

EOS Inc Limited

Gateway 36 – Phase 3 Development

Geotechnical Design Report
Mineshafts 435401-002 and 435401-003

325389-R05 (00)

RSK GEOSCIENCES

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RSK GENERAL NOTES

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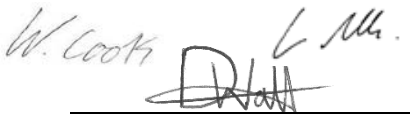
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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

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1 INTRODUCTION

RSK Environment Limited (RSK) have been instructed by EOS Inc Limited (EOS) to conduct an intrusive investigation and to prepare a Geotechnical Design Report relating to the two recorded mineshafts (Coal Authority reference 435401-002 and 435401-003) on the Phase 3 area of the Gateway 36 development site, Hoyland, South Yorkshire. A site location plan is presented on **Figure 1.**

The project was carried out to an agreed brief as set out in RSK proposals, reference 322638TL04A dated 19 May 2021 and 325389TL03(00) dated 26 August 2021, and work was undertaken under Coal Authority permit reference 20223_1 dated 17 June 2021, a copy of which is provided in **Appendix A**

The Phase 3 site is proposed for commercial development. A single Unit, of approximately 350,000 square feet, is proposed to the centre south of the development plot, which is presented on **Figure 2.** Over most of the building area ground levels are to be cut to achieve platform development levels and a programme of ground treatment works (by surcharging) are currently underway. Mine shaft 435401-003 lies outside of the proposed building area to the southwest and mine shaft 435401-002 lies beneath the western end of the proposed building.

This Design Report presents the finding of the recently completed investigation and assessment work. It also includes background information gained from a series of previous ground investigations carried out by RSK. This available information is then used to consider the structural integrity of the existing shaft caps and their ability to support the proposed development. An outline of the report is as follows:

- **Section 1** and **Section 2** – Relevant background information
- **Section 3** – Recent site investigation works for the two mine shafts
- **Section 4** and **Section 5** – Laboratory analyses and results
- **Section 6** – Structural assessment of existing caps
- **Section 7** – Conclusions.

1.1 Background

The site was historically subject to deep coal mining (Rockingham colliery operated by the NCB and closed in 1979) and was subsequently subject to surface coal mining (the Rockingham opencast site operated by RJB Mining in the 1990's). The two mine shafts, which are the subject of this report (Coal Authority reference 435401-002 and 435401-003), were the main mine entries of the Rockingham colliery. Although other mine entries were present, these were all removed during the subsequent opencast mining operations. When the opencast operations achieved base of excavation the two mine shafts were treated by backfilling (in 1990) and capping at rockhead in 1992. The opencast void was then backfilled (with locally derived re-worked overburden materials) and these operations were largely completed by 1997.

RSK have been involved in site investigation and assessment work for the wider site since 2013 and were previously involved in the assessment and development of the Hoyland

Business Park site which lies to the east, which is also underlain by opencast backfill. Several investigations have been completed, including a long-term large scale load test on the Phase 3 area and relevant information from these investigations is included in **Section 2.3**.

The loading test, and previous assessment work completed, has demonstrated that the opencast backfill is susceptible to load induced settlement. Consequently, where the new building is proposed ground treatment by surcharging will be required to induce a significant proportion of the anticipated ground settlement in advance of construction. This approach was successfully undertaken for the Hoyland Business Park and is underway for both the Phase 2 development area (to the south of the Parkway) and the Phase 3 area (the subject site).

The proposed development platform for Phase 3 requires existing ground levels to be reprofiled to provide a level building area. Over most of the building area ground levels are to be cut (by up to 7 m) and outside the building platform to the north levels have to be raised in the service yard area. In the vicinity of the two mine shafts ground levels are to be cut by approximately 2.50 m and 5 m, however at both locations surcharge treatment works are proposed which will include a 6 m high surcharge over the building footprint and perimeter area.

1.2 Objectives

The objective of this report is to present information from the recent intrusive investigation and to allow a structural assessment relating to the reinforced concrete caps on two Coal Authority recorded mineshafts (reference 435401-002 and 435401-003), which are present within the Phase 3 development plot. The specific objectives were:

- confirm the depth to, and lateral extents of, the shaft cap (where access allowed) of mineshafts 435401-002 and 435401-003
- drill through each of the shaft caps to confirm the presence of the shaft, the thickness of the cap and to determine if is infilled or voided to the full depth of drilling
- recover core from the cap for logging and laboratory testing
- recover core from rockhead for logging and laboratory testing
- using the findings of the intrusive investigations to complete a structural assessment of the mine shaft caps to assess their suitability for retention and to support the proposed development.

The Coal Authority reviewed and agreed the approach proposed by RSK scope of works (reference 322638TL04 dated 1 June 2020).

1.3 Limitations

The information presented in this report is based on the ground conditions encountered during the site work and on the results of tests made in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. Depth to rockhead is based on recovery of samples and contextual information regarding the site history.

This report is subject to the RSK service constraints agreed with the appointment between EOS and RSK.

2 THE SITE

2.1 Site location

Site location details are presented in Table 1 and a site location plan is provided on **Figure 1.**.

Table 1 Site location details

Site name	Gateway 36 development site – Phase 3
Location	Land to north of Dearne Valley Parkway, Hoyland
National Grid reference (centre of site)	435403, 401141

2.2 Site description

The site covers an area of approximately 10.5 hectares. It is bounded to the west by the Rockingham 1 development area and an associated SUDS pond, to the north by open agricultural fields, to the west by Hoyland Business Park and to the south by the dual carriageway (the Parkway) beyond which is the Phase 2 development area.

An access estate road leading off the Dearne Valley Parkway is currently under construction, and a scheme of ground treatment (surcharging) of the building footprint was started in July 2021.

Historically, the site was subject to deep underground mining (Rockingham Colliery from pre-1893 to 1979) and used for opencast coal mining (1991 to 1995), and subsequent backfilling and restoration, which was completed by 2002.

As a result of the former opencast extraction of coal a significant thickness of made ground is present beneath the site. This comprises the excavated overburden material required to gain access to the coal seams and then replaced to infill the ensuing void space after the opencast coal extraction. This is recorded to have been placed primarily as non-engineered (uncontrolled) backfill though engineered fill was placed to support the Dearne Valley Parkway and is recorded to have been built up from the base of the pit.

Most of the mine entries recorded on site have been removed during the opencast works. The two recorded mine entries remaining are detailed below:

- shaft 435401-002, plugged at the depth of the Flockton seam in 1990, partially removed by opencast mining and capped at the base of the opencast workings in June 1992
- shaft 435401-003, was filled in 1990, partially removed by opencast mining and capped at the base of the opencast workings in June 1992.

2.3 Previous Investigations

RSK have carried out several phases of site investigation work across the wider site including the Rockingham 1 area (already developed and lying to the west of the subject site), the Phase 2 area (lying to the south of the Parkway) and the Phase 3 area (the subject site). The investigations were completed between 2013 and the present day. The investigations included trial pits, shallow cable percussive boreholes and window sample boreholes and deeper rotary openhole and cored boreholes. The work also included a large-scale load test, which was located on the Phase 3 development area over mine shaft 435401-002.

Many reports have been produced by RSK, but the main ones include:

- RSK Report Reference 321393 – R1 (01), dated July 2013: Rockingham, South Yorkshire: Appraisal of Ground Conditions and Coal Mining Review
- RSK Report Reference 321393 – R4 (01), dated April 2015: Geo-environmental Site Assessment: Rockingham 3
- RSK Report Reference 322494-R1 (00), dated February 2019; Preliminary Risk Assessment and Coal Mining Risk Assessment: J36 Phase 2, Rockingham
- RSK Report Reference 322638-R1 (01), dated December 2019; Preliminary Risk Assessment and Coal Mining Risk Assessment: J36 Phase 2 Phase 2B and Phase 3, Rockingham
- RSK Report Reference 322638-R02 (01), dated May 2020: Geo-environmental and Geotechnical Site investigation: J36, Phases 2 and 3, Rockingham

2.3.1 Ground conditions

The key findings from the above investigations are summarised within RSK report 325389-R01(00) and are presented below.

Previous ground investigations undertaken by RSK in 2015 and 2019 have confirmed the expected presence of a variable thickness of opencast backfill across the Phase 3 area, ranging between approximately 20 m in the west and 50m in the east (west of Elsecar Fault), and up to 20 m east of the fault. Backfill materials generally comprised an upper layer of re-worked natural slightly gravelly clay, which in-turn is underlain by opencast backfill generally comprising firm to stiff friable clay with a significant proportion of granular material comprised of gravels, cobbles and boulders of grey mudstone, sandstone and siltstone.

The underlying bedrock is recorded as being Pennine Middle Coal Measures Formation, comprising mudstone, siltstone and sandstone with coal seams.

The Elsecar Fault is present beneath the eastern part of the site, which it crosses in a northwest to southeast direction and is downthrown by between 60 m and 70 m on the north eastern side. As a result, across the subject site the thickness of opencast backfill increased progressively towards the east and the fault plane and over the fault and further to the east a second area of opencast workings were present which extended off-site beneath the adjacent Hoyland Business Park area and eastern part of the Phase 2 development area. Coal seams were removed by opencast mining at a shallower depth

to the east of the fault. Consequently, a buried high wall is present through the site which in part coincides with the location of the Elsecar fault.

Rotary boreholes have been advanced to rockhead to confirm the full thickness of opencast backfill and validate the depth of previous opencast workings recorded on abandonment plans.

2.3.2 Large-scale load test

RSK have carried out large-scale surcharge load tests to assess the settlement characteristics of the backfill materials present within the plot during 2016.

This load test was designed to apply a load of approximately 100 kN/m^2 across a broad ground surface of 40 m by 55 m, which would apply stress to the full depth of opencast backfill. The test was designed to mimic the area and load expected to be exerted by a typical light industrial or commercial building. Settlement monitoring infrastructure comprising two hydrostatic profile gauges and one extensometer were installed prior to construction. Following baseline readings, settlement was monitored during construction and post-construction within the shallow surface beneath the footprint of the load test (using two hydrostatic profile gauges) as well as settlement through the backfill profile using a borehole installed with magnet extensometers.

Typical settlements of 200 mm were recorded toward the centre of the surcharge mound, with generally 70 percent of the total settlement being recorded shortly after placement, and the results for the shallow magnets generally showed a pattern of rapid settlement during the mound construction, followed by stability once the mound was complete. Little settlement was recorded at or below 10.40 m depth.

2.3.3 Previous mineshaft investigation

An initial phase of investigation of the two shafts was attempted in February 2020. This was of limited success, as stockpiled materials were present completely restricting access to one shaft, but limited investigation was possible for shaft 435401-003. A borehole (RBH521) was sunk to 23.80 m below ground level by rotary openhole methods, where it encountered an obstruction (expected to be the concrete shaft cap). The open borehole was then dipped (with a dipmeter) to confirm depth and see if standing water was present, however the site engineer who carried out the work could not bottom out the borehole (48 m). Although this was anomalous with the drilled depth the site engineer thought that the borehole may have broken through the shaft cap and possibly entered a voided section beneath it. A monitoring standpipe (50 mm diameter HDPE) was then installed to keep the borehole open and allow subsequent monitoring. When this was subsequently dipped (on several occasions), the dipmeter could only be dropped to a depth of 22 m. The anomalous conditions in RBH521 were subsequently discussed with the client and the Coal Authority and a revised borehole investigation was agreed (RSK document reference 322638TL04, dated 1 June 2020). It was agreed that these works would take place at a later date, once access to both mineshafts was available.

