

3.2.2 Hydrogeology

The Environment Agency (EA)⁸ has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set out for superficial and bedrock geologies and are based on the importance of aquifers for potable water supply and their role in supporting surface water bodies and wetland ecosystems.

The Boyn Hill Gravel Member and the Lambeth Group deposits are classified as *Secondary 'A' Aquifers*. According to the EA these can be described as: '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.' The London Clay Formation is Unproductive Strata and the underlying Chalk Formation is a *Principal Aquifer*.

The site is not situated within a groundwater Source Protection Zone (SPZ), although a Zone 3 'total catchment' area is situated approximately 1km to the east of the site. There are no licensed groundwater/surface water abstractions or discharge consents to groundwater/surface water within 500m of the site.

The nearest surface water bodies are the Whiteknights Lake and associated streams approximately 170m west of the site and an unnamed surface drain which runs through 'The Wilderness' area of woodland approximately 60m east of the site. The River Kennet is around 2.3km west and north of the site and the River Lodden is around 2.4km southeast of the site. Both join the River Thames to the north of the site.

The site is understood to be vulnerable to surface water flooding, and as such some surface water drainage manholes on site are used as soakaways. The site is considered to be at low risk from flooding relating to rivers or the sea⁹. A groundwater flood risk potential plan has been produced for the site, which indicates that the majority of the site is considered to be at medium risk from groundwater flooding (Plate 3). This risk will need to be considered during the design of the proposed development.

⁸ [Magic Map Application \(defra.gov.uk\)](https://magic.defra.gov.uk/) [Accessed March 2024].

⁹ [Your long term flood risk assessment - Check your long term flood risk - GOV.UK](https://gov.uk/guidance/your-long-term-flood-risk-assessment-check-your-long-term-flood-risk) [Accessed March 2024].

Plate 3. Groundwater Flood Risk Potential



3.2.3 Environmental Setting

The following designations and features have been identified for the site and surrounding area¹:

- Ecologically sensitive or ecologically important sites are not located within 500m of the site,
- Several listed buildings are located within 500m of the site:
 - The Grade II listed 'The Citadel', Reading/Region 6 War Room is located adjacent to the southeast boundary of the site, which is understood to contain asbestos within the building fabric³.
 - The Grade II listed South Lodge.
 - The Grade II listed North Lodge.
 - A Grade II listed landscape garden feature.
- There is one recorded pollution incident to controlled waters located 370m west of the site classified as Category 3 (Minor Incident).
- Historical or current licensed landfill sites are not located within 500m of the site.
- There is one current fuel station located 240m northeast of the site located off Wilderness Road/Wokingham Road.

- There are records of a single historical tank mapped in the 1980s located in the southeast of the site.
- The site is categorised as being at *Low Risk from all UXO (unexploded ordnance) types*.
- The site is in a low radon probability area (where <1% of homes are expected to be at or above the action level).
- There are several services and significant site facilities on site associated with the existing development:
 - HV and LV power cables associated with facility feeds and street lighting.
 - A substation in the northeast corner of the site.
 - A telecommunications cable associated with inter-university communications.
 - Surface water and foul water drainage systems with surface water soakaways as deep manholes.
 - CCTV.
 - Earthing infrastructure.
 - Some suspected 'unidentified' service routes.
 - Below ground fuel supply pipework is suspected adjacent to the War Room.
- The University of Reading Harry Pitt Building adjacent to the west of the site contains an MRI scanner with significant re-calibration tasks and costs associated with it being taken off-line/becoming operational. Its 'delicate' status makes it vulnerable to physical vibrations and electrical continuity throughout all stages of site development (demolition, preparation and clearance, and redevelopment).

4. PREVIOUS GROUND INVESTIGATION

4.1 Atkins Investigation, dated October and November 2022

A site investigation was carried out by Geotechnics Limited in October and November 2022, on behalf of Atkins which included the following:

- Four (4 No.) Dynamically Sampled Windowless / Cable Percussion boreholes (BH01 to BH04) with rotary follow on (up to 25m bgl);
- Twenty four (24 No.) trial pits, completed using a mixture of machine, hand, and vacuum excavation methods (TP01 to TP05, IP01 to IP14);
- Nine (9 No.) In-situ California Bearing Ratio (CBR) tests;
- Three (3 No.) In-situ Plate Load tests;
- Two (2 No.) asphalt road pavement core samples;
- Two (2 No.) soil electrical resistivity tests;
- Installation of four groundwater standpipes within boreholes BH01 to BH04 during the site works period;
- Post-fieldwork monitoring of groundwater levels (for a period of six return visits); and
- Geotechnical and geo-environmental laboratory testing of soil, leachate, and groundwater samples obtained during the ground investigation.

