locations and the base is not proven. The sandstone becomes weak - medium strong at a depth of 8.18m bgl in RC01 and 6.50m bgl in RC02. There are varying levels of recovery throughout both boreholes but as the boreholes reached depth the recovery levels became greater, corresponding with the strength changes throughout the borehole. Below 9.50m bgl in RC01 there were frequent black sandstone lithorelics observed up to 3mm in size.

5.1.4 Groundwater

Groundwater was not encountered in any borehole during the initial investigation.

During subsequent monitoring, groundwater was recorded in all locations however, due to the low volumes encountered in WS01 to WS05, the levels are inferred as being the result of rainwater that has fallen into the borehole during the removal of the rubber bung or perched water within the shallow ground. Slightly more groundwater was encountered in RC01 with approximately 1.50m of groundwater being present during the first monitoring visit. However, due to the mOD levels of the ground water with the deeper RC01, it is assumed that the levels recorded within the WS boreholes are of perched water.

Due to installation issues, the gas bung in RC02 was lodged within the borehole pipe and could not be removed without damaging the well installation (and subsequently compromising the gas monitoring), therefore, groundwater levels could not be recorded from this well.

Groundwater level and ground gas monitoring records are presented in **Appendix E**.

5.1.5 Ground Gas Monitoring

Three ground gas monitoring visits were conducted on the 13th and 28th October, and 11th November 2022. Of the 3 visits all boreholes apart from RC01 on the visit of the 11th November were recorded for ground gases. Over the visits atmosphere pressure ranged from 1001 m bar to 1011 m bar.

Results of the gas monitoring are discussed in Section 7.

5.1.6 Visual and Olfactory Observations

Made Ground was recorded at all exploratory locations, but no visual or olfactory evidence of contamination was found during the intrusive works.

Roots and rootlets were observed within the Made Ground in HP01 and HP02 to depths of 0.30m.

6 Laboratory Chemical Analysis

Soil samples were submitted to i2 Analytical who are UKAS accredited in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

6.1 Soil Analysis Summary

Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against screening criteria for a 'Commercial' end-use, which is considered most appropriate for this site based on the current proposed development.

Asbestos was not detected in any samples analysed.

WAC analysis was carried out on one soil sample from HP01 at 0.60m bgl. The results indicated that the sample analysed would be suitable for disposal as a stable, non-reactive hazardous waste in a non-hazardous landfill.

Environmental Laboratory analysis detailed test reports are included in **Appendix F**.

7 Ground Gas Analysis

Where applicable, the results of ground gas monitoring have been compared to CIRIA 665: 'Assessing Risks Posed by Hazardous Ground Gases to Buildings' and BS 8485:2015: 'Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings'.

7.1 Summary of Ground Gas Results

Three monitoring visits were undertaken over an eight-week period after borehole installation. Ground gas concentrations were measured in WS01, WS03, WS04, WS05, RC01 and RC02. Over the three visits, a maximum steady state carbon dioxide (CO_2) concentration of 0.1% was recorded. Oxygen concentrations ranged from 19.7% to 20.4%. Carbon monoxide (CO), Methane (CH_4) and Hydrogen Sulphide (H_2S) concentrations were below detection levels. The full ground gas and groundwater monitoring record is presented in **Appendix E**.

7.2 Recorded Flow Rate

Flow was not detected in any borehole during monitoring visits.

7.3 Gas Screening Value and Classification

The Gas Screening Value (GSV) for the site based on the recorded maximum concentrations of methane and carbon dioxide is provided in **Table 6.1.**

Table 6.1 – Gas Screening Values for Methane and Carbon Dioxide

Peak Flow Rate (l/hr)	Worst Case CO_2 (%)	CO_2 GSV	Worst Case CH_4	CH_4 GSV
<0.1	0.1	<0.0001	<0.1	<0.0001

Based on the full ground gas monitoring record, the worst case value of CO_2 GSV of <0.0001 l/hr, a classification of Characteristic Situation 1 is considered applicable to the site. Therefore, gas protection measures would not be required.

8 Updated Conceptual Site Model

In accordance with BS 10175, a general schematic section has been developed for the site based on the previously presented data and contaminant linkage assessment. This is shown in **Figure 1**.

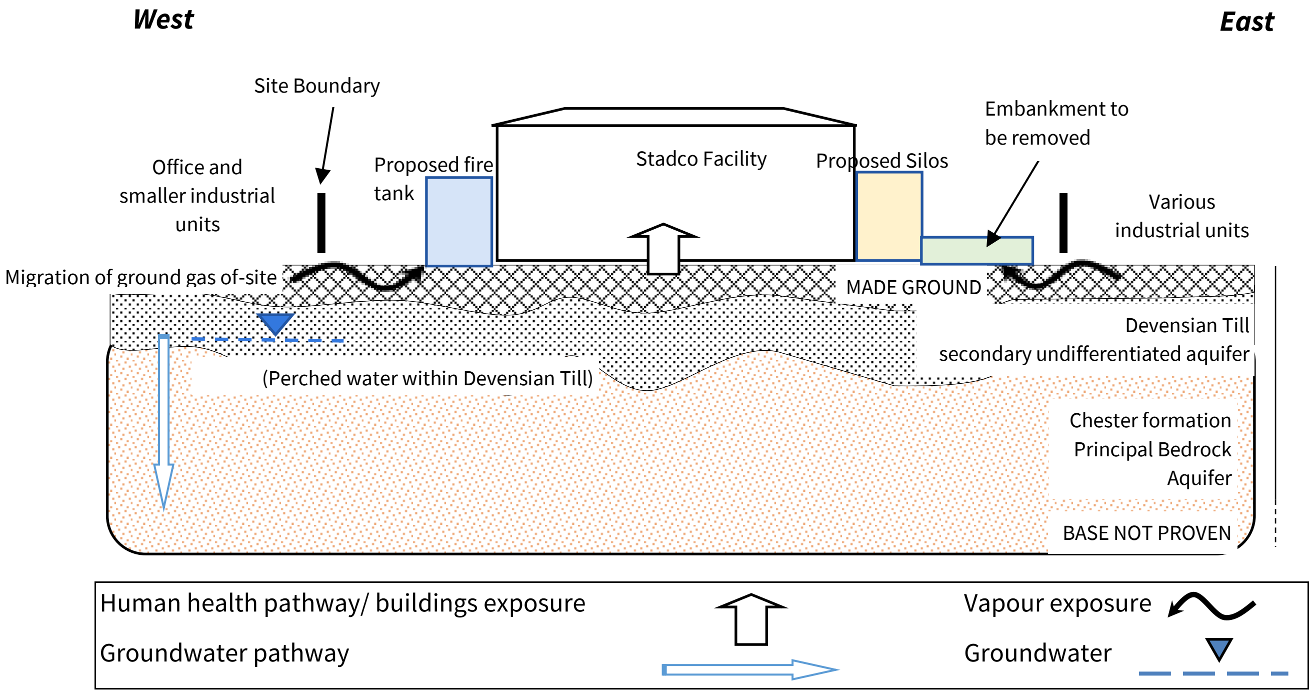

Figure 8.1 – Updated Conceptual Site Model based on the proposed development (not to scale)

The model for the site shows the encountered geology, proposed site usage, and vulnerable receptors. The information presented above represents the updated conceptual ground model that may need to be revised based on data obtained during any future investigation. The Conceptual Site Model and proposed end use described above should be considered broadly representative of a commercial end-use of the site, as a worst case scenario, as defined in SR3 'Updated Technical Model to the CLEA Model' (SC050021/SR3, 2011) for the purpose of this report.

8.1 Soil and Groundwater Generic Qualitative Risk Assessment

The updated assessment of plausible contaminant linkages based on current available guidance published by a number of sources and is summarised in **Appendix B**. The contaminant linkages have been individually assessed and a summary of the potential geo-environmental risks associated with the site and in the context of the proposed development is provided in **Table 8.1**.

Table 8.1 – Summary of Updated Qualitative Risk Assessment

Issue	Risk Rating	Justification Comments
Contamination Potential		
Potential for significant on-site contamination.	Low	Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria.
Potential for contaminants to migrate via soil/air/groundwater pathways to site.	Low	Shallow granular deposits were encountered which could provide a pathway for migration to site. However, groundwater was not encountered during the intrusive fieldwork.
Potential for contaminants to migrate via soil/air/groundwater pathways off-site.	Low	Shallow granular deposits were encountered which could provide a pathway for migration off-site. The bedrock underlying the site is also classified as a principal aquifer. However, groundwater was not encountered during the intrusive fieldwork.
Geo-environmental Risk		
Risk of contamination harm to human health (end users) based on encountered conditions.	Negligible	Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria.
Risk to site workers.	Low	Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria.
Risk of pollution to controlled water – Principal Aquifer	Low	Superficial deposits underlying the Made Ground were primarily granular and are considered a secondary undifferentiated aquifer, the bedrock sandstone is considered a Principal Aquifer. Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria. No new source of contamination was identified during the investigation and further groundwater analysis beyond the previous investigation was not deemed to be required. Therefore, the previous assessment risk of very low to low is applicable.

Issue	Risk Rating	Justification Comments
Risk of pollution to controlled water – Surface Waters	Low	Battlefield Brook is downstream (300m south) from the site, and maybe considered as a surface water risk. However, given the distance, site superficial geology, migration route required and the managed surface water drainage (interceptor system), the risk of groundwater migration reaching the brook and subsequently the river Severn, is considered low.
Hazards to building structures and services – excluding ground gas.	Low	Based on the results of soil chemical analysis, ground conditions conforming to DS-1 and ACEC Class AC-1 prevails and the use of subsurface concrete should comply with the above-mentioned classification in line with the principles of the BRE Specialist Digest 1 (BRE SD1, 2005).
Liabilities		
Likelihood of designation as Contaminated Land under Part 2A of EPA 1990.	Low	Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria.
Liability issues for owner.	Low	Potential liability issues have been not been identified.
Development Implications		
Possible requirement for remediation of soil.	Low	Analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria.
Possible requirement for remediation of groundwater.	Low	Groundwater samples were not analysed as part of this investigation, however analysis of selected soil samples did not indicate any elevated concentrations of contaminants when compared against the relevant screening criteria.
Special requirements for water supply pipes.	Low	Depending on final depth design a full UK UU WIR assessment may be required. Based on chemical analysis (TPH samples exceeding PE Threshold in a sample from WS03 at 0.9m bgl) Barrier pipe may be required, or a capping material utilised in this area. Advice from the water supply company should be sought.
Potential limitations on foundation design	Low	Ground conditions encountered do not present limitations on the foundation design
Risk of encountering materials classed as hazardous waste.	Low to moderate	None of the samples tested identified the presence of asbestos. One sample from HP01 at 0.60m bgl was analysed for Waste Acceptance Criteria and was classified as suitable for disposal as stable non-reactive hazardous waste in a non-hazardous landfill. It is recommended any material subject to disposal should be tested to determine its Waste Acceptance Criteria.

9 Geotechnical Assessment

9.1 Proposed Development and Anticipated Structural Loads

Based on the information presented on **Drawing K0273-BLA-D-001-00** (the base plan for which was supplied by the client), the redeveloped site would accommodate a fire tank, silos, a car park, and a weighbridge and its associated kiosk. There may also be requirement for constructing a retaining wall to protect the proposed car park against potential slope stability of an existing embankment.

The client has provided ByrneLooby with the following estimate of the unfactored loads:

- Fire Tank - 120kN/m^2

  and

- Silos - 75kN/m^2

9.2 In-Situ and Laboratory Data Review

Details of the in-situ and the laboratory geotechnical tests undertaken including test certificates are presented in **Appendices D and G.**

Figure 9.1 (next page) is a graphical representation of the corrected Standard Penetration Test (SPT) values versus depth.

These in situ test results demonstrate that the natural superficial deposits (i.e. Devensian Till) can potentially provide a geotechnically suitable founding medium for the foundations of the proposed structures. Within the Devensian Till deposits, a minimum SPT N_{60} value of 11.5 has been recorded. This SPT value has been recorded in a layer of very sandy clay of relatively limited thickness of 0.35m in WS05 (at depths between 1.00m bgl and 1.35m bgl which is equivalent of between 70.57m and 70.22m AOD).

The global minimum SPT N_{60} value was recorded at 10.4 in a soft to firm layer of Made Ground in WS04 described as very sandy clay. This layer has been recorded between 0.80m (70.75m AOD) and 1.50m bgl (70.05m AOD). All the SPT N_{60} values recorded at depths 2m bgl or greater exceed the value of 32.2, irrespective of the lithology they were recorded in.

It should be noted that WS01 and WS02 are located in the proposed car park area, WS03 (and RC01) in the footprint of the proposed silos, RC02 in the proposed location of the fire tank (and WS04 near this location), and WS05 in the footprint of the weighbridge and its associated kiosk.

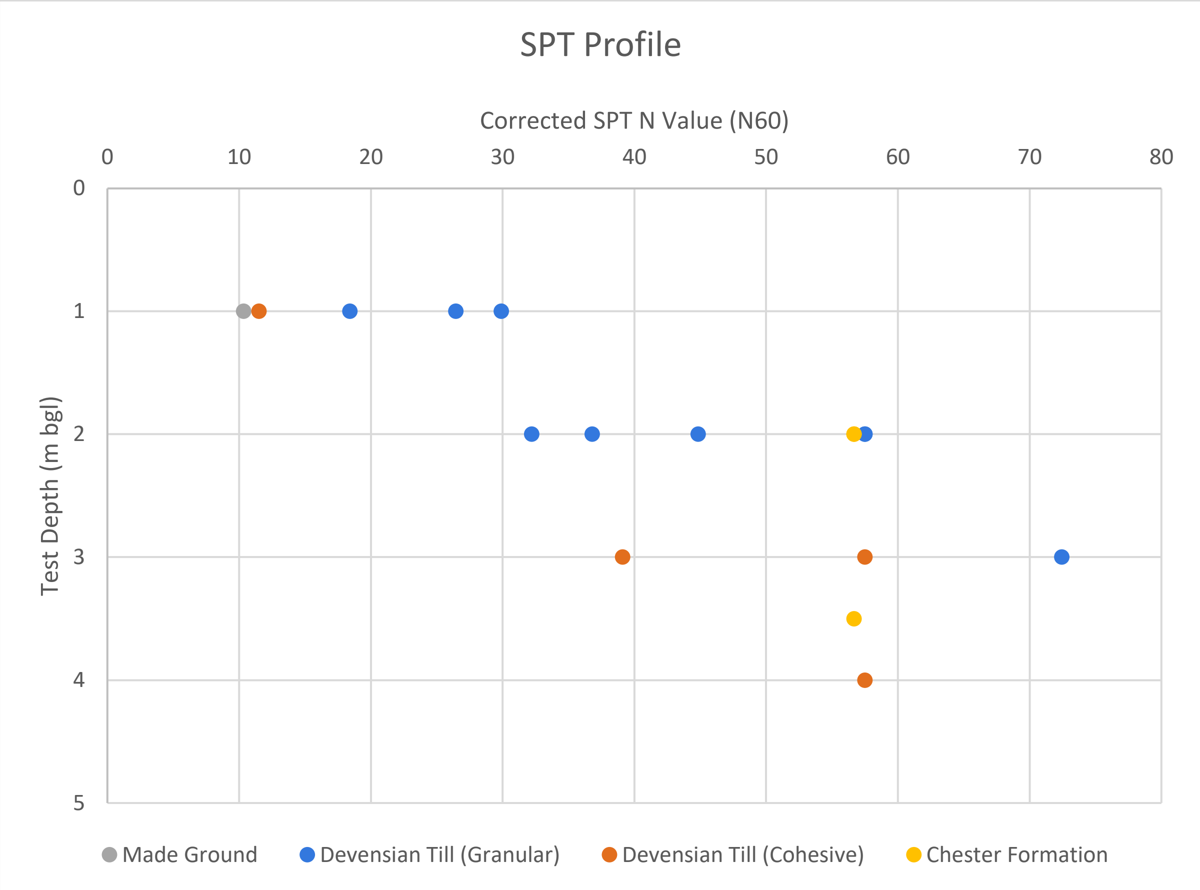

Figure 9.1: SPT N_{60} Profile

Figure 9.2 is the plasticity chart prepared for three soil samples from WS03, WS04, and WS05. One of the samples scheduled was reported as sand, hence non-plastic, and is not considered further here. Two of the samples were from the predominantly cohesive Made Ground.

The sample depths range between 0.6m bgl (in WS03 with the corresponding level for the sample being 71.04m AOD) to 1.5m bgl or 70.05m AOD (in WS04). The percentage passing the 425um sieve range between 64% and 92% with an average of 76.7%. The Liquid Limits were measured between 32% and 33% with an average of 32.7% and the Plastic Limit values range between 11% and 12% with an average of 11.7%. The corresponding Plasticity Indices were reported between 20% and 22% with an average of 21%. The corresponding 'Modified Plasticity Indices' were then calculated to range between 14% and 18% with an average of 16%.

The results indicate 'low plasticity' and 'low volume change potential', suggesting that when there are cohesive layers (i.e. clay) within the superficial deposits of the Devensian Till lithology, these will likely be of low volume change potential. This observation in combination with the facts that no groundwater strikes were recorded during drilling and the clay layers recorded have a considerable granular content will support the assessment that traditional shallow foundations would also provide a technically feasible foundation solution for the structures where natural clay was recorded in the exploratory holes located in their footprint, noting in some of the exploratory holes such as WS03 and RC01, no layers of natural clay were recorded and the Devensian Till deposits were recorded as medium dense to dense granular soils.

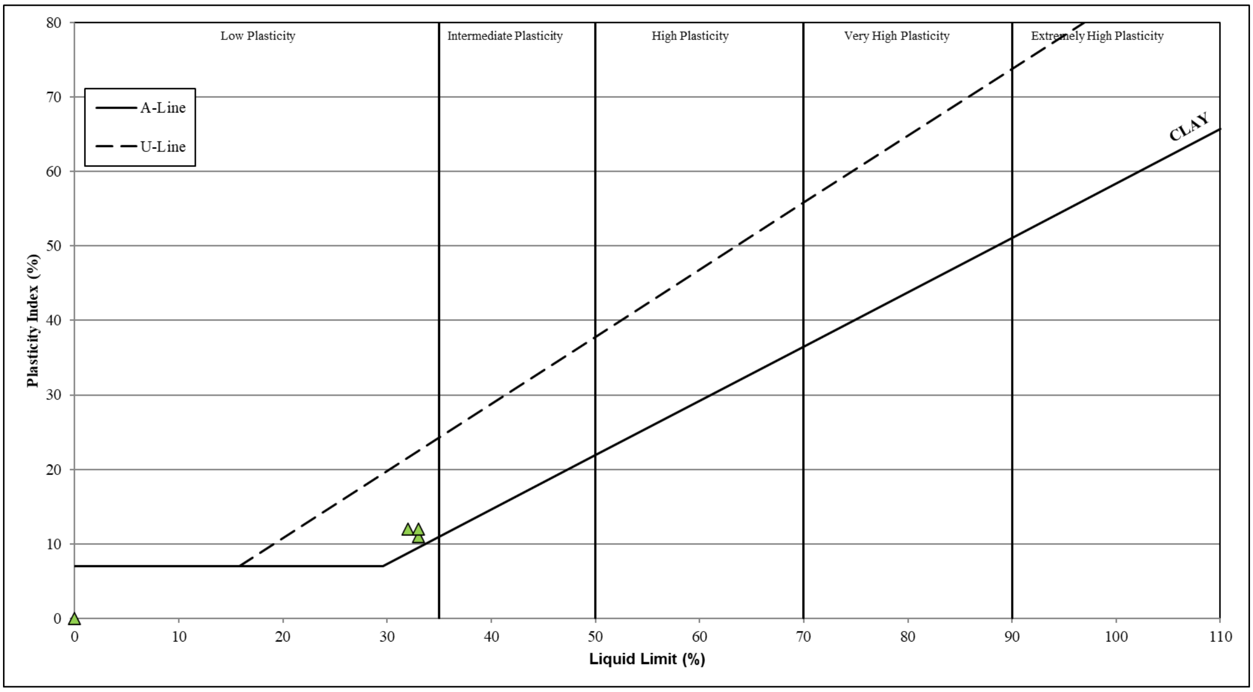

Figure 3: Plasticity Chart

Four uniaxial compressive strength (UCS) tests performed on representative core samples of the rock (i.e. sandstone) resulted in values ranging between 9.7MPa and 14.1MPa. For the Point Load (Index) tests, $I_{s(50)}$ values ranging between 0.04MPa and 0.17MPa were recorded. This data would be of value for any future deep (i.e. piled) foundation design.

The laboratory test certificates are included in **Appendix G**.

9.3 Foundation Appraisal

Due to the presence of geotechnically competent natural deposits of Devensian Till at depths suitable for the adoption of shallow foundations, it is unlikely that piled foundations, despite remaining as a technically feasible option, would provide an economically justifiable foundation solution for the proposed structures.

Traditional shallow foundations such as pad foundations, strip footings, and rafts (if preferred for the proposed silos) will likely provide a cost-effective foundation solution for the proposed structures.

It is understood that the client aspires to found the proposed structures at existing ground levels (with existing slabs being broken out). However, we strongly recommend that constructing the foundations on untreated (i.e. non-engineered) Made Ground should be avoided. Made Ground is the most susceptible medium to both lateral and downward variation in geotechnical properties when compared with the natural ground. Whilst the Made Ground recorded in the exploratory holes of the subject investigation have shown some semblance of geotechnical competence (e.g. an SPT N_{60} value of 10.4 in WS04), an earthworks operation should be specified, implemented, and validated as part of a detailed shallow foundation design and construction for the proposed structures.

If for the reasons outside ByrneLooby's current knowledge, more structurally onerous elements (e.g. structures with contact pressure at the founding level exceeding 250 kPa) will be required as part of the proposed works, the assessment given herein should be revisited by a suitably qualified geotechnical engineer where the loading and tolerable settlement criteria should be taken into account for a technically feasible and most cost-effective foundation option appraisal and design (e.g. piled foundations).

9.4 Bearing Capacity

The concept of '*presumed bearing values*' for foundation on soil has been introduced in *Foundation Design and Construction' by MJ Tomlinson (7th Edition)*. **Tables 9.1 and 9.2** contain the presumed capacity values for three sizes of pad foundations for the proposed fire tank and the weighbridge kiosk and three sizes of strip foundations for the proposed silos, respectively.

Table 9.1 Presumed Bearing Capacity – Pad Foundations (Fire Tank and Weighbridge Kiosk)

Presumed Bearing Capacity (kN/m^2) *		
Foundation Size		
1m x 1m	2m x 2m	4m x 4m
150	85	75

* **Maximum allowable settlement of 50mm is accounted for and the foundation depth is 1m.**

Table 9.2 Presumed Bearing Capacity – Strip Footings (Silos)

Presumed Bearing Capacity (kN/m^2) *		
Foundation Breadth (Width)		
1m	2m	4m
250	200	150

* **Maximum allowable settlement of 50mm is accounted for and the foundation depth is 0.75m.**

The presumed bearing values should only be used for an initial foundation design purpose. In adopting these figures, it should also be noted that at the minimum foundation depths (presented as 1m for **Table 9.1** and 0.75m in the case of **Table 9.2**) are based on the following assumptions:

- Through an earthworks specification, only competent natural deposits of Devensian Till, re-engineered Made Ground, or suitably compacted and fill in compliance with the earthworks specification should be accepted as the founding medium.

and

- The earthworks specification should be prepared by a suitably qualified geotechnical specialist and the earthworks including but not limited to laboratory-based and in-situ tests should be supervised and validated independently.

'Allowable bearing capacity' for a foundation is not only a function of the underlying soil/ground strength/stiffness parameters, groundwater level, foundation basal inclination, load eccentricity, and proximity to a slope, it is also a function of the tolerable settlement value of the structure in question. For relatively wide structures / foundations such as a basal concrete slab which the client may prefer to adopt and design for the proposed silos, it will be the tolerable settlement value which will most certainly dictate the allowable bearing capacity.

Therefore, it is imperative that advice from a suitably qualified foundation design / geotechnical specialist will be sought as part of the proposed structures detailed design.

9.5 Groundwater and Excavations

Although no water strikes were recorded during the subject drilling works, perched surface water (masquerading as groundwater) will likely be encountered in excavations of shallow foundations at this site. Any water in excavations can be controlled by sump pumping. If inflows are relatively localised, this may cause softening of the ground and require localised excavation support in order to prevent instability of the sides of excavations.

Excavations through the soils to a depth of about 1.5m should be stable in the short term (up to 3 to 4 hours). However, it is anticipated that layers of natural granular soils encountered, will lead to the gradual collapses of the excavations through undercutting any overlying cohesive deposits, leading to instability of the sides of excavations.

All excavations should be carried out in accordance with CIRIA Report 97 “Trenching Practice” and BS6031: 2009: Code of Practice for Earthworks. Further guidance on this aspect of site works is given in the British Standards for “Workmanship on Building Sites”, BS 8000, Parts 1 and 14, and in the Construction Industry Training Board’s Site Safety Note 10.

Excavation depths should generally be readily achieved using conventional hydraulic plant (e.g. wheeled JCB or similar) although larger plant (tracked 360° or similar) will have higher excavation rates as these machines will be better suited to handling any boulders that are encountered.

9.6 Buried Concrete

The results of laboratory pH and sulphate content (included in **Appendix G**) indicate that the Design Sulphate Class of DS-1 and ACEC Class AC-1 conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore, no special precautions are required at the site in this context for the design of concrete in terms of the durability and structural performance.

Any fill material to be imported onto the site should be tested and to ensure the classification given here is not exceed. Otherwise, the classification should be revisited by a suitably qualified specialist.

9.7 Concrete Cores and Structural Assessment

The Concrete Core Location Plan is presented on **Drawing K0273-BLA-D-003-00**.

The results of the 26No. Concrete Compressive Strength tests are presented in **Appendix G.**

A ground-bearing slab assessment completed by Melia, Smith, and Jones Ltd (on behalf of ByrneLooby) is presented as **Appendix H** to this report.

10 Conclusion and Recommendations

The following recommendations are based on the results of the Conceptual Site Model and risk assessment.

10.1 Summary of Site Investigation Results

The encountered ground conditions and analysis results are summarised in the following section.

10.1.1 Summary of Encountered Ground Conditions and Groundwater

The encountered ground conditions generally comprised Made Ground to depths of between 1.00m bgl to 2.00m bgl.

Superficial Deposits of Devensian Till were encountered underlying the Made Ground to depths of between 2.00 m bgl and 4.00m bgl, with stratum thickness varying between 0.30 m to 2.50m. This stratum broadly comprised a firm to stiff, reddish brown, slightly gravelly clayey sand with the gravel component consisting of angular to rounded, fine to coarse sandstone. A layer of firm reddish brown slightly gravelly sandy clay was encountered in WS04 and WS05.

Bed rock geology of weak sandstone was encountered in both RC01 and RC02 at depths of 2.00m bgl underlying the Made Ground and superficial deposits in both. This stratum had a thickness of 9.00m at both locations and the base was not proven. The sandstone became weak - medium strong at a depth of 8.18m bgl in RC01 and 6.50m bgl in RC02.

Groundwater was not encountered during the site works. During subsequent monitoring, groundwater was recorded at various depths within the monitoring boreholes. The groundwater recorded, is assumed to be part of perched water within shallow superficial and Made Ground deposits, and not representative of overall groundwater regime, which is assumed to be at greater depths within the bedrock geology.

10.1.2 Summary of Health and Environmental Risk assessment

The Generic Quantitative Risk Assessment (GQRA) undertaken concluded the following:

- Analysis of selected soil samples did not indicate any elevated concentration of contaminants when compared against screening criteria for Commercial end-use. Asbestos was not detected within any of the samples analysed.

- WAC analysis was carried out on one soil sample. The results indicated that the sample analysed would be suitable for disposal as a stable non-reactive hazardous waste in non-hazardous landfill.

10.1.3 Summary of Gas Monitoring Results

Over three monitoring visits within a six week period, a maximum steady state carbon dioxide (CO2) concentration of 0.1% was recorded. Oxygen concentrations ranged from 19.7% to 20.4%. Carbon monoxide (CO), Methane (CH4) and Hydrogen Sulphide (H2S) concentrations were below detection levels. Based on the full ground gas monitoring record and the CO_2 GSV of <0.0001 l/hr, Characteristic Situation 1 is considered applicable to the site.

10.2 Environmental Conclusion

Based on the Conceptual Site Model and risk assessment, the risk to end users is likely to be negligible as most of the site is likely to be covered in impermeable hardstanding, and in addition elevated concentrations of contaminants in soils were not encountered during this site investigation. There is a low risk to site workers when working with potentially contaminated soils.

Risk of pollution to controlled waters has been assessed as low given the previous investigations and that no additional potential on-site contamination sources were encountered during this investigation. Additionally, the risk of percolation of any contaminants through the Made Ground is reduced by the use of impermeable hardstanding on site and managed drainage system (on site interceptor).

10.3 Geotechnical Considerations

Due to the presence of geotechnically competent natural deposits of Devensian Till at depths suitable for the adoption of shallow foundations, it is unlikely that piled foundations, despite remaining as a technically feasible option, would provide an economically justifiable foundation solution for the proposed structures.

Traditional shallow foundations such as pad foundations, strip footings, and rafts (if preferred for the proposed silos) will likely provide a cost-effective foundation solution for the proposed structures.

It is understood that the client aspires to found the proposed structures at existing ground levels (with existing slabs being broken out). However, we strongly recommend that constructing the foundations on untreated (i.e. non-engineered) Made Ground should be avoided.

The ‘presumed bearing capacity’ (i.e. indicative) values presented in Section 9.4 should only be used for an initial foundation design. These values are given based on the assumption that, through an earthworks specification, only competent natural deposits of Devensian Till, re-engineered Made Ground, or suitably compacted and fill in compliance with the earthworks specification would be accepted as the founding medium for the shallow foundations of the proposed structures. The earthworks specification should be prepared by a suitably qualified geotechnical specialist and the earthworks including but not limited to laboratory-based and in-situ tests should be supervised and validated independently.

Design Sulphate Class of DS-1 and ACEC Class AC-1 conditions prevail in accordance with BRE Special Digest 1, 2005 (the Design Concrete Class). Therefore, no special precautions are required at the site in this context for the design of concrete in terms of the durability and structural performance.

Any fill material to be imported onto the site should be tested and to ensure the classification given here is not exceed. Otherwise, the classification should be revisited by a suitably qualified specialist.

10.4 Ground-bearing Slab Assessment

A ground-bearing slab assessment completed by Melia, Smith, and Jones Ltd (on behalf of ByrneLooby) is presented as **Appendix H** to this report.

10.5 Recommendations

10.5.1 Geotechnical Design

'Allowable bearing capacity' for a foundation is not only a function of the underlying soil/ground strength/stiffness parameters, groundwater level, foundation basal inclination, load eccentricity, and proximity to a slope, it is also a function of the tolerable settlement value of the structure in question. For relatively wide structures / foundations such as a basal concrete slab which the client may prefer to adopt and design for the proposed silos, it will be the tolerable settlement value which will most certainly dictate the allowable bearing capacity.

Therefore, it is imperative that advice from a suitably qualified foundation design / geotechnical specialist will be sought as part of the proposed structures detailed design.

10.5.2 Remediation of Impacted Soils

Remediation is not considered necessary based on the findings of this site investigation. Should unexpected contamination be encountered during future development works at the site, the conceptual site model and geo-environmental risk assessment should be updated.

10.5.3 Surface Water Management

Surface water should be managed across the site, a drainage system should be developed to prevent surface water percolation through the Made Ground, which may have the potential to impact the below aquifers.

10.5.4 Gas Recommendations

Characteristic Situation 1 is considered applicable to this site. Based on this low risk, gas protection measures are not considered to be required for the proposed development.

10.5.5 Watching Brief

It is recommended that a watching brief is maintained on site, particularly during the groundwork stage. During any ground works an appraisal of the exposed soils should be made by a competent person, this as an example could be the site manager. If any material is noted to show visual and/or olfactory signs of contamination it should be stockpiled separately and tested prior to its appropriate removal off-site or re-use. If soils suspected of being contaminated are encountered, it is recommended that a contaminated land specialist is consulted.

10.5.6 Buried Services

Potable water pipework shall comply with the Water Supply Regulations, the agreement of the water provider and Local Authority should also be sought regarding the potable water pipework and fittings selected prior to commencement.

10.5.7 Importing and Re-Use of Soil and Materials Management Plan

Excavated soil that is to remain and be re-used on site, assuming it is suitable for the proposed use, may not be determined as waste and its re-use therefore may not require an Environmental Permit. It may be necessary to consult the Environment Agency or other statutory bodies regarding re-use of soils as part of the proposals and whether a Materials Management Plan or Environmental Permit is required. In any case, a site waste management plan or materials management plan may assist the design and cost assessment of the proposed development. This should be devised within the design phase of the scheme.

10.5.8 Soil Disposal

The client and contractors are advised to follow the process outlined in the Environment Agency's Technical Guidance Document WM3 '*Waste Classification – Guidance on the Classification and Assessment of Waste*', 1st Edition v1.2.GB, October 2021. Background information and the results of chemical laboratory analysis within this assessment may be used as part of an initial characterisation to determine the likely waste classification of waste soils. For any soils intended for disposal, it may be required to carry out Waste Acceptance Criteria (WAC) analysis.

WAC analysis was carried out on one soil sample prior to disposal off site. The results indicated that the sample analysed would be suitable for disposal as a stable non-reactive hazardous waste in non-hazardous landfill.