2.4 Expected Ground Conditions above Mineshafts

Based on the abandonment plans and the previous investigations detailed in **Section 2.3** above, it was expected that 435401-002 shaft cap would be present between 102 mAOD and 104mAOD, which would be 27 m and 29 m below ground level (at the time of drilling). It was expected that 435401-003 shaft cap would be present between 106 mAOD and 108 m AOD, which would be 21 m and 23 m below ground level (at the time of drilling).

It was expected that backfill materials would be encountered to the top of the caps and surrounding rockhead, and that rockhead would comprise Coal Measures bedrock comprising mudstone, siltstone and sandstone.

2.4.1 Groundwater Conditions

The previous investigations have included monitoring of groundwater levels in both shallow and deep boreholes. Monitoring of the deeper boreholes (installed into bedrock) has been carried out from 2013 to 2020. The monitoring has confirmed that deeper groundwater levels have remained largely stable during the monitoring period. Limited fluctuations, as would be expected, have been recorded.

There are two deep monitoring installations in the vicinity of the proposed building Unit on Phase 3, including borehole RBH305 (closest to the mine shafts some 40 m to the east) and RBH306 (a further 300 m to the north east). The most recent monitoring of these boreholes in 2019 and 2020 recorded stable levels at an average elevation of 100.26 m AOD in borehole RBH305 and at 91.76 m AOD in RBH306. These levels are within the opencast backfill materials; at RBH305 approximately 4 m above rockhead level; and in RBH306 some 11 m above rockhead level. The mine shafts are located further to the west, where rockhead is at more shallow depth and, on the basis of extrapolating the piezometric surface from the two monitoring boreholes, standing deep groundwater levels would be expected at an elevation of approximately 101 m AOD in the vicinity of the shafts, which is close to bedrock level.

3 SITE WORKS

The intrusive investigation works were carried by Groundsource Drilling & Contracting Limited using a Casagrande C6 rig, under the full-time supervision of an RSK engineer. The work was undertaken under Coal Authority permit reference 20223_1 dated 17 June 2021, a copy of which is provided in **Appendix A**.

Boreholes were advanced by rotary openhole drilling methods and cores were recovered by water-flush to allow the visual inspection and logging of materials present and selection of samples for laboratory testing. Water-flush was used whilst drilling beneath the shaft caps.

3.1 Borehole investigation

Clearance for services was undertaken on 18 June 2021 and the intrusive work was completed between 21 June and 5 July 2021. The investigation works included the drilling of 24 rotary probeholes in total.

The drilled probeholes and termination depths (meters below ground level, mbgl) are listed below:

Coal Authority reference 435401-002

- Shaft-002 (drilled on CA recorded position): 42.00 m bgl
- BH201: 28.00 m bgl
- BH202: 33.00 m bgl
- BH203: 28.00 m bgl
- BH204: 33.00 m bgl
- BH205: 27.80 m bgl
- BH206: 27.80 m bgl
- BH207: 28.00 m bgl
- BH208: 33.00 m bgl
- BH209: 33.00 m bgl
- BH210: 28.00 m bgl
- BH211: 33.00 m bgl
- BH212: 33.00 m bgl
- BH213: 28.00 m bgl.

Coal Authority reference 435401-003

- Shaft-003 (drilled on CA recorded position set out by Principal Contractor): 42.00 m bgl
- BH003A (drilled on CA recorded position set out by RSK): 42.00 m bgl
- BH301: 22.20 m bgl

- BH302: 22.20 m bgl
- BH303: 27.00 m bgl
- BH304: 22.50 m bgl
- BH305: 27.00 m bgl
- BH306: 22.50 m bgl
- BH307: 27.00 m bgl
- BH308: 22.00 m bgl.

Rock-core locations

- Rockhead probehole: 30.00 m bgl
- Rockhead core hole: 28.40 m bgl.

The ground conditions encountered, sample descriptions and indicated depth to rockhead are presented in the borehole records in **Appendix B** and photographs of the site works are presented in **Appendix C.**

A plan showing the probehole locations for mineshafts 435401-002 and 435401-003 are presented in **Figure 3** and **Figure 4.** A plan showing the confirmed mineshaft locations and assumed extent in relation to the proposed development layout are presented in **Figure 5.**

4 LABORATORY ANALYSIS

The following geotechnical and petrological laboratory tests were scheduled on samples recovered from the cores from the associated locations.

4.1 435401-002

- compressive strength of reinforced concrete core
- point load test of reinforced concrete core
- chloride, alkali, cement and sulfate content of concrete reinforced core
- petrographic analysis of reinforced concrete core.

The reported laboratory results are provided in **Appendix D**.

4.2 435401-003

- compressive strength of reinforced concrete core
- point load test of reinforced concrete core
- chloride, alkali, cement and sulfate content of concrete reinforced core
- petrographic analysis of reinforced concrete core
- petrographic analysis of recovered shaft fill material.

The reported laboratory results are provided in **Appendix D**.

4.3 Burnt shale material

- petrographic analysis of burnt shale material, reference by the laboratory as 'Fired Clay Material'. This is a sample of burnt shale from the ground surface to allow comparison with the recovered shaft fill material.

The reported laboratory results are provided in **Appendix D**.

4.4 Rock core

- point load test at surface of rock (shallowest depth).

The reported laboratory results are provided in **Appendix D**.

5 LABORATORY RESULTS

A summary of reported laboratory testing results are provided below.

Compressive strength of the concrete cores ranged from 53.1 N/mm^2 to (C1, shaft cap 435401-002) to 59.1 N/mm^2 (sample C2, shaft cap 435401-003).

Reported mean axial point load index for shaft cap 435401-002 was 2.52 MN/m^2 and mean diametral point load index was 3.65 MN/mm^2. The reported mean axial point load index for shaft cap 435401-003 was 2.47 MN/m^2 and mean diametral point load index was 2.87 MN/mm^2. The reported mean axial point load index for the recovered core from rockhead at 25.40 m bgl was 1.91 MN/m^2 and mean diametral point load index was 0.65 MN/mm^2.

Petrographic analysis of recovered concrete core from shaft 435401-002 identified partially crushed heterogenous quartzitic gravel, nominal 20 mm maximum sized, very angular to well rounded, continuously graded, evenly distributed and randomly orientated particles. The upper part of the core comprised a horizontal, 16 mm diameter, ribbed steel reinforcement bar. The lower end of the core recovery exhibited two horizontal 40 mm diameter, ribbed, steel reinforcement bars at 738-832 mm depth from the upper surface of the core. A full petrographic description is provided in **Appendix D**.

Petrographic analysis of recovered concrete core from shaft 435401-003 identified two types of concrete within the core Concrete I coarse aggregate was comprised of partially crushed heterogenous quartzitic gravel, nominal 14 mm maximum sized, very angular to well rounded, continuously graded, evenly distributed and randomly orientated particles. Concrete II coarse aggregate comprised partially crushed heterogenous quartzitic gravel, nominal 14 mm maximum sized, very angular to well rounded, continuously graded, evenly distributed and randomly orientated particles. 40 mm diameter reinforcement comprised of ribbed steel reinforcement bars were present at 400-440 mm and 546-584 mm depths from the upper surface.

Petrographic analysis of material recovered from within shaft 435401-003 was reported to comprise a <2.5 mm sized heterogeneous material, comprising colliery and mining waste products. The material contained burnt shale with fired clay brick material, hard and very hard quartzite and black slag and brown clinker.

Petrographic analysis of burnt shale reference material recovered from ground surface comprised heterogeneous blocky/rough lumps of reddish orange-brown, pale reddish brown to medium grey burnt clay material with pale yellow traces. Black, pale yellow, pale grey, greyish brown, dark grey, yellowish grey speckled inclusions were observed the sample. Apparently fresh but with variable levels of sintering/burning.

Petrographic analysis of the recovered sandstone above shaft cap 435401-003 was comprised of impure quartz-wacke sandstone with mudstone/shale horizons.

Petrographic analysis of recovered rock core from bedrock between the shafts was comprised of silty mudstone with mudstone/shale horizons.

Reported cement content for shaft caps 435401-002 and 435401-003 were 432 kg/m^3 to 447 kg/m^3, alkali content of concrete 3.9 kg/m^3 to 4.0 kg/m^3, chloride content of concrete <0.02% (for both).

The concrete examined and tested is consistent with a concrete design classes DC-1 and DC-2 (also DC-3z and DC-4z where only resistance to acidic groundwater rather than sulfate is required). Given the thickness of the concrete encountered, these would be suitable for use in ground with ACEC class AC-2 and for a 120-year service life in AC-3 conditions. Aggressiveness class AC-2 typically corresponds to Design Sulfate class DS-2, and similarly AC-3 with DS-3 (both for groundwater of normal mobility and pH).

The reported laboratory results are provided in **Appendix D**.

6 STRUCTURAL ASSESSMENT

The following sections detail the structural assessment of the two mineshaft caps 435401-002 and 435401-003.

6.1 Material properties

The cap thickness for shaft 435401-002 was recorded during drilling as 1.30 m thickness, with 0.83 m of core recovered. Significant core loss is attributed to wearing or fragmentation during coring and loss of core from the core barrel during extraction of the core barrel from underlying shaft fill.

Core recovered from shaft 435401-003 was recorded as 0.78 m from a 1.30 m thick cap.

For modelling purposes, a reinforced slab thickness of 1.30 m for both shaft caps has been adopted as proved by rotary drilling.

Cores recovered from 435401-002 (borehole reference 'Shaft-002) and 435401-003 (borehole reference 'Shaft-003') confirm the presence of one 16 mm ribbed high yield reinforcing bar in the top of the cap over shaft 435401-002 and two 40mm ribbed high yield reinforcing bars in the bottom of both shafts 435401-002 and 435401-003, corresponding with the minimum reinforcement requirements stipulated within 'CIRIA Special Publication 32 1984' i.e. the relevant guidance available for the treatment of abandoned mine workings at the time the shafts were capped.

Compressive strength testing was carried out on two concrete core samples recording strengths >50 N/mm^2 and thus confirming a minimum concrete grade of C50/60.

6.2 Ground parameters

Both existing mineshaft caps are located at competent rockhead comprising of mudstone/sandstone as confirmed by rotary open borehole logging and the made ground/overburden above them is confirmed as opencast backfill (mudstone/sandstone boulders).

From review of the proposed development layout and rotary borehole drilling logs the depth from proposed slab finished floor level to top of existing cap 435401-002 is 24.00 m.

Existing shaft cap 435401-003 is located outside of the proposed development footprint however the rotary open borehole logs confirm an overburden depth of 22.20 m as existing however final proposed external levels are to be lowered by circa 2.50 m locally which will reduce the overburden depth to circa 20.00 m.