Based on the above information, CGL produced a Geotechnical and Geoenvironmental Factual and Interpretive Report⁴ for MACE, dated September 2023.

5. SUPPLEMENTARY CGL GROUND INVESTIGATION

5.1 Site Investigation

The CGL supplementary site investigation was carried out between 19th and 22nd February 2024 and comprised the following:

-  Specialist service clearance of all exploratory hole locations for buried services using Ground Penetrating Radar (GPR) and CAT & Genny tools prior the intrusive investigation. Additionally elevation and GPS Coordinates were produced for each infiltration and CBR location;
-  Six (6 No.) infiltration test pits (SW01 to SW06) with tests undertaken from depths of between 0.62m below ground level (mbgl) (66.10mOD) and 1.10mbgl (65.17mOD) in accordance with BRE 365¹⁰; and
-  Thirteen (13 No.) in-situ California Bearing Ratio (CBR) tests by a CBR apparatus to depths of between 0.85m (65.75mOD) and 1.16m (65.35mOD).

In addition to the above, CGL provided a twin drum vibration roller for the Client's team (Create Consulting Engineers Limited) to undertake a monitoring exercise to record and monitor the vibrations emitted from tracking of the roller.

A traffic marshal was present during the site works in order to secure safe movement of the equipment/plant across the site.

Results of the vibration monitoring are anticipated to be presented under separate cover by Create Consulting Engineers Limited.

5.2 Testing Rationale

The testing rationale was based on the BDP SI specification report¹¹ provided to CGL by MACE and is presented overleaf. The testing depths were followed as closely as possible, allowing for on - site constraints.

¹⁰ BRE. (2016). *Soakaway design*. BRE DG 365

¹¹ BDP (2023) ECMWF Stage 4 Site Investigation: Scope of Works. Doc Ref: P3002898-BDP-C-SI-01 Rev R01

Table 1. Summary of proposed infiltration testing depths

<i>Location ID</i>	<i>Ground Level (mOD)</i>	<i>Test level (mOD)</i>	<i>Test depth (mbgl)</i>
SW101	66.69	66.10	0.59
SW102	66.60	65.80	0.80
SW103	66.62	66.10	0.80
SW104	66.20	65.20	1.00
SW105	66.50	65.60	0.90
SW106	66.71	65.80	0.91

Notes

*mbgl=meters below ground level

*mOD= meters Ordnance Datum

Table 2. Summary of proposed CBR testing depths

<i>Location ID</i>	<i>Surface</i>	<i>Ground Level (mOD)</i>	<i>Test level (mOD)</i>	<i>Test depth (mbgl)</i>
CBR101	Grass	66.71	65.71	1.00
CBR102	Tarmac	66.61	65.54	1.07
CBR103	Tarmac	66.69	65.54	1.15
CBR104	Tarmac	66.56	65.70	0.86
CBR105	Tarmac	66.50	65.35	1.15
CBR106	Grass	66.57	65.68	0.89
CBR107	Tarmac	66.45	65.49	0.96
CBR108	Un-surfaced	66.03	65.13	0.90
CBR109	Grass	66.18	65.06	1.12
CBR110	Grass	66.25	65.22	1.03
CBR111	Tarmac	66.57	65.42	1.15
CBR112	Grass	66.68	65.67	1.01
CBR113	Grass	66.48	65.63	0.85

5.3 Ground Conditions

The ground conditions encountered during the CGL supplementary investigation are summarised in Table 3 overleaf.

An exploratory hole location plan is included as Appendix A.

The infiltration testing logs can be found in Appendix B.