10.5.9 Statutory Authority Consultation

Should the planning conditions require, it is recommended that this report is sent to the statutory authorities including the Local Authority Environmental Health and Planning Departments prior to remediation or development of the site commencing to seek their comments. Where necessary, they will consult the Environment Agency or other relevant statutory authorities. If applicable to this project, this report should also be provided to the relevant building warranty provider. Where remediation works are required, a verification report should be submitted to the relevant authorities for approval in accordance with relevant Planning Conditions.

10.5.10 Health and Safety

As outlined within the HSE publication "Successful Health and Safety Management – HSG65" this report should inform your development of safe systems of work and the information used as an input to the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015.

In accordance with the Construction Design and Management (CDM) Regulations 2015, ByrneLooby has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report, ByrneLooby has discharged and completed all contractual and legal requirements for these positions and has no further involvement with the project. It is the developer's duty, as required by the CDM Regulations, to appoint others to fill these roles for the further development of the site.

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11 References

1. AGS: 2010: Electronic transfer of geotechnical and geo-environmental data (Edition 4 including addendum 3, 2011). Association of Geotechnical and Geo-environmental Specialists.

2. BRE Special Digest 1: 2005 Concrete in aggressive ground.

3. BS 1377 : 1990 : Methods of test for soils for civil engineering purposes. Published in nine parts. British Standards Institution.

4. BS 5930 : 2015 + A1:2020 : Code of practice for site investigation. British Standards Institution.

5. BS8458:2015+A1:2019 : Code of practice for the design of protective measure for methane and carbon dioxide ground gases for new buildings. British Standards Institution.

6. BS 10175 : 2011 + A2:2017: Investigation of potentially contaminated sites – Code of Practice. British Standards Institution

7. BS EN 1997-1: 2004 : Eurocode 7 – Geotechnical Design – Part 1: General rules. Including UK National Appendix of November 2007. British Standards Institution.

8. BS EN ISO 14688-1 : 2002 : Geotechnical investigation and testing – Identification and classification of soil – Part 1: Identification and description. British Standards Institution.

9. BS EN ISO 14688-2 : 2018 : Geotechnical investigation and testing – Identification and classification of soil – Part 2: Principles for a classification. British Standards Institution.

10. BS EN ISO 14689 : 2018 : Geotechnical investigation and testing – Identification and classification of rock – Part 1: Identification and description. British Standards Institution.

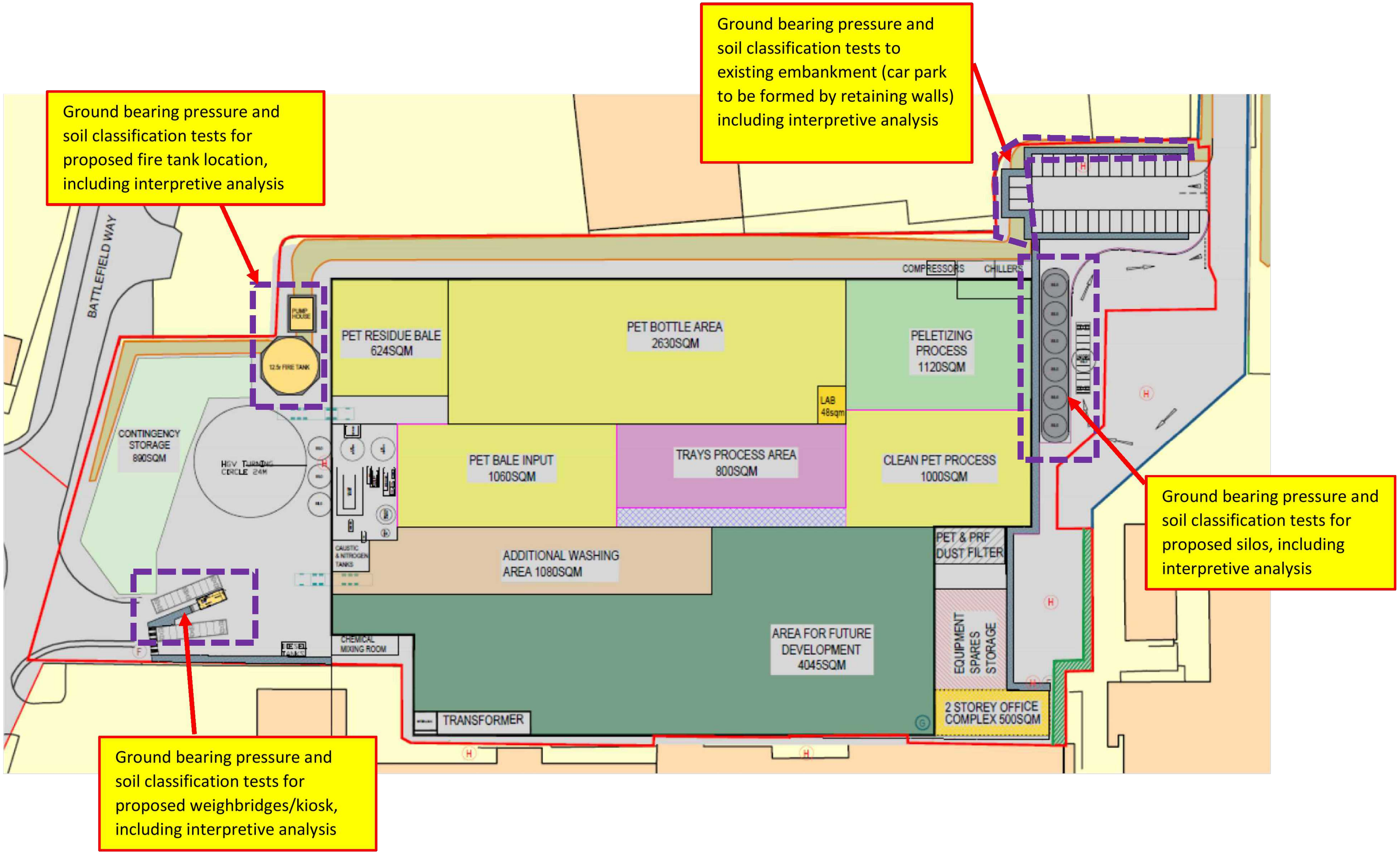
11. BS EN ISO 22475-1 : 2006 : Geotechnical investigation and testing – Sampling methods and groundwater measurements – Part 1: Technical principals for execution (July 2011 reprint). British Standards Institution.

12. BS EN ISO 22476-3 : 2005 : Geotechnical investigation and testing – Field Testing – Part 3: Standard penetration test

12 Drawings

1. K0273-BLA-D-001-00 – Proposed layout and testing requirements
2. K0273-BLA-D-002-00 – Exploratory Hole Location Plan
3. K0273-BLA-D-003-00 – Concrete Core Location Plan

A4



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KEY:

SITE BOUNDARY

CLIENT
VEOLIA ES (UK) LTD

PROJECT
STADCO, BATTLEFIELD WAY

DRAWING TITLE
PROPOSED LAYOUT AND TESTING REQUIREMENTS

Date: 24/11/22	Scale: NTS	Drawn: HW	Chk: HW	App: KA
Project No: K0273	Drg. No: K0273-BLA-D-001			Rev: 00

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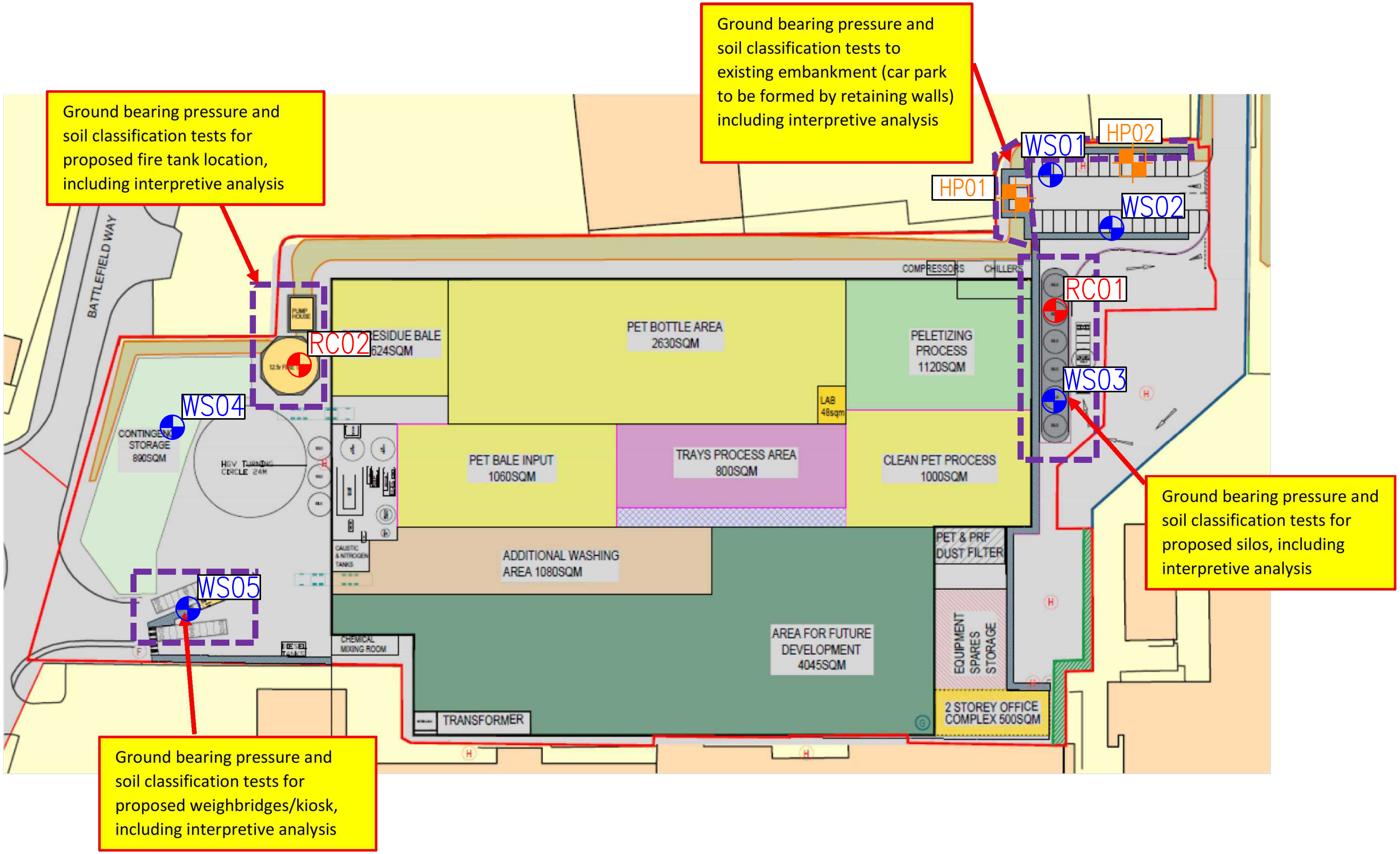

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KEY:

- SITE BOUNDARY
- TRIAL PIT LOCATION
- WINDOW SAMPLER LOCATION
- ROTARY CORE LOCATION

CLIENT: VEOLIA ES (UK) LTD				
PROJECT: STADCO, BATTLEFIELD WAY				
DRAWING TITLE: EXPLORATORY HOLE LOCATION PLAN				
Date: 24/11/22	Scale: NTS	Drawn: HW	Chk: HW	App: KA
Project No: K0273	Drg. No: K0273-BLA-D-002			Rev: 00

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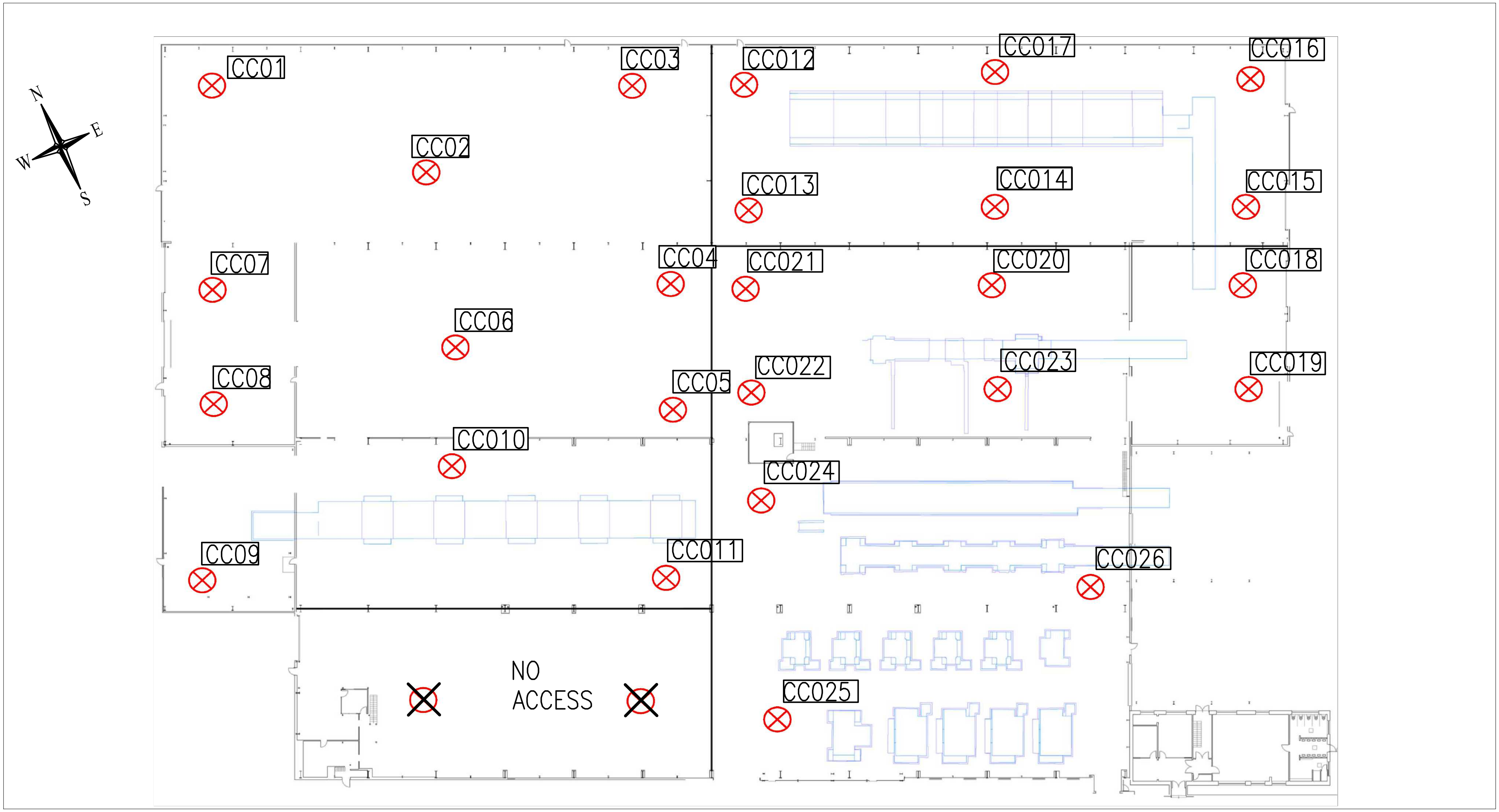

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KEY:

SITE BOUNDARY

Concrete Core Location

CLIENT	VEOLIA ES (UK) LTD
PROJECT	STADCO, BATTLEFIELD WAY
DRAWING TITLE	CONCRETE CORE LOCATION PLAN
Date: 29/11/22	Scale: NTS
Drawn: HW	Chk: HW
App: KA	
Project No: K0273	Drg. No: K0273-BLA-D-003
Rev: 00	

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Appendix A – Service Constraints, Report Limitations & Planning Requirements

Service Constraints, Report Limitations & Planning Requirements

This consultancy contract, report, and the site investigation (together comprise the "Services") were compiled and carried out by ByrneLooby Partners UK Limited (ByrneLooby) for A.E Yates (the "client") on the basis of a defined programme and scope of works and the terms of a contract between ByrneLooby and the "client." The Services were performed by ByrneLooby with all reasonable skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by ByrneLooby taking into account the limits of the scope of works required by the client, the prevailing site conditions, the time scale involved and the resources, including financial and manpower resources, agreed between ByrneLooby and the client. ByrneLooby Partners UK Limited cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered out with the agreed scope of works.

Other than that, expressly contained in the above paragraph, ByrneLooby provides no other representation or warranty whether express or implied, is made in relation to the Services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of ByrneLooby. If a third party relies on this report, it does so wholly at its own and sole risk and ByrneLooby disclaims any liability to such parties.

It is ByrneLooby's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without ByrneLooby's review and advice shall be at the client's sole and own risk.

The information contained in this report is protected by disclosure under Part 3 of the Environmental Information Regulations 2004 pursuant to the provisions of Regulation 12(5) without the consent in writing of a Director of ByrneLooby Partners UK Limited.

The report was written in March 2022 and should be read in light of any subsequent changes in legislation, statutory requirements, and industry practices. Ground conditions can also change over time and further investigations, or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of ByrneLooby. In the absence of such written advice of ByrneLooby, reliance on the report in the future shall be at the client's own and sole risk. Should ByrneLooby be requested to review the report in the future, ByrneLooby shall be entitled to additional payment at the then existing rate, or such other terms as may be agreed between ByrneLooby and the client.

The observations and conclusions described in this report are based solely upon the Services that were provided pursuant to the agreement between the client and ByrneLooby. ByrneLooby has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report. ByrneLooby is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, ByrneLooby did not seek to evaluate the presence on or off the site of electromagnetic fields or materials in buildings (i.e., materials inside or as part of the building fabric) such as asbestos, lead paint, radioactive or hazardous materials.

The Services are based upon ByrneLooby's observations of existing physical conditions at the site gained from a walkover survey of the site together with ByrneLooby's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst ByrneLooby Partners UK Limited have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report. Further ByrneLooby was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. ByrneLooby is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to ByrneLooby and including the doing of any independent investigation of the information provided to ByrneLooby save as otherwise provided in the terms of the contract between the client and ByrneLooby.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and ByrneLooby based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site.

Throughout the report the term ‘geotechnical’ is used to describe aspects relating to the physical nature of the site (such as foundation requirements) and the term ‘geo-environmental’ is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation, and these two main aspects are inter-related. The geo-environmental sections are written in broad agreement with BS 10175:2011+A2 2017. For the geotechnical aspects of the report, the general requirements of Eurocode 7 (BS EN 1997-2:2007) are to produce a Ground Investigation Report (GIR) which shall form part of the Geotechnical Design Report (GDR). The geotechnical section of this report is intended to fulfil the general requirements of the GIR as outlined in BS EN 1997-2, Section 6. The GIR contains the factual information including geological features and relevant data, and a geotechnical evaluation of the information stating the assumptions made in the interpretation of the test results. This report shall not be considered as being a GDR.

Planning Requirements

The National Planning Policy Framework (NPPF, 2019) emphasises the presumption in favour of sustainable development. Paragraph 11, which defines the presumption in favour of sustainable development, has two similar clauses which related to potentially contaminated land and sensitive receptors:

11) Plans and decisions should apply a presumption in favour of sustainable development.

*For **plan-making** this means that:*

b) strategic policies should, as a minimum, provide for objectively assessed needs for housing and other uses, as well as any needs that cannot be met within neighbouring areas, unless:

i) the application of policies in this Framework that protect areas or assets of particular importance provides a strong reason for restricting the overall scale, type or distribution of development in the plan area;

*For **decision-taking** this means:*

d) where there are no relevant development plan policies, or the policies which are most important for determining the application are out-of-date, granting permission unless:

ii) the application of policies in this Framework that protect areas or assets of particular importance provides a clear reason for refusing the development proposed

In accordance with the NPPF, areas or assets of particular importance are defined as:

Habitats sites (and those sites listed in paragraph 176 – potential Special Protection Areas and Possible Areas of Conservation; listed or proposed Ramsar sites; and sites identified, or required, as compensatory measures for adverse effects on habitats sites, potential Special Protection Areas, possible Special Areas of Conservation, and listed or proposed Ramsar sites) and/or designated as Sites of Special Scientific Interest; land designated as Green Belt, Local Green Space, an Area of Outstanding Natural Beauty, a National Park (or within the Broads Authority) or defined as Heritage Coast; irreplaceable habitats; designated heritage assets *(and other heritage assets of archaeological interest referred to in footnote 63 (Non-designated heritage assets of archaeological interest, which are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets.); and areas at risk of flooding or coastal change*.

Paragraph 118 states that planning policies and decisions should:

- *give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land;*

Paragraph 170 clarifies that enhancing the natural environment includes:

Planning policies and decisions should contribute to and enhance the natural and local environment by:

- *protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan);*
- *recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland;*
- *maintaining the character of the undeveloped coast, while improving public access to it where appropriate;*
- *minimising impacts on and providing net gains for biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;*
- *preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and*
- *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.*

Paragraph 180 of NPPF states that planning policies and decisions should ensure the following:

- *Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development.*

Paragraph 178 of NPPF states that planning policies and decisions for developments should also ensure that:

a) *a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);*

b) *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*

c) *adequate site investigation information, prepared by a competent person, is available to inform these assessments.*

Paragraph 179 states that where a site is affected by contamination or land stability issues, responsibility for securing a safe development rest with the developer and/or landowner.

This report has been prepared and authorised by staff that are competent as defined in the NPPF.

Unexploded Ordnance

Clients have a legal duty under the CDM 2015 Regulations to provide designers and contractors with project-specific health and safety information needed to identify hazards and risks. This includes the possibility of unexploded ordnance (UXO) being encountered on the site. Further details are given in CIRIA Report C681 (Stone et al 2009). A non-UXO specialist screening exercise has been carried out for the site by considering any evidence of UK defence activities on or near the site evident from the gathered desk study information and the unexploded aerial delivered bomb (UXB) regional risk maps produced by Zetica. Other data sources are available, but as a first stage screening exercise the freely available Zetica maps have been used. The level of risk stated is that determined by Zetica, a company experience in the desk study, field investigation and clearance of UXO/UXB.

Appendix B – Environmental Risk Assessment Methodology and Terminology

B

Environmental Risk Assessment Methodology & Terminology

LEGISLATION OVERVIEW

This report includes hazard identification and environmental risk assessment in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a "suitable for use approach," which is relevant to both the current use of land and also to any proposed future use. The contaminated land regime is the statutory regime for remediation of contaminated land that causes an unacceptable level of risk and is set out in Part 2A of the Environmental Protection Act 1990 ("EPA 1990"). The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health, or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

"any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:

a) Significant harm is being caused or there is a significant possibility of such harm being caused;

or

b) Pollution of controlled waters is being, or is likely to be, caused."

In order to assist in establishing if there is a "significant possibility of significant harm" there must be a "contaminant linkage" for potential harm to exist. That means there must be a source(s) of contamination, sensitive receptors present and a connection or pathway between the two. This combination of contaminant-pathway-receptor is termed a "contaminant linkage or CPR linkage."

Part IIA of The Environmental Protection Act 1990 is supported by a substantial quantity of guidance and other Regulations. Key implementing legislation of the Part 2A regime includes the Contaminated Land (England) Regulations 2006 (SI 2006/1380) as amended by the overarching legislation for the contaminated land regime, which implements the provisions of Part IIA of the Environmental Protection Act 1990 (as inserted by section 57 of the Environment Act 1995), came into force on 14th July 2000 together with recent amended regulations: Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263). Revised Contaminated Land Statutory Guidance was published by DEFRA in April 2012. Part IIA defines the duties of Local Authorities in dealing with it. Part IIA places contaminated land responsibility as a part of planning and redevelopment process rather than Local Authority direct action except in situations of very high pollution risk.

In the planning process guidance is provided by National Planning Policy Framework (NPPF) of July 2018 which requires that a site which has been developed shall not be capable of being determined "contaminated land" under Part IIA. In practice, Planning Authorities require sites being developed to have a lower level of risk post development than the higher level of risk that is required in order to determine a site as being contaminated in accordance with Part IIA. This is to ensure that there is a suitable zone of safety below the level for Part IIA determination and prevent recently developed sites becoming reclassified as contaminated land if there are future legislative or technical changes (e.g., a substance is subsequently found to be more toxic than previously assessed this increases its hazard).

The criteria for assessing concentrations of contaminants and hence determining whether a site represents a hazard are based on a range of techniques, models and guidance. Within this context it is relevant to note that Government objectives are:

a) to identify and remove unacceptable risks to human health and the environment;
b) to seek to bring damaged land back into beneficial use;
c) to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

These three objectives underlie the "suitable for use" approach to risk management and remediation of contaminated land. The "suitable for use" approach focuses on the risks caused by land contamination. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Risks therefore should be assessed on a site-by-site basis.

The "suitable for use" approach then consists of three elements:

a) ensuring that land is suitable for its current use - in other words, identifying any land where contamination is causing unacceptable risks to human health and the environment, assessed on the basis of the current use and circumstances of the land, and returning such land to a condition where such risks no longer arise ("remediating" the land); the contaminated land regime provides the regulatory mechanisms to achieve this;
b) ensuring that land is made suitable for any new use, as planning permission is given for that new use - in other words, assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before official permission is given for the development and, where necessary to avoid unacceptable risks to human health and the environment, remediating the land before the new use commences; this is the role of the town and country planning and building control regimes; and
c) limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought - in other words, recognising that the risks from contaminated land can be satisfactory assessed only in the context of specific uses of the land (whether current or proposed), and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby running the risk of distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

The mere presence of contaminants does not therefore necessarily warrant action, and consideration must be given to the scale of risk involved for the use that the site has and will have in the future.

OVERALL METHODOLOGY

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in the EA online guidance: Land Contamination: Risk Management (LCRM) (Environment Agency, 2020), and BS10175:2011+A2 2017. Important aspects of the risk assessment process are transparency and justification. The particular rationale behind the risk assessments presented is given in this appendix.

The first stage of a two-staged investigation and assessment of a site is the Preliminary Investigation (BS 10175:2011), often referred to as the Phase 1 Study, comprising desk study and walk-over survey, which culminates in the Preliminary Risk Assessment. A preliminary conceptual site model (CSM) is developed which identifies potential geotechnical and geo-environmental hazards and the qualitative degree of risk associated with them. From the geo-environmental perspective, the Hazard Identification process uses professional judgement to evaluate all the hazards in terms of potential contaminant linkages (of contaminant source-pathway-receptor). Potential contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and generic risk assessment.

The second stage is the Ground Investigation, Generic Risk Assessment and Geotechnical Interpretation. This represents the further assessment mentioned above. The scope of the Ground Investigation is based on the findings of the Preliminary Risk Assessment and is designed to reduce uncertainty in the geotechnical and geo-environmental hazard identification. The Ground Investigation comprises fieldwork, laboratory testing and usually also on-site monitoring. The Ground Investigation may include the Exploratory, Main and Supplementary Investigations described in BS 10175:2011+A2 2017. The results of the Ground Investigation reduces uncertainty in the geotechnical and geo-environmental risks. Depending on the findings more detailed investigations or assessments may be required.

PRELIMINARY RISK ASSESSMENT

Current practice recommends that the determination of potential liabilities that could arise from land contamination be carried out using the process of risk assessment, whereby "risk" is defined as:

"(a) The probability, or frequency, or occurrence of a defined hazard; and
(b) The magnitude (including the seriousness) of the consequences."

The UK's approach to the assessment of environmental risk is set out in by the Department of the Environment Transport and the Regions (2000) publication "A Guide to Risk Assessment and Risk Management for Environmental Protection" (also called Greenleaves II). This established an iterative, systematic staged process which comprises:

a) Hazard identification;
b) Hazard assessment;
c) Risk estimation;
d) Risk evaluation;
e) Risk assessment;

At each stage during the development process, the above steps are repeated as more detailed information becomes available for the site.

For an environmental risk to be present, all three of the following elements must be present:

- Source/Contaminant: hazardous substance that has the potential to cause adverse impacts;
- Receptor: target that may be affected by contamination: examples include human occupants/users of site, water resources (rivers or groundwater), or structures;
- Pathway: a viable route whereby a hazardous substance may come into contact with the receptor.

The absence of one or more of each component (contaminant, pathway, receptor) would prevent a contaminant linkage being established and there would be no significant environmental risk.

The identification of potential contaminant linkages is based on a Conceptual Model of the site, which is subject to continual refinement as additional data becomes available. As part of a Preliminary Risk Assessment (Desk Study and site walk over) a Preliminary Conceptual Site Model (PCSM) is formed. Based on the PCSM, potential contaminant linkages can be assessed. If the PCSM and hazard assessment indicate that a contaminant linkage is not of significance then no further assessment or action is required for this linkage. For each significant and potential linkage, a risk assessment is carried out. The linkages which potentially pose significant risks may require a variety of responses ranging from immediate remedial action or risk management or, more commonly, further investigation and risk assessment. This next stage is termed a Phase II Main Site Investigation and should provide additional data to allow refinement of the Conceptual Site Model and assess the level of risk from each contaminant linkage.

Definition of Risk Assessment Terminology

CIRIA Report C552, Contaminated Land Risk Assessment A Guide to Good Practice, 2001 sets out a methodology for estimating risk. The methodology for risk evaluation is a qualitative method for interpreting the output for the risk estimation stage of the assessment. It involves the classification of the:

- Magnitude of the potential consequence (severity) of risk occurring.
- Magnitude of the probability (likelihood) of the risk occurring.

The classification of consequence and probability are set out in table B1 and B2 below:

Table B1 Classification of Consequence

Classification	Definition	Examples
Severe (Sv)	Short term (acute) risk to human health likely to result in "significant harm" as defined by the Environment protection Act 1990, Part IIA. Short term risk of pollution of controlled waters. Catastrophic damage to buildings / property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem	High concentrations of cyanide on the surface of an informal recreation area Major spillage of contaminants from site into controlled water. Explosion causing building collapse (can also equate to a short-term human health risk if buildings are occupied.)
Medium (Md)	Chronic damage to Human Health ("significant harm"). Pollution of controlled waters. A significant change in a particular ecosystem, organism forming part such ecosystem.	Concentrations of contaminants from site exceeding generic or site-specific screening criteria. Leaching of contaminants into a major or minor aquifer. Death of species within a designated nature reserve.
Mild (Mi)	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures, and services. Damage to sensitive buildings / structures / services or the environment.	Pollution of non-classified groundwater. Damage to building, rendering it unsafe to occupy (e.g., foundation damage resulting in instability)
Minor (Mr)	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by measures such as protective clothing etc). Easily repairable effects of damage to buildings, structures, and services.	The presence of contaminants at such concentrations that protective equipment is required during site work. The loss of plants in a landscaping scheme. Discolouration of concrete.

The classification of consequence does not take into account the probability of the consequence being realised. Therefore there may be more than one consequence for a particular pollutant linkage. Both a severe and medium classification can result in death. Severe relates to short term (acute) risk while medium relates to long term (chronic) risk. Mild relates to significant harm but to less sensitive receptors. Minor classification relates to harm which is not significant but could have a financial cost.

Table B2 Classification of Probability

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

The classification gives a guide as to the severity and consequence of identified risk when compared with other risk presented on the site. It should be noted that if a risk is identified it cannot be classified as “no risk” but as “very low risk”. Differing stakeholders may have a different view on the acceptability of a risk.

Once the consequence and probability have been classified these can be compared using a matrix (**Table B3**) to identify an overall risk category. These categories and the actions required are categorised in **Table B4.**

Table B3 Risk Evaluation Matrix

		Consequence			
		Severe (Sv)	Medium (Md)	Mild (Mi)	Minor (Mr)
Probability	High likelihood (Hi)	Very High Risk (VH)	High Risk (H)	Moderate Risk (M)	Mod/Low Risk (M/L)
	Likely (Li)	High Risk (H)	Moderate Risk (M)	Mod/Low Risk (M/L)	Low Risk (L)
	Low likelihood (Lw)	Moderate Risk (M)	Mod/Low Risk (M/L)	Low Risk (L)	Very Low Risk (VL)
	Unlikely (Ul)	Mod/Low Risk (M/L)	Low Risk (L)	Very Low Risk (VL)	Very Low Risk (VL)

Table B4 **Risk Categorisations**

Very High Risk (VH)	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk (H)	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer-term.
Moderate Risk (M)	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer-term.
Low Risk (L)	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk (VL)	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

GENERIC QIANTITATIVE RISK ASSESSMENT

In the following sections the current UK guidance on risks to the following receptors are discussed: human health, plant life and controlled waters

Human Health
The overall methodology for assessing the risk to human health from potential contaminants in soil is set out in the Environment Agency's guidance "Using Soil Guideline Values" SC050021/SGV Introduction, March 2009 and using the CLEA 1.06 model software (and CLEA 1.071 for nickel). The generic assessment criteria are in accordance with the following:

- Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil;
- Science Report SC050021/SR3: Updated technical background to the CLEA model;
- Science Report SC050021/SR4: CLEA Software (Version 1.071, 2014) & Handbook;
- Toxicological reports and SGV technical notes;
- Toxicological data published by LQM/CIEH (2009) and CL:AIRE/EIC/AGS (2009);
- DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013);
- LQM/CIEH Suitable 4 Use Levels (S4ULs) for Human Health Risk Assessment; and,
- Toxicology review published by the European Food Safety Authority for nickel (2015).

In March 2014 six 'proposed' Category 4 Screening Levels (pC4SL) were issued by Defra. These screening values are considered to be within Category 4 as defined in the Contaminated Land Statutory Guidance and indicate safe levels for new developments passing through the planning system. The SGV for lead has been withdrawn, and the pC4SL for lead has been derived using current best practice. In January 2015 LQM/CIEH published S4ULs for 89 contaminants in accordance with the C4SL methodology.

Note that groundwater contamination may pose a risk to human health but that there are no relevant generic assessment criteria available for comparison. ByrneLooby has derived our own assessment criteria for this.