6.3 Analysis method

The structural assessment of the existing mineshaft caps has been carried out in accordance with current European design codes using an ultimate limit state linear elastic analysis:

BS EN 1991 – Actions on Structures.

BS EN 1992 – Design of Concrete Structures.

BS EN 1997 – Geotechnical Design.

6.4 Structural assessment

The structural assessment has been carried out on the worst-case existing shaft 435401-002 which is subject to the largest overburden and is positioned within the footprint of the proposed development.

Whilst the shaft diameter has been confirmed at 4.90 m an additional offset of 0.50 m has been allowed for from the inside face of the shaft in order to provide contingency and ensure the cap is adequate to span beyond the shaft lining and the rock immediately surrounding the edge of the shaft i.e., a conservative diameter of 5.90 m is considered within the structural assessment.

The 40 mm diameter reinforcing bars confirmed present within the bottom of both shaft caps are assumed to be at max 200mm centres (in both directions) in accordance with the available guidance at the time of installation (CIRIA SP32) and a minimum concrete cover of 100 mm has been conservatively assumed. The worst-case effective depth has also been used throughout the structural assessment based on the shallowest longitudinal bar.

As the existing cap slabs are located circa 20.0m below the surface of the proposed development platform level a nominal variable load of 2.5 kN/m^2 has been considered within the assessment and a load factor of 1.5 has been applied in accordance with EC2 requirements. As the depth and nature of the overburden material and shaft cap have been investigated and confirmed a reduced load factor of 1.0 has been applied for these permanent loads in accordance with EC7 ‘Table A.4’. A typical 200 mm thick ground bearing reinforced concrete slab has been assumed at proposed ground level with an applied permanent load factor of 1.35 being taken in accordance with EC2.

The bending capacity of the existing cap slab and its reinforcement has been calculated and compared to the applied maximum bending moment to be supported by the cap in accordance with the current standard BS EN 1992 approach and based on all available investigation data and conclusions available (as outlined above) to assess its suitability in bending following construction of the proposed development. Similarly, the shear capacity of the existing cap slab without shear reinforcement has been calculated in accordance with BS EN 1992 and compared with the applied maximum shear force at the support based on a circular depression to assess existing suitability in shear following construction of the proposed development.

All technically reviewed and approved design calculations are presented in full in **Appendix E**.

6.5 Results

The findings of the structural assessment confirm the following:

- Shear capacity check: shear reinforcement is not required
- Bending check: reinforcement is satisfactory
- Serviceability checks: span/depth ratio is satisfactory.

Both existing reinforced concrete cap slabs over shafts 435401-002 and 435401-003 can accommodate the maximum applied bending moment applied by the proposed development without the need for any strengthening/treatment works.

Both existing reinforced concrete cap slabs over shafts 435401-002 and 003 can accommodate the maximum applied shear force applied by the proposed development without the need for any strengthening/treatment works.

All technically reviewed and approved design calculations are presented in full in **Appendix E**.

7 CONCLUSIONS

7.1 Investigation

Based on the recent investigation works and proposed development layout, the following conditions may be concluded to be present for the two mineshafts:

- Both have heavily reinforced concrete caps, and the concrete is of high strength. The caps are of 1.30 m in thickness and have been demonstrated to have approximate dimensions of 10.00 m by 10.00 m.
- Both shaft caps are founded on competent rock.
- The shafts beneath the caps are backfilled and this was proven to the full depths of drilling (minimum depths of 18.00 m and 16.00 m below the caps for each shaft).
- The opencast backfill materials above the shaft caps comprise reworked Coal Measures and superficial soils, which increase in stiffness and strength with depth.
- One of the shafts (435401-002) lies beneath the proposed large commercial building. In advance of building development, ground treatment works have been carried out, which include additional pre-loading of the building and perimeter area with a 6m high surcharge mound. The construction of the surcharge mound over this area (Mound 1) has been recently completed and settlement monitoring is ongoing. The full surcharge works are scheduled to be complete in the first/second quarter 2022. When the treatment is complete the final development surface will have been subject to significant pre-loading (approximate 120 kPa load on the development platform surface).
- Shaft 435401-003 lies in an area where ground levels have to be cut by approximately 2.50 m to achieve development platform level (NB this shaft is outside the building footprint in an external yard area). Shaft 435401-002 lies in an area which has been subject to a large-scale load test with 5.00 m thickness of materials placed for the last 5 years. Consequently, both shaft positions have already been subject to significant pre-loading.

7.2 Structural assessment

The structural assessment concludes the following:

- Both existing reinforced concrete cap slabs over shafts 435401-002 and 435401-003 can accommodate the maximum applied bending moment applied by the proposed development without the need for any strengthening/treatment works.
- Both existing reinforced concrete cap slabs over shafts 435401-002 and 435401-003 can accommodate the maximum applied shear force applied by the proposed development without the need for any strengthening/treatment works.

7.3 General

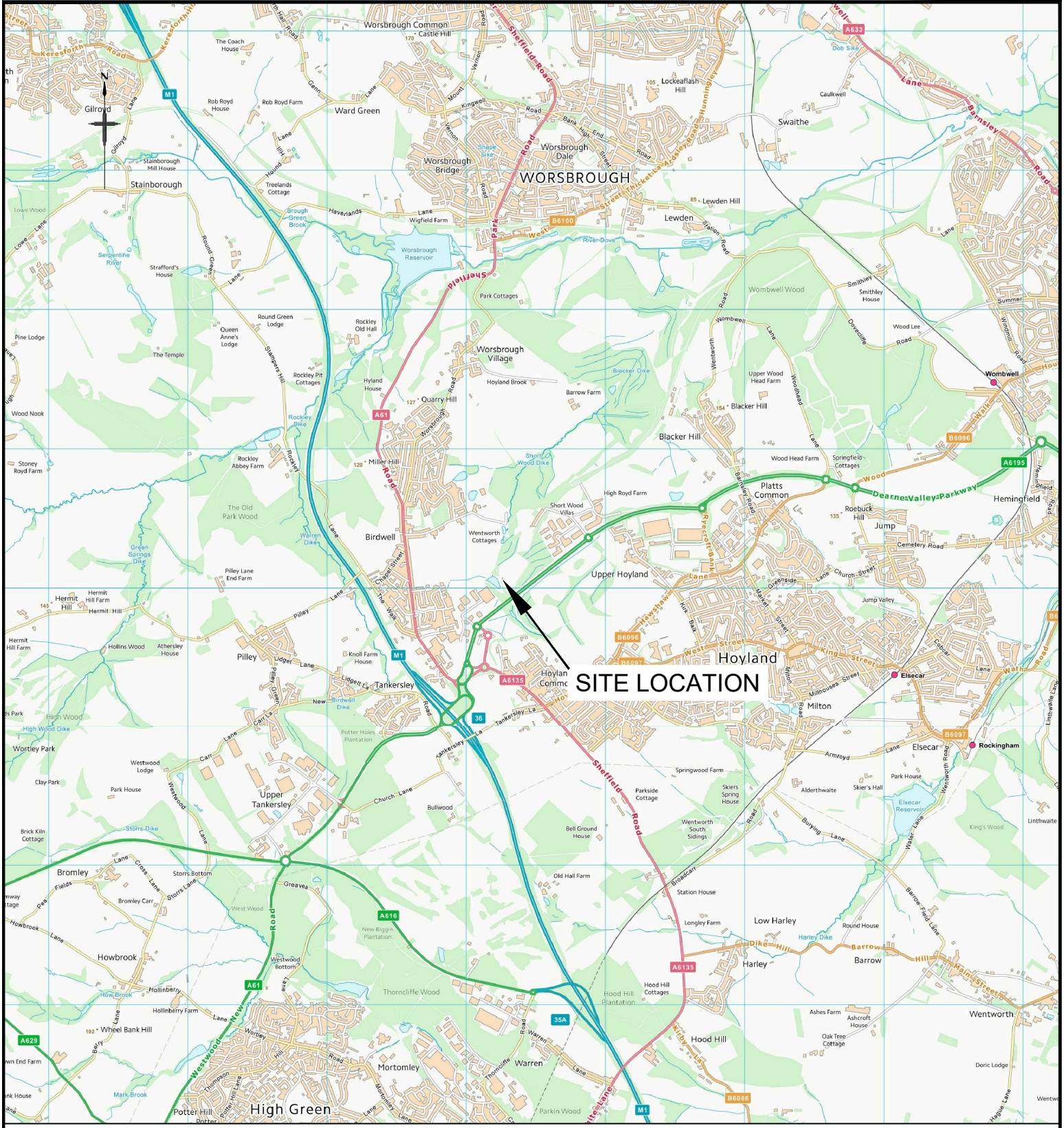
The recent investigations have confirmed that the two mine shafts have reinforced concrete caps and that beneath this there is in situ backfill material. At both shaft locations some pre-loading (relative to final ground levels) has already taken place, and this will be enhanced by surcharge

treatment works which are ongoing. We believe that the current status of the shafts does not require any further treatment, and the overall position will be further benefited from the ongoing ground treatment works. **Consequently, no further action or treatment is required.**

The June 2021 boreholes were cement grouted on completion, however the installation in borehole RBH521 (February 2020) has been lost. When surcharge treatment works are completed, ground levels will be cut to the elevation of the final development platform. It is recommended that these works are closely inspected in the vicinity of RBH521 and if the installation is encountered this is then subject to cement grouting.