Table 3. Summary of ground conditions encountered during CGL supplementary investigation

Strata	Depth to top of stratum mbgl (mOD)	Thickness (m)	Locations encountered
Tarmacadam / Paving slab	0.00 (66.60 to 66.62)	0.05	SW102 and SW103
Made Ground Dark grey gravelly slightly sandy clay / silt with gravel of charcoal and red brick fragments over dark grey silty gravel with flint gravel and red brick fragments.	0.00 (66.20 to 66.71)	0.35 to 0.60	All
Boyn Hill Member Greyish yellow slightly gravelly silty SAND.	0.40 (66.20 to 66.22)	0.40 to 0.44	SW102, SW103, SW104 and SW105
Dark grey silty GRAVEL of flint.	0.40 to 0.50 (66.21 to 66.29)	Base not proven	SW101 and SW106

5.4 Made Ground

Made ground was encountered in all locations and generally comprised dark grey gravelly sandy clay / silt with gravel of flint, rare gravel of charcoal and red brick fragments. Below this, a layer of dark grey silty gravel was encountered within locations SW104 and SW106. Tarmacadam or paving materials were encountered above the made ground within SW102 and SW103.

5.5 Boyn Hill Member

The Boyn Hill Member was encountered in all locations and was proved to the maximum depth investigated of 1.00mbgl (65.20mOD). This material typically comprised greyish yellow to yellow slightly gravelly silty fine and medium sand with fine to coarse subangular to subrounded flint gravel. Within SW101 and SW106, the formation comprised dark grey silty fine to coarse subangular to subrounded gravel of flint.

5.6 Groundwater

Groundwater strikes were recorded in the base of soakaway trial pits SW102, SW103, SW104 and SW105, as summarised in Table 4 overleaf. It should be noted that within the locations SW101 and SW106 no groundwater was encountered.

Table 4. Summary of groundwater strikes

Location	Depth m (mOD)
SW102	0.80 (65.80)
SW103	0.80 (65.82)
SW104	1.00 (65.20)
SW105	0.90 (65.60)

6. GEOTECHNICAL INTERPRETATION & RECOMMENDATIONS

6.1 General

The following section provides recommendations for the proposed development regarding geotechnical aspects, based on the information obtained during the ground investigations at the site and the laboratory results.

6.2 Soakaway Testing

A total of six (6 No.) infiltration test pits were completed to enable soakaway testing in accordance with BRE 365¹⁰. The trial pits were excavated with a mini excavator with a 0.5m wide toothless bucket and the water for each test was supplied using a tractor towed water bowser.

Generally, the ground conditions encountered during the soakaway testing were found to be consistent with the previous investigation undertaken by Atkins³, comprising Made Ground over the Boyn Hill Member formation.

A summary of the infiltration tests is provided in Table 5 below. The trial pit logs and soakaway calculation sheets are included in Appendix B and Appendix C respectively.

Table 5. Soakaway testing results

Location	Target Stratum	Depth of test (m bgl)	Depth of test (mOD)	Infiltration Rate (m/s)	Notes
SW101	Boyn Hill Member (Gravel)	0.59	66.10	1.84 x 10 ⁻⁵	Pit stable
				1.22 x 10 ⁻⁵	
				1.30 x 10 ⁻⁵	
SW102	Boyn Hill Member (Sand)	0.80	65.80	2.96 x 10 ⁻⁶	Test Incomplete ¹
SW103	Boyn Hill Member (Sand)	0.80	65.82	-	Test Incomplete ²
SW104	Boyn Hill Member (Sand)	1.00	65.20	-	Test Incomplete ²
SW105	Boyn Hill Member (Sand)	0.90	65.60	-	Test Incomplete ²
SW106	Boyn Hill Member (Gravel)	0.91	65.80	-	Test Incomplete ³
				7.62 x 10 ⁻⁶	

Table notes

¹ Test incomplete, only one 'run' was completed.

² Test incomplete, due to slow infiltration rate and time constraints

³ Test incomplete, only two 'runs' were completed.

The results of the soakaway testing indicate infiltration rates are generally in the order of $\times 10^{-5}$ m/s to 10^{-6} m/s where a single test (SW101) was completed in accordance with BRE 365 guidance. Testing in locations SW102 to SW106 was not completed in accordance with BRE 365¹⁰ due to three full tests not being achieved as a result of slow infiltration rates and time constraints on site. Extrapolation of the results of the remaining failed locations was not undertaken as a second or third test was not possible due to time constraints.