Phytotoxic Risks
Generic assessment of phytotoxicity is by comparison with guideline values presented in the British Standard for Topsoil and the MAFF document "Code of Good agricultural practice for the protection of soil", October 1998. This is in accordance with LCRM's reference to DEFRA notice CLAN 4/04.

Controlled Waters
Risks to controlled waters (groundwater and surface waters) from contaminants are assessed in accordance with the EA documents "The Environment Agency's Approach to Groundwater Protection" (2017) and Remedial Targets Methodology (RTM, 2006). Pollutant inputs from

contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Environment Agency's 'limit' pollution objective. Acceptable water quality targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)). The risk posed to controlled waters from total soil concentrations cannot be directly assessed. The risk is assessed either by comparison of results of leachate tests carried out on soil samples, or from the direct testing of samples of groundwater to screening criteria. Leachate testing generally forms a conservative assessment and is not appropriate for organic contaminants.

CURRENT GUIDANCE ON INTERPRETATION OF CHEMICAL ANALYSIS OF SOILS

Contaminated land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995. This supports a 'suitable for use' based approach to the risk assessment of potentially contaminated land. The site-specific risk assessment is based upon assessment of plausible contaminant linkages, referred to as the contaminant-pathway- receptor model, based upon the current or proposed use of the site.

Before undertaking a risk assessment, a conceptual site model is devised in order to identify the potential contaminants, pathways and receptors. The individual contaminants, pathways and receptors then need to be further investigated in order to refine the initial assessment and risk assessment undertaken.

In March 2002, the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency published the Contaminated Land Exposure Assessment (CLEA) Model and a series of related reports. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. These reports (CLR7-10) together with associated "SGV" documents were withdrawn and the following documents have been published as revised guidance to the CLEA assessment:

- Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.
- Environment Agency : 2008: Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
- Environment Agency : 2008: Science Report SC050021/SR3: Updated technical background to the CLEA model.
- Environment Agency : 2008 : Compilation of Data for Priority Organic Contaminants for Derivation of Soil Guideline Values Science report SC050021/SR7
- Environment Agency : Science Report SC050021/SR4: CLEA Software (Version 1.071, 2015) & Handbook.
- DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
- LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment.

Additional guidance on statistical assessment replacing CLR 7 is partly provided in:

- CL:AIRE: 2009: Guidance on Comparing Data With a Critical Concentration

A different approach to the statistical appraisal of data is required depending on whether the assessment of risk is to assess whether land is Contaminated Land in accordance with regulations, or whether the assessment is to assess whether the site is suitable for new development in according with Planning guidance. This is discussed further in CL:AIRE: 2009 "Guidance on Comparing Data With a Critical Concentration".

The introduction of the Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) reassessed the CLEA Model and the derived SGVs (and associated GACs calculated using the model). This re-assessment concluded that the SGVs/GACs were conservative screening criteria for determining the suitability of soil with regard to the risk to human health under the planning regime and defined a new upper limit for planning purposes which is the boundary between the new Category 3 and 4. In March and September 2014 DEFRA issued guidance on these new Category 4 Screening Levels (C4SL) and these are discussed further below.

Soil Guideline Values

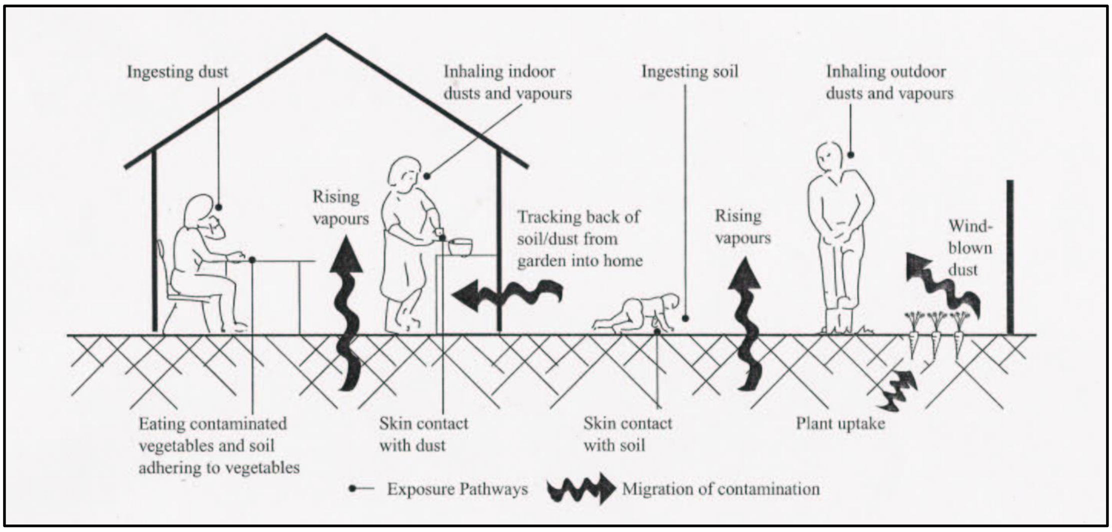
A program for the derivation of SGVs based on the above guidance is provided by the Environment Agency and is entitled "CLEA Software Version 1.06". These reports, together with supporting toxicology reviews ("Tox" or Supplementary Information Reports) for individual substances (which will be gradually updated), Soil Guideline Value Reports and other guidance referred to in the above documents, provide guidance and the scientific basis for assessing the risk to human health from potential contaminants. Soil Guideline Value Reports (SGV Reports) have been published for a number of contaminants and these are published on the Environment Agency website. Eventually the reports will include SGVs for:

- heavy metals and other inorganic compounds: arsenic, cadmium, chromium, cyanide, lead (now withdrawn), mercury nickel (now withdrawn), and selenium;
- benzene, ethylbenzene, toluene, and xylenes;
- phenol;
- dioxins and dioxin-like polychlorinated biphenyls (PCBs);
- polycyclic aromatic hydrocarbons (PAHs) – 11 substances.

In September 2015, CLEA was re-issued as 'CLEA Version 1.071'. Currently, the software has been used to produce an in-house GAC for nickel, following with withdrawal of the SGV.

In addition, CIEH through LQM and the EIC have published generic assessment criteria (GACs) for a wide variety of other parameters including metals, hydrocarbons, chlorinated aliphatic compounds, PAHs and explosive substances for three standard land uses. These have been produced to supplement the Environment Agency guidance. These GACs will be replaced by SGVs when or if the Environment Agency publishes any more SGVs.

The CLEA model has been developed to calculate an estimated tolerable daily soil intake (TDSI) for site users given a set 'default' exposure pathways. Ten human exposure pathways are covered in the CLEA model as presented below:



- Ingestion:
  - ingestion of outdoor soil;
  - ingestion of indoor dust;
  - ingestion of home-grown vegetables;
  - ingestion of soil attached to home grown vegetables.

- Dermal Contact:
  - dermal contact with outdoor soil;
  - dermal contact with indoor dust.

- Inhalation:
  - inhalation of outdoor dust;
  - inhalation of indoor dust;
  - inhalation of outdoor soil vapour;
  - inhalation of indoor soil vapour.

It should be noted that there are other potential exposure pathways on some sites not included in the CLEA model e.g., certain organic compounds can pass through plastic water pipes into drinking water supply.

The presence and/or significance of each of the above exposure pathways are dependent on the type of land use being considered and the nature of the contaminant under scrutiny. Accordingly, the CLEA model considers for principle 'default' land use types and makes a series of 'default' assumptions with regard to human exposure frequency, duration and critical human target groups for each land use considered:

- residential land use;
- allotments;
- commercial and industrial land use.

The land use categories defined in the CLEA are detailed below.

Residential: This land use category assumes that people live in a variety of dwellings including terraced, detached and semi-detached houses up to two storeys high. The structure of buildings varies. Default parameters for building materials and building design are included in CLEA documents to calculate the relevant multi-layer diffusion coefficients for vapour intrusion and to model indoor vapour intrusion. The CLEA model assumes that regardless of the style of housing the residents will have access to either a private garden or community open space nearby, and that soil tracked into the home will form indoor dust. It allows for the ingestion pathways from home grown vegetables.

Allotments: The CLEA model incorporates an assessment of land provided by local authorities specifically for people to grow fruit and vegetables for their own consumption. Consumption of such fruit and vegetables present several exposure pathways; plants absorb contaminants mainly via water uptake through roots, the contaminants move to edible portions of plants via translocation and contaminated soil particles become trapped in the skin and between leaves. At present the model fails to account for exposure through the consumption of animals, and their products (e.g., eggs), which have been reared on contaminated land.

Commercial/Industrial: Although there are a wide variety of workplaces and work-related activities, the CLEA assessment of this land-use assumes that work occurs in a permanent, three-storey structure, where employees spend most time indoors, conducting office-based or light physical work. The model assumes employees sit outside during breaks for most of the year. Limitations in applying this land-use to different industries is detailed in EA publication "Updated technical background to the CLEA model" (2011). The generic model assumes that the site would not be covered by hard standing. Risk of exposure to contaminants would be clearly less where commercial land is essentially all buildings and hard standing.

Based on the assumptions of each land use and the associated applicable exposure pathways, a 'Soil Guideline Value' (SGV) may be calculated for each contaminant under consideration for a particular land use in order to determine whether certain contaminant soil concentrations pose a significant risk to human health. The primary purpose of the CLEA SGVs are as 'trigger values' – indicators to a risk assessor that soil concentrations below this level require no further assessment as it can be assumed that the soil is suitable for the proposed use. Where soil concentrations occur above the SGV then further assessment of the results is required. The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012 provides new clarity on the assessment of risk where soil concentrations exceed the SGV. The guidance introduces a four-stage classification system relating to concentration of contaminants and the assessed risk which indicates appropriate actions. Category 1 and 2 sites are classified as "Contaminated Land" as defined in Part IIA of The Environmental Protection Act (1990). Category 3 and 4 sites are not considered as "Contaminated Land" in accordance with the Act. This can be explained using the figure on the following page.

There are also difficulties in establishing soil concentrations of contaminants beyond which risks from exposure to these contaminants would be 'unacceptable' and that they would lead to "significant possibility of significant harm" as defined in Part IIA of The Environmental Protection Act (1990) and determine that the land is "contaminated." This ultimately requires detailed 'toxicological' information of the health effects of individual contaminants and also a scientific judgement on what constitutes an 'unacceptable' risk. It is for local authorities or the

Environment Agency to determine whether a particular site is contaminated land, and it is for local Planning Authorities to determine whether land affected by contamination can be redeveloped.

Given the SGVs have been derived only for a limited number of contaminants and there was little prospect of further SGVs being published, two professional groupings have produced Generic Assessment Criteria (GACs) in accordance with the CLEA model for a large number of additional contaminants. These GACs were recognised in the new Contaminated Land Statutory Guidance (DEFRA, 2012) and have been produced as follows:

- *LQM/CIEH : 2009 Nathaniel CP, McCaffrey C, Ashmore MH, Cheng NPS GROUP, Gillett A, Ogden R & Scott D : 2009 . The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition). Land Quality Press, Nottingham.*
- *CL:AIRE/EIC/AGS: 2009 : Soil Generic Assessment Criteria (GAC) for Human Health Risk Assessment. Contaminated Land: Applications in Real Environments, Environment Industries Commission & Association of Geotechnical and Environmental Specialists. December 2009.*

Category 4 Screening Levels and LQM/CIEH Suitable 4 Use Levels

For new developments progressing through the planning regime, it is desirable that the soil concentrations are within Category 4 where there is a valid contaminant linkage. The upper boundary between Category 4 and 3 is not defined in the guidance. This boundary can also be better defined by carrying out a Detailed Quantified Risk Assessment (DQRA) and this is discussed later in this appendix.

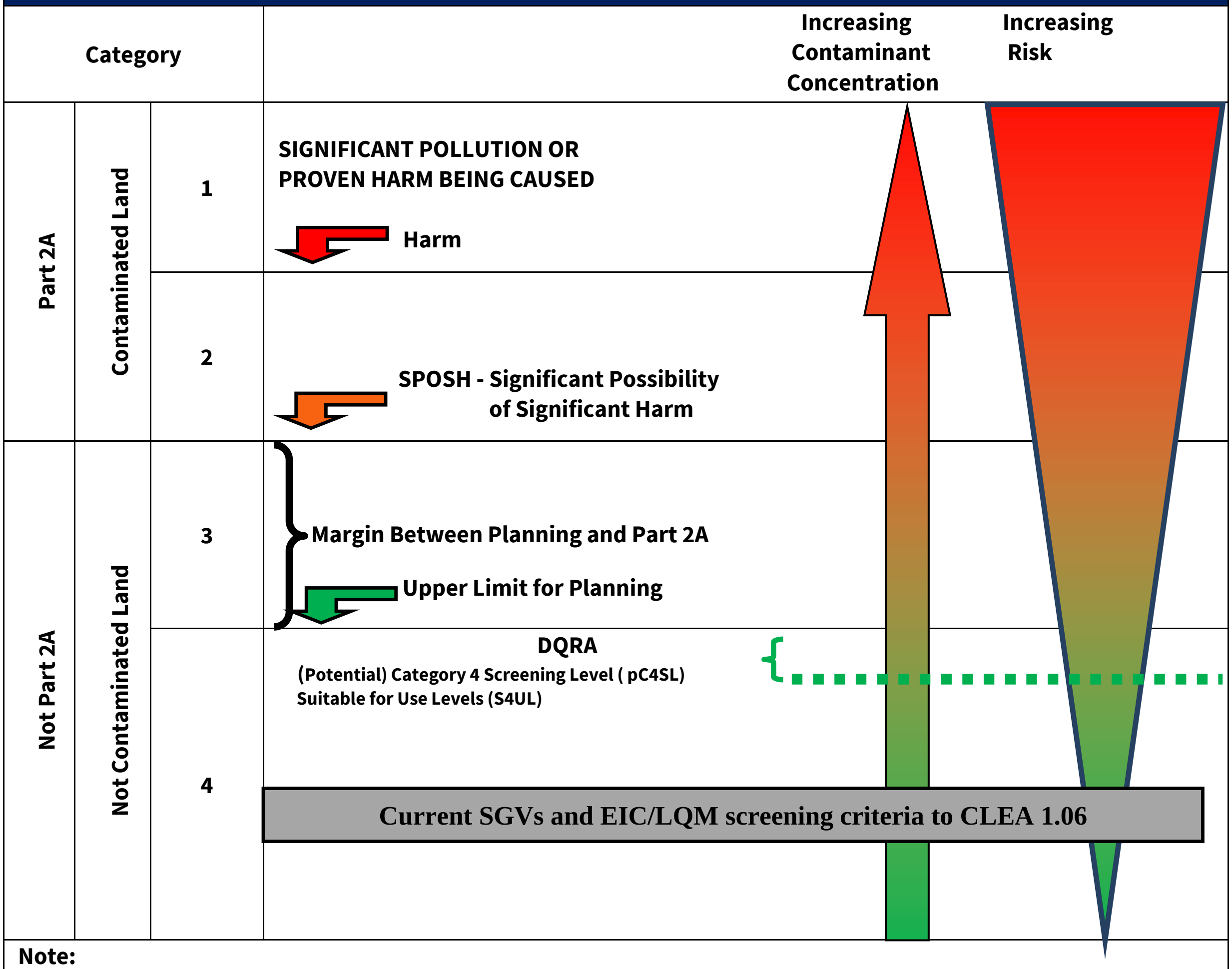
In December 2013 Defra issued the findings of a research project undertaken by CL:AIRE to set out the framework by which potential Category 4 Screening Levels (pC4SL) may be derived. The report was not designed to produce 'final' C4SL as the steering group producing the report believes that final C4SL should be set by a 'relevant authority' (e.g., Defra), the toxicological framework proposed has not been reviewed by the Committee on Toxicity and the document has yet to be subject to peer review.

In March 2014, appendices to the main Defra report were published detailing the derivation of pC4SL for 6 contaminants and other appendices regarding a review of the CIEH/CL:AIRE statistics guidance and sensitivity analysis. For each contaminant, a range of pC4SL have been produced relating to modifying toxicological parameters only, modifying exposure parameters only or by modifying both. It should be noted that the pC4SL produced for lead (the SGV was withdrawn in 2011) has undertaken a relatively large toxicological review in relation to modelling blood lead concentrations. pC4SL have been produced for:

- Arsenic;
- Benzene;
- Benzo(a)pyrene (as a surrogate marker for PAHs);
- Cadmium;
- Chromium (VI); and
- Lead

As previously discussed the values were initially published as 'potential' C4SL but have become 'final' following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014). It is considered that the pC4SL provide a simple test for deciding whether land is suitable for use without any remediation. The pC4SL represent a new set of screening levels that are more pragmatic (but strongly precautionary) compared to the existing soil guideline values (SGVs and the other GACs calculate in accordance with the existing CLEA methodology). The pC4SL provide cautious estimates of contaminant concentrations in soil that are still considered to present an acceptable level of risk, within the context of Part 2A, by combining information on toxicology, exposure assessment and normal levels of exposure to these contaminants. pC4SL values should not be seen as 'SPOH values.' Exceeding a pC4SL means that further investigation is required, not that the land is necessarily contaminated. In January 2015, LQM published Suitable 4 Use Levels (S4ULs) for a further 89 contaminants using the Defra C4SL methodology. In a similar manner to the pC4SLs, no authoritative review has been undertaken although the approach and quality of the work undertaken is widely accepted as being of high quality.

Relationship Between Contaminant Concentration, Risk and Screening Values



Note:

The vertical scale should not be considered as being linear and will be site and contaminant specific.

- SPOSH concentrations could be 10 to 100 times the SGV/EIC/LQM screening concentration.
- C4SL were issued as 'potential' but have become 'final' following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014).

Lead:
The SGV for lead was withdrawn in 2011 and is not used in this report. The pC4SL for lead provides a technically robust and conservative assessment tool using significantly updated toxicological modelling in line with current scientific understanding of lead toxicology.

Nickel
The SGV for nickel was withdrawn in 2015 and is not used in this report. In-house GACs for nickel have been produced using the updated toxicological review by the EFSA and the CLEA 1.071 software.

Public Open Space
The Defra report (December 2013) has also introduced exposure scenarios for two other commonly occurring land uses which require assessment (under the planning and Part 2A regimes) on a relatively frequent basis. These exposure scenarios are:

- Public Open Space – Space Near Residential Housing (POS_{resi}); and,
- Public Open Space – Public Park (POS_{park}).

Potential use of pC4SL relating to Public Open Space (POS) require care due to the significant variability in exposure characteristics. For example, POS may include:

- Children's play areas, public parks where children practise sport several times a week and teenagers only once a week;
- Grassed areas adjacent to residential properties which are rarely used;
- Dedicated sports grounds where exposure is only to players and groundworkers; and,
- Nature reserves or open ground with low level activity (for example, dog walking).

Within the Defra report (December 2013) the following exposure scenarios have been modelled as these are considered the most important for potential exposure for the critical receptor i.e., young children:

- Green open space close to housing, including tracking back of soil (POS_{resi}); and
- Park-type scenario where distance is considered sufficient to discount tracking back of soil (POS_{park}).

Detailed Quantified Risk Assessment (DQRA)
SGVs, GACs, pC4SL and S4ULs are based on a number of basic assumptions. There are two main options for developing Site Specific Assessment Criteria (SSAC) by adjusting the CLEA model so that they have greater relevance to the site:

- **Simple adjustment of the generic SGV / C4SL model**. Such adjustment is restricted to the choice of exposure routes selected for the generic land use, building type, soil type and soil organic matter content within the CLEA software.

- **Detailed adjustment.** It may be relevant to make greater modifications to the model due to the specific use of the land in question. This can include modification to any parameter value, including exposure assumptions, building parameters, and the choice and application of fate and transport models. This is equally relevant to site-specific modifications of existing generic land uses, the development of new land uses, and the inclusion of additional exposure pathways. Much of this can be undertaken using the CLEA software. Depending on the complexity of the detailed adjustments required, it may be necessary to use other tools either alone or in conjunction with the CLEA software. Both options should follow established protocols for DQRA and require sufficient justification and supporting information for the adjustments made. Detailed adjustments are likely to require substantially greater technical justification and supporting documentation, especially if modifications are based on information not contained within the SGV framework documents.

The two choices present the risk assessor with three options/decisions:

1. Use a published SGV/GAC/pC4SL/S4UL if it can be demonstrated that the assumptions inherent in the value are appropriate to the site in question. If they are not, proceed to either option 2 or 3 below.

2. Make simple site-specific adjustments to the generic exposure model used to derive the SSAC. Three examples of when this could be appropriate are:

    a. High density residential development with no exposed contaminated soil at surface. It is appropriate in this case to consider the relevance of direct contact pathways and consumption of homegrown produce.

    b. Soil type is significantly different (specifically when soil type is likely to be less protective e.g., made ground) to that assumed in the SGV/GAC/pC4SL/S4UL.

    c. Soil organic matter content is significantly different to that assumed in the derivation of the SGV/GAC/pC4SL/S4UL.

3. If simple adjustments are not sufficient to reflect site conditions, undertake a DQRA. This may be undertaken using the CLEA software or by using an alternative risk assessment methodology that is relevant, appropriate, authoritative, and scientifically based. Changes to toxicological end points may also be considered, although this should only be undertaken by a toxicology expert. In the context of this guidance, simple adjustments of a generic land use scenario for soil type or SOM content for example are not considered sufficient to be classed as a DQRA.

DQRAs should be conducted with the agreement of the local authority (or the Environment Agency) since it is the authority that determines whether land is Contaminated Land or whether Planning Permission for a new development may be granted.

Representative Data

The type, quantity and quality of the available soil data influence the method chosen to obtain a site representative soil concentration that is compared with an SGV/GAC/pC4SL/S4UL in the screening process. The soil data should be representative of the exposure scenario being considered. This can include factors such as:

- Averaging area over which exposure occurs;
- Sample depth; and,
- Heterogeneity of soil.

where the 'averaging area' is defined as:

> *"That area (together with a consideration of depth) of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions".*

Site investigations take discrete samples from a given area (and to a certain depth). It has to be assumed that these samples are to some degree representative of the contaminant concentration throughout that volume of soil. The critical soil volume (taking into account area and depth) which might be usefully compared with an SGV/GAC/pC4SL/S4UL is a site-specific decision, but a starting point is the generic land use scenarios used in the derivation of the SGV/GAC/pC4SL/S4UL. The critical soil volume depends on two factors:

- Contaminant distribution and vertical profile (bands of highly contaminated material or lateral hot spots should not necessarily be averaged out with more extensive cleaner areas of soil without justification)
- Contribution to average exposure underpinning the SGV. Direct contact exposure pathways depend on the adult or child coming into contact with near-surface soils and the area over which that exposure occurs is usually important (i.e., the averaging area). Vapour pathways are less dependent on surface area, for example vapour intrusion may result from a highly concentrated hot spot beneath a building leading to elevated average indoor air concentrations. For the three standard land uses for which SGVs are derived, relevant considerations are:
- For the standard **residential or allotment land use**, the critical soil volume is the area of an individual garden, communal play area or working plot from the surface to a depth of between 0.50m and 1.00m. This is the ground over which children are most likely to come into contact with soil or from which vegetable and fruit produce will be harvested. In the case of volatile contaminants, it may also be appropriate to consider the volume of soil underneath the footprint of the building although vapour intrusion may be driven by a soil volume much smaller than this if the contaminant source is highly concentrated.
- For the standard **commercial land use**, the critical soil volume has to be decided on a case-by- case basis due to the wide range of possible site layouts. However, for non-volatile contaminants, landscaped and recreational areas around the perimeter of office buildings are likely to be most important. For volatile contaminants, the footprint occupied by the building itself should also be considered.

- For **most exposure pathways**, the contamination is assumed to be at or within one metre of the surface.

The use of averaging areas must be justified on the basis of relevance to the exposure scenario. SGVs are relevant only when the exposure assumptions inherent in them are appropriate for the identified exposure averaging area. Further guidance on critical soil volumes and the consideration of averaging exposure areas can be found in:

- *Secondary model procedure for the development of appropriate soil sampling strategies for land contamination (Environment Agency, 2000);*
- *Guidance on comparing soil contamination data with a critical concentration (CIEH/CL:AIRE, 2009); and*
- *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Appendix I (Defra December 2013, March 2014)*

It is the mean soil concentration for the individual contaminant within an individual averaging area, which is compared to the SGV. However, as contaminant concentrations vary across a site, and sampling and analysis will introduce measurement errors, the comparison between measured mean concentration and the SGV must take this uncertainty into account.

There are two principal options available to obtain site representative soil concentrations from a site investigation dataset; statistical and non-statistical methods. Data objectives, quality and quantity are likely to determine which approach is most appropriate. If statistical methods such as those presented in CIEH/CL:AIRE (2011) are to be used, sufficient data need to be available or obtained. No one single statistical approach is applicable to all sites and circumstances. The wider range of robust statistical techniques developed by organisations including the US Environmental Protection Agency (USEPA) are also important tools. Risk assessors should choose an appropriate statistical approach on the basis of the specific site and the decision that is being made. For further guidance on the appropriate use of statistical approaches, refer to USEPA 2006 or good environmental monitoring statistics textbooks.

When statistical approaches are inappropriate (this will depend on the objectives of the site investigation), individual or composite samples should be compared directly to the SGV. Guidance on use of alternative data handling approaches such as the use of composite sampling can be found in documents such as:

- *Verification of remediation of land contamination* (Environment Agency, 2010);
- *Sampling and testing of wastes to meet landfill Waste Acceptance Criteria* (Environment Agency, 2005);
- *Guidance on choosing a sampling design for environmental data collection* (USEPA, 2002); and,
- *Soil Quality – Sampling, ISO 10381 series* (ISO, 2002–2007).

The statistical tests should not be used as arbiters for decisions under Part 2A. They are an additional, useful line of evidence to assist in decision-making. The implications of the basis for the derivation of the site representative soil concentration must be taken into account in any decision-making process and clearly documented.

Where the statistical tests are conducted in accordance with the method described in CL:AIRE 2009:

- For the Planning situation, it has to be demonstrated that the concentration of contaminants is low compared to the pC4SL/S4UL or SSAC. All of the test data should be below the screening criteria and no statistical analysis is required or if there are exceedances of the criteria then a statistical assessment is required. For the statistical assessment this decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is lower than the screening criteria.

- For the Part 2A scenario the regulator needs to determine whether the concentration of contaminants is greater than the SGV/GAC/pC4SL/S4UL or SSAC. This decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is higher than the SSAC. However, the regulator may proceed with determination if there is just a 51% probability, “on the balance of probabilities.”

If the screening levels are exceeded then more sophisticated quantitative risk assessment can be undertaken or remedial action may be taken to break the contaminant linkages. The benefits of undertaking a quantitative risk assessment must be weighed against the likelihood that it will bring about cost savings in the proposed remediation. Further information about the use of soil guideline values is provided in Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.

GENERIC RISK ASSESSMENT CRITERIA FOR RISK TO PLANTS

Soil contaminants, if present at sufficient concentrations, can have an adverse effect on the plant population. Phytotoxic effects can be manifested by a variety of responses, such as growth inhibition, interference with plant processes, contaminant-induced nutrient deficiencies and chlorosis (yellowing of leaves). All chemicals are probably capable of causing phytotoxic effects. Thus, the phytotoxic potential of substances is dependent on the concentrations capable of having adverse effects on plants and the concentrations likely to be found at contaminated sites. Phytotoxicity is a difficult parameter to quantify given that experimental techniques vary widely, and variations exist in plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Contaminants may be taken up and accumulated by plants through a range of mechanisms. The principal pathways are active and/or passive uptake through the plant root, adsorption to root surfaces and volatilisation from the soil surface followed by foliar uptake. After plant uptake, contaminants may be metabolised or excreted, or they may be bioaccumulated and this is highly species dependant. Many of the substances capable of adversely affecting vegetation exert this effect because of their water solubility, a characteristic that could result in their transport from contaminated sites into adjacent locations where the chemical may generate a phytotoxic response. This could be important if, for example, the adjacent site has important conservation status.

The concentration in soil at which substances become phytotoxic depend on a range of factors including plant type, soil type, pH, the form and availability of the contaminant and other vegetation stress factors that may be present (such as drought). Some plants (including some rare plants will only grow in soils where there are relatively high concentrations which would be phytotoxic to other species. Whilst many contaminants may be phytotoxic, data are limited. Some heavy metals are essential as trace elements for plant growth but may become toxic at higher concentrations.

ByrneLooby has carried out a review of a number of current and former guidance documents and other texts on phytotoxicity. It is not possible to produce a definitive list of phytotoxic substances on account of the variables mentioned above. However, a number of metals are repeatedly cited as commonly occurring priority pollutants. As a result, the following list is adopted by ByrneLooby as indicators of the potential for phytotoxicity: As, Cr, Cu, Ni and Zn (note that Boron has been excluded from this list because the more modern studies do not assess this).

As the CLEA framework is a risk-based approach, applied to humans, an alternative strategy is required to assess the risk to plants from substances that are phytotoxic. Reference to published criteria and background concentrations can help put site data into context. Published assessment criteria for the protection of plant life from a number of countries are given in the following Table. The most authoritative source is the British Standard for topsoil, but this only lists three elements. LCRM states that the ICRCL Guidance Note 70/90 can be used for initial screening criteria. This approach has been adopted by ByrneLooby where BS3882 is lacking, but where an ICRCL 70/90 criterion is lacking, the lowest criterion in Table below from, firstly UK, and, secondly, European and then other worldwide criteria. The adopted criteria are highlighted in the table 3.8. The MAFF value of 250 mg/kg has been chosen for As over the ICRCL value of 50 mg/kg as MAFF explains the 50 is applicable to vegetables and human health, whereas 250 is applicable to the plants themselves.

Table B.5: Published Assessment Criteria for Phytotoxic Elements (mg/kg)							
Reference	**As**	**CR (Total)**	**Cr (III)**	**Cr (VI)**	**Cu**	**Ni**	**Zn**
British Standard for topsoil (BS3882:2007)	-	-	-	-	200 (pH >7) 135 (pH 6-7) 100 (pH 5.5-6.0)	110 (pH >7) 75 (pH 6-7) 60 (pH 5.5-6.0)	300 (pH >7) 200 (pH 6-7) 200 (pH 5.5-6.0)
MAFF Code of Good Agricultural Practice for the Protection of Soil (1998)	250	-	400 for sites containing sewage and sludge	-	500 (grass) but may fall to 250 for clover and sensitive species (at pH>6)	110 (pH>7) 75 (pH 6-7) 60 (pH 5.5-6.0)	1000 (clover & grass at pH 6), may fall to 300 for sensitive species (at pH 6-7)
ICRCL 59/83 (1987) now withdrawn for human health assessment	-	-	-	-	130	70	300
ICRCL 70/90 (1990) threshold trigger value	50	-	-	25 *	250	-	1000
Dutch ecotoxicological intervention value (Swartjes 1993 & 1994)	40	230	-	7	190	-	-
Australian Guideline B(1) (1999), Interim Urban Ecological Investigation Level (EIL). Soils not generally considered phytotoxic below these EILs.	20	-	400	1	100	60	200
New Zealand guidelines for timber treatment sites (1977), estimated based on Cu bioavailability *	-	-	-	-	500 - 1000 clay soils	-	-
New Zealand guidelines for timber treatment sites (1977), soil criteria for protection of plant life (residential/ agricultural setting)	10-20	-	600	25	130	-	-

Note: * Cr (VI) is only likely to be present in as a significant proportion of total Cr where pH >12 so this does not routinely need to be tested for regarding plant health.

CURRENT GUIDANCE FOR CONTROLLED WATERS RISK ASSESSMENT

Summary of Regulatory Context

Government policy is based upon a "suitable for use approach," which is relevant to both the current use of land and also to any proposed future use. When considering the current use of land, Part IIA of the Environment Protection Act 1990 [4] (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995 [5], which came into force in England on 1 April 2000. The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health, controlled waters or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

> *"any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:*
>
> a) *Significant harm is being caused or there is a significant possibility of such harm being caused; or,*
>
> b) *Pollution of controlled waters is being, or is likely to be, caused."*

Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as:

> *"the entry into controlled waters of **any** poisonous, noxious or polluting matter or **any** solid waste matter"*

Part IIA is supported by a substantial quantity of guidance and other Regulations, especially for England, The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012. The document re-confirms the duties of Enforcing Authorities in dealing with contamination including the role of the Environment Agency which has powers under Part 7 of The Water Resources Act (1991) to take action to prevent or remedy the pollution of controlled waters, including circumstances where the pollution arises from contamination in the land.

Part IIA introduces the concept of a contaminant linkage; where for potential harm to exist, there must be a connection between the source of the hazard and the receptor via a pathway. Risk assessment in contaminated land is therefore directed towards identifying the contaminants, pathways and receptors that can provide contaminant linkages. This is known as the contaminant-pathway-receptor link (CPR or contaminant linkage).

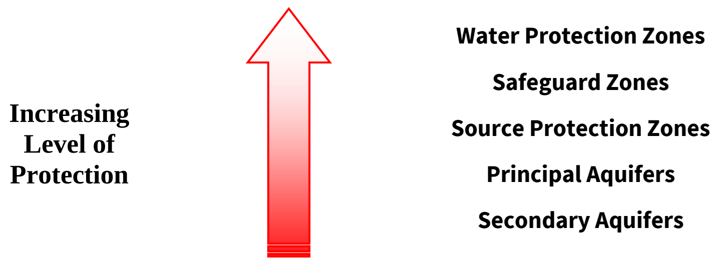
Part IIA places contaminated land responsibility as a part of the planning and redevelopment process rather than Local Authority or Environment Agency taking direct action except in situations of very high pollution risk or where harm is occurring. In the planning process guidance is provided by National Planning Policy Framework (NPPF) of March 2012. This requires that a site which has been developed shall not be capable of being determined "contaminated land" under Part IIA. Therefore, appropriate risk-based investigation is required to identify the contaminant linkages that can then be assessed, and then mitigated using methods that can be readily agreed with the planners.