FIGURES

Figure 1 Site location plan



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RSK GEOSCIENCES

Spring Lodge
172 Chester Road
Helsby
Cheshire
WA6 0AR

Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

Client: EOS INC LIMITED

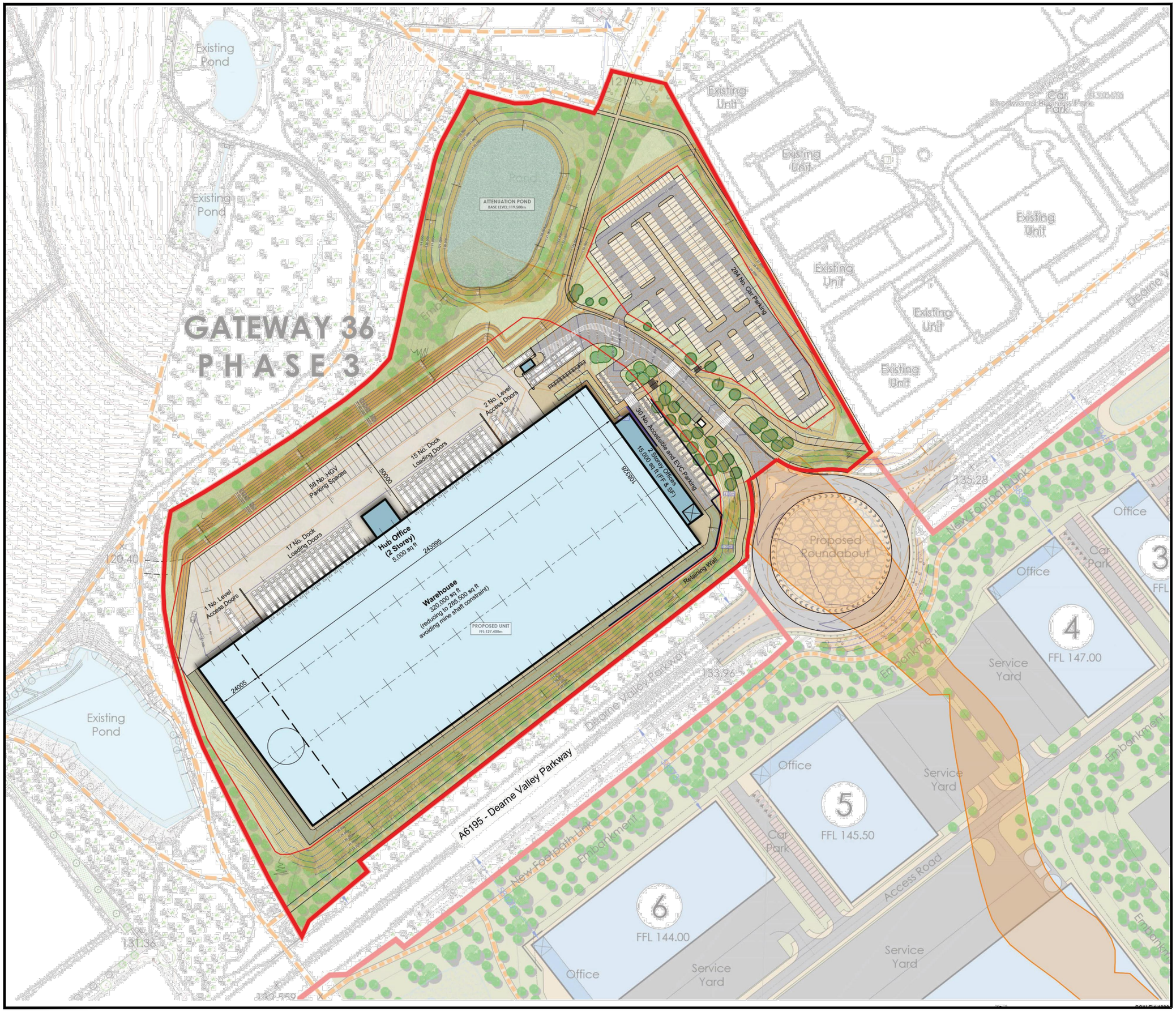
Project Title: GATEWAY 36 DEVELOPMENT SITE - PHASE 3

Drawing Title: SITE LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date	Project No.	Drawing File
HD	24.08.21	SR	24.08.21	SR	24.08.21	325389	325389-Site location Plan FIG01

Scale	Orig Size	Dimensions	Drawing No.	Rev.
NTS	A4	—	FIGURE 1	01

Figure 2 Proposed development layout



LEGEND:

Site boundary

N

NOTE:
Proposed layout '21049_F0004[C]_Site Layout - Option 3 Revision E, dated 27.01.2021

REV	DATE	DESCRIPTION	BY	CHD.	APR.
01	24.08.21	FIRST ISSUE	HD	SR	SR

Dimensions	Projection	Scale	Orig Size
m		1:2,000	A3

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CLIENT
EOS INC LIMITED

PROJECT
GATEWAY 36 DEVELOPMENT SITE - PHASE 3

TITLE
PROPOSED DEVELOPMENT LAYOUT

JOB No.:	DRAWING FILE:			
325389	FIGURE 02			
BY:	DATE:	CONTRACT NO.		REV:
HD	24.08.21		FIGURE 2	01

Scale 1 : 2,000
0 20 40 60 80 100m

Figure 3 Mineshaft 435401-002

MINESHAFT LOCATION
435401-002

0 1 2 3 4 5

129.64

130.35

208

204

MH

202

130.0

203

201

130.81

BH002

205

130.14

130.5

206

211

207

212

209

210

213

130.63

129.80

LEGEND:

- ASSUMED POSITION OF 4.9m DIAMETER MINESHAFT
- CONJECTURED EXTENT OF MINESHAFT CAP
- DRILLING GRID ON 2m SPACING
- PROBEHOLE DRILLED - JUNE 2021
- COAL AUTHORITY RECORDED POSITION OF MINESHAFT 435401-002

N

REV	DATE	DESCRIPTION	BY	CHD.	APR.
01	24.08.21	FIRST ISSUE	FP	SR	SR

Dimensions	Projection	Scale	Orig Size
m		1:100	A3

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Tel: +44 1928 726006
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Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES INVESTMENTS LTD

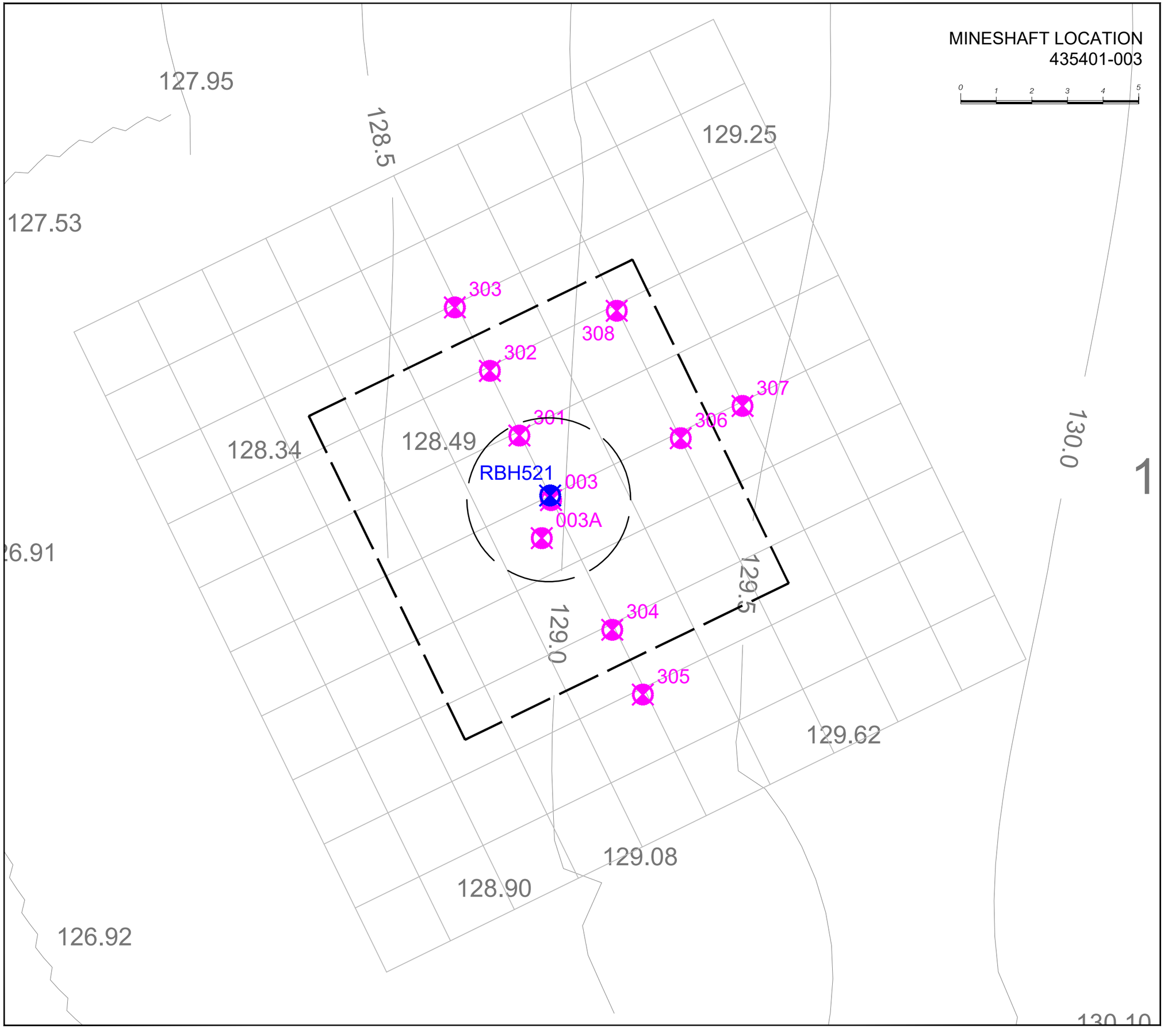
PROJECT
GATEWAY 36 - PHASE 3

TITLE
MINESHAFT 435401-002 PROBEHOLE INVESTIGATION PLAN

JOB NO:	DRAWING FILE:
325389	FIGURE 03

BY:	DATE:	CONTRACT NO.		REV:
HD	24.08.21			01

Figure 4 Mineshaft 435401-003



LEGEND:

- ASSUMED POSITION OF 4.6m DIAMETER MINESHAFT
- CONJECTURED EXTENT OF MINESHAFT CAP
- DRILLING GRID ON 2m SPACING
- PROBEHOLE DRILLED - JUNE 2021
- PROBEHOLE DRILLED BY RSK - FEBRUARY 2020

N

REV	DATE	DESCRIPTION	BY	CHD.	APR.
01	24.08.21	FIRST ISSUE	HD	SR	SR

Dimensions	Projection	Scale	Orig Size
m		1:100	A3

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Tel: +44 1928 726006
Fax: +44 1928 725633
Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES INVESTMENTS LTD