6.3 CBR Testing

A total of thirteen (13 No.) in-situ CBR tests were undertaken by using a CBR apparatus in order to assess the CBR value of the near surface soils. The values recorded, varied between 1.4% and 10.9%, whilst in a few locations the test refused due to the soil density and compaction. A summary of all recorded CBR values is presented in Table 6. The CBR sheets are included in Appendix C.

Table 6. CBR testing results

<i>Location</i>	<i>Depth of test (mbgl)</i>	<i>Test Level (mOD)</i>	<i>Accepted CBR Value %</i>	<i>Notes</i>
CBR101	1.00	65.71	3.7	Test successful
CBR102	1.07	65.54	6.7	Test successful
CBR103	1.15	65.54	7.5	Test successful
CBR104	0.86	65.70	1.4	Test successful
CBR105	1.15	65.35	5.7	Test successful
CBR106	0.89	65.68	1.5	Test successful
CBR107	0.96	65.49	-	Test refused due to gravels
CBR108	0.90	65.13	-	Test refused due to gravels
CBR109	1.12	65.06	-	Test refused due to gravels
CBR110	1.03	65.22	-	Test refused due to gravels
CBR111	1.15	65.42	3.5	Test successful
CBR112	1.01	65.67	10.9	Test successful
CBR113	0.85	65.63	2.8	Test successful

It is anticipated that formation levels beneath areas of new hardstanding will be founded in Boyn Hill Gravel. Based on the results of the investigation and in-situ CBR testing, the following CBR values for the Boyn Hill Gravel have been determined:

- For the Boyn Hill Gravel, a design CBR value of 2% should be adopted for the pavement design at this stage.

All materials within 450mm of the road surface should be non-frost susceptible. The final design values detailed above should be determined once a source of fill material is known and verified prior to and

during construction. The design subgrade CBR values should be based upon the guidance presented within CD225¹².

During construction, it is recommended that the sub-grade formation layer be proof rolled prior to placement of the first layer of engineered fill material with any soft spots or loose deleterious areas identified during the proof roll removed and replaced with Engineered Fill. Any soft and/or compressible deposits identified in areas of proposed fill should be excavated and removed prior to the placement of Engineered fill. It is recommended that a suitably qualified geotechnical engineer inspects the formation prior to the commencement of backfill works.

It should be noted that for some of the locations, the test was carried out under wet conditions and this is considered to be the reason for some of the lower CBR values recorded. Careful management of road / pavement construction is recommended during periods of wet weather to protect the formation level and to minimise softening of the near surface layers.

During the previous investigation carried out by Atkins, CBR tests were undertaken in 9 No. locations using the TRL-DCP in-situ test method, to a maximum depth of approximately 1.20m. The average CBR values for depths of between ground level and 0.50m were 3% to 5%, whilst for depths between 0.50m and 1.20m were above 20%.

¹² CD 225 Design for new pavement foundations IAN 73/06 revision 1 (2009), HD 25/94

APPENDIX A

Exploratory Hole Records

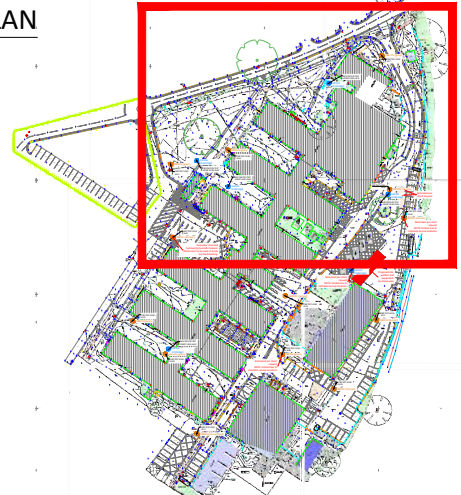


KEY



Soakaway

KEYPLAN



Location ID	Ground level (mOD)	Test invert level (mOD)	Test depth (mbgl)
SW101	66.69	66.10	0.59
SW102	66.60	65.80	0.80
SW103	66.62	65.82	0.80
SW104	66.20	65.20	1.00
SW105	66.51	65.60	0.90
SW106	66.71	65.80	0.91