Environment Agency Guidance

Legislation and guidance surrounding the protection of controlled waters in the UK is numerous and can be complex. The Environment Agency's overall position on groundwater is *"To protect and manage groundwater resources for present and future generation in ways that are appropriate for the risks that we identify"* (The Environment Agency's Approach to Groundwater Protection, 2017). In brief, the core objectives of the existing legislation serve to enforce this position.

In 1992, the National Rivers Authority published their Policy and Practice for the Protection of Groundwater (PPPG), this document was influential as it provided a focus for key developments such as Source Protection Zones (SPZs) and Groundwater Vulnerability Maps. The Policy was then revised in 1998, since which there have been substantial changes in legislation, driven by Europe. Key European Directives relating to groundwater include the Groundwater Directive (80/68/EEC) and the Water Framework Directive (2000/60/EC). Aspects of these directives are controlled by primary UK legislation such as the Water Resources Act 1991 as amended by the Water Act 2003. Further to legislative changes, gaps identified in the 1998 PPPG required addressing. These changes are reflected in the Environment Agency Policy document *The Environment Agency's Approach to Groundwater Protection"* of March 2017.

The Environment Agency follows a tiered, risk-based approach to drinking water protection, and this should be taken into account when carrying out controlled waters risk assessment:



Tools available for Risk Assessment of Controlled Waters

In order for a developer of a potentially contaminated site to fulfil their obligations under the legislation, a site assessment would be required to be undertaken in order to identify any potential risks to controlled waters and to derive suitable clean-up criteria if necessary to ensure the protection of controlled waters. A number of tools are available for this purpose.

Three main stages apply to any risk assessment of controlled waters, these are:

i. Risk Screening (devise Conceptual Site Model, making reference to groundwater vulnerability maps, site setting etc)

ii. Generic Risk Assessment (using the EA Remedial Targets Methodology – Tier 1 - Comparison of groundwater data with relevant standards)

iii. Detailed Quantitative Risk Assessment (Consideration of aquifer properties and site-specific parameters, using the EA Remedial Targets Methodology - Tiers 2 & 3)

The process is summarised below (Taken from the Environment Agency GP3 consultation document, 2006):

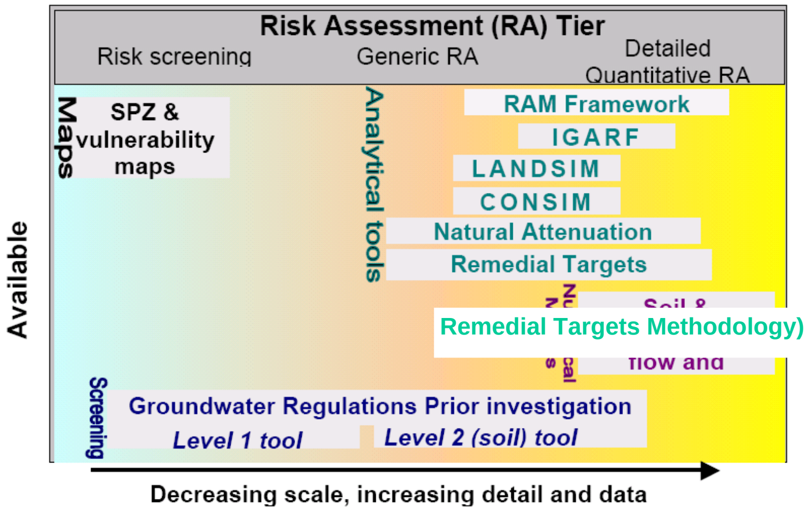


Figure 1-1 Environment Agency groundwater assessment tools, mapped against the different levels of risk assessment.

When assessing groundwater impact the Environment Agency advocate the application of their framework methodology “Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination” Environment Agency (2006). The methodology has four tiers of assessment:

Tier 1 utilises either a soil concentration (calculation of pore water concentrations based on partitioning calculations), leaching test or pore-water concentration of perched water as a source concentration input and these are contrasted directly to water quality standards. No dilution or attenuation is considered at Level 1.

Tier 2 (groundwater) considers dilution of the contaminant within the underlying receiving groundwater or surface water body. To determine a dilution, factor the infiltration rate of pore water and the discharge of groundwater beneath the source must be determined. Level 2 Assessment comprises a comparison between measured groundwater concentrations with to water quality standards.

Tier 3 considers natural attenuation in the form of dispersion, retardation and degradation of the contaminant. As the levels are progressed, the assessment becomes increasingly more detailed and less conservative as the data requirements are increased with each successive tier. The Environment Agency has released Excel Worksheets to carry out basic calculations using a conservative approach up to Tier 3. However, in this case the conceptual model is a simple one and assumes there is a simple migration of contaminants from the source zone into the aquifer receptor. Using these worksheets requires a sensitivity analysis showing how by varying each parameter, what effect it might have on the outcome of the assessment. Groundwater conceptual models are not always this simple.

Tier 4 is for more complex conceptual models where multiple sources, multiple pathways, multiple receptors and complex water balances can be assessed.

The Environment Agency developed a spreadsheet-based code to support the Remedial Target Methodology, and the code is capable of undertaking assessments for Tiers 1 to 3. Tier 4 assessment is not supported by the spreadsheet-based code.

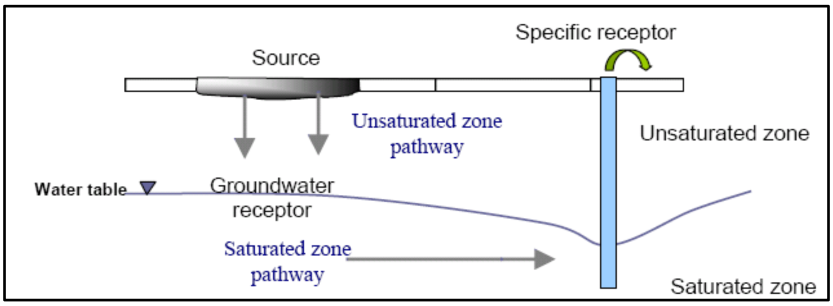
A more advanced code, ConSim 2, developed on behalf of the Environment Agency to support the Remedial Targets Methodology, allows for the introduction of additional geological horizons and is used mainly to determine the concentrations reaching a receptor and the timescales over which this may happen.

The codes assess only the dissolved phase contaminants. There are many further codes commercially available for use in controlled waters risk assessment, particularly for more complex situations, however, these should be used with caution and only once agreement has been obtained from the Environment Agency. All have the overall aim of the estimation of risk from contaminant linkages and the protection of controlled waters.

General notes on each stage of the controlled waters risk assessment process

Risk Screening

The understanding of the Conceptual Site Model (CSM) is the key to assessing any site. Using a robust CSM, potential pathways or receptors may be screened out from any further assessment at an early stage. For example, if the pathway through the unsaturated zone is blocked by the presence of a significant thickness of low permeability clay. A greater understanding of the CSM is achieved with each tier of risk assessment. An example of a basic Source-Pathway-Receptor concept is given below (taken from the Environment Agency GP3, 2006):



Generic Risk Assessment

When undertaking the Generic Hydrogeological Risk Assessment (EA Remedial Targets Methodology Tier 1), comparison of chemical analytical results is made with screening criteria. Published values of screening criteria with which chemical test results can be compared are published in the following guidance:

There is a hierarchy of screening criteria which is as follows:

- Updated Recommendations on Environmental Technical Standards, River Basin Management (2015-21), April 2012 by the UK Technical Advisory Group on the Water Framework Directive;
- Environmental Quality Standards (EQS) for freshwaters based on The EC Dangerous Substances Directive (76/464/EEC and Daughter Directives);

- Surface Waters (Abstraction for Drinking Water)(Classification) Regulations (1996)
- Surface Waters (Fishlife) (Classification) Regulations (1997)
- UK Drinking Water Standards (DWS) (Water Supply (Water Quality) Regulations 2000);
- Dutch Ministry of Housing, Spatial Planning and Environment (2001) Intervention Values and Target Values – soil quality standards;
- World Health Organisation Guidelines for Drinking Water (2004)

Should the Level 1 or 2 assessments indicate threshold levels to be exceeded, then there are three alternative ways in which to proceed:

- To devise suitable remedial solutions;
- To carry out more investigation, sampling and analysis;
- To conduct a site-specific Detailed Quantitative Risk Assessment (DQRA) to whether or not the soil materials are suitable for their site-specific intended use or to devise a site-specific clean-up level.

Detailed Quantitative Risk Assessment (DQRA)
The decision to carry out a DQRA will be dependent on the extent and implications of the initial qualitative and generic assessment. The scope of any such assessment will be accurately defined by the outcomes of the former two stages. The CSM will be sufficiently refined by this stage that only certain contaminants of concern, certain pathways and certain receptors will require further assessment, the remainder having been screened out.

Additional site-specific data is normally required for this stage of assessment, as explained above, more processes that are capable of affecting contaminant concentrations are considered (such as dilution and attenuation).

Remediation criteria derived will therefore be specific to each site and will be based on a detailed assessment of the potential impact at the identified receptor or *compliance point*. A greater level of confidence can be placed on the predicted impact on the compliance point following a DQRA.

Definition of Controlled Waters

The term 'controlled waters' is defined in Section 104 of the Water Resources Act 1991 as:

> *"Territorial Waters…which extend seawards for three miles…, coastal waters…, inland freshwaters, waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata."*

Note that the definition of groundwater under the Water Resources Act 1991 includes all water within underground strata (including soil / pore water in the unsaturated zone). The definition of groundwater under the Groundwater Directive however is limited to water in the saturated zone. For the purposes of Part IIA of the Environmental Protection Act 1990, the Environment Agency recommends that the groundwater within the saturated zone only is considered as the receptor (rather than soil / pore water).

Environment Agency's Aquifer Designations

The Environment Agency have classified different types of aquifers from which groundwater can be extracted. The aquifer designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey.

The maps are split into two different types of aquifer designation:

- **Superficial (Drift)** – permeable unconsolidated (loose) deposits.
- **Bedrock (Solid)** – solid permeable formations e.g., sandstone, chalk, limestone.

The aquifer designations displayed on the Environment Agency maps are as follows:

- **Principal Aquifers (formerly termed Major Aquifers) –** These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as a major aquifer.
- **Secondary Aquifers (formerly termed Minor Aquifers) –** These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:
    - **Secondary A** - 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;
    - **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
    - **Secondary Undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
- **Unproductive Strata (formerly termed Non-Aquifer) –** These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Hazardous and Non-Hazardous Substances

The Groundwater (England and Wales) Regulations 2009 control the disposal to the hydrogeological environment of potentially polluting substances which are divided into Hazardous Substances and Non-hazardous Contaminants (this roughly approximates to the former List 1 and List 2 substances).

Hazardous Substances are the most damaging and toxic and must be prevented from directly or indirectly entering the groundwater environment. Hazardous Substances include mineral oils and hydrocarbons, pesticides, biocides, herbicides, solvents and some metals. Discharge of Hazardous Substances to Controlled Waters must be prevented.

Non-hazardous Pollutants are any contaminants other than Hazardous Substances. Non-hazardous Pollutants are potentially toxic but are less harmful than Hazardous Substances, but their direct discharge to groundwater is generally not permitted and any indirect discharge to groundwater must be limited and be controlled by technical precautions in order to prevent pollution. Non-hazardous Pollutants include ammonia and nitrites, many metals and fluorides.

MANAGEMENT OF CONTAMINATED LAND

When risk assessment of the site has been completed and this indicates that remedial works are required, the main guidance in managing this process is set out in the DEFRA/EA online guidance LCRM (2020) "Land Contamination: Risk Management" The stages of managing remediation are as follows:

(a) Options Appraisal and develop Remediation Strategy;
(b) Develop Implementation Plan and Verification Plan;
(c) Remediation, Verification and Monitoring.

The Remediation Strategy sets out the remediation targets, identifies technically feasible remedial solutions and presents an evaluation of the options so that these can be assessed enabling that the most suitable solution is adopted. An outline of the proposed remedial method should be presented. Agreement should be sought of the appropriate statutory bodies for the Remediation Strategy before proceeding to the next stage.

The Implementation Plan is a detailed method statement setting out how the remediation is to be carried out including stating how the site will be managed, welfare procedures, health and safety considerations together with practical measures such as details of temporary works, programme of works, waste management licences and regulatory consents required. Agreement should again be sought of the appropriate statutory bodies for this Plan.

The Verification Plan sets out the requirements for gathering data to demonstrate that the remediation has met the required remediation objectives and criteria. The Verification Plan presents the requirements for a wide range of issues including the level of supervision, sampling and testing regimes for treated materials, waste and imported materials, required monitoring works during and post remediation, how compliance with all licenses and consents will be checked etc. Agreement should again be sought of the appropriate statutory bodies for the Verification Plan. On completion of the remediation a Verification Report should be produced to provide a complete record of all remediation activities on-site and the data collected as required in the Verification Plan. The Verification Report should demonstrate that the remediation has met the remedial targets to show that the site is suitable for the proposed use.

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GLOSSARY

TERMS		UNITS	
AST	Above Ground Storage Tank	m	Metres
BGS	British Geological Survey	km	Kilometres
BSI	British Standards Institute	%	Percent
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes	%v/v	Percent volume in air
CIEH	Chartered Institute of Environmental Health	mb	Milli Bars (atmospheric pressure)
CIRIA	Construction Industry Research Association	l/hr	Litres per hour
CLEA	Contaminated Land Exposure Assessment	ha	Hectare (10,000m^2)
CSM	Conceptual Site Model	µg/l	Micrograms per Litre (parts per billion)
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)	ppb	Parts Per Billion
DWS	Drinking Water Standard	mg/kg	Milligrams per kilogram (parts per million)
EA	Environment Agency	ppm	Parts Per Million
EQS	Environmental Quality Standard	mg/m^3	Milligram per metre cubed
GAC	General Assessment Criteria	Mg/m^3	Megagram per metre cubed
GL	Ground Level	µg/m^3	Microgram per metre cubed
GSV	Gas Screening Value	m bgl	Metres Below Ground Level
HCV	Health Criteria Value	m bcl	Metre Below Cover Level
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel)	mOD	Metres Above Ordnance Datum (sea level)
ND	Not Detected	kN/m^2	Kilo Newtons per metre squared
LMRL	Lower Method Reporting Limit	kPa	Kilo Pascal – same as kN/m^2
NR	Not Recorded	µm	Micro metre
OD	Ordnance Datum		
PAH	Poly Aromatic Hydrocarbon		
PCB	Poly-Chlorinated Biphenyl		
PID	Photo Ionisation Detector		
PCSM	Preliminary Conceptual Site Model		
SGV	Soil Guideline Value		
TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)		
SPT	Standard Penetration Test		
SVOC	Semi Volatile Organic Compound		
UST	Underground Storage Tank		
VCCs	Vibro Concrete Columns VSCs Vibro Stone Columns		
VOC	Volatile Organic Compound		

Appendix C – Photographs

C

BYRNELOOBY
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Concrete Core Photo Sheet

CC1

Project name:
STADCO

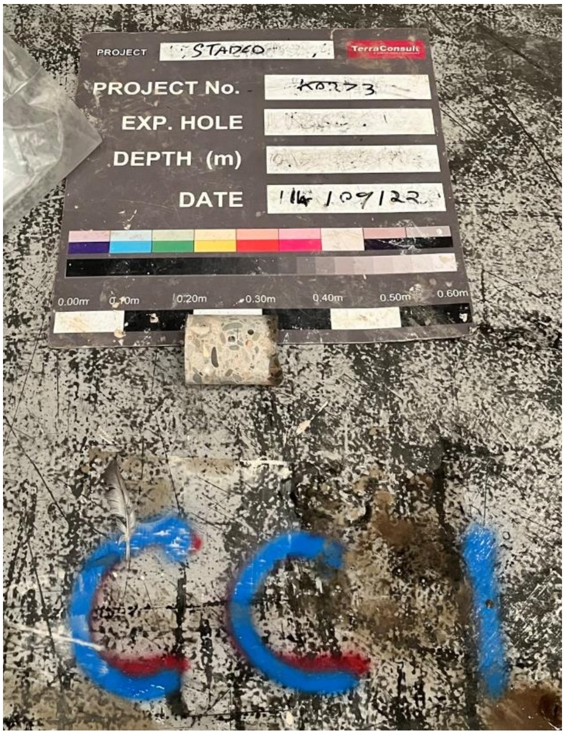
Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1



CC1: Core

CC1: Reinstatement

AGS
Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC2

Project name: **STADCO**

Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC2: Core

CC2: Reinstatement

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

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Concrete Core Photo Sheet

CC3

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC3: Core

CC3: Reinstatement

Concrete Core Photo Sheet

CC4

Project name: **STADCO**

Project No: **K0273**

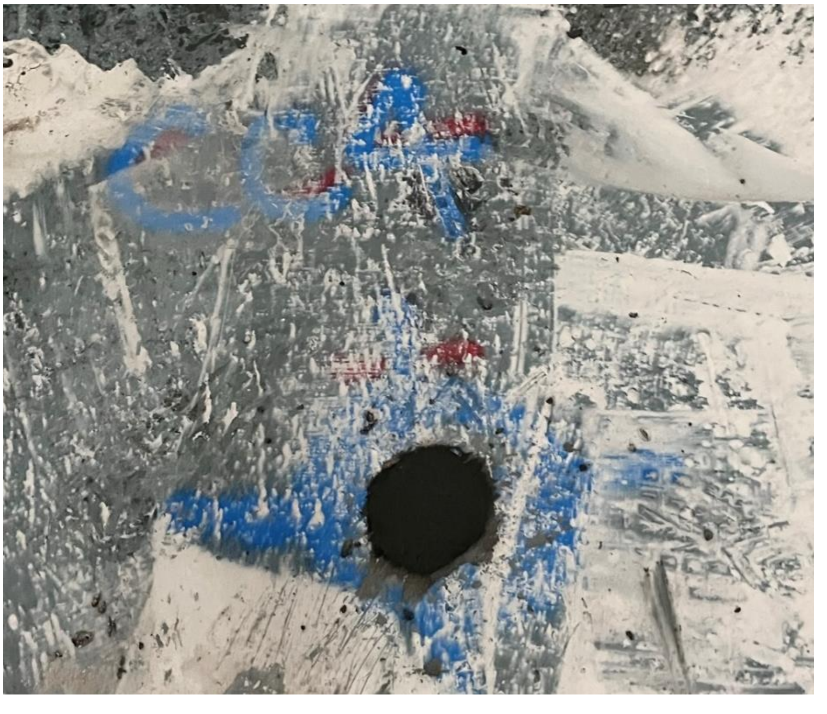
Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC4: Core



CC4: Reinstatement

AGS Suite 104 Mere Business Park Leaside Saint Helens WA(5GG

Unless otherwise stated: Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor **Allied Infrastructure**

Logged By **AS** Checked By **HP**

Concrete Core Photo Sheet

CC5

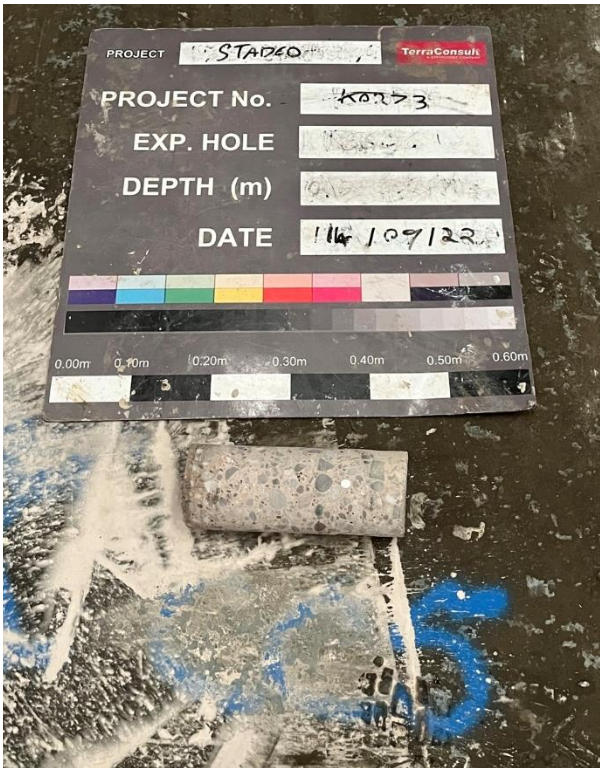
Project name:
STADCO

Client:
Veolia

Project No:
K0273

Start Date
15/09/22

End Date
15/09/22



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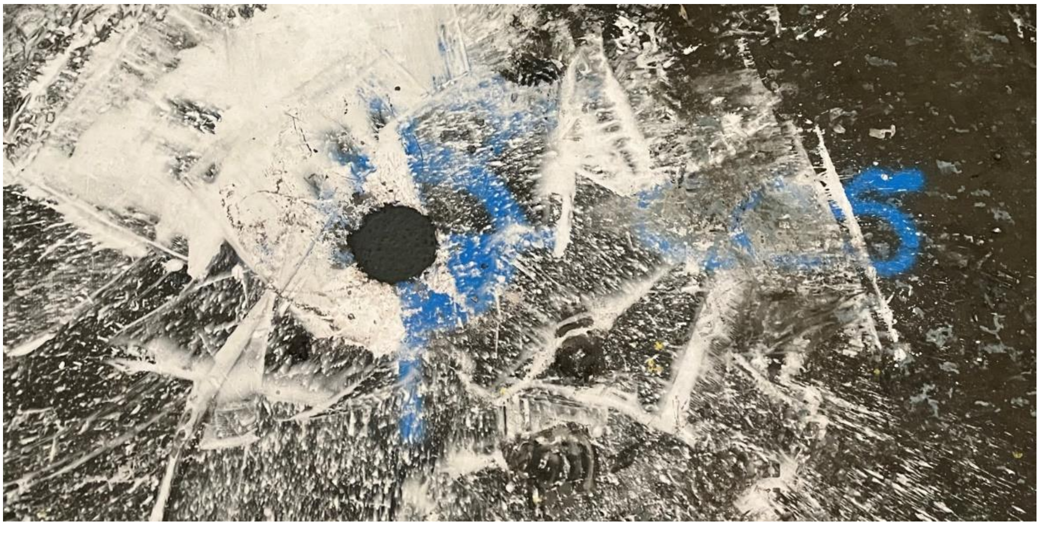

CC5: Reinstatement

AGS
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Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

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Concrete Core Photo Sheet

CC6

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC6: Core

CC6: Reinstatement

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Concrete Core Photo Sheet

CC7

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC7: Core

CC7: Reinstatement

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Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By	Checked By
AS	**HP**

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CC8

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC8: Core

CC8: Reinstatement

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Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

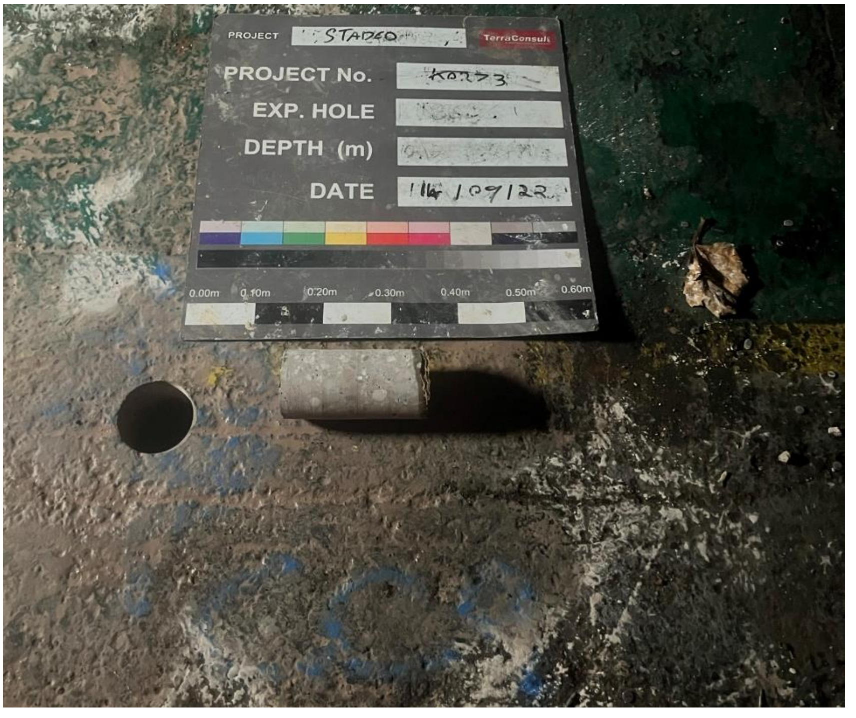
Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC9

Project name: **STADCO**	Project No: **K0273**	Start Date 15/09/22
Client: **Veolia**		End Date 15/09/22

Sheet 1 of 1



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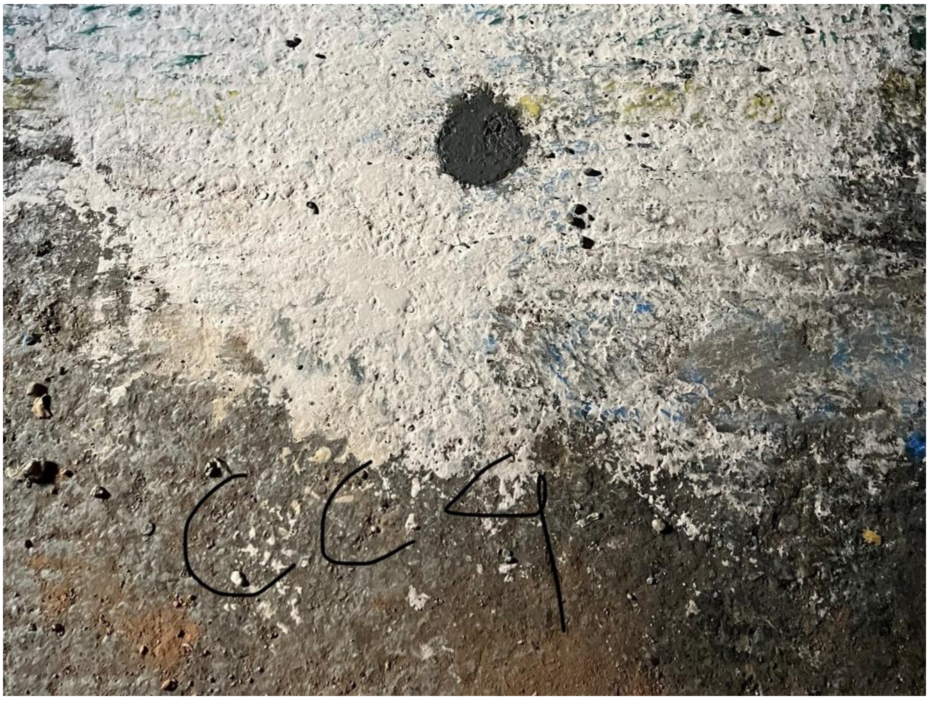

CC9: Reinstatement

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

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Concrete Core Photo Sheet

CC10

Project name:	Project No:	Start Date
STADCO	**K0273**	15/09/22
Client:		End Date
Veolia		15/09/22

CC10: Core

CC10: Reinstatement

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC11

Project name:
STADCO

Project No:
K0273

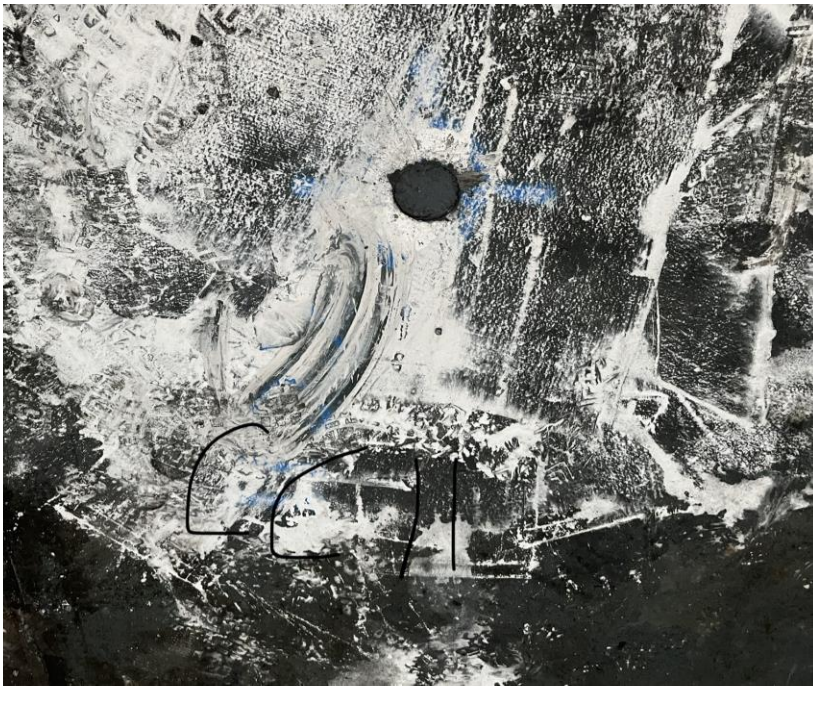
Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC11: Core



CC11: Reinstatement

Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By Checked By
AS **HP**

Concrete Core Photo Sheet

CC12

Project name:
STADCO

Client:
Veolia

Project No:
K0273

Start Date
15/09/22

End Date
15/09/22

Sheet 1 of 1

CC12: Core

CC12: Reinstatement

Concrete Core Photo Sheet

CC13

Project name:
STADCO

Client:
Veolia

Project No:
K0273

Start Date
15/09/22

End Date
15/09/22

CC13: Core

CC13: Reinstatement

AGS
Suite 104
Mere Business Park
Leaside
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By	Checked By
AS	**HP**

Concrete Core Photo Sheet

CC14

Project name: **STADCO**

Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC14: Core

CC14: Reinstatement

AGS
Suite 104
Mere Business Park
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC15

Project name: **STADCO**

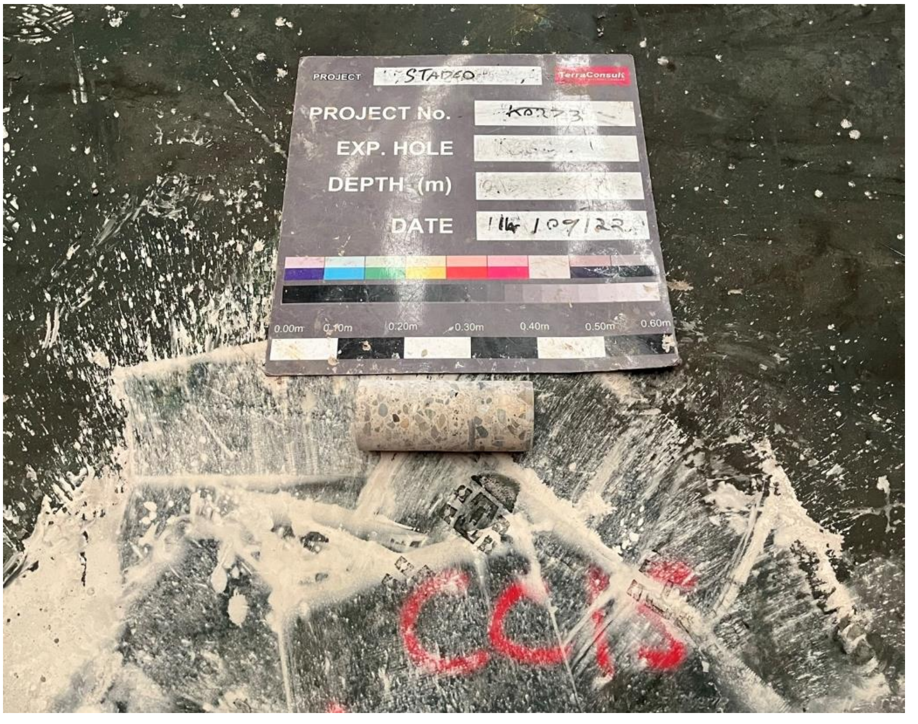
Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1



CC15: Core

CC15: Reinstatement

Suite 104
Mere Business Park
Leaside
Saint Helens
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Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By **AS** Checked By **HP**

Concrete Core Photo Sheet

CC16

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC16: Core

CC16: Reinstatement

AGS
Suite 104
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By Checked By
AS **HP**

Concrete Core Photo Sheet

CC17

Project name: **STADCO**	Project No: **K0273**	Start Date 15/09/22
Client: **Veolia**		End Date 15/09/22

Sheet 1 of 1

CC17: Core

CC17: Reinstatement

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Concrete Core Photo Sheet

CC18

Project name: **STADCO**

Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC18: Core

CC18: Reinstatement

AGS
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By	Checked By
AS	HP

Concrete Core Photo Sheet

CC19

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Project name: **STADCO**

Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC19: Core

CC19: Reinstatement

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Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By	Checked By
AS	**HP**

Concrete Core Photo Sheet

CC20

Project name: **STADCO**

Project No: **K0273**

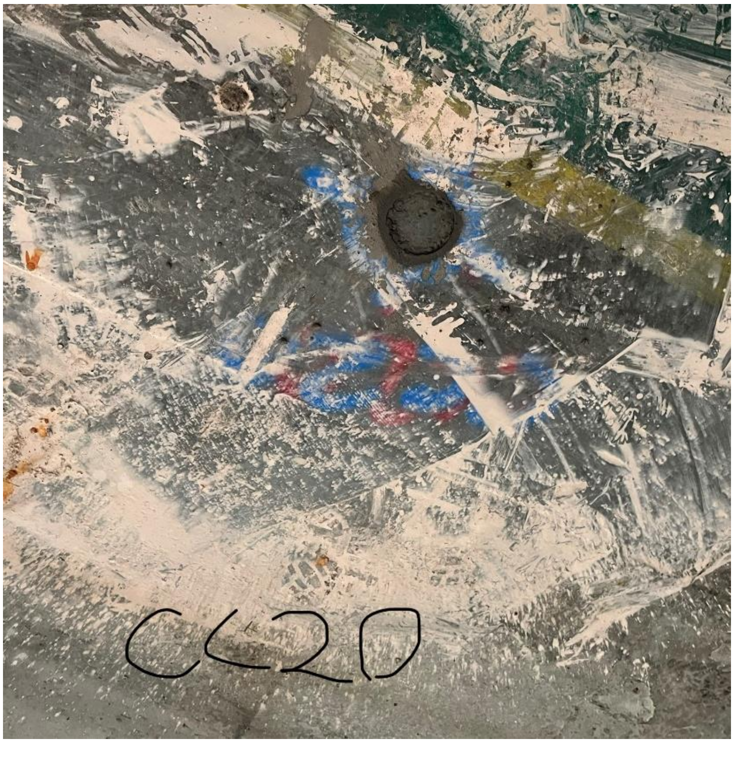
Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC20: Core



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AGS Suite 104 Mere Business Park Leaside Saint Helens WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC21

Project name: **STADCO**

Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC21: Core

CC21: Reinstatement

AGS

Suite 104
Mere Business Park
Leaside
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

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Concrete Core Photo Sheet

CC22

Project name:	Project No:	Start Date
STADCO	**K0273**	15/09/22
Client:		End Date
Veolia		15/09/22

Sheet 1 of 1

CC22: Core

CC22: Reinstatement

AGS
Suite 104
Mere Business Park
Leaside
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC23

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

Sheet 1 of 1

CC23: Core

CC23: Reinstatement

Suite 104
Mere Business Park
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Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC24

Project name:
STADCO

Project No:
K0273

Start Date
15/09/22

Client:
Veolia

End Date
15/09/22

CC24: Core

CC24: Reinstatement

AGS
Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Allied Infrastructure	**AS**	**HP**

Concrete Core Photo Sheet

CC25

Project name: **STADCO**

Project No: **K0273**

Start Date 15/09/22

Client: **Veolia**

End Date 15/09/22

Sheet 1 of 1

CC25: Core

CC25: Reinstatement

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Concrete Core Photo Sheet

CC26

Project name:
STADCO

Client:
Veolia

Project No:
K0273

Start Date
15/09/22

End Date
15/09/22

Sheet 1 of 1

CC26: Core

CC26: Reinstatement

AGS
Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Allied Infrastructure

Logged By Checked By
AS **HP**

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Rotary Core Photo Sheet

RC01

Project name:
STADCO

Project No:
K0273

Start Date
28/09/22

Client:
Veolia

End Date
28/09/22

Sheet 1 of 2

[RC01: 1.50 – 6.50m]

RC01: 6.50 – 9.50m

AGS
Suite 104
Mere Business Park
Leaside
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WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Ace Drilling

Logged By Checked By
AS **HP**

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Rotary Core Photo Sheet

RC01

Project name:
STADCO

Project No:
K0273

Start Date
28/09/22

Client:
Veolia

End Date
28/09/22

[RC01: 9.50 – 11.00m]

Rotary Core Photo Sheet

RC02

Project name: **STADCO**

Project No: **K0273**

Start Date 28/09/22

Client: **Veolia**

End Date 28/09/22

Sheet 1 of 1

[RC02: 5.00 – 8.00m]

[RC02: 8.00 – 11.00m]

AGS Suite 104 Mere Business Park Leaside Saint Helens WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Ace Drilling	AS	HP

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Window Sample Photo Sheet

WS01

Project name: **STADCO**
Project No: **K0273**
Start Date 14/09/22
Client: **Veolia**
End Date 14/09/22
Sheet 1 of 1

[WS01: 0.30 – 1.00m]

WS01: 1.00 – 2.00m

AGS
Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Regional Drilling Ltd.