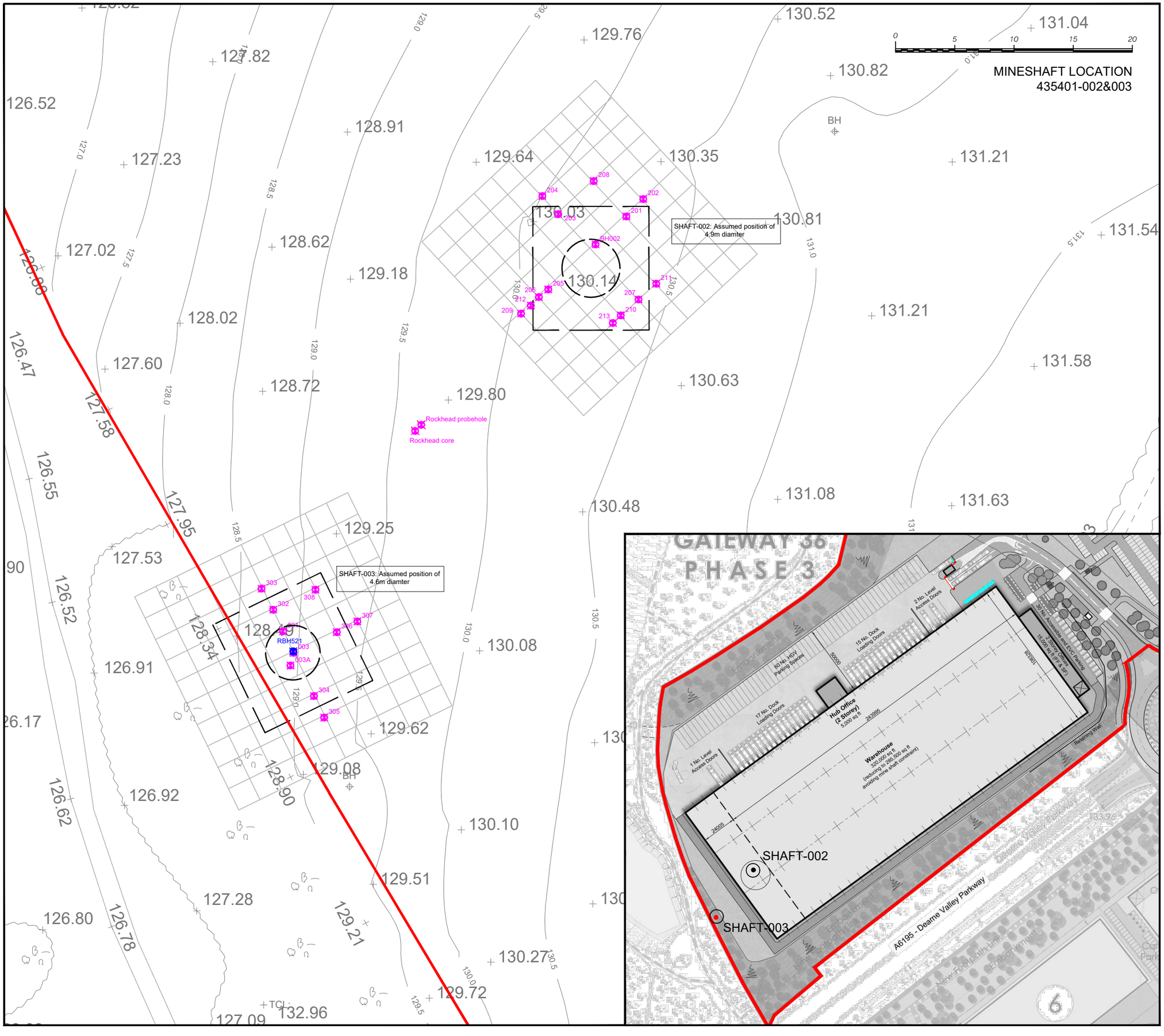
PROJECT
GATEWAY 36 - PHASE 3

TITLE
MINESHAFT 435401-003 PROBEHOLE INVESTIGATION PLAN

JOB NO:	DRAWING FILE:
325389	FIGURE 04

BY:	DATE:	CONTRACT NO.		REV:
HD	24.08.21			01

Figure 5 Mineshaft investigation location plan



LEGEND:

- PLOT BOUNDARY
- CONJECTURED EXTENT OF MINESHAFT CAP
- DRILLED GRID ON 2m SPACING
- PROBEHOLE DRILLED - JUNE 2021
- PROBEHOLE DRILLED - FEBRUARY 2020
- SHAFT-002: ASSUMED POSITION OF 4.9m DIAMETER MINESHAFT
- SHAFT-003: ASSUMED POSITION OF 4.6m DIAMETER MINESHAFT

N

REV	DATE	DESCRIPTION	BY	CHD.	APR.
01	24.08.21	FIRST ISSUE	HD	SR	SR

Dimensions	Projection	Scale	Orig Size
m		1:300	A3

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Web: www.rsk.co.uk

CLIENT
HARWORTH ESTATES INVESTMENTS LTD

PROJECT
GATEWAY 36 - PHASE 3

TITLE
MINESHAFT INVESTIGATION PLAN

JOB NO:	DRAWING FILE:
325389	FIGURE 05

BY:	DATE:	CONTRACT NO.		REV:
HD	24.08.21			01

APPENDIX A
COAL AUTHORITY PERMIT

The Coal Authority

Permit to Enter or Disturb Coal Authority Interests

Permit 20223_1

Name and Address of Permit Holder:

RSK Environment Ltd
172 Chester Road
Helsby
WA6 0AR

Site Location:

Rockingham Colliery
Barnsley
S74 9NJ

This certificate hereby grants the above named Permit Holder a Permit to carry out:-

Investigation and treatment of two mine entries (coal Authority references 435401-003, 435401-002) all within the Authority's interests at the identified site location above as shown on the Grant Permit Boundary (overleaf) for the period of 12 months from the granted date shown below. *The granting of this Permit does not constitute advice given by the Authority in relation to the proposed operations. It is the Permit Holder's responsibility to obtain appropriate health, safety, environmental, technical and legal advice.*

Mandatory Conditions:

1. *Gas Monitoring CO, CH_4, CO_2, O_2, H_2S at borehole and rig*
2. *Treatment design and specification to be agreed in writing following engineering appraisal prior commencement*
3. *Operators undertaking the work must be in possession of this certificate and the Permit boundary plan at the time of works*

Signed: Leigh Sharpe Granted Date: ***17/06/2021***

For and on behalf of The Coal Authority

Nominated Representative: Leigh Sharpe, Permitting Manager;
The Coal Authority, Permitting Office, 200 Lichfield Lane, Mansfield, Notts, NG18 4RG
Tel: 01623 637450; E-Mail: permissions@coal.gov.uk

The Coal Authority

Granted Permit Boundary

Permit Ref: 20223_1

Permit Boundary:



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The Coal Authority

Permitting Office
Coal Authority
200 Lichfield Lane
Mansfield
Nottinghamshire
NG18 4RG

T 01623 637450 (Permitting)
www.gov.uk/coalauthority

Our Ref: 20223

26th June 2020

RSK Environment Ltd
172 Chester Road
Helsby
WA6 0AR

For the attention of Alex Cox

By email: acox@rsk.co.uk

Dear Alex,

Rockingham Colliery, Barnsley, S74 9NJ
Application for a Permit to Enter or Disturb Coal Authority Mining Interests

I refer to your application, on behalf of your client for permission to enter the Coal Authority's property. Attached to this letter is the signed permit certificate and supporting documentation which allows you to carry out the works to the specifications in the documents you submitted within “the site” as shown on the attached plan.

Please note that you may require permission from other property owners such as the surface land owner or other mineral owners.

You should be aware that mine gas may be present within coal seams, voids in shallow mine workings, mine entries, voids above such workings and in any permeable strata or surface fill material. More guidance on managing the risk of hazardous gases can be viewed on our website.

Consequently there is a risk of encountering mine gas during the proposed works. All boreholes and excavations should be regularly tested, particularly at times of falling barometric pressure, for all gases associated with coal mining, commonly carbon dioxide, carbon monoxide, methane, oxygen and hydrogen sulphide.

If mine gas or mine water is encountered, you should ensure that such occurrences are documented and that appropriate actions are taken. Any surface construction must take account of the risks associated with building on land that may be susceptible to surface emissions of mine gases and mining related instability. Care should be taken to ensure any exposed coal seams and all boreholes and excavations are effectively sealed with a cement based material at the earliest opportunity to prevent continued ingress of air.

The accompanying permit certificate and supporting documentation should be distributed to all interested parties (especially the site operatives) and be available on site for inspection by ourselves or by the HSE.

This permit certificate is issued on the understanding that, under no circumstances will works other than those specified, be carried out without the prior written approval of the Authority.

You must employ systems for managing health and safety; identifying hazards, assessing risks, creating risk profiles and establishing control measures to control risk to 'As low As Reasonably Practicable' (ALARP). You must ensure at all times that control measures are maintained to prevent and if necessary mitigate against any loss of control. Risks must be controlled to ALARP.

It is your duty to consider if the Borehole Sites and Operations Regulations 1995 apply to your activity and comply with the regulations as required.

It is the responsibility of the Designer to ensure that the proposed works are sufficient for any planned developments at the site, especially if the discharge of a planning condition is necessary. If at any point you consider that additional works may be required please contact me to discuss this.

Please note that the information regarding these shafts was supplied to you under recent permit 19588 and we have not replicated that data here. If you require confirmation of that please contact me and I will supply the information. It is important that all the relevant information provided to you is passed to the contractor carrying out the works such that these can be designed appropriately and a safe system of work established.

As you will be aware the permitting process is separate to and not dependent upon Planning, the granting of this permit should therefore not be construed to indicate in anyway endorsement of a remedial strategy and its aim to discharge any relevant Planning Condition/s. The latter, if we are consulted by the LPA will be considered at a time when completion reporting has been provided detailing all of the works carried out, their validation and the ground conditions/mining circumstances established. Planning considers if the site has been made safe and stable for the intended development and this includes all the area within the Planning Boundary.

Please submit full details of all works undertaken as required by section 8 of the permit terms and conditions, when the works are complete. At this time you will need to confirm if the permit should remain in place. If you wish to discuss this or any other matter, please do not hesitate to contact me using the contact details shown.

Please quote the Coal Authority Reference No.20223 on all future correspondence.

If you want further information on the Permitting process, please visit:
https://www.gov.uk/get-a-permit-to-deal-with-a-coal-mine-on-your-property

The Permitting Office is open: Monday to Thursday – 8:45am to 5pm and Friday – 8:45am to 4.30pm for any queries.

Yours faithfully

Leigh Sharpe

Permitting Manager

T 01623 637229
E permissions@coal.gov.uk

APPENDIX B
PROBEHOLE RECORDS

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-002**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**29.06.21** End: **30.06.21**	**130.93**	**E:435302.5 N:401038.3**	**1** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 1.40m, sandstone boulder.		
				. . . 7.10m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium, water flush was used after 25.00m bgl. Cored 28.00m to 29.30m.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.
5. Borehole drilled on Coal Authority recorded position.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 25/08/21 - 10:39 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-002**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**29.06.21** End: **30.06.21**	**130.93**	**E:435302.5 N:401038.3**	**2** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 9.10m to 11.90m, mudstone/sandstone boulders.	(28.00)	
				. . . 15.20m to 18.40m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 25/08/21 - 10:39 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-002**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**29.06.21** End: **30.06.21**	**130.93**	**E:435302.5 N:401038.3**	**3** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 25.00m to 28.00m, sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 25/08/21 - 10:39 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-002**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**29.06.21** End: **30.06.21**	**130.93**	**E:435302.5 N:401038.3**	**4** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.00	
				MADE GROUND: Reinforced concrete. Recovered 830mm core, 16mm reinforcing bar at top and two layers of 40mm reinforcing between cap middle and base.	(1.30) 29.30	
				MADE GROUND: Mine shaft infill. . . . 31.00m to 42.00m, infill with boulders.	(12.70)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-002**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**29.06.21** End: **30.06.21**	**130.93**	**E:435302.5 N:401038.3**	**5** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Mine shaft infill. *(stratum copied from 29.30m from previous sheet)*	42.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 25/08/21 - 10:39 | AW1 |

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH201**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**30.06.21** End: **30.06.21**	**131.09**	**E:435305.7 N:401040.8**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 7.00m to 8.10m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:21 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH201**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**30.06.21** End: **30.06.21**	**131.09**	**E:435305.7 N:401040.8**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 12.40m to 13.30m, mudstone/sandstone boulder.		
					(28.00)	
				. . . 16.20m to 17.80m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:21 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH201**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**30.06.21** End: **30.06.21**	**131.09**	**E:435305.7 N:401040.8**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 20.50m to 21.00m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH201**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**30.06.21** End: **30.06.21**	**131.09**	**E:435305.7 N:401040.8**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.00	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH202**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**131.12**	**E:435307.2 N:401042.0**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 7.00m to 7.80m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH202**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**131.12**	**E:435307.2 N:401042.0**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 9.00m to 10.90m, mudstone/sandstone boulders.	(28.50)	
				. . . 15.40m to 17.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH202**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**131.12**	**E:435307.2 N:401042.0**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 21.90m to 22.10m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH202**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**131.12**	**E:435307.2 N:401042.0**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.50	
				SANDSTONE.	(4.50) 33.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH203**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.87**	**E:435300.2 N:401041.4**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.90m to 10.10m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH203**