Location ID	Surface	Ground level (mOD)	Test level (mOD)	Test depth (mbgl)
CBR101	Grass	66.714	65.714	1.00
CBR102	Tarmac	66.614	65.544	1.07
CBR103	Tarmac	66.691	65.541	1.15
CBR104	Tarmac	66.563	65.703	0.86
CBR105	Tarmac	66.504	65.354	1.15
CBR106	Grass	66.569	65.679	0.89
CBR107	Tarmac	66.448	65.488	0.96
CBR108	Un-surfaced	66.033	65.133	0.90
CBR109	Grass	66.181	65.061	1.12
CBR110	Grass	66.252	65.222	1.03
CBR111	Tarmac	66.573	65.423	1.15
CBR112	Grass	66.676	65.666	1.01
CBR113	Grass	66.482	65.632	0.85

4	08/03/2024	Revised following completion of the site works
3	05/02/2024	Revised following Mace/BDP comments
2	26/01/2024	Revised following new liaison with University
1	18/01/2024	Revised following new client drawing
0	17/01/2024	First Issue
Rev	Date	Comments



Project **Reading ECMWF Headquarters**

Client **Mace Construct Limited**

Drawing title **Exploratory Hole Location Plan**

Scale(s) NTS	Job No. CGL/10078A
Drawn CGH 10/03/2024	Dwg No. CGL10078A - Sketch 1
Checked JSB 11/03/2024	Rev. 4
Approved RNS 11/03/2024	