Logged By Checked By
AS **HP**

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Window Sample Photo Sheet

WS02

Project name:	Project No:	Start Date
STADCO	**K0273**	14/09/22
Client:		End Date
Veolia		14/09/22

[WS02: 0.25 – 1.00m]

WS02: 1.00 – 2.00m

AGS
Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used	Contractor	Logged By	Checked By
	Regional Drilling Ltd.	**AS**	**HP**

BYRNELOOBY AN ayesa COMPANY

Window Sample Photo Sheet

WS03

Project name: **STADCO**

Project No: **K0273**

Start Date 14/09/22

Client: **Veolia**

End Date 14/09/22

Sheet 1 of 1

[WS03: 0.25 – 0.50m]

WS03: 0.50 – 1.50m

AGS Suite 104 Mere Business Park Leaside Saint Helens WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Regional Drilling Ltd.

Logged By	Checked By
AS	**HP**

BYRNELOOBY AN ayesa COMPANY

Window Sample Photo Sheet

WS04

Project name:
STADCO

Project No:
K0273

Start Date
14/09/22

Client:
Veolia

End Date
14/09/22

[WS04: 0.25 – 1.00m]

WS04: 1.00 – 2.00m

AGS
Suite 104
Mere Business Park
Leaside
Saint Helens
WA(5GG

Unless otherwise stated:
Depth (m), Diameter (mm),Time (hhmm), Thickness (m), Level (mOD).

Equipment Used

Contractor
Regional Drilling Ltd.

Logged By Checked By
AS **HP**

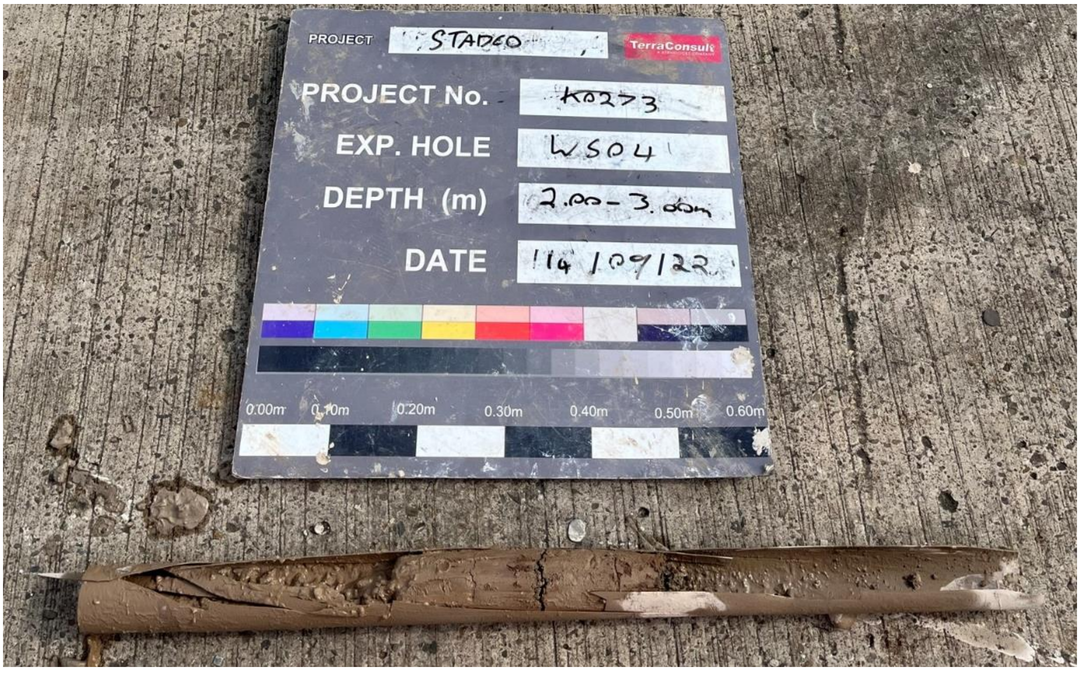
Project name:
STADCO

Project No:
K0273

Start Date
14/09/22

Client:
Veolia

End Date
14/09/22



[WS04: 2.00 – 3.00m]

WS04: 3.00 – 4.00m

Window Sample Photo Sheet

WS05

Project name:
STADCO

Client:
Veolia

Project No:
K0273

Start Date
14/09/22

End Date
14/09/22

Sheet 1 of 1

[WS05: 0.25 – 1.00m]

WS05: 1.00 – 2.00m

Appendix D – Fieldwork Records

D

Trial Pit Log

BYRNELOOBY

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	AS	Method:	Hand dug trail pit.	Width:	0.30	Easting:	350722.09 m E	Start:	14/09/2022
Checked by:	TM			Length:	0.30	Northing:	316335.85 m N	End:	14/09/2022
Approved by:	HW	Plant:	Hand digging tools	**Orientation:**		Level:	72.45 m OD	Logged:	14/09/2022
		Shoring:	None	Strike A - C = °		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
				MADE GROUND: Grass over slightly gravelly slightly clayey SAND with occasional rootlets. Gravel is angular to subrounded fine to coarse of various lithologies. (MADE GROUND)			
			72.25 0.20	MADE GROUND: Reddish brown slightly gravelly slightly silty SAND. Gravel is angular to subrounded, fine to coarse of various lithologies. (MADE GROUND)	0.20 - 0.30	D1	
					0.30	ES3	
					0.30 - 1.20	B2	
			(1.00)		0.60	ES3	
			71.25 1.20	Trial pit ends at 1.20 m (Target depth reached)			

Groundwater entries:				Depth related remarks:			General remarks:	
Depth:	Rose to:	After (mins):	Remarks:	From	to:	Remarks:	Weather:	
							Stability:	Stable
							Remarks:	Target depth reached. Groundwater not encountered.

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue:	FINAL	Project:	STADCO, Shrewsbury	Exploratory position reference:	
Scale:	1:25	Project No:	K0273	**HP01**	
		Client:	Veolia		Sheet 1 of 1

Trial Pit Log

BYRNELOOBY

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	AS	Method:	Hand dug trail pit.	Width:	0.30	Easting:	350743.15 m E	Start:	14/09/2022
Checked by:	TM			Length:	0.30	Northing:	316337.71 m N	End:	14/09/2022
Approved by:	HW	Plant:	Hand digging tools	**Orientation:**		Level:	72.23 m OD	Logged:	14/09/2022
		Shoring:	None	Strike A - C = °		Grid:	OSGB		

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (Thickness)	Stratum Description	Depth	Type & No	Results
			72.03	0.20	MADE GROUND: Grass over light brown slightly gravelly SAND with occasional rootlets. Gravel is angular to subrounded, fine to medium of various lithologies. (MADE GROUND)	0.00 - 0.20 0.10	D1 ES2	
			71.03	1.20 (1.00)	MADE GROUND: Brownish orange slightly gravelly SAND. Gravel is angular to subrounded, fine to coarse of various lithologies. (MADE GROUND)	0.20 - 1.20 0.50	B2 ES2	
					Trial pit ends at 1.20 m (Target depth reached)			

Groundwater entries:

Depth:	Rose to:	After (mins):	Remarks:

Depth related remarks:

From	to:	Remarks:

General remarks:

Weather:

Stability: Stable

Remarks: Target depth reached. Groundwater not encountered.

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: FINAL

Scale: 1:25

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

HP02

Dynamic Sample Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	3.00	14-09-22	14-09-22	Regional Drilling	Window sample rig	AS	14-09-22	Refusal at base. Groundwater not encountered.

Location details:

mE:	350729.88
mN:	316338.63
mAOD:	71.63
Grid:	OSGB

Water-strike	Level	Depth (thickness)	Stratum Description
			MADE GROUND: CONCRETE
	71.38	0.25 (0.35)	MADE GROUND: Brown slightly sandy subangular to sub rounded fine to coarse GRAVEL of various lithologies.
	71.03	0.60 (0.40)	POSSIBLE MADE GROUND: Reddish brown slightly gravelly clayey SAND with occasional pockets of greyish green coarse sand up to 10mm in size. Gravel is angular to subrounded, fine to coarse mudstone and sandstone.
(50)	70.63	1.00 (0.65)	Reddish brown slightly gravelly clayey, fine to medium SAND. Gravel is subrounded, fine to coarse sandstone.
SP (50)	69.98	1.65 (1.77)	Brownish red slightly gravelly fine to medium SAND, with occasional bands of yellow sand up to 30mm in size. Gravel is subangular to subrounded fine to medium sandstone and mudstone.
	68.21	3.42	Dynamic sample ends at 3.42 m (Refusal at 3.42m)

Samples & In Situ Testing

Water	Casing	Depth	Type & No	Results
		0.00 - 0.25	B	
		0.30 - 0.60	D1	
		0.60 - 1.00	B2	
		0.80	ES2	
Dry		1.00 - 1.45	S	N=26 (7,7/7,6,7,6)
		1.10	ES2	
		1.20 - 1.30	D3	
		1.30 - 1.65	B4	
		1.65 - 3.00	B5	
Dry		2.00 - 2.45	S	N=39 (6,8/9,9,11,10)
Dry		3.00 - 3.42	S	63 (3,11/63 for 275mm)

Inst (Ø)

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Casing:

Cased to:	Diameter (mm):

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Ø	Duration:	Recovery:
2.00	3.00			100

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: FINAL

Scale: 1:25

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

WS01

Dynamic Sample Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	2.00	14-09-22	14-09-22	Regional Drilling	Window sample rig	AS	14-09-22	Refusal at base. Groundwater not encountered.

Location details:

mE:	350735.90
mN:	316322.49
mAOD:	71.62
Grid:	OSGB

Level	Depth (thickness)	Stratum Description	Water	Casing	Depth	Type & No	Results
		MADE GROUND: CONCRETE			0.00 - 0.25	B5	
71.37	0.25 (0.35)	MADE GROUND: Brown sandy angular to subrounded, fine to coarse GRAVEL of various lithologies.			0.30 0.40 - 0.60	ES5 D1	
71.02	0.60 (0.40)	MADE GROUND: Reddish brown slightly gravelly very clayey SAND, with occasional pockets of black ash, up to 40mm in size and occasional pockets of greyish green coarse sand up to 20mm in size. Gravel is angular to subrounded fine to medium sandstone and mudstone.			0.60 - 1.00 0.90	B2 ES5	
70.62	1.00 (0.70)	Reddish brown slightly gravelly slightly clayey SAND. Gravel is angular to subrounded, fine to medium sandstone.	Dry		1.00 - 1.45 1.00 - 1.70 1.10	S B3 ES5	N=23 (6,6/6,5,6,6)
69.92	1.70 (0.70)	Brownish red slightly gravelly fine to medium SAND. Gravel is angular to subrounded fine to medium sandstone and mudstone.			1.70 - 2.00	B4	
			Dry		2.00 - 2.40	S	50 (11,12/50 for 255mm)
69.22	2.40	Dynamic sample ends at 2.40 m (Refusal at 2.40m)					

Inst (Ø)

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Casing:

Cased to:	Diameter (mm):

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Ø	Duration:	Recovery:
0.25	1.00			100
1.00	2.00			100

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: FINAL

Scale: 1:25

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

WS02

Dynamic Sample Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	2.00	14-09-22	14-09-22	Regional Drilling	Window sample rig	AS	14-09-22	Refusal at base. Groundwater not encountered.

Location details:

mE:	350711.30
mN:	316300.03
mAOD:	71.64
Grid:	OSGB

Water-strike	Level	Depth (thickness)	Stratum Description	Water	Casing	Depth	Type & No	Results
			MADE GROUND: CONCRETE			0.00 - 0.25	B4	
	71.39	0.25 (0.35)	MADE GROUND: Brown sandy angular to subrounded, fine to coarse GRAVEL of various lithologies.			0.40	ES4	
	71.04	0.60 (0.40)	MADE GROUND: Firm reddish brown slightly gravelly very sandy CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies.			0.60 - 1.00	B1	
						0.90	ES4	
(50)	70.64	1.00 (1.42)	Brownish red slightly gravelly SAND. Gravel is angular to subrounded, fine to medium sandstone.	Dry		1.00 - 1.45	S	N=16 (3,4/4,4,4,4)
						1.00 - 2.00	B2	
SP (50)				Dry		2.00 - 2.42	S	50 (8,12/50 for 265mm)
	69.22	2.42	Dynamic sample ends at 2.42 m (Refusal at 2.42m)					

Inst (Ø)

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Casing:

Cased to:	Diameter (mm):

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Ø	Duration:	Recovery:
0.25	0.50			100
0.50	1.50			100
1.50	2.00			30

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: FINAL

Scale: 1:25

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

WS03

Sheet 1 of 1

Dynamic Sample Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	4.00	14-09-22	14-09-22	Regional Drilling	Window sample rig	AS	14-09-22	Refusal at base. Groundwater not encountered.

Location details:

mE:	350536.86
mN:	316371.08
mAOD:	71.55
Grid:	OSGB

Water-strike	Level	Depth (thickness)	Stratum Description
			MADE GROUND: CONCRETE
	71.30	0.25	MADE GROUND: Grey sandy angular to subrounded, fine to medium GRAVEL of various lithologies.
		(0.55)	
(50)	70.75	0.80	MADE GROUND: Soft to firm reddish brown slightly gravelly very sandy CLAY. Gravel is angular to subrounded, fine to medium of various lithologies.
		(0.70)	
	70.05	1.50	Reddish brown slightly gravelly clayey SAND. Gravel is angular to subrounded, fine to medium sandstone and mudstone.
		(1.50)	
	68.55	3.00	Stiff reddish brown slightly gravelly very sandy CLAY. Gravel is angular to subrounded, fine to medium sandstone and mudstone.
		(1.42)	
SP (50)			
	67.13	4.42	Dynamic sample ends at 4.42 m (Refusal at 4.42m)

Inst (Ø)

Samples & In Situ Testing

Water	Casing	Depth	Type & No	Results
		0.00 - 0.25	B2	
		0.40	ES2	
		0.60 - 0.80	D1	
		0.80 - 1.50	B2	
Dry		1.00 - 1.45	S	N=9 (1,1/1,2,3,3)
		1.10	ES2	
		1.50 - 3.00	B3	
		1.90	ES2	
Dry		2.00 - 2.45	S	N=32 (6,7/8,8,8,8)
Dry		3.00 - 3.45	S	N=34 (6,6/7,7,9,11)
		3.00 - 4.00	B4	
Dry		4.00 - 4.42	S	50 (5,5/50 for 275mm)

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Casing:

Cased to:	Diameter (mm):

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Ø	Duration:	Recovery:
0.25	1.00			75
1.00	2.00			80
2.00	3.00			90
3.00	4.00			100

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: FINAL

Scale: 1:25

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

WS04

Sheet 1 of 1

Dynamic Sample Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	3.00	14-09-22	14-09-22	Regional Drilling	Window sample rig	AS	14-09-22	Refusal at base

Location details:

mE:	350530.52
mN:	316331.05
mAOD:	71.57
Grid:	OSGB

Water-strike	Level	Depth (thickness)	Stratum Description
			MADE GROUND: CONCRETE
	71.32	0.25	
			MADE GROUND: Grey sandy angular to subrounded, fine to coarse GRAVEL of various lithologies.
		(0.75)	
(50)	70.57	1.00	Firm brownish red slightly gravelly very sandy CLAY. Gravel is angular to subrounded, fine to medium sandstone and mudstone.
		(0.35)	
	70.22	1.35	Reddish brown slightly gravelly very clayey fine to medium SAND. Gravel is angular to subrounded, fine to medium sandstone and mudstone.
		(1.40)	
			2.50 - 3.00 m: Occasional pockets of coarse yellow sand up to 30mm in size.
	68.82	2.75	Brownish red slightly gravelly slightly clayey SAND. Gravel is angular to subrounded, fine to medium sandstone.
SP (50)		(0.62)	
	68.20	3.37	Dynamic sample ends at 3.37 m (Refusal at 3.37m)

Samples & In Situ Testing

Water	Casing	Depth	Type & No	Results
		0.00 - 0.25	B1	
		0.50	ES4	
		0.60 - 0.80	D1	
Dry		1.00 - 1.45	S	N=10 (1,1/1,2,3,4)
		1.10	ES4	
		1.20 - 1.35	D2	
		1.35 - 3.00	B3	
Dry		2.00 - 2.45	S	N=28 (2,3/5,7,7,9)
Dry		3.00 - 3.37	S	50 (8,11/50 for 220mm)

Inst (Ø)

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Casing:

Cased to:	Diameter (mm):

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Ø	Duration:	Recovery:
0.25	1.00			53
1.00	2.00			100
2.00	3.00			100

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue: FINAL

Scale: 1:25

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

WS05

Sheet 1 of 1

Borehole Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RC	0.00	11.00	15-09-22	15-09-22	Ace Drilling	Rotary core rig			AS	28-09-22	Target depth reached. Groundwater not encountered.

Location details:

mE:	350718.21
mN:	316314.82
m OD:	71.69
Grid:	OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thickness)	Stratum Description
	(50)			(1.50)	MADE GROUND: Greyish red SAND AND GRAVEL of fine to coarse, subangular to subrounded of various lithologies.
			70.19	1.50 (0.50)	Drillers descriptions: Red SAND *1.50 - 1.75 m: Assumed zone of core loss.* *1.75 - 2.00 m: None intact recovered as angular to subrounded, fine to coarse GRAVEL of sandstone and mudstone.*
			69.69	2.00 (2.57)	Drillers descriptions: Red WEAK SANDSTONE. *2.00 - 2.30 m: None intact, none intact recovered as red fine to medium SAND.* *2.30 - 2.50 m: Assumed zone of core loss.* *2.50 - 3.50 m: None intact recovered as slightly gravelly very clayey SAND. Gravel is angular to subrounded fine to medium sandstone and mudstone.* *3.50 - 3.88 m: None intact recovered as red SAND.* *3.88 - 4.40 m: Assumed zone of core loss.* *4.40 - 4.57 m: None intact recovered as red slightly gravelly fine to medium SAND. Gravel is subangular to subrounded fine to medium sandstone.*
			67.12	4.57 (2.92)	Extremely weak red fine to medium SANDSTONE. Discontinuities are extremely closely to closely spaced, horizontal, planar rough with sand infill up to 30mm in thickness. *4.64 - 4.71 m: None intact recovered as red fine to medium SAND.* *5.00 - 5.56 m: Assumed zone of core loss.* *5.56 m: Below 5.56m with occasional bands of greyish green sandstone up to 100mm in thickness.* *6.31 - 6.50 m: None intact recovered as red fine to medium SAND.* *6.50 - 6.82 m: Assumed zone of core loss.* *6.82 m: DIscontinuities become closely to medium spaced.*
			64.20	7.49 (0.69)	Weak greyish green fine to medium SANDSTONE. Discontinuities are very closely to closely spaced, horizontal, planar rough with occasional sand dusting. *7.82 - 7.90 m: None intact recovered as angular to subrounded, fine to coarse GRAVEL of sandstone.* *8.00 - 8.18 m: Assumed zone of core loss.*
			63.51	8.18 (2.82)	Weak - medium dense red fine to coarse SANDSTONE. Discontinuities are closely to medium spaced, horizontal and sub-horizontal, planar rough with occasional sand dusting. *8.18 - 8.30 m: None intact recovered as SAND and angular to subrounded fine to medium GRAVEL of sandstone.* *9.50 - 9.56 m: Assumed zone of core loss.* *9.56 m: Below 9.56m with frequent black sandstone lithorelics up to 3mm in size.*
	Inst (Ø)				

Samples & In Situ Testing

Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
		1.50 - 2.00	50 n/a n/a		
Dry		~~2.00 - 2.30 S~~			50 (3,5/50 for 150mm)
		2.30 - 3.50	83 n/a n/a	NI NI NI	
Dry		~~3.50 - 3.88 S~~			50 (5,7/50 for 225mm)
		3.88 - 5.00	53 27 10	65 70 110	
		5.00 - 6.50	63 44 7	20 50 75	
		6.50 - 8.00	79 69 33	50 80 130	
		8.00 - 9.50	88 81 57	50 150 370	

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

Dia (mm):	Depth:	Casing:
146	11.00	1.50

Depth related remarks:

From	to:	Remarks:

Flush details:

Depth:	Type:	Return:	Colour:
1.50 - 5.00	w	50%	Red
5.00 - 1.00	w	0%	Red

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.

Log issue: FINAL

Scale: 1:50

Project: STADCO, Shrewsbury

Project No: K0273

Client: Veolia

Exploratory position reference:

RC01

Borehole Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RC	0.00	11.00	15-09-22	15-09-22	Ace Drilling	Rotary core rig			AS	28-09-22	Target depth reached. Groundwater not encountered.

Location details:

mE: 350718.21
mN: 316314.82
m OD: 71.69
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
								9.50 - 11.00	96 87 71	60 170 290	
					10.79 - 10.86 m: None intact recovered as angular to subrounded, fine to coarse GRAVEL of sandstone.						
	SP (50)		60.69	11.00	Borehole ends at 11.00 m (Termination reason: Target depth reached)						
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:

Struck: Rose to: Casing: Sealed:

Diameter & casing:

Dia (mm):	Depth:	Casing:
146	11.00	1.50

Depth related remarks:

From to: Remarks:

Flush details:

Depth: Type: Return: Colour:

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.

Log issue: FINAL
Scale: 1:50

Project: STADCO, Shrewsbury
Project No: K0273
Client: Veolia

Exploratory position reference:
RC01

Borehole Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RC	0.00	11.00	16-09-22	16-09-22	Ace Drilling	Rotary core rig			AS	28-09-22	Target depth reached. Groundwater not encountered.

Location details:

mE: 350570.35
mN: 316372.01
m OD: 71.49
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
				(1.50)	MADE GROUND: Greyish red SAND AND GRAVEL of fine to coarse, subangular to subrounded of various lithologies.						
			69.99	1.50 (0.50)	Drillers descriptions: COBBLES with red sand matrix, low core recovery. *1.50 - 1.60 m: Assumed zone of core loss.* *1.60 - 2.00 m: None intact recovered as clayey angular to subrounded fine to coarse GRAVEL of sandstone.*			1.50 - 2.00	80 n/a n/a		
			69.49	2.00 (1.90)	Drillers descriptions: Red WEAK SANDSTONE. *2.00 - 2.38 m: None intact, recovered as clayey fine to medium SAND.* *2.38 - 3.06 m: Assumed zone of core loss.* *3.06 - 3.31 m: Non intact, recovered as soft brown slightly gravelly very sandy CLAY. Gravel is angular to subrounded fine to coarse sandstone.* *3.31 - 3.50 m: None intact recovered as red fine to medium SAND.* *3.50 - 3.80 m: Assumed zone of core loss.* *3.80 - 3.90 m: None intact recovered as fine to medium SAND.*	Dry		~~2.00 - 2.38 S~~ 2.38 - 3.50	60 n/a n/a	NI NI NI	50 (3,5/50 for 225mm)
	(50)		67.59	3.90 (2.60)	Extremely weak red fine to medium SANDSTONE. Discontinuities are extremely closely to very closely spaced, horizontal, planar rough with sand infill up to 5mm in thickness. *4.88 - 5.00 m: None intact recovered as SAND and angular to subrounded fine to coarse GRAVEL of sandstone.* *5.00 - 5.12 m: Assumed zone of core loss.* *5.12 - 5.27 m: None intact recovered as angular to subrounded coarse GRAVEL of sandstone.* *5.70 - 5.78 m: None intact recovered as SAND and angular to subrounded fine to medium GRAVEL of sandstone.*			3.50 - 5.00 5.00 - 6.50	80 68 n/a; 92 77 n/a	10 30 70; 20 50 75	
			64.99	6.50 (1.50)	Weak - medium strong red fine to fine to coarse SANDSTONE. Discontinuities are very closely to medium spaced, sub-horizontal, planar rough with occasional sand dusting. *7.72 - 7.79 m: Band of red extremely weak MUDSTONE.*			6.50 - 8.00	100 100 7	50 80 130	
			63.49	8.00 (0.30)	Weak - medium strong greyish green fine to medium SANDSTONE. Discontinuities are closely spaced, horizontal, planar rough with occasional sand dusting.			8.00 - 9.50	100 93 35	50 150 370	
			63.19	8.30 (2.70)	Weak - medium strong red fine to coarse SANDSTONE with occasional clay lenses up to 10mm in width. Discontinuities are very closely to medium spaced, horizontal, planar rough with occasional sand dusting.						
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

Dia (mm):	Depth:	Casing:
		1.50

Depth related remarks:

From	to:	Remarks:

Flush details:

Depth:	Type:	Return:	Colour:
1.50 - 11.00	w	100%	Red

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.

Log issue: FINAL
Scale: 1:50

Project: STADCO, Shrewsbury
Project No: K0273
Client: Veolia

Exploratory position reference:
RC02

Borehole Log

BYRNELOOBY

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill bit:	Logger:	Logged:	Remarks:
RC	0.00	11.00	16-09-22	16-09-22	Ace Drilling	Rotary core rig			AS	28-09-22	Target depth reached. Groundwater not encountered.

Location details:

mE: 350570.35
mN: 316372.01
m OD: 71.49
Grid: OSGB

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks/ samples
								9.50 - 11.00	100 100 63	60 170 290	
	SP (50)		60.49	11.00	Borehole ends at 11.00 m (Termination reason: Target depth reached)						
	Inst (Ø)					Water	Casing	Depth/Core Run	TCR SCR RQD	If	Results/remarks

Groundwater entries:

Struck: Rose to: Casing: Sealed:

Diameter & casing:

Dia (mm):	Depth:	Casing:
		1.50

Depth related remarks:

From to: Remarks:

Flush details:

Depth: Type: Return: Colour:

AGS Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.