Contract Ref:	Start: **01.07.21** End: **01.07.21**	Ground Level:	National Grid Co-ordinate:	Sheet:
325389		**130.87**	**E:435300.2 N:401041.4**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 14.00m to 16.10m, mudstone/sandstone boulders.	(28.00)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH203**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.87**	**E:435300.2 N:401041.4**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 21.90m to 22.10m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH203**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.87**	**E:435300.2 N:401041.4**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.00	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH204**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.90**	**E:435299.0 N:401043.1**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.80m to 10.20m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT Prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH204**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.90**	**E:435299.0 N:401043.1**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 13.60m to 16.50m, mudstone/sandstone boulders.	(28.50)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH204**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.90**	**E:435299.0 N:401043.1**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 20.80m to 22.00m, boulders.		
				. . . 24.40m to 25.90m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH204**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.90**	**E:435299.0 N:401043.1**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.50	
				SANDSTONE.	(4.50) 33.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH205**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.74**	**E:435298.5 N:401035.4**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.70m to 9.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH205**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.74**	**E:435298.5 N:401035.4**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 14.00m to 15.00m, mudstone/sandstone boulders.	(27.80)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH205**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.74**	**E:435298.5 N:401035.4**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 18.50m to 19.20m, boulders. . . . 20.10m to 21.00m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH205**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.74**	**E:435298.5 N:401035.4**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	27.80	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH206**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.79**	**E:435297.7 N:401034.7**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.70m to 9.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH206**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.79**	**E:435297.7 N:401034.7**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 10.90m to 11.50m, mudstone/sandstone boulders.		
					(27.80)	
				. . . 14.10m to 15.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH206**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.79**	**E:435297.7 N:401034.7**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 19.50m to 20.10m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH206**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.79**	**E:435297.7 N:401034.7**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	27.80	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH207**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.91**	**E:435306.1 N:401033.6**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 7.00m to 8.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH207**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.91**	**E:435306.1 N:401033.6**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 9.50m to 10.30m, mudstone/sandstone boulders.	(28.00)	
				. . . 14.80m to 15.30m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH207**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.91**	**E:435306.1 N:401033.6**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 18.20m to 19.00m, boulders.		
				. . . 24.60m to 25.50m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH207**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**01.07.21** End: **01.07.21**	**130.91**	**E:435306.1 N:401033.6**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.00	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH208**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.90**	**E:435303.6 N:401045.5**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencaast backfill.		
				. . . 6.90m to 10.20m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH208**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.90**	**E:435303.6 N:401045.5**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencaast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 12.50m to 14.00m, mudstone/sandstone boulders.		
					(28.50)	
				. . . 16.80m to 17.10m, boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH208**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.90**	**E:435303.6 N:401045.5**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencaast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 18.80m to 19.60m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH208**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.90**	**E:435303.6 N:401045.5**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencaast backfill. *(stratum copied from 0.00m from previous sheet)*	28.50	
				SANDSTONE.	(4.50) 33.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH209**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.80m to 9.10m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH209**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**2** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 11.00m to 11.50m, mudstone/sandstone boulder.		
				. . . 14.00m to 15.40m, mudstone/sandstone boulders.	(28.30)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH209**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**3** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 19.50m to 20.00m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH209**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.30	
				SANDSTONE.	(4.70) 33.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH210**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.74**	**E:435304.3 N:401032.7**	**1** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.90m to 7.50m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH210**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.74**	**E:435304.3 N:401032.7**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 9.00m to 10.20m, mudstone/sandstone boulders. . . . 12.50m to 13.50m, mudstone/sandstone boulders. . . . 15.60m to 16.50m,boulder.	(28.00)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH210**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.74**	**E:435304.3 N:401032.7**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH210**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.74**	**E:435304.3 N:401032.7**	**4** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.00	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH211**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.92**	**E:435307.8 N:401034.4**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 0.70m to 8.60m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH211**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.92**	**E:435307.8 N:401034.4**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 10.00m to 12.00m, mudstone/sandstone boulders. . . . 15.50m to 16.00m, mudstone/sandstone boulder.	(28.50)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH211**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.92**	**E:435307.8 N:401034.4**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 25.00m to 26.00m, boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH211**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.92**	**E:435307.8 N:401034.4**	**4** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.50	
				SANDSTONE.	(4.50) 33.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH212**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**1** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.90m to 9.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH212**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 10.90m to 11.50m, mudstone/sandstone boulder.		
				. . . 14.00m to 15.40m, mudstone/sandstone boulders.	(28.30)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH212**

Contract Ref:	Start: **05.07.21** End: **05.07.21**	Ground Level:	National Grid Co-ordinate:	Sheet:
325389		**130.78**	**E:435296.8 N:401034.2**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 19.50m to 20.00m, boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH212**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**130.78**	**E:435296.8 N:401034.2**	**4** of **4**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.30	
				SANDSTONE.	(4.70) 33.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH213**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.79**	**E:435302.4 N:401031.3**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.70m to 7.50m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH213**

Contract Ref:	Start: **05.07.21** End: **05.07.21**	Ground Level:	National Grid Co-ordinate:	Sheet:
325389		**130.79**	**E:435302.4 N:401031.3**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 9.00m to 10.20m, mudstone/sandstone boulders. . . . 12.50m to 13.50m, mudstone/sandstone boulders. . . . 15.30m to 16.50m, mudstone/sandstone boulders.	(28.00)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH213**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.79**	**E:435302.4 N:401031.3**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH213**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**130.79**	**E:435302.4 N:401031.3**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	28.00	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-003**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**22.06.21** End: **23.06.21**	**129.24**	**E:435277.1 N:401004.3**	**1** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium, water flush was used after 19.35m bgl. Cored from 19.35m to 22.20m and 22.20m to 24.25m.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.
5. Borehole drilled on Coal Authority recorded position.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-003**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**22.06.21** End: **23.06.21**	**129.24**	**E:435277.1 N:401004.3**	**2** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	(22.20)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-003**

Contract Ref:	Start: **22.06.21** End: **23.06.21**	Ground Level:	National Grid Co-ordinate:	Sheet:
325389		**129.24**	**E:435277.1 N:401004.3**	**3** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 19.35m to 22.20m, sandstone boulder.	22.20	
				MADE GROUND: Concrete. Recovered 780mm reinforced concrete, two layers of 40mm diameter reinforcing bar.	(1.30) 23.50	
				MADE GROUND: Mine shaft infill.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-003**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**22.06.21** End: **23.06.21**	**129.24**	**E:435277.1 N:401004.3**	**4** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Mine shaft infill. *(stratum copied from 23.50m from previous sheet)*	(18.50)	
				. . . 35.00m, brick fill or burnt shale infill.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Shaft-003**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**22.06.21** End: **23.06.21**	**129.24**	**E:435277.1 N:401004.3**	**5** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Mine shaft infill. *(stratum copied from 23.50m from previous sheet)*	42.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Concrete coring + Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	AGS

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH003A**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **28.06.21**	**129.32**	**E:435277.0 N:401003.0**	**1** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 5.80m to 6.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium, water flush was used after 22.20m bgl.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH003A**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **28.06.21**	**129.32**	**E:435277.0 N:401003.0**	**2** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 10.50m to 11.10m, boulder.	(22.20)	
				. . . 12.50m to 13.00m, boulder.		
				. . . 15.50m to 16.40m, boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH003A**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **28.06.21**	**129.32**	**E:435277.0 N:401003.0**	**3** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	22.20	
				MADE GROUND: Very hard drilling, concrete shaft cap.	(1.30) 23.50	
				MADE GROUND: Mine shaft infill.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH003A**

Contract Ref:	Start: **25.06.21** End: **28.06.21**	Ground Level:	National Grid Co-ordinate:	Sheet:
325389		**129.32**	**E:435277.0 N:401003.0**	**4** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Mine shaft infill. *(stratum copied from 23.50m from previous sheet)*	(18.50)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH003A**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **28.06.21**	**129.32**	**E:435277.0 N:401003.0**	**5** of **5**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Mine shaft infill. *(stratum copied from 23.50m from previous sheet)*	42.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH301**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.11**	**E:435276.1 N:401006.1**	**1** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill		
				. . . 5.00m to 6.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH301**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.11**	**E:435276.1 N:401006.1**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill *(stratum copied from 0.00m from previous sheet)*	(22.20)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

AGS

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH301**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21**	**129.11**	**E:435276.1 N:401006.1**	**3** of **3**
	End: **24.06.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill *(stratum copied from 0.00m from previous sheet)*	22.20	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH302**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21**	**129.16**	**E:435275.3 N:401007.8**	**1** of **3**
	End: **24.06.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 4.50m to 6.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH302**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.16**	**E:435275.3 N:401007.8**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 10.00m to 11.00m, mudstone/sandstone boulders.		
					(22.20)	
				. . . 12.00m to 13.00m, sandstone boulder.		
				. . . 16.00m to 17.20m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH302**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21**	**129.16**	**E:435275.3 N:401007.8**	**3** of **3**
	End: **24.06.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	22.20	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH303**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.20**	**E:435274.5 N:401009.7**	**1** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Overburden (MADE GROUND)		
				. . . 6.00m to 7.00m, mudstone/sandstone boulders.		
				. . . 7.90m to 8.70m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH303**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.20**	**E:435274.5 N:401009.7**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Overburden (MADE GROUND) *(stratum copied from 0.00m from previous sheet)* . . . 10.50m to 11.40m, mudstone/sandstone boulders. . . . 12.00m to 22.70m, boulders.	(22.70)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH303**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.20**	**E:435274.5 N:401009.7**	**3** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Overburden (MADE GROUND) *(stratum copied from 0.00m from previous sheet)*	22.70	
				SANDSTONE.	(4.30) 27.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH304**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.47**	**E:435278.9 N:401000.8**	**1** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 4.80m to 6.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH304**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.47**	**E:435278.9 N:401000.8**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	(22.50)	
				. . . 12.30m to 13.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH304**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**24.06.21** End: **24.06.21**	**129.47**	**E:435278.9 N:401000.8**	**3** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 20.80m to 21.50m,boulders.	22.50	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH305**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.51**	**E:435279.7 N:400998.9**	**1** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 4.80m to 7.10m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH305**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.51**	**E:435279.7 N:400998.9**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	(23.00)	
				. . . 13.90m to 14.70m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH305**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.51**	**E:435279.7 N:400998.9**	**3** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 21.00m to 22.00m, boulders.	23.00	
				SANDSTONE.	(4.00)	
					27.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH306**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21**	**129.37**	**E:435280.9 N:401005.8**	**1** of **3**
	End: **25.06.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 5.00m to 9.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH306**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.37**	**E:435280.9 N:401005.8**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	(22.50)	
				. . . 12.30m to 13.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH306**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.37**	**E:435280.9 N:401005.8**	**3** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 20.60m to 21.90m, boulders.	22.50	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH307**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.51**	**E:435282.7 N:401006.2**	**1** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 5.00m to 7.80m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH307**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.51**	**E:435282.7 N:401006.2**	**2** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	(23.00)	
				. . . 15.00m to 15.90m, boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH307**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**25.06.21** End: **25.06.21**	**129.51**	**E:435282.7 N:401006.2**	**3** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	23.00	
				SANDSTONE.	(4.00) 27.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH308**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**129.42**	**E:435279.2 N:401009.6**	**1** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 5.60m to 6.50m, mudstone/sandstone boulder.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH308**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21**	**129.42**	**E:435279.2 N:401009.6**	**2** of **3**
	End: **05.07.21**			