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KEY

CBR

Soakaway

KEYPLAN

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Project

Reading ECMWF Headquarters

Client

Mace Construct Limited

Drawing title

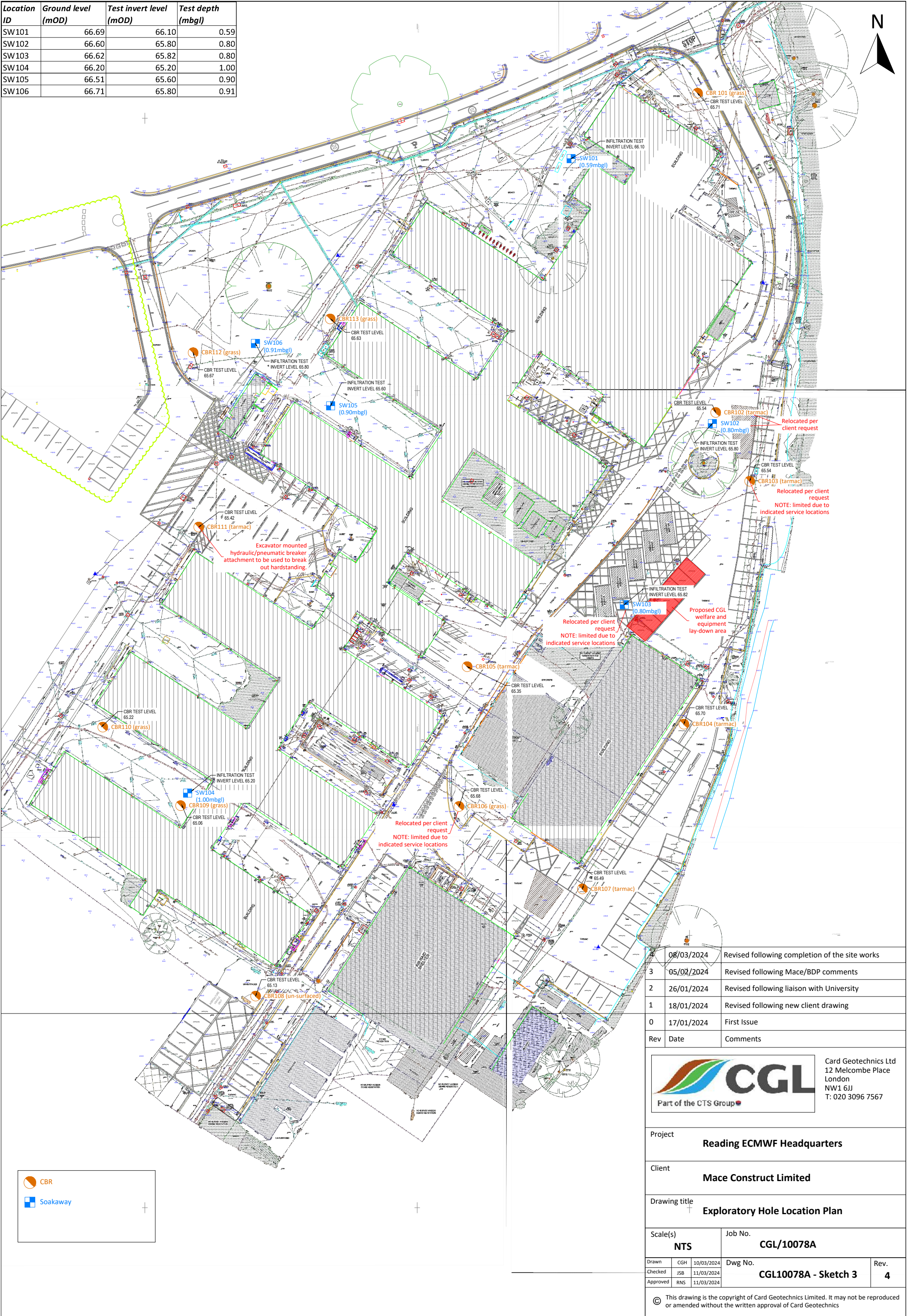
Exploratory Hole Location Plan

Scale(s)	Job No.
NTS	CGL10078A

Drawn	CGH	10/03/2024	Dwg No.	Rev.
Checked	JSB	11/03/2024	CGL10078A - Sketch 2	4
Approved	RNS	11/03/2024		

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SW106	66.71	65.80	0.91



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Client	Mace Construct Limited		
Drawing title	Exploratory Hole Location Plan		
Scale(s)	NTS	Job No.	CGL/10078A
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Approved	RNS 11/03/2024		
		Rev.	4

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APPENDIX B

Trial Pit logs

Project Title: ECMWF - New Headquarters - CBRs							Status: FINAL		Location ID SW101		 Card Geotechnics Limited, 12 Melcombe Place, London, NW1 6JJ www.cgl-uk.com	
Client: Mace Construct Limited							Location Type: Trial pit/trench					
Method and Plant Used				Groundwater								
From (m)	To (m)	Type	Plant Used	Strike (m)	Time (min)	Rose To						
0.00	0.59	TP	Mini Digger									
							Coords: 474178.925E/171792.928N Level: 66.689m					
							Final Depth: 0.59 m					
							Orientation: 0° Inclination: 90°					
							Date Start: 20/02/2024 Date End: 20/02/2024					
							Sheet 1 of 1					
Samples & Tests				Water Level (m)	Legend	Strata Depth (m)	Level (m)	Strata Description			Inst/ Backfill (m)	Depth (m)
Sample Depth (m)	Type/ Ref	Tests/Results										
0.40 - 0.59	B 1					0.40	66.29	Grass over dark grey slightly gravelly slightly sandy clay/silt. Gravel is subangular to subrounded fine to coarse of flint. Rare subangular to subrounded fine to medium gravel of charcoal and red brick fragments. [MADE GROUND]				
						0.59	66.10	Dark grey silty GRAVEL. Gravel is subangular to subrounded fine to coarse of flint. [BYON HILL MEMBER]				
					EOH at 0.59m - Terminated as target depth reached							
												1
												2
Notes:							Soakaway Tests				Scale: 1:10	
1. Topsoil scraped back and placed aside in order to undertake trial pit excavation. 2. Infiltration test carried out in accordance to BRE 365. 3. Trial pit was stable during testing. 4. Trial pit was backfilled with arisings and topsoil was reinstated to original state. 5. Weather: Overcast / Dry							Test No.	Date	Duration (hh:mm)	Infiltration Rate	Logged By: SJP	
							1	20/02/2024	02:00	0.00001840 m/s	Checked By: JSB	
							2	20/02/2024	02:17	0.00001220 m/s	Approved By: MPC	
							3	20/02/2024	01:00	0.00001300 m/s		
							Pit Details				Section ID:	
Stability				Shoring	Length (m)	Width (m)	CGL Reference					
Stable					1.00	0.50	CGL_10078A					

[illegible]

[illegible]

[illegible]