Log issue: FINAL
Scale: 1:50

Project: STADCO, Shrewsbury
Project No: K0273
Client: Veolia

Exploratory position reference:
RC02

Appendix E – Monitoring Records

No: K0273 — **GROUNDWATER AND GROUND GAS MONITORING** — BYRNELOOBY

Site: Stadco, Shrewsbury

Location	Date	Monitored by	Well Details		Groundwater		Gas											Weather		Serial No.
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Water Sample Taken?	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure (mb)	Flow (l/h)	CH_4 (% v/v)	GSV CH_4 (l/hr)	CO_2 (% v/v)	GSV CO_2 (l/hr)	O_2 (% v/v)	CO (ppm)	H2S (ppm)	Conditions	Ambient Temp °C	
RC01	13/10/22	A. Smith	90	10.86	10.50	No	1009			0.00	0.00	0.0000	0.10	0.0000	20.40	0.00	0.00			
	28/10/22	O. Smith / E. Gray	90	10.71	10.41	No	1002			0.10	-0.20	-0.0002	0.00	0.0000	19.30	0.00	0.00	Dry		
	11/11/22	E. Gray	90	Screw broken	Screw broken	No	NM			NM	NM	N/A	NM	N/A	NM	NM	NM	Dry		
RC02	13/10/22	A. Smith	90	Bung Stuck	Bung Stuck	No	1009			0.00	0.00	0.0000	0.00	0.0000	20.20	0.00	0.00			
	28/10/22	O. Smith / E. Gray	90	Bung Stuck	Bung Stuck	No	1001			-0.10	-0.20	0.0002	0.00	0.0000	19.20	0.00	0.00	Dry		
	11/11/22	E. Gray	90	Bung Stuck	Bung Stuck	No	NM			NM	NM	N/A	NM	N/A	NM	NM	NM	Dry		
WS01	13/10/22	A. Smith	90	2.80	2.40	No	1008			0.00	0.00	0.0000	0.00	0.0000	19.80	0.00	0.00			
	28/10/22	O. Smith / E. Gray	90	2.60	2.00	No	NM	Water in bung		NM	NM	N/A	NM	N/A	NM	NM	NM	Dry		
	11/11/22	E. Gray	90	2.46	1.70	No	1011			0.00	0.00	0.0000	0.00	0.0000	20.50	0.00	0.00	Dry		
WS03	13/10/22	A. Smith	90	1.65	1.51	No	1011			0.00	0.00	0.0000	0.00	0.0000	19.70	0.00	0.00			
	28/10/22	O. Smith / E. Gray	90	1.63	1.07	No	1002			0.00	-0.20	0.0000	0.00	0.0000	19.30	0.00	0.00	Dry		
	11/11/22	E. Gray	90	1.62	0.92	No	1011			0.00	0.00	0.0000	0.00	0.0000	19.90	0.00	0.00	Dry		
WS04	13/10/22	A. Smith	90	3.78	1.22	No	1009			0.00	0.00	0.0000	0.00	0.0000	20.10	0.00	0.00			
	28/10/22	O. Smith / E. Gray	90	3.75	1.11	No	1002			0.30	-0.30	-0.0009	0.00	0.0000	18.80	0.00	0.00	Dry		
	11/11/22	E. Gray	90	3.75	0.92	No	1012			0.00	0.00	0.0000	0.00	0.0000	18.30	0.00	0.00	Dry		
WS05	13/10/22	A. Smith	90	2.95	1.58	No	1008			0.00	0.00	0.0000	0.00	0.0000	18.60	0.00	0.00			
	28/10/22	O. Smith / E. Gray	90	1.94	0.73	No	1001			0.03	0.20	0.0001	0.00	0.0000	16.40	0.00	0.00	Dry		
	11/11/22	E. Gray	90	1.94	0.25	No	1011			0.00	0.00	0.0000	0.00	0.0000	19.60	0.00	0.00	Dry		

NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

$$GSV\ (l/HR) = \frac{[\text{gas concentration }(\%v/v)] \times [\text{gas well flow rate }(l/hr)]}{100}$$

Appendix F – Environmental Laboratory Results

F

eurofins Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	22-35500-1		
Initial Date of Issue:	30-Sep-2022		
Client	Byrne Looby Partners		
Client Address:	Suite 104, Mere Grange Business Park St Helens WA9 5GG		
Contact(s):	Adam Smith Hannah Plunkett		
Project	K0273 Stadco, Shrewsbury		
Quotation No.:	Q22-27364	**Date Received:**	16-Sep-2022
Order No.:	141746	**Date Instructed:**	22-Sep-2022
No. of Samples:	15		
Turnaround (Wkdays):	5	**Results Due:**	28-Sep-2022
Date Approved:	30-Sep-2022		

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Soil

Project: K0273 Stadco, Shrewsbury

Client: Byrne Looby Partners				**Chemtest Job No.:**	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500
Quotation No.: Q22-27364				**Chemtest Sample ID.:**	1507759	1507760	1507762	1507764	1507765	1507766	1507767	1507768	1507769
				Sample Location:	HP01	HP01	HP02	WS01	WS01	WS02	WS02	WS02	WS03
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.3	0.6	0.5	0.8	1.1	0.3	0.9	1.1	0.4
				Date Sampled:	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022
				Asbestos Lab:	DURHAM		DURHAM	DURHAM		DURHAM	DURHAM		DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
ACM Type	U	2192		N/A	-		-	-		-	-		-
Asbestos Identification	U	2192		N/A	No Asbestos Detected		No Asbestos Detected	No Asbestos Detected		No Asbestos Detected	No Asbestos Detected		No Asbestos Detected
Moisture	N	2030	%	0.020	6.1	3.4	4.1	16	6.4	3.8	8.0	8.6	8.1
Soil Colour	N	2040		N/A	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown
Other Material	N	2040		N/A	Stones and Roots	Stones	Stones and Roots	None	Stones	Stones	Stones	Stones	Stones
Soil Texture	N	2040		N/A	Sand	Sand	Sand	Clay	Sand	Sand	Sand	Sand	Sand
pH	U	2010		4.0	8.3	8.7	8.3	8.6	8.5	9.1	8.7	8.9	10.1
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.023	< 0.010	< 0.010	0.092
Chloride (Water Soluble)	U	2220	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.016	< 0.010	< 0.010	0.017
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphate (Total)	U	2430	%	0.010	0.040	0.016	< 0.010	< 0.010	< 0.010	0.010	< 0.010	< 0.010	0.053
Arsenic	U	2455	mg/kg	0.5	5.6	4.7	3.3	3.8	< 0.5	4.0	3.0	1.7	21
Cadmium	U	2455	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chromium	U	2455	mg/kg	0.5	13	11	7.9	8.7	< 0.5	6.0	6.9	4.7	11
Copper	U	2455	mg/kg	0.50	13	13	6.5	7.1	< 0.50	13	6.2	3.6	110
Mercury	U	2455	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel	U	2455	mg/kg	0.50	12	11	10	12	< 0.50	7.4	8.7	5.8	19
Lead	U	2455	mg/kg	0.50	22	19	6.6	7.1	< 0.50	3.0	7.6	2.0	8.1
Selenium	U	2455	mg/kg	0.25	0.35	0.28	0.28	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25	0.33
Zinc	U	2455	mg/kg	0.50	69	38	23	20	< 0.50	14	16	10	42
Total Organic Carbon	U	2625	%	0.20	1.7	0.65	0.28	< 0.20	< 0.20	0.86	< 0.20	< 0.20	4.6
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Results - Soil

Project: K0273 Stadco, Shrewsbury

Client: Byrne Looby Partners				**Chemtest Job No.:**	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500
Quotation No.: Q22-27364				**Chemtest Sample ID.:**	1507759	1507760	1507762	1507764	1507765	1507766	1507767	1507768	1507769
				Sample Location:	HP01	HP01	HP02	WS01	WS01	WS02	WS02	WS02	WS03
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.3	0.6	0.5	0.8	1.1	0.3	0.9	1.1	0.4
				Date Sampled:	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022
				Asbestos Lab:	DURHAM		DURHAM	DURHAM		DURHAM	DURHAM		DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Naphthalene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Coronene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 17 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 28	U	2815	mg/kg	0.010		< 0.010							
PCB 52	U	2815	mg/kg	0.010		< 0.010							
PCB 90+101	U	2815	mg/kg	0.010		< 0.010							
PCB 118	U	2815	mg/kg	0.010		< 0.010							
PCB 153	U	2815	mg/kg	0.010		< 0.010							
PCB 138	U	2815	mg/kg	0.010		< 0.010							
PCB 180	U	2815	mg/kg	0.010		< 0.010							
Total PCBs (7 Congeners)	U	2815	mg/kg	0.10		< 0.10							
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Soil

Project: K0273 Stadco, Shrewsbury

Client: Byrne Looby Partners				**Chemtest Job No.:**	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500
Quotation No.: Q22-27364				**Chemtest Sample ID.:**	1507770	1507771	1507772	1507773	1507774	1507775
				Sample Location:	WS03	WS04	WS04	WS04	WS05	WS05
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.9	0.4	1.1	1.9	0.5	1.1
				Date Sampled:	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022
				Asbestos Lab:		DURHAM			DURHAM	
Determinand	**Accred.**	**SOP**	**Units**	**LOD**						
ACM Type	U	2192		N/A		-			-	
Asbestos Identification	U	2192		N/A		No Asbestos Detected			No Asbestos Detected	
Moisture	N	2030	%	0.020	8.2	5.8	15	6.8	6.1	13
Soil Colour	N	2040		N/A	Brown	Brown	Brown	Brown	Brown	Brown
Other Material	N	2040		N/A	Stones	Stones	Stones	None	Stones	Stones
Soil Texture	N	2040		N/A	Sand	Sand	Clay	Clay	Sand	Clay
pH	U	2010		4.0	9.1	10.2	9.9	9.4	10.0	9.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.10	0.047	0.089	0.029	0.12	0.018
Chloride (Water Soluble)	U	2220	g/l	0.010	< 0.010	0.023	< 0.010	0.016	< 0.010	0.012
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Sulphate (Total)	U	2430	%	0.010	< 0.010	0.067	0.034	0.012	0.046	0.019
Arsenic	U	2455	mg/kg	0.5	2.2	25	3.7	6.9	3.1	11
Cadmium	U	2455	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chromium	U	2455	mg/kg	0.5	5.6	13	13	4.5	11	8.8
Copper	U	2455	mg/kg	0.50	5.0	130	100	21	65	35
Mercury	U	2455	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nickel	U	2455	mg/kg	0.50	6.9	23	13	7.7	11	14
Lead	U	2455	mg/kg	0.50	3.3	11	6.1	3.4	6.1	6.2
Selenium	U	2455	mg/kg	0.25	< 0.25	0.44	0.42	< 0.25	0.51	< 0.25
Zinc	U	2455	mg/kg	0.50	13	52	43	14	32	25
Total Organic Carbon	U	2625	%	0.20	< 0.20	3.4	0.70	2.1	0.62	0.52
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	24	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	65	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	89	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Results - Soil

Project: K0273 Stadco, Shrewsbury

Client: Byrne Looby Partners				**Chemtest Job No.:**	22-35500	22-35500	22-35500	22-35500	22-35500	22-35500
Quotation No.: Q22-27364				**Chemtest Sample ID.:**	1507770	1507771	1507772	1507773	1507774	1507775
				Sample Location:	WS03	WS04	WS04	WS04	WS05	WS05
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.9	0.4	1.1	1.9	0.5	1.1
				Date Sampled:	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022	14-Sep-2022
				Asbestos Lab:		DURHAM			DURHAM	
Determinand	**Accred.**	**SOP**	**Units**	**LOD**						
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	89	< 10	< 10	< 10	< 10	< 10
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Naphthalene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Coronene	N	2800	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 17 PAH's	N	2800	mg/kg	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
PCB 28	U	2815	mg/kg	0.010						
PCB 52	U	2815	mg/kg	0.010						
PCB 90+101	U	2815	mg/kg	0.010						
PCB 118	U	2815	mg/kg	0.010						
PCB 153	U	2815	mg/kg	0.010						
PCB 138	U	2815	mg/kg	0.010						
PCB 180	U	2815	mg/kg	0.010						
Total PCBs (7 Congeners)	U	2815	mg/kg	0.10						
Total Phenols	U	2920	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

Results - Single Stage WAC

Project: K0273 Stadco, Shrewsbury

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	22-35500						
Chemtest Sample ID:	1507760						
Sample Ref:							
Sample ID:							
Sample Location:	HP01						
Top Depth(m):	0.6						
Bottom Depth(m):							
Sampling Date:	14-Sep-2022				**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	U	%	0.65	3	5	6
Loss On Ignition	2610	U	%	1.9	--	--	10
Total BTEX	2760	U	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	U	mg/kg	< 0.10	1	--	--
TPH Total WAC	2670	U	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH	2010	U		8.7	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.011	--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U	0.0035	0.035	0.5	2	25
Barium	1455	U	0.091	0.91	20	100	300
Cadmium	1455	U	< 0.00011	< 0.0011	0.04	1	5
Chromium	1455	U	0.0045	0.045	0.5	10	70
Copper	1455	U	0.023	0.23	2	50	100
Mercury	1455	U	0.00011	0.0011	0.01	0.2	2
Molybdenum	1455	U	0.033	0.33	0.5	10	30
Nickel	1455	U	0.0063	0.063	0.4	10	40
Lead	1455	U	0.0033	0.033	0.5	10	50
Antimony	1455	U	0.024	0.24	0.06	0.7	5
Selenium	1455	U	0.019	0.18	0.1	0.5	7
Zinc	1455	U	< 0.003	< 0.025	4	50	200
Chloride	1220	U	46	460	800	15000	25000
Fluoride	1220	U	0.66	6.6	10	150	500
Sulphate	1220	U	83	830	1000	20000	50000
Total Dissolved Solids	1020	N	200	2000	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	5.5	55	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	3.4

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measuremernt by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.

Test Methods

SOP	Title	Parameters included	Method summary
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Appendix G – Geotechnical Laboratory Results

G

MURRAY RIX
CONSULTANCY, SITE INVESTIGATION
CONSTRUCTION MATERIALS TESTING

TEST REPORT

Client Byrne Looby

Address Suite 104
Mere Grange Business Park
St Helens
WA9 5GG

Contract K0273 -
STADCO, Shrewsbury

Job Number MRN 4450/11

Date of Issue 09 November 2022

Page 1 of 16

Approved Signatories

S J Hutchings, O P Davies

Notes

1 All remaining samples and remnants from this contract will be disposed 28 days from the date of this report unless you notify us to the contrary.

2 Result certificates, in this report, not bearing a UKAS mark, are not included in our UKAS accreditation schedule.

3 Opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

4 Certified that the samples have been examined and tested in accordance with the terms of the contract/order and unless otherwise stated conform to the standards/specifications quoted.

5 The results included within the report are representative of the samples submitted for analysis.

6 This certificate should not be reproduced, except in full, without the express permission of the laboratory.

Andrew House, Hadfield Street, Dukinfield, Cheshire SK16 4QX Tel: 0161 475 0870
Email: enquiries@murrayrix.com Website: www.murrayrix.com

Also at: London: 020 8523 1999

M U R R A Y R I X

ANDREW HOUSE, HADFIELD STREET,
DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

TEST CERTIFICATE

PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892-4:2016

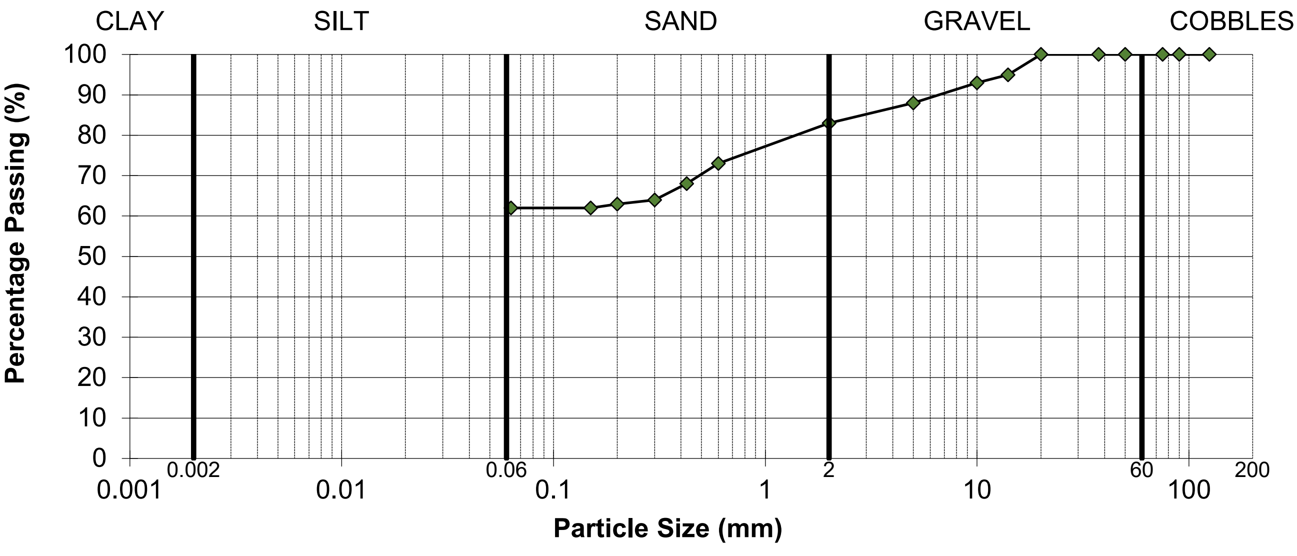
Determination of Water Content in accordance with BS EN ISO 17892-1:2014 (Oven Dry)

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Standish
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS01 1.30	DATE SAMPLED	Not advised
LAB SAMPLE No	118116	DATE RECEIVED	21-Oct-22
DATE TESTED	27-Oct-22	SAMPLED BY	Client

MATERIAL	Stiff brown slightly sandy slightly gravelly CLAY
ADVISED SOURCE	Site Investigation Sample

Sieve Size (mm)	% Passing (%)	Specification (%)	Sieve Size (mm)	% Passing (%)	Specification (%)
125	100		5	88	
90	100		2	83	
75	100		0.6	73	
50	100		0.425	68	
37.5	100		0.3	64	
20	100		0.2	63	
14	95		0.15	62	
10	93		0.063	62	



REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager)

DATE 09-Nov-22

MURRAY RIX

ANDREW HOUSE, HADFIELD STREET,
DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

UKAS TESTING 1580

TEST CERTIFICATE

PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892-4:2016

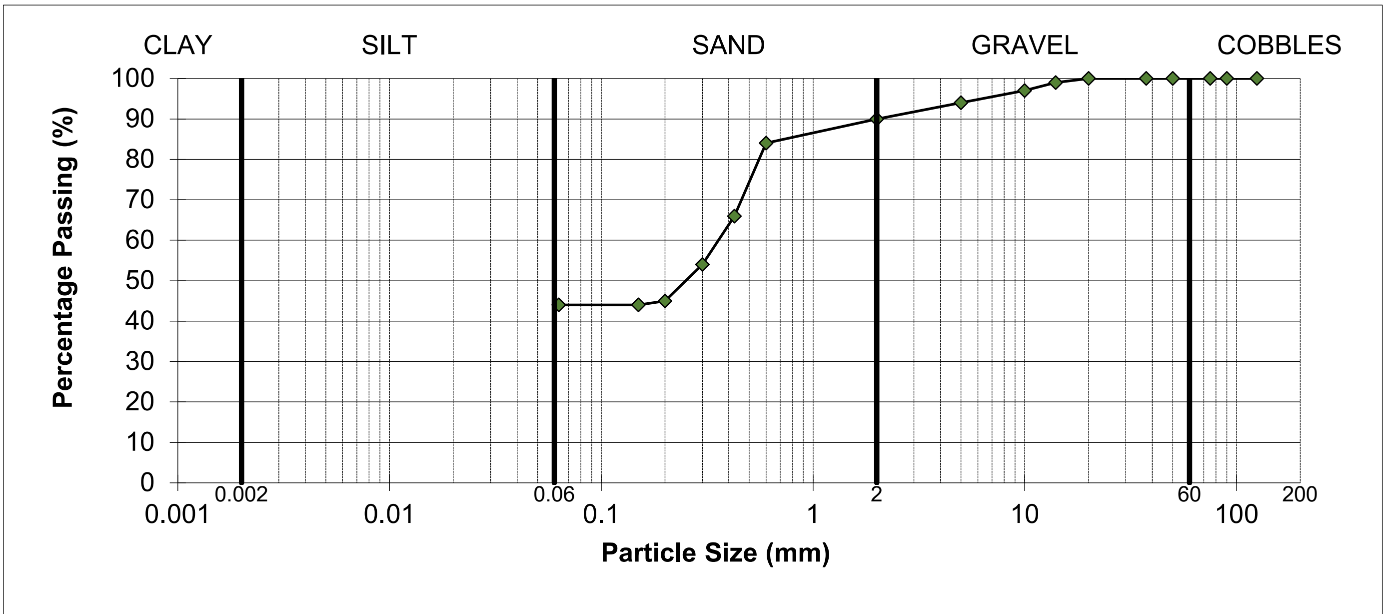
Determination of Water Content in accordance with BS EN ISO 17892-1:2014 (Oven Dry)

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Standish
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS03 1.00	DATE SAMPLED	Not advised
LAB SAMPLE No	118119	DATE RECEIVED	21-Oct-22
DATE TESTED	27-Oct-22	SAMPLED BY	Client

MATERIAL	Firm brown silty sandy slightly gravelly CLAY
ADVISED SOURCE	Site Investigation Sample

Sieve Size (mm)	% Passing (%)	Specification (%)	Sieve Size (mm)	% Passing (%)	Specification (%)
125	100		5	94	
90	100		2	90	
75	100		0.6	84	
50	100		0.425	66	
37.5	100		0.3	54	
20	100		0.2	45	
14	99		0.15	44	
10	97		0.063	44	



REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager)

DATE 09-Nov-22

MURRAY RIX

ANDREW HOUSE, HADFIELD STREET,
DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

UKAS TESTING 1580

TEST CERTIFICATE

PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892-4:2016

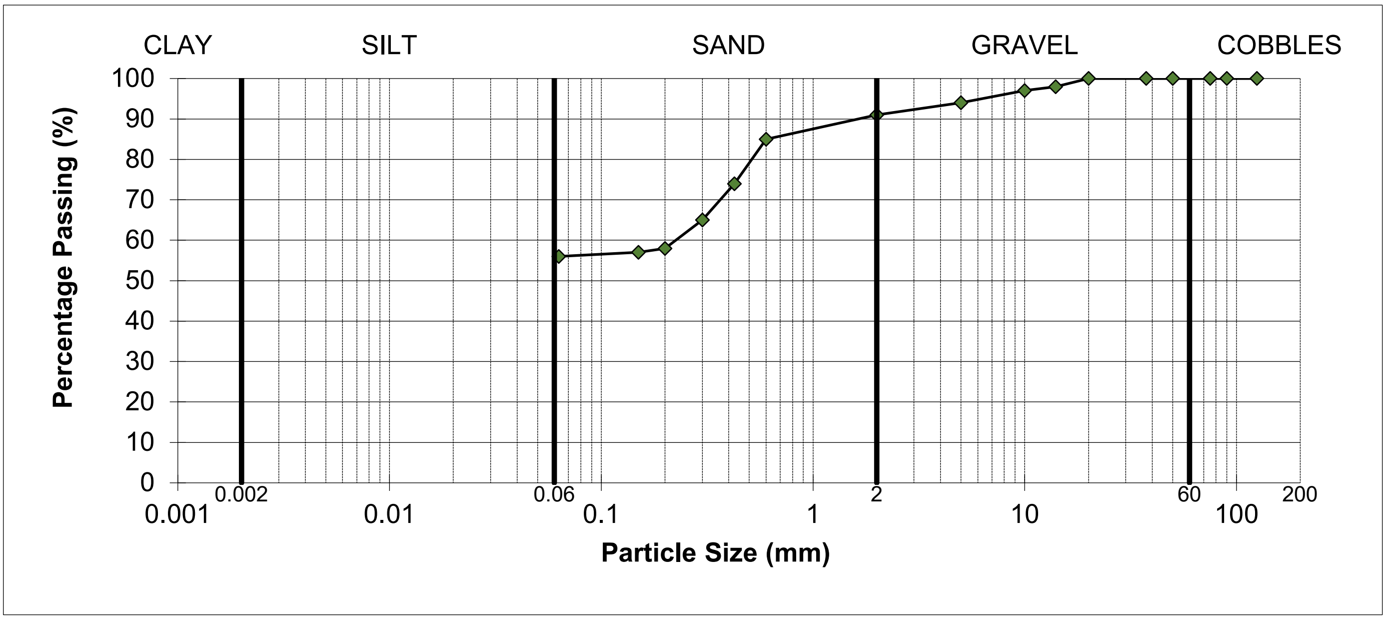
Determination of Water Content in accordance with BS EN ISO 17892-1:2014 (Oven Dry)

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Standish
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS04 1.50	DATE SAMPLED	Not advised
LAB SAMPLE No	118121	DATE RECEIVED	21-Oct-22
DATE TESTED	27-Oct-22	SAMPLED BY	Client

MATERIAL	Stiff brown silty sandy slightly gravelly CLAY
ADVISED SOURCE	Site Investigation Sample

Sieve Size (mm)	% Passing (%)	Specification (%)	Sieve Size (mm)	% Passing (%)	Specification (%)
125	100		5	94	
90	100		2	91	
75	100		0.6	85	
50	100		0.425	74	
37.5	100		0.3	65	
20	100		0.2	58	
14	98		0.15	57	
10	97		0.063	56	



REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager) DATE 09-Nov-22

MURRAY RIX

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UKAS TESTING 1580

TEST CERTIFICATE

PARTICLE SIZE DISTRIBUTION

BS EN ISO 17892-4:2016

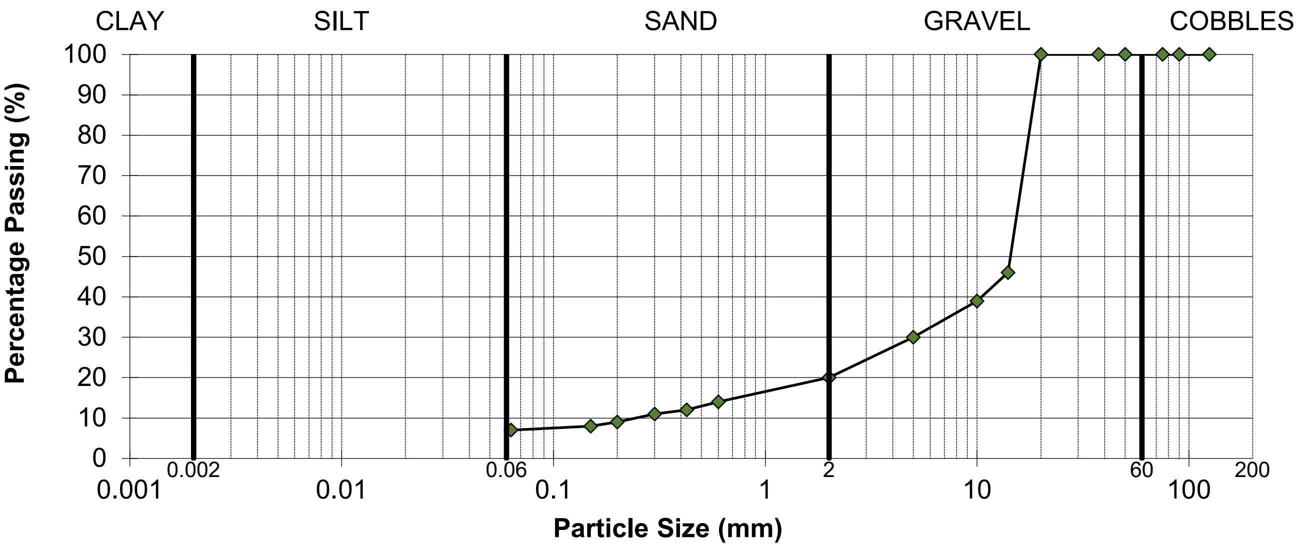
Determination of Water Content in accordance with BS EN ISO 17892-1:2014 (Oven Dry)

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Standish
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS05 0.60	DATE SAMPLED	Not advised
LAB SAMPLE No	118124	DATE RECEIVED	21-Oct-22
DATE TESTED	27-Oct-22	SAMPLED BY	Client

MATERIAL	Grey brown silty slightly sandy GRAVEL
ADVISED SOURCE	Site Investigation Sample

Sieve Size (mm)	% Passing (%)	Specification (%)	Sieve Size (mm)	% Passing (%)	Specification (%)
125	100		5	30	
90	100		2	20	
75	100		0.6	14	
50	100		0.425	12	
37.5	100		0.3	11	
20	100		0.2	9	
14	46		0.15	8	
10	39		0.063	7	



REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager) DATE 09-Nov-22

MURRAY RIX

ANDREW HOUSE, HADFIELD STREET,
DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

UKAS TESTING 1580

TEST CERTIFICATE

LIQUID LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.3 (30° FALL CONE) 1 POINT METHOD
PLASTIC LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.5
WATER CONTENT METHOD BS EN ISO 17892-1:2014

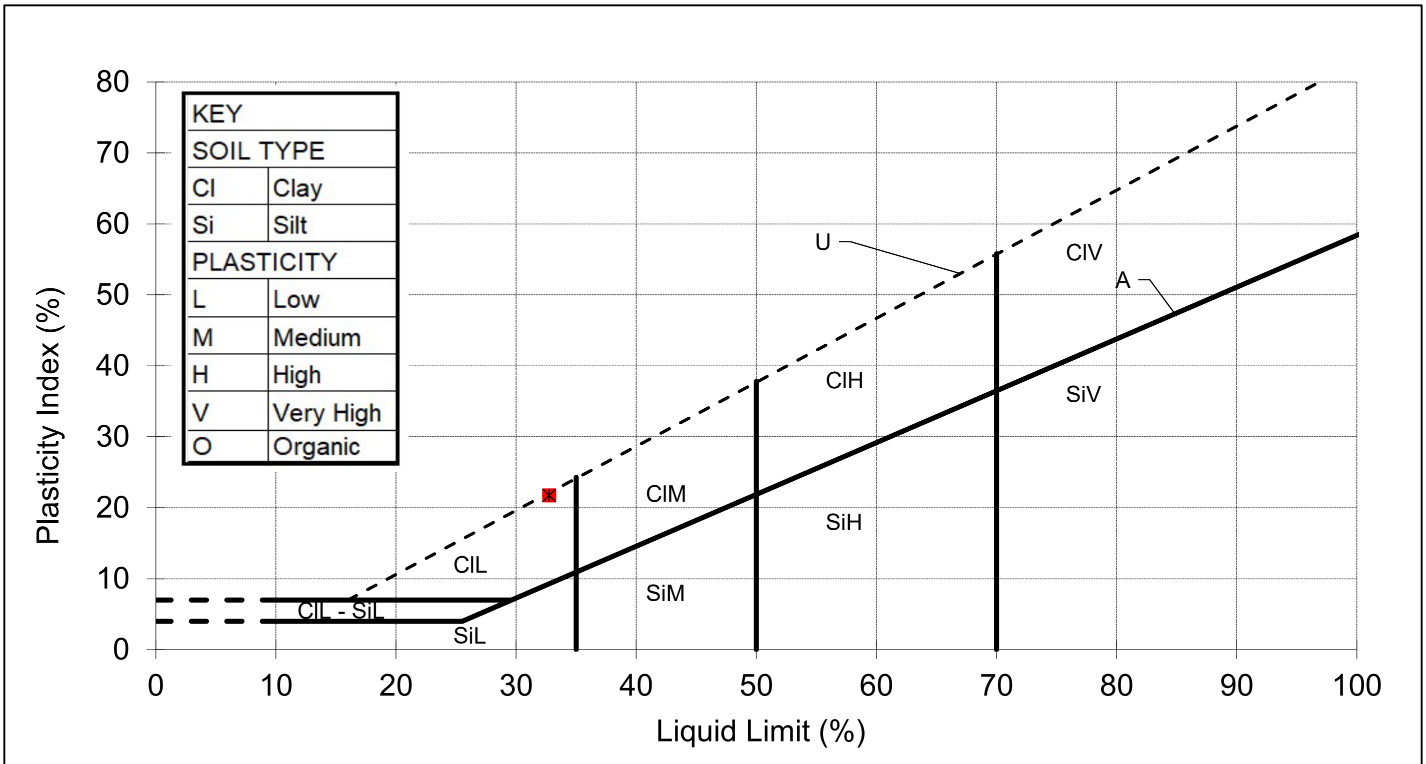
CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS03 0.60	DATE SAMPLED	Not advised
SAMPLE No.	118118	DATE RECEIVED	21-Oct-22
DATE TESTED	03-Nov-22	SAMPLED BY	Client

MATERIAL	Soft to firm brown silty slightly sandy gravelly CLAY		
ADVISED SOURCE	Site Investigation Sample	WATER CONTENT	Increasing
SAMPLE HISTORY	Natural State	% RET. 425um BY	Wet Sieved

Test Readings mm (average)		Moisture Content %	Correction Factor	Correction factor from Clayton and Jukes 1978
Determination 1 (avg)	17.3	31.2	1.037	
Determination 2 (avg)	17.6	32.0		

Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
17.5	33	11	22	64



REMARKS

SIGNED

NAME O.P. Davies BA (Hons)
(Laboratory Manager)

DATE 09-Nov-22

MURRAY RIX

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DUKINFIELD, CHESHIRE SK16 4QX
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TEST CERTIFICATE

LIQUID LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.3 (30° FALL CONE) 1 POINT METHOD
PLASTIC LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.5
WATER CONTENT METHOD BS EN ISO 17892-1:2014

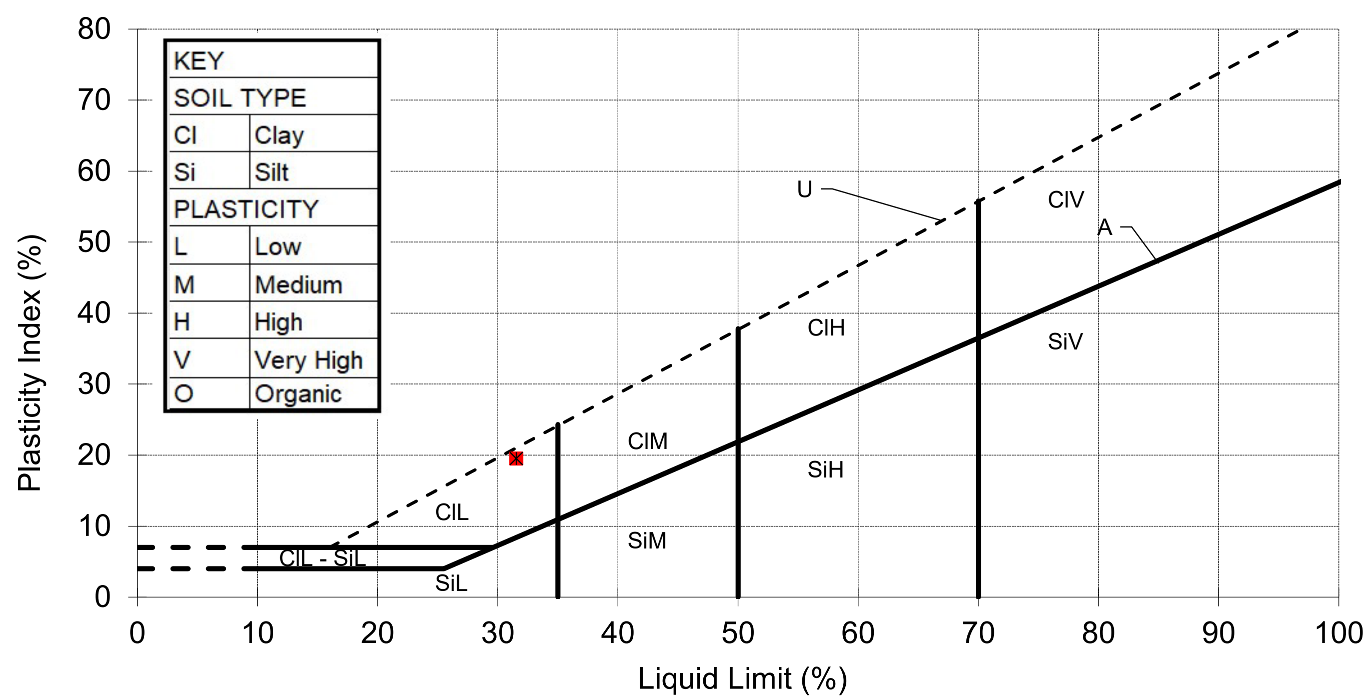
CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS04 0.80	DATE SAMPLED	Not advised
SAMPLE No.	118120	DATE RECEIVED	21-Oct-22
DATE TESTED	03-Nov-22	SAMPLED BY	Client

MATERIAL	Stiff brown silty slightly sandy slightly gravelly CLAY		
ADVISED SOURCE	Site Investigation Sample	WATER CONTENT	Increasing
SAMPLE HISTORY	Natural State	% RET. 425um BY	Hand Picked

Test Readings mm (average)		Moisture Content %	Correction Factor	Correction factor from Clayton and Jukes 1978
Determination 1 (avg)	18.5	30.8	1.023	
Determination 2 (avg)	18.5	30.9		

Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
13.1	32	12	20	92



REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager) DATE 09-Nov-22

MURRAY RIX

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DUKINFIELD, CHESHIRE SK16 4QX
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TEST CERTIFICATE

LIQUID LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.3 (30° FALL CONE) 1 POINT METHOD
PLASTIC LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.5
WATER CONTENT METHOD BS EN ISO 17892-1:2014

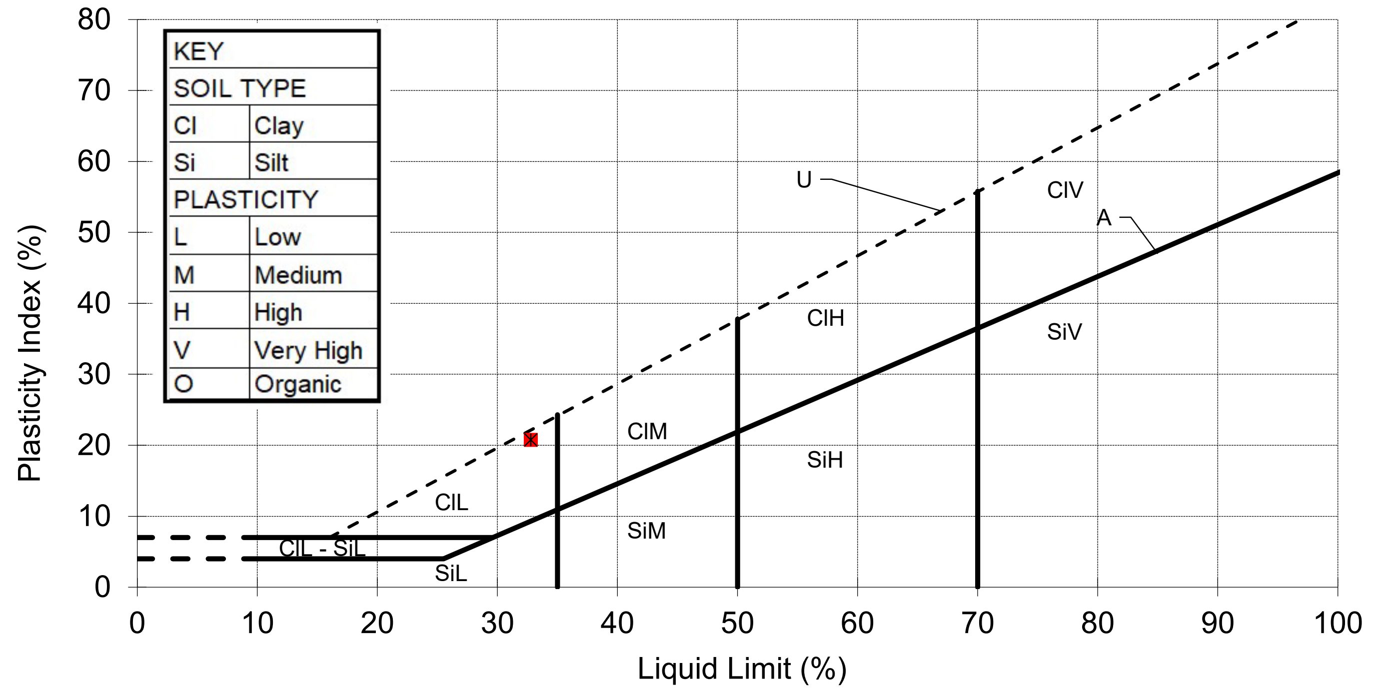
CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS04 1.50	DATE SAMPLED	Not advised
SAMPLE No.	118121	DATE RECEIVED	21-Oct-22
DATE TESTED	03-Nov-22	SAMPLED BY	Client

MATERIAL	Stiff brown silty sandy slightly gravelly CLAY		
ADVISED SOURCE	Site Investigation Sample	WATER CONTENT	Increasing
SAMPLE HISTORY	Natural State	% RET. 425um BY	Wet Sieved

Test Readings mm (average)		Moisture Content %	Correction Factor	Correction factor from Clayton and Jukes 1978
Determination 1 (avg)	19.8	32.5	1.001	
Determination 2 (avg)	20.1	33.0		

Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
11.5	33	12	21	74



REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager) DATE 09-Nov-22

MURRAY RIX

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DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

TEST CERTIFICATE

LIQUID LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.3 (30° FALL CONE) 1 POINT METHOD
PLASTIC LIMIT BS EN ISO 17892-12:2018+A1:2021 Clause 5.5
WATER CONTENT METHOD BS EN ISO 17892-1:2014

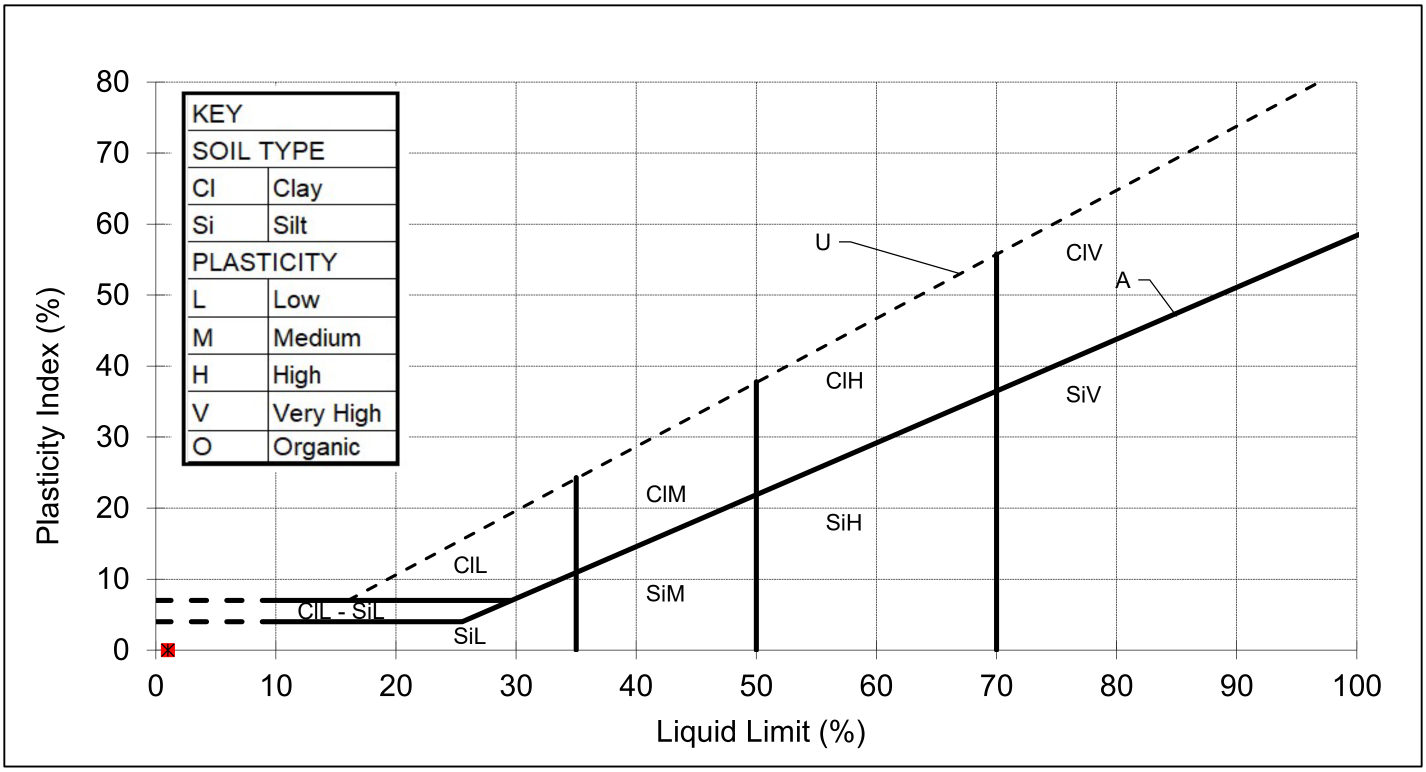
CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	WS05 0.60	DATE SAMPLED	Not advised
SAMPLE No.	118124	DATE RECEIVED	21-Oct-22
DATE TESTED	03-Nov-22	SAMPLED BY	Client

MATERIAL	Grey brown silty slightly sandy GRAVEL		
ADVISED SOURCE	Site Investigation Sample	WATER CONTENT	Increasing
SAMPLE HISTORY	Natural State	% RET. 425um BY	Wet Sieved

Test Readings mm (average)		Moisture Content %	Correction Factor	Correction factor from Clayton and Jukes 1978
Determination 1 (avg)	N/A	N/A	N/A	
Determination 2 (avg)	N/A	N/A		

Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
6.1	N/A	Non Plastic	N/A	12



REMARKS

SIGNED

NAME	O.P. Davies BA (Hons) (Laboratory Manager)	DATE	09-Nov-22

MURRAY RIX
ANDREW HOUSE, HADFIELD STREET,
DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

TEST CERTIFICATE

DETERMINATION OF WATER-SOLUBLE SULPHATE IN SOIL
& DETERMINATION OF THE pH VALUE
BS 1377-3:2018+A1:2021, Cl. 7.3 & Cl. 12

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

DATE TESTED	28-Oct-22	DATE SAMPLED	Not advised
SAMPLED BY	Client	DATE RECEIVED	21-Oct-22
PRE-TREATMENT	Air Dried	ADVISED SOURCE	Site Investigation Samples

Sample Number	Sample Label	Material	% Ret. 2mm	pH Value	Water Soluble Sulphate as SO_4 (mg/l)
118115	WS01 0.60	Stiff brown silty slightly sandy slightly gravelly CLAY	0	8.5	10
118117	WS02 0.60	Stiff brown silty slightly sandy slightly gravelly CLAY	0	8.3	10
118118	WS03 0.60	Soft to firm brown silty slightly sandy gravelly CLAY	20	9.2	20
118120	WS04 0.80	Stiff brown silty slightly sandy slightly gravelly CLAY	0	9.0	60

REMARKS

SIGNED

NAME O.P-. Davies BA (Hons)
(Laboratory Manager)

DATE 09-Nov-22

MURRAY RIX

ANDREW HOUSE, HADFIELD STREET,
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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS
ASTM D7012 - 14 Method C

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE REFERENCE	RC02 9.75-9.95	DATE RECEIVED	21-Oct-22
SAMPLE NUMBER	118128	DATE SAMPLED	Not advised
DATE TESTED	27-Oct-22	SAMPLED BY	Client

DIMENSIONS

TESTED BY	MR	DIAMETER (mm)	100
LENGTH AFTER PREPARATION (mm)	200	LENGTH/DIAMETER RATIO	2.00

METHOD OF END PREPARATION	Saw / Grinding	TIME IN WATER PRIOR TO TEST	0 Hours
DATE OF DRILLING	Not advised	DRILLED BY	Others
MATERIAL	Rock Core	SAMPLE LOCATION	Not advised

DESCRIPTION OF CORE AFTER TEST	Split vertically from top to bottom, with no visible end effects

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	76.5	MEASURED COMPRESSIVE STRENGTH (N/mm2)	9.7

COMPRESSIVE STRENGTH (MPa)	**9.7**

Comments / Deviation from standard method / Abnormalities noted during visual inspection.
None

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

M U R R A Y R I X

ANDREW HOUSE, HADFIELD STREET,

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TEL 0161 475 0870

TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

ASTM D7012 - 14 Method C

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE REFERENCE	RC02 8.73-8.91	DATE RECEIVED	21-Oct-22
SAMPLE NUMBER	118126	DATE SAMPLED	Not advised
DATE TESTED	27-Oct-22	SAMPLED BY	Client

DIMENSIONS

TESTED BY	MR	DIAMETER (mm)	100
LENGTH AFTER PREPARATION (mm)	200	LENGTH/DIAMETER RATIO	2.00

METHOD OF END PREPARATION	Saw / Grinding	TIME IN WATER PRIOR TO TEST	0 Hours
DATE OF DRILLING	Not advised	DRILLED BY	Others
MATERIAL	Rock Core	SAMPLE LOCATION	Not advised

DESCRIPTION OF CORE AFTER TEST	Split vertically from top to bottom, with no visible end effects

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	110.4	MEASURED COMPRESSIVE STRENGTH (N/mm2)	14.1

COMPRESSIVE STRENGTH (MPa)	**14.1**

Comments / Deviation from standard method / Abnormalities noted during visual inspection.
None

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

M U R R A Y R I X

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

ASTM D7012 - 14 Method C

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE REFERENCE	RC01 9.50-9.73	DATE RECEIVED	21-Oct-22
SAMPLE NUMBER	118133	DATE SAMPLED	Not advised
DATE TESTED	27-Oct-22	SAMPLED BY	Client

DIMENSIONS

TESTED BY	MR	DIAMETER (mm)	100
LENGTH AFTER PREPARATION (mm)	200	LENGTH/DIAMETER RATIO	2.00

METHOD OF END PREPARATION	Saw / Grinding	TIME IN WATER PRIOR TO TEST	0 Hours
DATE OF DRILLING	Not advised	DRILLED BY	Others
MATERIAL	Rock Core	SAMPLE LOCATION	Not advised

DESCRIPTION OF CORE AFTER TEST	Split vertically from top to bottom, with no visible end effects

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	91.7	MEASURED COMPRESSIVE STRENGTH (N/mm2)	11.7

COMPRESSIVE STRENGTH (MPa)	**11.7**

Comments / Deviation from standard method / Abnormalities noted during visual inspection.
None

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

MURRAY RIX

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

ASTM D7012 - 14 Method C

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE REFERENCE	RC01 8.76-8.89	DATE RECEIVED	21-Oct-22
SAMPLE NUMBER	118131	DATE SAMPLED	Not advised
DATE TESTED	27-Oct-22	SAMPLED BY	Client

DIMENSIONS

TESTED BY	MR	DIAMETER (mm)	100
LENGTH AFTER PREPARATION (mm)	200	LENGTH/DIAMETER RATIO	2.00

METHOD OF END PREPARATION	Saw / Grinding	TIME IN WATER PRIOR TO TEST	0 Hours
DATE OF DRILLING	Not advised	DRILLED BY	Others
MATERIAL	Rock Core	SAMPLE LOCATION	Not advised

DESCRIPTION OF CORE AFTER TEST	Split vertically from top to bottom, with no visible end effects

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	84.5	MEASURED COMPRESSIVE STRENGTH (N/mm2)	10.8

COMPRESSIVE STRENGTH (MPa)	**10.8**

Comments / Deviation from standard method / Abnormalities noted during visual inspection.

None

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

MURRAY RIX

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DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

TEST CERTIFICATE

DETERMINATION OF POINT LOAD STRENGTH INDEX OF ROCK
METHOD IN ACCORDANCE WITH ASTM STANDARD D 5731

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	RC01	DATE SAMPLED	Not advised
LAB SAMPLE No	118130, 118132, 118134	DATE RECEIVED	21-Oct-22
DATE TESTED	04-Nov-22	SAMPLED BY	Client

MATERIAL	Rock Core
ADVISED SOURCE	Site Investigation Sample

Depth (m)	Test Type*	D (mm)	W** (mm)	Load (P) (kN)	D_e^2 (mm^2)	D_e (mm)	Is (MPa)	F	$I_{s(50)}$ (MPa)
6.86-6.94	A	100.0	72.7	0.3	9256.45	96.21	0.03	1.34	0.04
9.44-9.50	A	100.0	56.7	0.9	7219.27	84.97	0.12	1.27	0.16
10.91-11.00	A	100.0	72.0	1.1	9167.32	95.75	0.12	1.34	0.16
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00

Test Type * — *W Entry required if test type is not Diametral

A	Axial Test	D	Diametral Test
B	Block Test	I	Irregular Lump Test

REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager) — DATE 09-Nov-22

M U R R A Y R I X

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DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

TEST CERTIFICATE

DETERMINATION OF POINT LOAD STRENGTH INDEX OF ROCK
METHOD IN ACCORDANCE WITH ASTM STANDARD D 5731

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewsbury
JOB NUMBER	MRN 4450/11

SAMPLE LABEL	RC02	DATE SAMPLED	Not advised
LAB SAMPLE No	118127, 118125, 118129	DATE RECEIVED	21-Oct-22
DATE TESTED	04-Nov-22	SAMPLED BY	Client

MATERIAL	Rock Core
ADVISED SOURCE	Site Investigation Sample

Depth (m)	Test Type*	D (mm)	W** (mm)	Load (P) (kN)	D_e^2 (mm^2)	D_e (mm)	Is (MPa)	F	$I_{s(50)}$ (MPa)
6.59-6.70	A	100.0	74.7	0.8	9511.10	97.52	0.08	1.35	0.11
9.41-9.50	A	100.0	84.7	1.0	10784.34	103.85	0.09	1.39	0.13
10.18-10.28	A	100.0	91.7	1.4	11675.61	108.05	0.12	1.41	0.17
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00
					0.00	0.00	0.00	0.00	0.00

Test Type * — *W Entry required if test type is not Diametral

A	Axial Test	D	Diametral Test
B	Block Test	I	Irregular Lump Test

REMARKS

SIGNED

NAME O.P. Davies BA (Hons) (Laboratory Manager) DATE 09-Nov-22

MURRAY RIX
CONSULTANCY, SITE INVESTIGATION
CONSTRUCTION MATERIALS TESTING

TEST REPORT

Client Byrne Looby

Address Suite 104
Mere Grange Business Park
St Helens
WA9 5GG

Contract K0273 -
STADCO, Shrewsbury

Job Number MRN 4450/12

Date of Issue 09 November 2022
Page 1 of 26

Approved Signatories

S J Hutchings, O P Davies

Notes

1 All remaining samples and remnants from this contract will be disposed 28 days from the date of this report unless you notify us to the contrary.

2 Result certificates, in this report, not bearing a UKAS mark, are not included in our UKAS accreditation schedule.

3 Opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

4 Certified that the samples have been examined and tested in accordance with the terms of the contract/order and unless otherwise stated conform to the standards/specifications quoted.

5 The results included within the report are representative of the samples submitted for analysis.

6 This certificate should not be reproduced, except in full, without the express permission of the laboratory.

MURRAY RIX

ANDREW HOUSE, HADFIELD STREET,
DUKINFIELD, CHESHIRE SK16 4QX
TEL 0161 475 0870

UKAS TESTING 1580

TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118090	**SITE MARK**	C1
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	125	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	2
REINFORCEMENT DIAMETER (mm)	10, 8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	45, 70

EXCESS VOIDAGE (%)	0.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2430

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	204.3	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	29.4
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**29.4 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
1 x 10mm, 62mm from top surface. 1 x 8mm, 88mm from top surface

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

Form encore1/issue2/revision2

MURRAY RIX

ANDREW HOUSE, HADFIELD STREET,
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TEL 0161 475 0870

UKAS TESTING 1580

TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118091	**SITE MARK**	C2
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	150	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	92	**LENGTH / DIAMETER RATIO**	0.98

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	3
REINFORCEMENT DIAMETER (mm)	8, 8, 4	**DISTANCE TO TOP OF PREPARED SPECIMEN**	40, 49, 61

EXCESS VOIDAGE (%)	3.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2400

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	199.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	28.8
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**28.8 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
3 x 8mm, 50, 59, 136mm from top surface. 1 x 4mm, 71mm from top surface, 1 x 6mm, 115mm from top surface

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

Form encore1/issue2/revision2

MURRAY RIX

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TEL 0161 475 0870

UKAS TESTING 1580

TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118092	**SITE MARK**	C3
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	165	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	90	**LENGTH / DIAMETER RATIO**	0.96

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	26

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2330

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	206.7	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	29.8
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**29.8 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 55, 130mm from top surface.

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BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118093	**SITE MARK**	C4
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	220	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	97	**LENGTH / DIAMETER RATIO**	1.03

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	3.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2290

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	332.5	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	47.9
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**47.9 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 59, 192mm from top surface.

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TEST CERTIFICATE

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BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118094	**SITE MARK**	C5
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	245	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	96	**LENGTH / DIAMETER RATIO**	1.02

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	48

EXCESS VOIDAGE (%)	1.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2340

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	187.8	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	27.1
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**27.1 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
1 x 8mm, 99mm from top surface. 1 x 10mm, 180mm from top surface

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118095	**SITE MARK**	C6
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	260	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	95	**LENGTH / DIAMETER RATIO**	1.01

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2310

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	288.4	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	41.6
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**41.6 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 120, 125mm from top surface. 1 x 10mm, 245mm from top surface

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118096	**SITE MARK**	C7
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	185	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	55

EXCESS VOIDAGE (%)	1.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2320

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	237.1	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	34.2
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**34.2 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
3 x 8mm, 92, 145, 153mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118097	**SITE MARK**	C8
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	240	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	96	**LENGTH / DIAMETER RATIO**	1.02

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2270

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	199.1	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	28.7
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**28.7 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 175, 208mm from top surface.

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DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118098	**SITE MARK**	C9
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	185	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	95	**LENGTH / DIAMETER RATIO**	1.01

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	2
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	61, 68

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2340

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	231.0	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	33.3
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**33.3 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
3 x 8mm, 105, 112, 152mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES

BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118099	**SITE MARK**	C10
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	440	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	95	**LENGTH / DIAMETER RATIO**	1.01

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2300

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	279.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	40.3
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**40.3 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
3 x 8mm, 410, 419, 423mm from top surface. As received core was received in 2 sections, test specimen was taken from the 0-140mm section.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118100	**SITE MARK**	C11
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	325	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	95	**LENGTH / DIAMETER RATIO**	1.01

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	50

EXCESS VOIDAGE (%)	1.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2390

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	271.1	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	39.1
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**39.1 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
1 x 8mm, 85mm from top surface, 3 x 10mm, 93, 115, 190mm from top surface. As received core was received in 3 sections, test specimen was taken from the middle section (120-245mm).

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118101	**SITE MARK**	C12
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	210	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	92	**LENGTH / DIAMETER RATIO**	0.98

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	2
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	76, 83

EXCESS VOIDAGE (%)	0.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2380

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	219.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	31.6
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**31.6 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
4 x 8mm, 55, 61, 153, 161mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118102	**SITE MARK**	C15
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	245	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	3
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	59, 68, 74

EXCESS VOIDAGE (%)	3.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2410

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	282.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	40.7
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**40.7 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
5 x 8mm, 68, 75, 80, 170mm from top surface, 2 x 4mm, 114, 165mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118103	SITE MARK	C13
DATE OF CORING	Not advised	CORED BY	Client
DATE RECEIVED	21 October 2022	DATE TESTED	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	ESTIMATED MAXIMUM SIZE OF AGGREGATE (mm)	20

LENGTH RECEIVED (mm)	230	DIAMETER (mm)	94
LENGTH AFTER PREPARATION (mm)	96	LENGTH / DIAMETER RATIO	1.02

METHOD OF END PREPARATION	Saw / Grinding	STORAGE CONDITIONS	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	NUMBER OF BARS	1
REINFORCEMENT DIAMETER (mm)	8	DISTANCE TO TOP OF PREPARED SPECIMEN	38

EXCESS VOIDAGE (%)	0.5	AGE AT TEST	Not Known

DENSITY, as received by water displacement (kg/m^3)	2340

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	212.4	MEASURED COMPRESSIVE STRENGTH (N/mm^2)	30.6
MODE OF FAILURE	Normal	SURFACE CONDITION AT TIME OF TEST	Dry

CORE COMPRESSIVE STRENGTH	**30.6 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 87, 172mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118104	**SITE MARK**	C14
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	240	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2330

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	300.3	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	43.3
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**43.3 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 80, 85mm from top surface.

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

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MURRAY RIX

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UKAS TESTING 1580

TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118105	**SITE MARK**	C16
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	240	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	93	**LENGTH / DIAMETER RATIO**	0.99

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	30

EXCESS VOIDAGE (%)	1.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2360

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	239.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	34.5
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**34.5 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
4 x 8mm, 80, 158, 176, 182mm from top surface, 1 x 4mm, 227mm from top surface.

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BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118106	**SITE MARK**	C17
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	230	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	28

EXCESS VOIDAGE (%)	1.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2390

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	318.2	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	45.9
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**45.9 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 80, 178mm from top surface, 1 x 4mm, 217mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118107	**SITE MARK**	C18
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	190	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	96	**LENGTH / DIAMETER RATIO**	1.02

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	19

EXCESS VOIDAGE (%)	2.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2280

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	202.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	29.2
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**29.2 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
4 x 8mm, 65, 158, 165, 171mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118108	**SITE MARK**	C20
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	200	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	2.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2290

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	202.6	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	29.2
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**29.2 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained no rebar.

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TEST CERTIFICATE

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BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118109	**SITE MARK**	C21
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	185	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	96	**LENGTH / DIAMETER RATIO**	1.02

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	89

EXCESS VOIDAGE (%)	2.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2320

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	232.5	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	33.5
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**33.5 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
3 x 8mm, 48, 54, 153mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118110	**SITE MARK**	C22
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	240	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	95	**LENGTH / DIAMETER RATIO**	1.01

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	4.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2340

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	196.9	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	28.4
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**28.4 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
2 x 8mm, 115, 220mm from top surface.

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BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118111	**SITE MARK**	C23
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022
SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20
LENGTH RECEIVED (mm)	230	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	91	**LENGTH / DIAMETER RATIO**	0.97
METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container
REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A
EXCESS VOIDAGE (%)	3.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2300

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	273.3	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	39.4
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**39.4 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
3 x 8mm, 110, 215, 220mm from top surface.

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118112	**SITE MARK**	C24
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	495	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	94	**LENGTH / DIAMETER RATIO**	1.00

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	10	**DISTANCE TO TOP OF PREPARED SPECIMEN**	38

EXCESS VOIDAGE (%)	10.0	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2360

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	335.1	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	48.3
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**48.3 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
1 x 10mm, 69mm from top surface, 1 x 8mm, 137mm from top surface. As received core was received in 3 sections, test specimen was taken from the top section (0-160mm).

NAME O.P. Davies BA (Hons) (Laboratory Manager) SIGNED DATE 09-Nov-22

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TEST CERTIFICATE

DETERMINATION OF THE COMPRESSIVE STRENGTH AND DENSITY OF CONCRETE CORES
BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118113	**SITE MARK**	C25
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	450	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	95	**LENGTH / DIAMETER RATIO**	1.01

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	No	**NUMBER OF BARS**	0
REINFORCEMENT DIAMETER (mm)	N/A	**DISTANCE TO TOP OF PREPARED SPECIMEN**	N/A

EXCESS VOIDAGE (%)	1.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2320

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	224.1	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	32.3
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**32.3 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core was received in 2 sections, test specimen was taken from the top section (0-160mm).

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(Laboratory Manager)

SIGNED

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TEST CERTIFICATE

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BS EN 12504-1 : 2019 & BS EN 12390-7 : 2019

CLIENT	Byrne Looby
SITE	K0273 - STADCO, Shrewbury
JOB NUMBER	MRN 4450/12

SAMPLE NUMBER	118114	**SITE MARK**	C26
DATE OF CORING	Not advised	**CORED BY**	Client
DATE RECEIVED	21 October 2022	**DATE TESTED**	07 November 2022

SAMPLE DESCRIPTION	Concrete Core	**ESTIMATED MAXIMUM SIZE OF AGGREGATE** (mm)	20

LENGTH RECEIVED (mm)	155	**DIAMETER** (mm)	94
LENGTH AFTER PREPARATION (mm)	96	**LENGTH / DIAMETER RATIO**	1.02

METHOD OF END PREPARATION	Saw / Grinding	**STORAGE CONDITIONS**	Sealed Container

REINFORCEMENT IN TEST SPECIMEN	Yes	**NUMBER OF BARS**	1
REINFORCEMENT DIAMETER (mm)	8	**DISTANCE TO TOP OF PREPARED SPECIMEN**	77

EXCESS VOIDAGE (%)	0.5	**AGE AT TEST**	Not Known

DENSITY, as received by water displacement (kg/m^3)	2300

COMPRESSIVE STRENGTH

LOAD AT FAILURE (kN)	273.3	**MEASURED COMPRESSIVE STRENGTH** (N/mm^2)	39.4
MODE OF FAILURE	Normal	**SURFACE CONDITION AT TIME OF TEST**	Dry

CORE COMPRESSIVE STRENGTH	**39.4 mPa**

COMMENTS/DEVIATIONS FROM STANDARD METHOD/ABNORMALITIES NOTED DURING VISUAL INSPECTION.
As received core contained the following rebar. Measurements are shown in mm.
4 x 8mm, 94, 122, 133, 137mm from top surface.

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Appendix H – Ground-Bearing Slab Assessment

H

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Consulting Civil & Structural Engineers

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Project

Stadco, Battlefield Way

Title

Ground-bearing Slab Assessment

Client

Byrne Looby

MSJ Job No
222158

Document No
REP 0001 222158 REP 0001 - Stadco Slab Assessment

Rev Date 23 January 2023

MSJ

Issue Record

Status	Rev	Description	By	Chk		Date
		First Issue	FH	BT		23/01/2023

Introduction

This report sets out the assessment made of the existing ground-bearing slab at Stadco, Battlefield Way, Shrewsbury, for the purpose of assessing the capacity of the slab to support new process equipment. The slab lies within a steel framed industrial building which appears to have been constructed in different stages. The slab also includes several large pits and trenches. An indicative photograph is provided below (showing Zone 9).

A ground investigation was carried out by Byrne Looby for the overall project site, and this included 26 no. core samples taken across the building, which were tested for thickness, concrete compressive strength and several other properties. The following reports should be read in conjunction with this report:

- K0273-ENV-R001 Phase 2 Site Investigation Report
- MRN 4450-12 - STADCO, Shrewsbury

Indicative photograph showing the pits in Zone 9

Executive Summary:

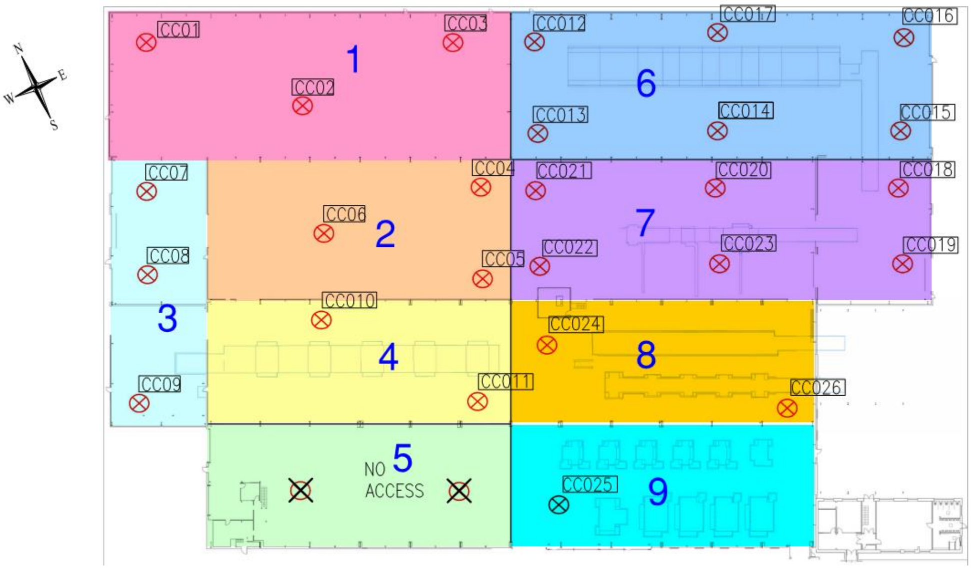
The survey results show a very inconsistent slab buildup, and no record information is available to confirm the original design.

It is not recommended to rely on these slabs for significant loading, as it is uncertain just how inconsistent the construction is. To support significant loads within this building, it is recommended that these slabs should be broken out and replaced with a purpose designed slab.

Notwithstanding the above, an attempt has been made to rationalise the survey results to give some indication of what would constitute a "significant load" for this building. If the loads to be applied are significantly lower than the capacities provided in the Results Summary below, then the project design engineer can take these into account when assessing the layouts and make an informed decision on the suitability of the proposal. It is important that the project engineer ensures they fully understand all of the limitations described in this document before relying on the results presented.

Due to the large variations in measured parameters, the slab has been separated into separate areas, roughly coinciding with different "buildings" and possibly constructed at different times. Conservative assessments have been made for the surveyed slabs in each area, and an indicative allowable point load is provided, along with an allowable proximity to slab edges and joints. These values should only be used indicatively and should not be considered as definitive allowable capacities, as they are based on limited and variable information. For example, for assessment purposes the slab thickness in each area is assumed to be equal to the minimum measured thickness in the samples from that area, but these values vary significantly and there is no guarantee that there are not areas with lower slab thickness which do not coincide with the samples taken. If a maximum point load is applied in one of these locations, then the slab could fail to support it, and the client should be aware of this risk.

The slab also includes significant pits and trenches, which were not included in the survey and are outside the scope of this assessment, but will have a significant impact on the location and capacity of any loading, both within the pits and adjacent to them.



Zone key-plan with core sample layout

Discussion:

- The details of the slab, including the thickness and concrete grade, vary wildly across the 26 samples taken. Any correlation with the various separate areas/buildings is limited.
- Therefore it is not possible to provide reliable capacities for allowable loads on the slab, and therefore the advice given in this report should not be taken as such.
- In order to provide indicative estimates of the likely slab capacities, the building has been split into distinct areas (see layout plan in Appendix A), and the core samples taken within each area have been assessed using a simple statistical analysis to determine properties to be used in the indicative slab assessment.
- Estimated capacities have been calculated following the guidance in The Concrete Centre Technical Report TR34 (4th Edition). Refer to calculations provided in Appendix B.
- Measured concrete compressive strength values also vary greatly, and in places are relatively low, many samples testing below 30 N/mm^2. Tested concrete strength is usually higher than specified in the original design due to safety factors in the mix design and concrete continuing to gain strength as it ages. The low strength values further reduce confidence in the capacity of this slab. For assessment purposes a relatively low-strength mix of RC20/25 has conservatively been used.
- Reinforcement was encountered in many of the core samples, typically 8mm diameter, indicating a likely A252 mesh. However the reinforcement appears to be in the top of the slab, indicating it is anti-crack reinforcement and does not contribute to slab strength. As the spacing is also not confirmed, no reinforcement has been allowed for in the capacity assessments.
- Towards the southern end of the site, the slabs appear to be relatively thin structural slabs with a thick layer of mass concrete below. It is not clear what this concrete is for, but it is assumed to be fill/blinding and not to contribute to the strength of the slab.
- CBR tests were not performed on the sub-base beneath the core samples, so an assessment of the subgrade reaction cannot be made. Byrne Looby have reviewed the ground conditions of the site in general and advised that a conservative value of 2% can be taken for the CBR. As described in TR34 (3rd Edition) slab capacity is not very sensitive to small changes in CBR, so this is not considered to be overly conservative, and the value advised by Byrne Looby has been used to estimate a value for the modulus of subgrade reaction, k, for use in the capacity assessments.
- **IMPORTANT NOTE:** this report is only an assessment of the capacity of the concrete slab to transmit point loads onto the sub-base which is directly supporting it. Note that there are extensive large pits and trenches across this area, for which we have no information. Loads applied to the slab near these pits will load the sub-base, which will in turn surcharge the walls of any adjacent pits. The effect of this is outside the scope of this report, but could be critical and should be assessed by a suitably qualified engineer.
- The brief mentions that there is the intention to support loads on the bases of the pits, but that these are considered acceptable as the pits are founded in stiffer ground. We have no information about the structure of these extensive pits, so this report does not advise on the suitability of supporting loads within them.

Assumptions:

- The slab is assumed to be a traditional reinforced concrete jointed ground-bearing slab. This is considered likely, but given the extent of pits and trenches, it should be confirmed before relying on any assessments made.
- The capacities provided in our assessment are based only on the information provided, and our best judgement on how to interpret them. The large inconsistencies in the survey results indicate that the slab is unusually variable, and there may well be locations with thinner and weaker slab than the minimum found in the 26 samples.
- Details of the support loads or structures have not been provided, so a nominal contact area of 200x200mm has been assumed in the calculations. Note that the calculation assumes that any baseplates are sufficiently stiff to spread the load evenly across their footprint.
- It is assumed that the loads are individual loads and are far enough separated from each other not to affect the slab jointly. If high loads are closely spaced they might act together and further checks will be required using the dimensioned layout. Refer to results summary table below for minimum load spacing.

Results Summary

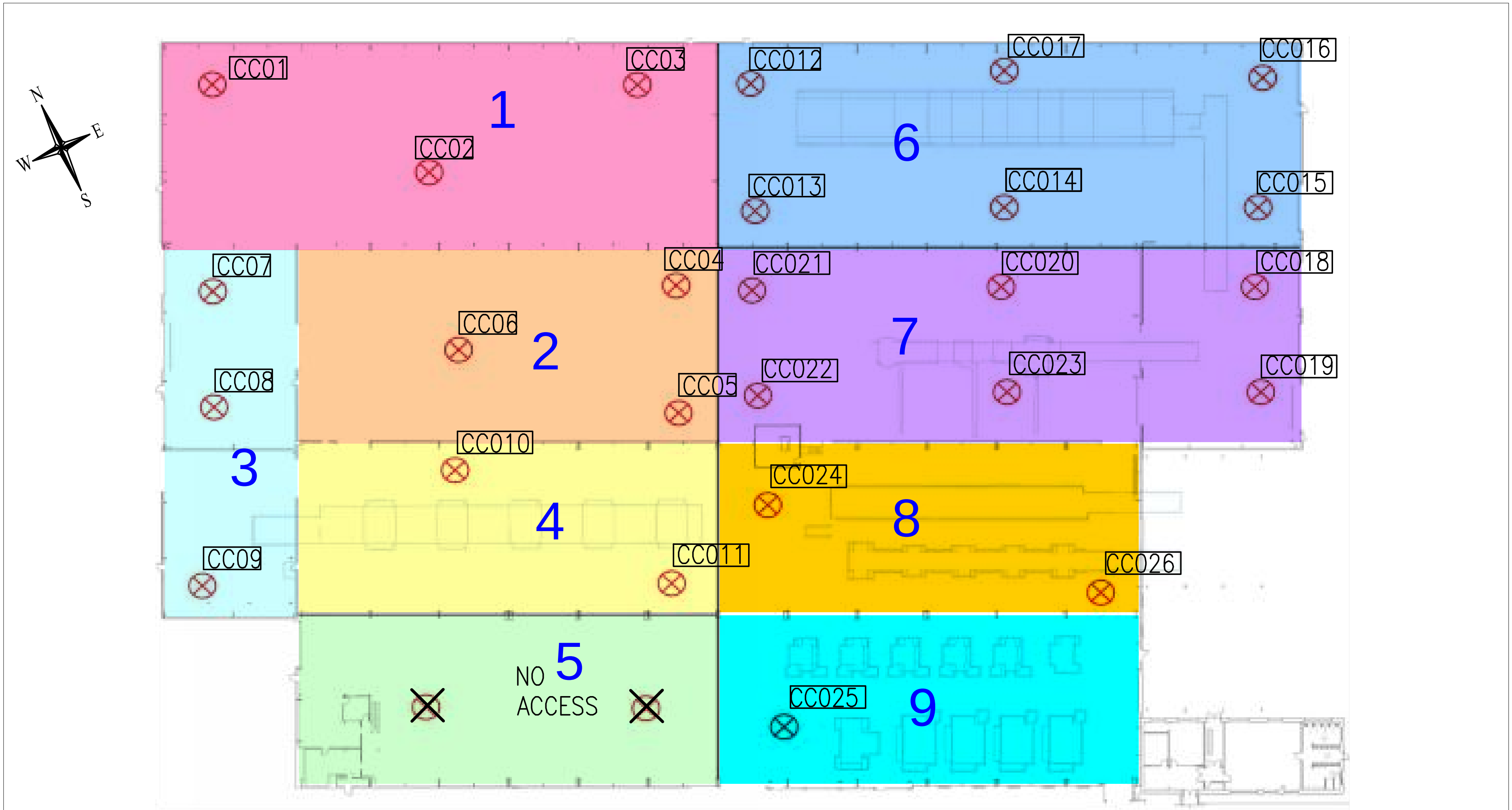
Below is a summary of the design parameters and calculated capacities for each zone, refer to Appendix B for more details. PL refers to the point load capacity calculated, characteristic (unfactored) load in kN. Minimum spacings are provided from a slab edge/joint, or adjacent load, for these calculated capacities to apply. If loads are to be applied closer to an edge/joint, then the slab capacity will be reduced and further assessment will be required.

							Minimum spacing	
Zone	Cores	Depth	Grade	CBR*	k	PL	from edge/joint	between two loads
		mm	N/mm^2		N/mm^3	kN (SLS)	mm	mm
1	3	125	25	2%	0.02	45	850	250
2	3	220	25	2%	0.02	110	1250	440
3	3	185	25	2%	0.02	77	1050	370
4	2	100	25	2%	0.02	32	750	200
5	0	x	x	2%	0.02	x	x	x
6	6	210	25	2%	0.02	94	1150	420
7	6	185	25	2%	0.02	77	1050	370
8 & 9	3	125	25	2%	0.02	60	950	250

* - advised by Byrne Looby

Appendix A – Layout

A4



GENERAL NOTES:

1. DO NOT SCALE OFF DRAWING. ALL LOCATIONS ARE APPROXIMATE.
2. DRAWING PROVIDED BY VEOLIA ES (UK) LTD.
3. ANY ANOMALIES IDENTIFIED WITH THE DETAILS SHOWN ON THIS DRAWING IS TO BE BROUGHT TO THE ATTENTION OF BYRNE LOOBY PRIOR TO CONSTRUCTION WORKS COMMENCING.

KEY:

SITE BOUNDARY

Concrete Core Location

CLIENT
VEOLIA ES (UK) LTD

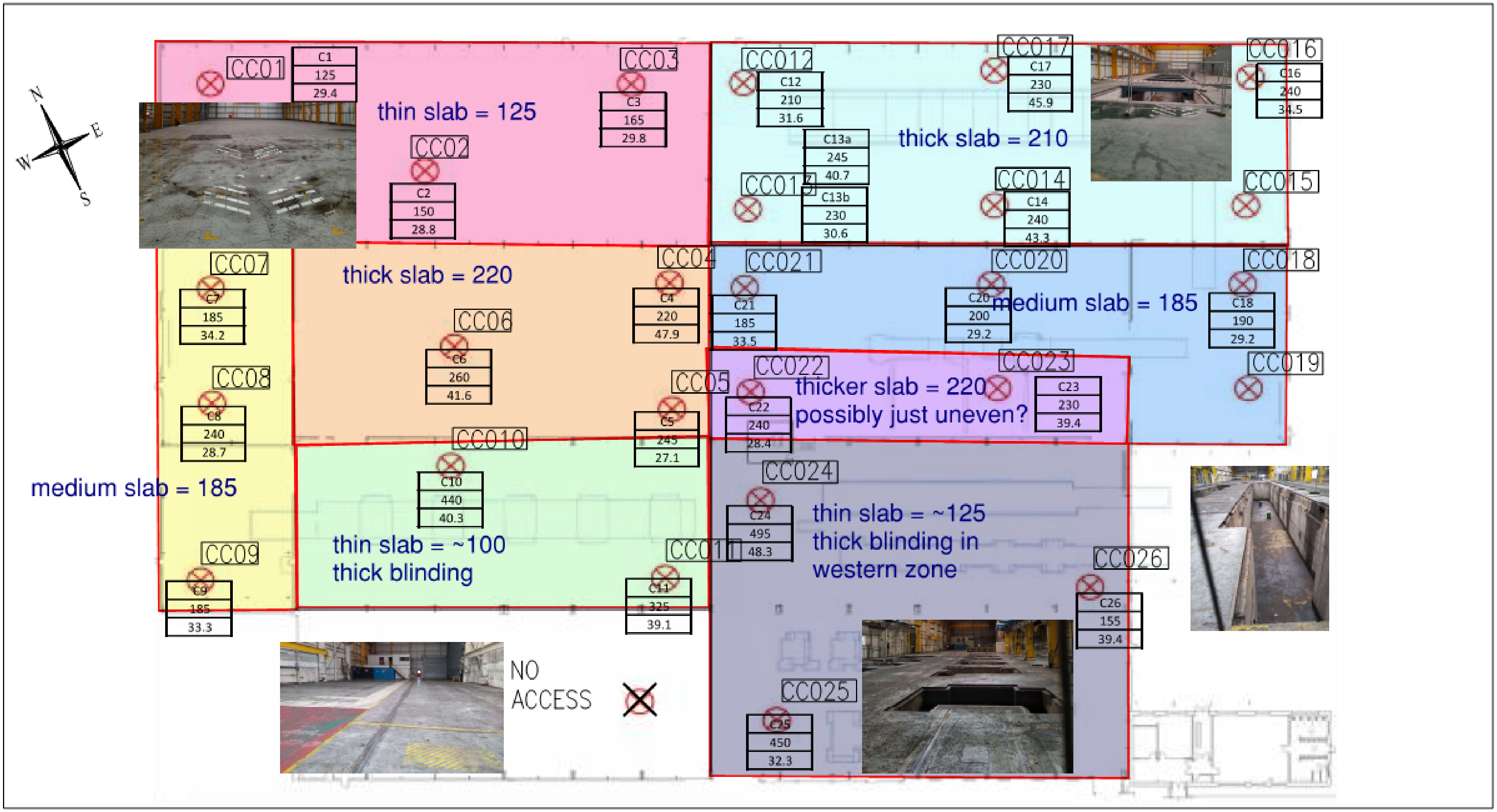
PROJECT
STADCO, BATTLEFIELD WAY

DRAWING TITLE
CONCRETE CORE LOCATION PLAN

Date: 29/11/22	Scale: NTS	Drawn: HW	Chk: HW	App: KA
Project No: K0273	Drg. No: K0273-BLA-D-003			Rev: 00

BYRNELOOBY
AN AYESA COMPANY

A4



GENERAL NOTES:

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KEY:

SITE BOUNDARY

Concrete Core Location

CLIENT
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STADCO, BATTLEFIELD WAY

DRAWING TITLE
CONCRETE CORE LOCATION PLAN

Date: 29/11/22	Scale: NTS	Drawn: HW	Chk: HW	App: KA
Project No: K0273	Drg. No: K0273-BLA-D-003			Rev: 00

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Appendix B – Assessment

Melia Smith & Jones Consulting Civil & Structural Engineers	Project Stadco Slab Review	By FH	Checked	Job No 222158
	Input data and Results Summary	Date Jan 22	Date	Sheet No. 1

Summary per Zone

Zone	Cores	Depth	Grade	CBR*	k	PL	s
		mm	N/mm^2	%	N/mm^3	kN (SLS)	mm
1	3	125	25	2%	0.02	45	850
2	3	220	25	2%	0.02	110	1250
3	3	185	25	2%	0.02	77	1050
4	2	100	25	2%	0.02	32	750
5	0	x	x	2%	0.02	x	x
6	6	210	25	2%	0.02	94	1150
7	6	185	25	2%	0.02	77	1050
8 & 9	3	125	25	2%	0.02	60	950

* - advised by Byrne Looby

Survey results summary

	H	f_{cu}	Zone
	mm	N/mm^2	
C1	125	29.4	1
C2	150	28.8	1
C3	165	29.8	1
C4	220	47.9	2
C5	245	27.1	2
C6	260	41.6	2
C7	185	34.2	3
C8	240	28.7	3
C9	185	33.3	3
C10	440**	40.3	4
C11	325**	39.1	4
C12	210	31.6	6
C13	230	30.6	6
C14	240	43.3	6
C15	245	40.7	6
C16	240	34.5	6
C17	230	45.9	6
C18	190	29.2	7
C19	x	x	7
C20	200	29.2	7
C21	185	33.5	7
C22	240	28.4	7
C23	230	39.4	7
C24	495**	48.3	8
C25	450**	32.3	9
C26	155	39.4	8

** - thin structural slab, with thick mass concrete below

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:-
   'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC01	125	0.02	29.4	2.0
CC02	150	0.02	28.8	2.0
CC03	165	0.02	29.8	2.0

	t	k	fck
Mean:	147	0.02	29.3

Standard deviation: 0.50
No. of tests: 3
t-statistic, for n: 2.92

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 27.9 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 33 N/mm2
(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored, for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	125	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.2	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.44	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

Design checks

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	710	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	5.7	kNm/m	*Eqn (2)*
a/l		0.16		

Ultimate capacities:

Internal,	Pui	=	68	kN	*Eqn (21/22)*
Edge,	Pue	=	41	kN	*Eqn (23/24)*
Corner,	Puc	=	25	kN	*Eqn (25/26)*

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 94 mm

Ultimate capacities:

Internal,	u1i	= 1978 mm	Rp	=	0.06 P	*Eqn (31)*
	Ppi	= 87.3 kN			*Eqn (13)*	
Edge,	u1e	= 1189 mm	Rp	=	0.13 P	*Eqn (32)*
	Ppe	= 56.8 kN			*Eqn (13)*	
Corner,	u1c	= 695 mm				
	Ppc	= 33.2 kN			*Eqn (13)*	

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint
Lte = 2 x 0.9 L = 1278 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*
transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 32 kN

Total capacity at joint = Pue / 0.85 + Pjt = 80.4 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	68	kN	45	kN
	Edge	41	kN	27	kN
	Corner	25	kN	17	kN
	Joint	68	kN	45	kN
Punching	Internal	87	kN	58	kN
	Edge	57	kN	38	kN
	Corner	33	kN	22	kN
Recommended	**Internal**	**68**	**kN**	**45**	**kN**
Critical Design	**Edge**	**41**	**kN**	**27**	**kN**
Values	**Corner**	**25**	**kN**	**17**	**kN**
	Joint	**57**	**kN**	**38**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 823 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

Melia Smith & Jones Consulting Civil & Structural Engineers	Project Stadco Slab Check	By FH	Checked	Job No 222158
	Ground Slab Assessment Zone 2	Date Jan 23	Date	Sheet No. 1

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:-
   'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC04	220	0.02	47.9	2.0
CC05	245	0.02	27.1	2.0
CC06	260	0.02	41.6	2.0

	t	k	fck
Mean:	242	0.02	38.9

Standard deviation: 10.67
No. of tests: 3
t-statistic, for n: 2.92

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 7.7 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 9 N/mm2

(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored, for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	220	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.0	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.44	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

Design checks

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	1085	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	16.4	kNm/m	*Eqn (2)*
a/l		0.1		

Ultimate capacities:

Internal,	Pui	=	164	kN	*Eqn (21/22)*
Edge,	Pue	=	98	kN	*Eqn (23/24)*
Corner,	Puc	=	58	kN	*Eqn (25/26)*

Melia Smith & Jones Consulting Civil & Structural Engineers	Project Stadco Slab Check Ground Slab Assessment Zone 2	By FH Date Jan 23	Checked Date	Job No 222158 Sheet No. 4

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 165 mm

Ultimate capacities:

Internal,	u1i	=	2873	mm	Rp	=	0.06 P	*Eqn (31)*
	Ppi	=	223	kN			*Eqn (13)*	
Edge,	u1e	=	1637	mm	Rp	=	0.12 P	*Eqn (32)*
	Ppe	=	136	kN			*Eqn (13)*	
Corner,	u1c	=	918	mm				
	Ppc	=	76.5	kN			*Eqn (13)*	

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint
Lte = 2 x 0.9 L = 1953 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*
transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 49 kN

Total capacity at joint = Pue / 0.85 + Pjt = 165 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	164	kN	110	kN
	Edge	98	kN	66	kN
	Corner	58	kN	39	kN
	Joint	164	kN	110	kN
Punching	Internal	223	kN	149	kN
	Edge	136	kN	91	kN
	Corner	76	kN	51	kN
Recommended	**Internal**	**164**	**kN**	**110**	**kN**
Critical Design	**Edge**	**98**	**kN**	**66**	**kN**
Values	**Corner**	**58**	**kN**	**39**	**kN**
	Joint	**136**	**kN**	**91**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 1198 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:- 'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC07	185	0.02	34.2	2.0
CC08	240	0.02	28.7	2.0
CC09	185	0.02	33.3	2.0

	t	k	fck
Mean:	203	0.02	32.1

Standard deviation: 2.95
No. of tests: 3
t-statistic, for n: 0.00

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 32.1 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 38 N/mm2

(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored, for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	175	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.1	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.44	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

<u>Design checks</u>

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	914	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	10.7	kNm/m	*Eqn (2)*
a/l		0.12		

Ultimate capacities:

Internal,	Pui	=	115	kN	*Eqn (21/22)*
Edge,	Pue	=	69	kN	*Eqn (23/24)*
Corner,	Puc	=	41	kN	*Eqn (25/26)*

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 131 mm

Ultimate capacities:

Internal, u1i = 2449 mm Rp = 0.06 P *Eqn (31)*
Ppi = 151 kN *Eqn (13)*

Edge, u1e = 1425 mm Rp = 0.12 P *Eqn (32)*
Ppe = 94.6 kN *Eqn (13)*

Corner, u1c = 812 mm
Ppc = 53.9 kN *Eqn (13)*

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint
Lte = 2 x 0.9 L = 1645 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*
transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 41 kN

Total capacity at joint = Pue / 0.85 + Pjt = 123 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	115	kN	77	kN
	Edge	69	kN	46	kN
	Corner	41	kN	28	kN
	Joint	115	kN	77	kN
Punching	Internal	151	kN	101	kN
	Edge	95	kN	63	kN
	Corner	54	kN	36	kN
Recommended	**Internal**	**115**	**kN**	**77**	**kN**
Critical Design	**Edge**	**69**	**kN**	**46**	**kN**
Values	**Corner**	**41**	**kN**	**28**	**kN**
	Joint	**95**	**kN**	**63**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 1027 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

Melia Smith & Jones Consulting Civil & Structural Engineers	Project Stadco Slab Check	By FH	Checked	Job No 222158
	Ground Slab Assessment Zone 4	Date Jan 23	Date	Sheet No. 1

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:-
   'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC10	440	0.02	40.3	2.0
CC11	325	0.02	39.1	2.0
----	325	0.02	39.1	2.0

	t	k	fck
Mean:	363	0.02	39.5

Standard deviation: 0.69
No. of tests: 3
t-statistic, for n: 0.00

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 39.5 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 46 N/mm2
(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored, for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	100	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.2	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.45	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

Design checks

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	601	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	3.7	kNm/m	*Eqn (2)*
a/l		0.19		

Ultimate capacities:

Internal,	Pui	=	48	kN	*Eqn (21/22)*
Edge,	Pue	=	29	kN	*Eqn (23/24)*
Corner,	Puc	=	18	kN	*Eqn (25/26)*

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 75 mm

Ultimate capacities:

Internal,	u1i	=	1742	mm	Rp	=	0.06 P		*Eqn (31)*
	Ppi	=	63	kN				*Eqn (13)*	
Edge,	u1e	=	1071	mm	Rp	=	0.14 P		*Eqn (32)*
	Ppe	=	42.2	kN				*Eqn (13)*	
Corner,	u1c	=	636	mm					
	Ppc	=	25	kN				*Eqn (13)*	

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint

Lte = 2 x 0.9 L = 1081 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*

transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 27 kN

Total capacity at joint = Pue / 0.85 + Pjt = 61.5 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	48	kN	32	kN
	Edge	29	kN	20	kN
	Corner	18	kN	12	kN
	Joint	48	kN	32	kN
Punching	Internal	63	kN	42	kN
	Edge	42	kN	28	kN
	Corner	25	kN	17	kN
Recommended	**Internal**	**48**	**kN**	**32**	**kN**
Critical Design	**Edge**	**29**	**kN**	**20**	**kN**
Values	**Corner**	**18**	**kN**	**12**	**kN**
	Joint	**42**	**kN**	**28**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 713 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

Melia Smith & Jones Consulting Civil & Structural Engineers	Project Stadco Slab Check	By FH	Checked	Job No 222158
	Ground Slab Assessment Zone 6	Date Jan 23	Date	Sheet No. 1

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:-
   'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC12	210	0.02	31.6	2.0
CC13	230	0.02	30.6	2.0
CC16	240	0.02	34.5	2.0
CC17	230	0.02	40.7	2.0

	t	k	fck
Mean:	228	0.02	34.4

Standard deviation: 4.54
No. of tests: 4
t-statistic, for n: 0.00

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 34.4 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 40 N/mm2
(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored,
for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from
only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	200	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures
in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.1	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.44	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

Design checks

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	1010	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	13.8	kNm/m	*Eqn (2)*
a/l		0.11		

Ultimate capacities:

Internal,	Pui	=	142	kN	*Eqn (21/22)*
Edge,	Pue	=	85	kN	*Eqn (23/24)*
Corner,	Puc	=	51	kN	*Eqn (25/26)*

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 150 mm

Ultimate capacities:

Internal,	u1i	= 2685 mm	Rp = 0.06 P		*Eqn (31)*
	Ppi	= 189 kN		*Eqn (13)*	
Edge,	u1e	= 1542 mm	Rp = 0.12 P		*Eqn (32)*
	Ppe	= 117 kN		*Eqn (13)*	
Corner,	u1c	= 871 mm			
	Ppc	= 66 kN		*Eqn (13)*	

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint
Lte = 2 x 0.9 L = 1818 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*
transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 45 kN

Total capacity at joint = Pue / 0.85 + Pjt = 145 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	142	kN	94	kN
	Edge	85	kN	57	kN
	Corner	51	kN	34	kN
	Joint	142	kN	94	kN
Punching	Internal	189	kN	126	kN
	Edge	117	kN	78	kN
	Corner	66	kN	44	kN
Recommended	**Internal**	**142**	**kN**	**94**	**kN**
Critical Design	**Edge**	**85**	**kN**	**57**	**kN**
Values	**Corner**	**51**	**kN**	**34**	**kN**
	Joint	**117**	**kN**	**78**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 1123 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

Melia Smith & Jones Consulting Civil & Structural Engineers	Project Stadco Slab Check	By FH	Checked	Job No 222158
	Ground Slab Assessment Zone 7	Date Jan 23	Date	Sheet No. 1

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:-
   'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC18	190	0.02	29.2	2.0
CC20	200	0.02	29.2	2.0
CC21	185	0.02	33.5	2.0
CC22	240	0.02	28.4	2.0

	t	k	fck
Mean:	204	0.02	30.1

Standard deviation: 2.31
No. of tests: 4
t-statistic, for n: 0.00

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 30.1 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 35 N/mm2
(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored, for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	175	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.1	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.44	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

Design checks

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	914	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	10.7	kNm/m	*Eqn (2)*
a/l		0.12		

Ultimate capacities:

Internal,	Pui	=	115	kN	*Eqn (21/22)*
Edge,	Pue	=	69	kN	*Eqn (23/24)*
Corner,	Puc	=	41	kN	*Eqn (25/26)*

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 131 mm

Ultimate capacities:

Internal, u1i = 2449 mm Rp = 0.06 P *Eqn (31)*
Ppi = 151 kN *Eqn (13)*

Edge, u1e = 1425 mm Rp = 0.12 P *Eqn (32)*
Ppe = 94.6 kN *Eqn (13)*

Corner, u1c = 812 mm
Ppc = 53.9 kN *Eqn (13)*

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint
Lte = 2 x 0.9 L = 1645 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*
transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 41 kN

Total capacity at joint = Pue / 0.85 + Pjt = 123 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	115	kN	77	kN
	Edge	69	kN	46	kN
	Corner	41	kN	28	kN
	Joint	115	kN	77	kN
Punching	Internal	151	kN	101	kN
	Edge	95	kN	63	kN
	Corner	54	kN	36	kN
Recommended	**Internal**	**115**	**kN**	**77**	**kN**
Critical Design	**Edge**	**69**	**kN**	**46**	**kN**
Values	**Corner**	**41**	**kN**	**28**	**kN**
	Joint	**95**	**kN**	**63**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 1027 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

ASSESSMENT OF EXISTING GROUND SLAB FOR LOADS FROM PROPOSED MEZZANINE COLUMNS

Design Philosophy

These calculations are to verify the capacity of a ground slab to support a new process equipment. They are for the use of Veolia/Byrne Looby only. The floor capacities given should be compared to the column loads applied by the equipment, taking into account the location of the columns in respect to joints, edges and corners. The capacities given are based on the information received from core samples and if there is significant variation in the slab thickness or strength not shown by the samples then capacities could be reduced.

References

1. Concrete Society Technical Report No. 34, 4th Edition:-
   'Concrete industrial ground floors - A guide to design and construction'
2. K0273-ENV-R001 Phase 2 Site Investigation Report

Loading information

Column and baseplate sizes for the proposed supports have not been provided.
For the purpose of these calculations a base plate size of 200 x 200
has been assumed, with sufficient stiffness to evenly distribute the load over it's full area.

Ground slab details

Slab details are obtained from the report K0273-ENV-R001 Phase 2 Site Investigation Report issued 30th November 2022

26 no. core samples were taken. These were measured for slab thickness and the presence and size of reinforcement noted. The samples were subjected to laboratory compressive strength tests.

Byrne Looby have provided a conservative estimate of 2% for the sub-base California Bearing Ratio (CBR). These values are converted to modulus of sub-grade reaction values 'k' for use in the slab capacity formulae. Note that this is not a very accurate method of determining 'k' values for slab design, however the capacity of the slab is not very sensitive to changes in 'k' so a conservative conversion is considered appropriate.

Slab data from test results

Test loc'n	Slab thickness, mm	Modulus 'k', N/mm3	Core strength N/mm2	CBR (%)
CC24	150	0.02	48.3	2.0
CC25	150	0.02	32.3	2.0
CC26	150	0.02	39.4	2.0

	t	k	fck
Mean:	150	0.02	40.0

Standard deviation: 8.02
No. of tests: 3
t-statistic, for n: 0.00

Melia Smith & Jones

Consulting Civil & Structural Engineers

Project	By	Checked	Job No
Stadco Slab Check	FH		222158
Ground Slab Assessment	Date	Date	Sheet No.
Zone 8 & 9	Jan 23		2

Estimated in-situ characteristic strength of concrete:

$f_{ck,is}$ = f_{mean} - ($t_{0.05}$ * s) = 40.0 N/mm2

Estimated design characteristic strength of concrete:

$f_{ck,cube}$ = $f_{ck,is}$ / 0.85 = 47 N/mm2

(adjusted for dry-cured samples)

Reinforcement: results are not clear so ignore
(Only bottom reinforcement is relevant for design purposes, so top reinf. ignored, for both bending and punching shear checks.)

Design-input data

Conservatively, assume following data for design purposes, as results from only three cores are available:

Baseplate size	=	200	mm	
Modulus of sub-grade reaction, k	=	0.02	N/mm^3	
Concrete compressive strength (cube), f_{cu}	=	25	N/mm^2	
Slab thickness, h	=	150	mm	
Bottom reinforcement included?	=	No	(Yes/No)	
Area of bottom reinforcement, A_s	=	252	mm^2/m	Not used
Depth to bottom reinforcement, d	=	150	mm	Not used

Derived data

The following data is derived from the above design-input data, using the procedures in Reference 1.

Equivalent contact radius, a = 113 mm

Concrete properties:

f_{ck}	=	20	N/mm^2	
f_{ctm}	=	2.2	N/mm^2	
$f_{ctk(0.5)}$	=	1.5	N/mm^2	
E_{cm}	=	30	kN/mm^2	
$f_{ctd,fl}$	=	2.1	N/mm^2	*Eqn (1)*
v_{max}	=	3.7	N/mm^2	
$v_{Rd,c}$	=	0.44	N/mm^2	*Eqn (12)*

Assumed data

Poisson's ratio, v	=	0.2	
Strength of steel, f_y	=	460	N/mm^2
Partial factor for steel, γ_s	=	1.15	
Partial factor for concrete, γ_c	=	1.5	

Design checks

Design checks are carried out in accordance with the procedures in Reference 1, for single, isolated, concentrated loads. (pairs of legs close together are treated as one)

Firstly, checks are carried out based on the bending strength of the slab, taking into account any reinforcement in the bottom of the slab. These checks are undertaken for three locations:

a) internal (remote from slab edges or corners)
b) edge (adjacent to a slab edge, but remote from a corner)
c) corner

For edge and corner locations it is assumed that the baseplate is adjacent to the edge or joint.

Secondly, checks are carried out based on the punching-shear strength of the slab again taking account of the any bottom reinforcement, and considering the same three locations.

Thirdly, the effect of load transfer across joints is considered.

All of these checks result in an estimate of the ultimate load capaciities for concentrated loads applied at the various locations. These are then converted into working load capacities by dividing by a global load factor of 1.5.

Finally, the critical load capacity for each location is determined as the lowest value from the above checks. For example for the internal location the critical value will be the lowest obtained from the bending, punching and load-transfer checks.

The critical design values are highlighted in the summary table on the last sheet.

Bending checks

Radius of relative stiffness, L	=	814	mm	*Eqn (20)*
Reinf. concrete moment capacity, M_{pfab}	=	0	kNm/m	*Eqn (3)*
Plain concrete moment capacity, M_{un}	=	8.0	kNm/m	*Eqn (2)*
a/l		0.14		

Ultimate capacities:

Internal,	Pui	=	90	kN	*Eqn (21/22)*
Edge,	Pue	=	55	kN	*Eqn (23/24)*
Corner,	Puc	=	33	kN	*Eqn (25/26)*

Punching checks

u1 = length of perimeter at a distance of 2d from the loaded area
depth to reinforcement, or 0.75 slab thickness if unreinforced, ds = 113 mm

Ultimate capacities:

Internal,	u1i	= 2214 mm	Rp = 0.06 P		*Eqn (31)*
	Ppi	= 117 kN		*Eqn (13)*	
Edge,	u1e	= 1307 mm	Rp = 0.13 P		*Eqn (32)*
	Ppe	= 74.6 kN		*Eqn (13)*	
Corner,	u1c	= 753 mm			
	Ppc	= 43 kN		*Eqn (13)*	

Load transfer at joints

Assuming joint is tied or dowelled, 15% of load is transferred by aggregate interlock.
For dowel, or fabric reinforcement, assume effective length of transfer along joint

Lte = 2 x 0.9 L = 1465 mm

Assuming 12mm dowels at 400 mm centres, and 10 kN per dowel *Eqn (16/17)*

transfer capacity, Psh = 25 kN/m

Total load transfer at joint, Pjt = Psh x Lte = 37 kN

Total capacity at joint = Pue / 0.85 + Pjt = 101 kN but </= Pui

Summary of results

Ultimate design load capacities, from the above calculations, are listed in the following table. These are converted to 'working load' capacities by dividing by: 1.5

Mode	Location	Ult. Load Capacity		Working Load Capacity	
Bending	Internal	90	kN	60	kN
	Edge	55	kN	36	kN
	Corner	33	kN	22	kN
	Joint	90	kN	60	kN
Punching	Internal	117	kN	78	kN
	Edge	75	kN	50	kN
	Corner	43	kN	29	kN
Recommended	**Internal**	**90**	**kN**	**60**	**kN**
Critical Design	**Edge**	**55**	**kN**	**36**	**kN**
Values	**Corner**	**33**	**kN**	**22**	**kN**
	Joint	**75**	**kN**	**50**	**kN**

Note: Edge and Corner locations are typically at the edge or corner of the building, or at the edge or corner of an area of slab isolated from from adjoining areas by full movement joints. Columns to be at least 927 mm from an edge for internal to apply, or the same distance from a corner for edge to apply.

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