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
				. . . 10.50m to 11.80m, mudstone/sandstone boulders.	(22.00)	
				. . . 13.00m to 13.70m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**BH308**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**05.07.21** End: **05.07.21**	**129.42**	**E:435279.2 N:401009.6**	**3** of **3**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)* . . . 18.00m to 19.50m, hard sandstone.	22.00	
				Terminated on obstruction (shaft cap).		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

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BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead core hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.3 N:401022.6**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.00m to 9.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium, water flush was used after 24.00m bgl.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.
5. Drilled half-way between recorded positions of shafts -002 and -003 to recover core from rockhead.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling + concrete coring	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:25 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead core hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.3 N:401022.6**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*	(25.40)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling + concrete coring	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead core hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.3 N:401022.6**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
					25.40	
				Silty MUDSTONE with MUDSTONE/SHALE horizons.		
					(3.00)	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling + concrete coring	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:25 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead core hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.3 N:401022.6**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				Silty MUDSTONE with MUDSTONE/SHALE horizons. *(stratum copied from 25.40m from previous sheet)*	28.40	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling + concrete coring	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:25 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead probe hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.8 N:401023.1**	**1** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill.		
				. . . 6.00m to 9.50m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

1. Location was cleared using GPR and a CAT prior to excavation.
2. Drilling was commenced using air as the flushing medium.
3. Upon completion the borehole was backfilled to the surface with cement.
4. Descriptions are based on limited arisings and are of a general nature only.
5. Probehole drilled to establish depth to rockhead prior to drilling adjacent 'Rockhead Core' probehole to recover core from confirmed rockhead.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead probe hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.8 N:401023.1**	**2** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
					(25.40)	
				. . . 12.80m to 13.70m, mudstone/sandstone boulders.		
				. . . 16.00m to 17.00m, mudstone/sandstone boulders.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:25 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead probe hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.8 N:401023.1**	**3** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				MADE GROUND: Opencast backfill. *(stratum copied from 0.00m from previous sheet)*		
					25.40	
				SANDSTONE.		

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
RSK Environment Ltd, Spring Lodge, 172 Chester Road, Helsby, Cheshire, WA6 0AR. Tel: 01928 726006, Fax: 01928 725633, Web: www.rsk.co.uk. | 24/08/21 - 14:25 | AW1 |

DRAFT

BOREHOLE LOG

Contract:	Client:	Borehole:
Rockingham Phase 3	**EOS Inc Ltd**	**Rockhead probe hole**

Contract Ref:	Start:	Ground Level:	National Grid Co-ordinate:	Sheet:
325389	**02.07.21** End: **02.07.21**	**130.12**	**E:435287.8 N:401023.1**	**4** of **4**

Drilling Progress Log		Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	Drill Time (hh:mm)					
				SANDSTONE. *(stratum copied from 25.40m from previous sheet)*	(4.60) 30.00	

Drilling Progress and Water Observations					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Rotary openhole drilling	**Casagrande C6**	**GDC**	**WCook**	S.R.

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | Log ROTARY OPENHOLE LOG - A4P | 325389-ROCKINGHAM-PHASE-3.GPJ - v10_01.
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APPENDIX C
PHOTOGRAPHIC LOG

RSK GEOSCIENCES	Report No: 325389-R05 (00)	PHOTOGRAPHIC LOG

Client name: Harworth Estates | **Site Location:** Gateway 36 – Phase 3

Photo No. 1	**Date:** 21/06/21

Direction Photo Taken:

N/A

Description:

Drilling equipment in position over shaft - 003



Photo No. 2	**Date:** 23/06/21

Direction Photo Taken:

N/A

Description:

0.78m recovered core, note two layers of 40mm reinforcing bar



RSK GEOSCIENCES	Report No: 325389-R05 (00)	PHOTOGRAPHIC LOG

Client name: Harworth Estates | **Site Location:** Gateway 36 – Phase 3

Photo No.	**Date:**
3	28/06/21

Direction Photo Taken:

N/A

Description:

Drilling equipment set-up over shaft -002



Photo No.	**Date:**
4	30/06/21

Direction Photo Taken:

N/A

Description:

0.83m recovered concrete core from shaft cap -002



APPENDIX D
LABORATORY TESTING CERTIFICATES

RSK Environment Ltd
Tel: +44 (0) 1442 437500
Fax: +44 (0) 1442 437550
Email: info2@rsk.co.uk
Web: www.rsk.co.uk

Materials & Structures
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

UKAS TESTING 0278

Certificate of Examination
ASTM C856/C856M-20
Petrographic Examination of Hardened Concrete

Your Ref.	325389	**RSK Sample Ref.**	19528/C1
Site	Rockingham Phase 3	**Client Sample Ref.**	435401-002, 28.00-29.30m
Client	RSK Geosciences	**Sample Type**	Rock/Concrete core
	18 Frogmore Road	**Location**	435401-002
	Hemel Hempstead	**Orientation**	Vertical, downwards
	HP3 9RT	**Sampled by/Date**	GDC/30.06.2021
		Date of Receipt	16.07.2021
	On behalf of Coal Authority	**Examined by/Date**	AS/23.07.2021-10.08.2021

SAMPLE

The sample comprised a nominal 70 mm diameter concrete core, approximately 830 mm in length. The diameter of the submitted core was less than that preferred by the standard (ideally 152 mm diameter). The concrete section of the core was advised to have been recovered between 28.0-29.3 m (MBGL) of the borehole.

METHODS OF EXAMINATION

A full description of the examination methods, including a glossary of descriptive terms, is given on the final page of this certificate.

EXAMINATION FINDINGS

The detailed petrographic examination findings are given in the following sheets of this certificate along with a record colour photograph and selected photomicrographs (photographs taken through the microscope). An overview of the findings is given below.

SUMMARY OVERVIEW

Composition and Constituents	Nominal 20 mm, partially crushed heterogeneous quartzitic gravel coarse aggregate and natural quartzitic sand fine aggregate, bound by a suspected Portland CEM-II-type cement matrix containing GGBS and ashy particles equivalent to an estimated 20-35 % binder replacement when compared to reference samples.
Mix Quality	Apparently well mixed and exhibiting poor to good compaction. Excess voidage 3-10 %. Apparent water/cement ratio was estimated as being at the lower end of the normal range (low microporosity throughout). However, the observation of microporosity and associated water/cement ratio estimation can be made unreliable by the inclusion of the mineral additions such as ash/GGBS etc.
Condition	The concrete exhibited multiple fractures, possibly related to the method of extraction. Rare secondary portlandite lining aggregate particles and air voids in the upper part of the core suggestive of minor secondary leaching.
Other Remarks	The end surfaces were worn and exhibited evidence of drilling and coring.

NOTE

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

Certificate prepared by

Alex Smith
Senior Geomaterials Scientist

Certificate reviewed and authorised by

Bradley Staniforth
Senior Geomaterials Scientist

Date of issue: 20 August 2021

Amendment: Depths of core recovery changed

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

RECORD PHOTOGRAPHS			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Description	As received photo of the concrete portion of the core as received. The depth from 28.00-29.30 m borehole depth.		



1st Reinforcement bar	2nd Reinforcement bar (left, drilled into)		3rd Reinforcement bar
			

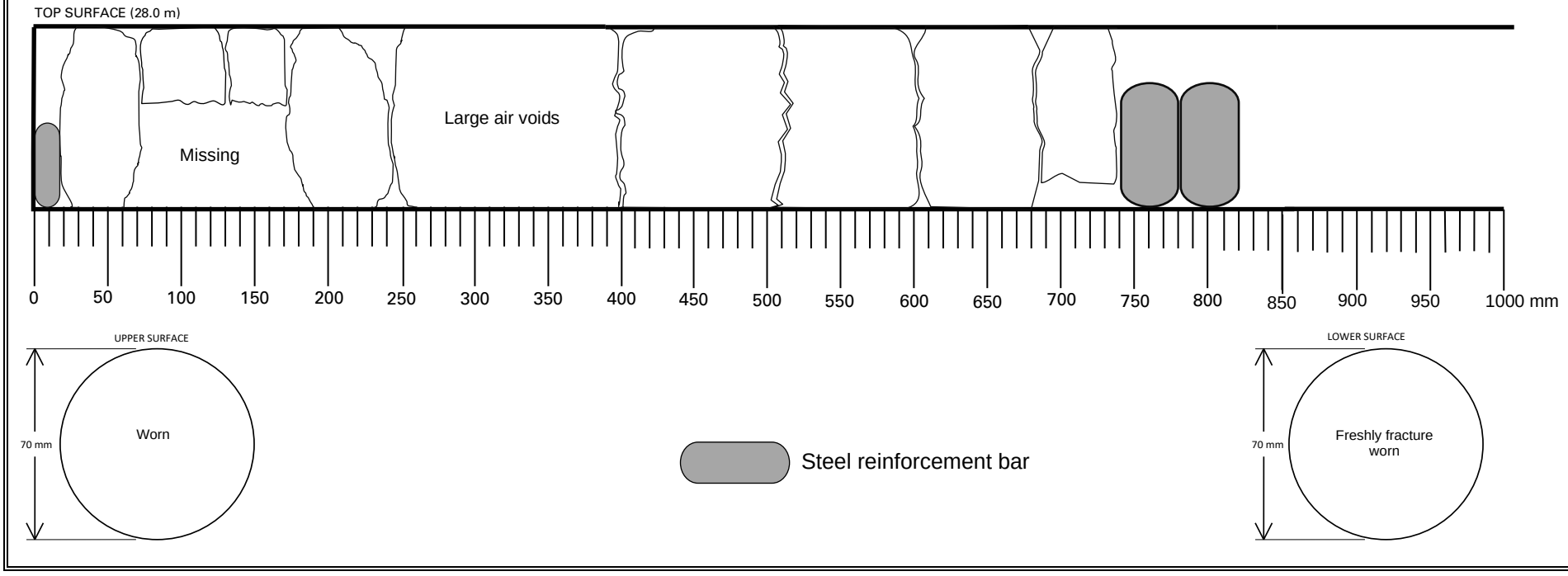
Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

RECORD PHOTOGRAPH

RSK Sample Ref	19528/C1	Client Sample Ref	435401-002, 28.00-29.30m

SAMPLE/CORE SKETCH

Core layout as received within core box. Log depths do not necessary relate to depth below ground surface.



Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

RECORD PHOTOGRAPHS			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Description	Views of the upper and lower surfaces of the core. Core diameter is 70 mm.		

UPPER SURFACE



LOWER SURFACE



Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

AS-RECEIVED CONCRETE CORE DETAILS			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Maximum Length, mm	832	**Diameter, mm**	70
Minimum Length, mm	818	**Number of Pieces**	12 + fragments
Nature of Upper Surface	Drilled worn/rebar	**Nature of Lower Surface**	Worn/freshly fractured/rebar
Portion Described	Representative thin-sections sawn from 16-72 mm (A), 170-220 mm (B) and 580-630 mm (C) depth from the provided upper surface.		

AGGREGATE DETAILS	
Coarse Aggregate *(incl. type, nominal max. size, shape, grading, distribution and orientation)*	Partially crushed heterogenous quartzitic gravel, nominal 20 mm maximum sized, very angular to well rounded, continuously graded, evenly distributed and randomly orientated particles.
Coarse Aggregate, Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major: QUARTZITE – Very hard to hard, strong, pale grey mottled/pale brown/brown coloured sub-crystalline to crystalline siliceous rock. Evidence of grain size reduction and recrystallisation. Sporadic particles exhibit a mild foliation and sporadic opaque mineral content. 40-50 %. SANDSTONE – Hard to very hard, brownish orange/white/ reddish brown coloured quartzitic clastic rock, with minor opaque mineral content and traces of iron oxide, phyllosilicate and calcite. Grain supported but exhibiting iron oxide rims and very little poor space. 40-50 %. Minor: CHERT – Very hard to hard, strong, conchoidal fracture, glassy lustre. Very fine to cryptocrystalline silica with quartz veins. 5 %. QUARTZ – Hard, coarse crystalline calcite. 5 %. Trace: LIMESTONE. RHYOLITE.
Cement:Aggregate Bond	Good
Additional Observations *(incl. evidence of deterioration etc)*	None.
Fine Aggregate *(incl. type, nominal max. size, shape, grading, distribution and orientation)*	Quartzitic sand, 4 mm nominal maximum sized, very angular to well rounded, continuous graded, evenly distributed and randomly orientated particles.
Fine Aggregate, Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major: QUARTZ – Hard, silica grains. 40-50 %. QUARTZITE – Very hard to hard, crystalline silica rocks, with rare foliation and minor to trace iron content. 20-30 %. Minor: SANDSTONE – Hard, quartzitic sedimentary rocks with minor iron and phyllosilicate. 5-10 %. SILTSTONE – Moderately hard, very fine quartzitic sedimentary rock. 3-4 %. CHERT – Very hard, micro/cryptocrystalline rock 3-4 %. Trace: RHYOLITE. CALCITE. PLAGIOCLASE FELDSPAR. PYROXENE. MICROGRANITE. MUSCOVITE MICA. LIMESTONE. GLAUCONITE.
Cement:Aggregate Bond	Good, only sporadic interfacial partings in evidence.
Additional Observations *(incl. evidence of deterioration etc)*	None.

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

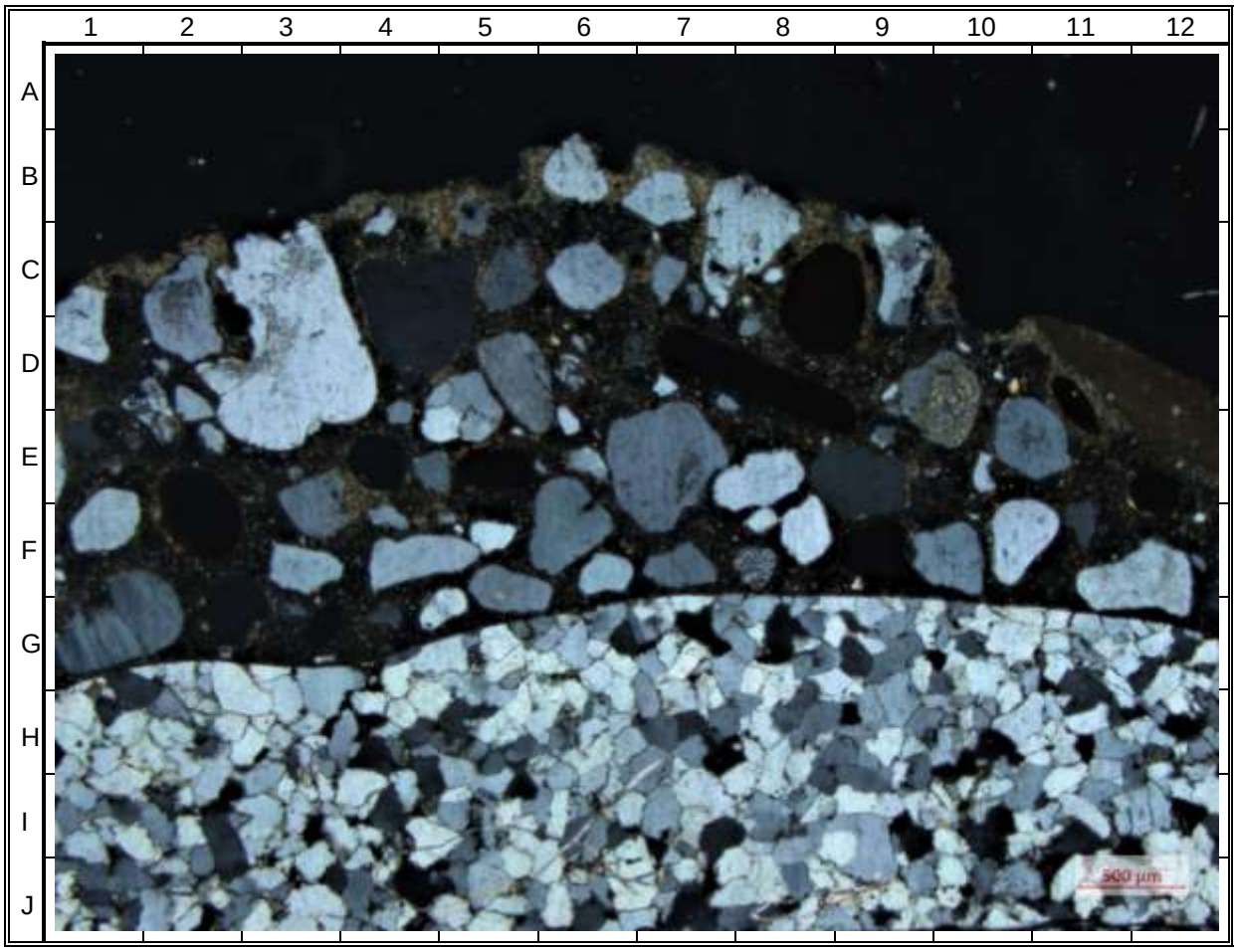
RSK Sample Ref	19528/C1	Client Sample Ref	435401-002, 28.00-29.30m

CONCRETE FEATURES	
Apparent Cement Type and Matrix Details *(Portland, High Alumina, White, PBC, etc and incl. hardness, colour, colour distribution and matrix distribution)*	Moderately hard, medium olive grey to mid grey, evenly distributed suspected CEM II Portland-type cement matrix. Exhibiting frequent, typically small to very large sized, randomly distributed, unhydrated and cement grains. These grains are often stained by the presence of GGBS ash mineral additions
Mineral Additions• *(incl. type, size, relative abundance, distribution and shape)*	Rare to frequent, angular to very angular GGBS kernels were unevenly distributed throughout the cement matrix of the core. Suspected 20-35 % cement replacement when compared to reference samples. Common, very angular to sub-rounded shaped, opaque ash particles present.
Air Void Details and Compaction *(incl. air void max. size, shape, distribution, orientation, presence of entrainment, excess voidage)*	18 mm maximum, typically 0.5-3.0 mm sized, irregular to spherical, variably distributed and randomly orientated entrapped air voids. Estimated excess voidage typically 3 % but up to 10 % (honeycombed) in areas. The presence of frequent/abundant, <0.5 mm sized, spherical air voids suggests the presence of an admixture imparting some degree of entrainment.
Microporosity and Water/Cement Ratio# *(incl., microporosity variations and relation to other features; assessment of original water/cement ratio)*	The observation of microporosity and associated water/cement ratio estimation can be made unreliable by the inclusion of the mineral additions such as ash/GGBS etc. The cement paste typically exhibited low microporosity. Areas of high microporosity were observed associated with porous aggregate particles, microcracks and sporadic bleeding channels.
Carbonation* *(incl. depths, variations and relation to surface cracking)*	The upper surface of the concrete was partially carbonated to a maximum depth of 1.5 mm.
Portlandite *(incl. size, shape, abundance and distribution of crystallites)*	The uncarbonated cement matrix exhibited sporadic, typically small to medium sized, portlandite crystallites that were often elongate or present formed around aggregate particles. Rare large secondary portlandite were present in thin section B.
Other Concrete Details *(incl. applied finishes, inclusions and impurities)*	The core represented a 3 m drilling depth, which suggested over 50 % of the concrete core was not retrieved. Worn lumps were present between 16-172 mm depth of the concrete. Continuous core was retrieved from 168-754 mm depth from the upper surface of the concrete core. The upper and lower surfaces of the concrete were worn and exhibited evidence of drilling.
Reinforcement *(incl. types, sizes, depths, orientations, evidence of corrosion)*	The upper part of the core at 28.0 MBGL comprised a horizontal, 16 mm diameter, ribbed steel reinforcement bar. The lower end of the core recovery exhibited two horizontal 40 mm diameter, ribbed, steel reinforcement bars at 738-832 mm depth from the upper surface of the core.
Evidence of Cracking *(incl. crack styles, abundance and relation to other features)*	Core fractures were present at 51-80 mm, 130 ±10 mm, 168-190 mm, 210-263 mm, 390-423 mm, 500-518 mm, 598-614 mm, 656-687 mm depths from the upper surface. Fragments were present at 72-172 mm. Sub-horizontal cracking was present running through the cement matrix between 600-620 mm depth from the upper surface. Sporadic to common microcracks ran through the cement matrix in a sub-polygonal pattern.
Presence of Deposits *(incl. gel, sulfates, carbonates, oxides, soot and their location, abundance and distribution)*	Secondary portlandite was observed within air voids and around aggregate particles in thin section A, 16-72 mm depth from the upper surface of the concrete.
Other Observations *(incl. sweaty patches, matrix alteration, bleeding, segregation, plastic settlement, loss of bond, embedded items)*	The concrete exhibited variable levels of GGBS and ash binder replacement/mineral addition but appeared generally sound without significant evidence of deterioration apart from cracking and fracturing which may be related to core extraction.

† cement type by reflected light microscopy
• some mineral additions are not easily identified by optical microscopy (e.g. microsilica, metakaolin)
* sometimes assisted by phenolphthalein indicator solution
# Estimated by fluorescence microscopy and based upon reference slides and images in D, Poole, A & Sims, I, *Concrete Petrography, A handbook of investigative techniques (second edition)*, Arnold, London, 2015.

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

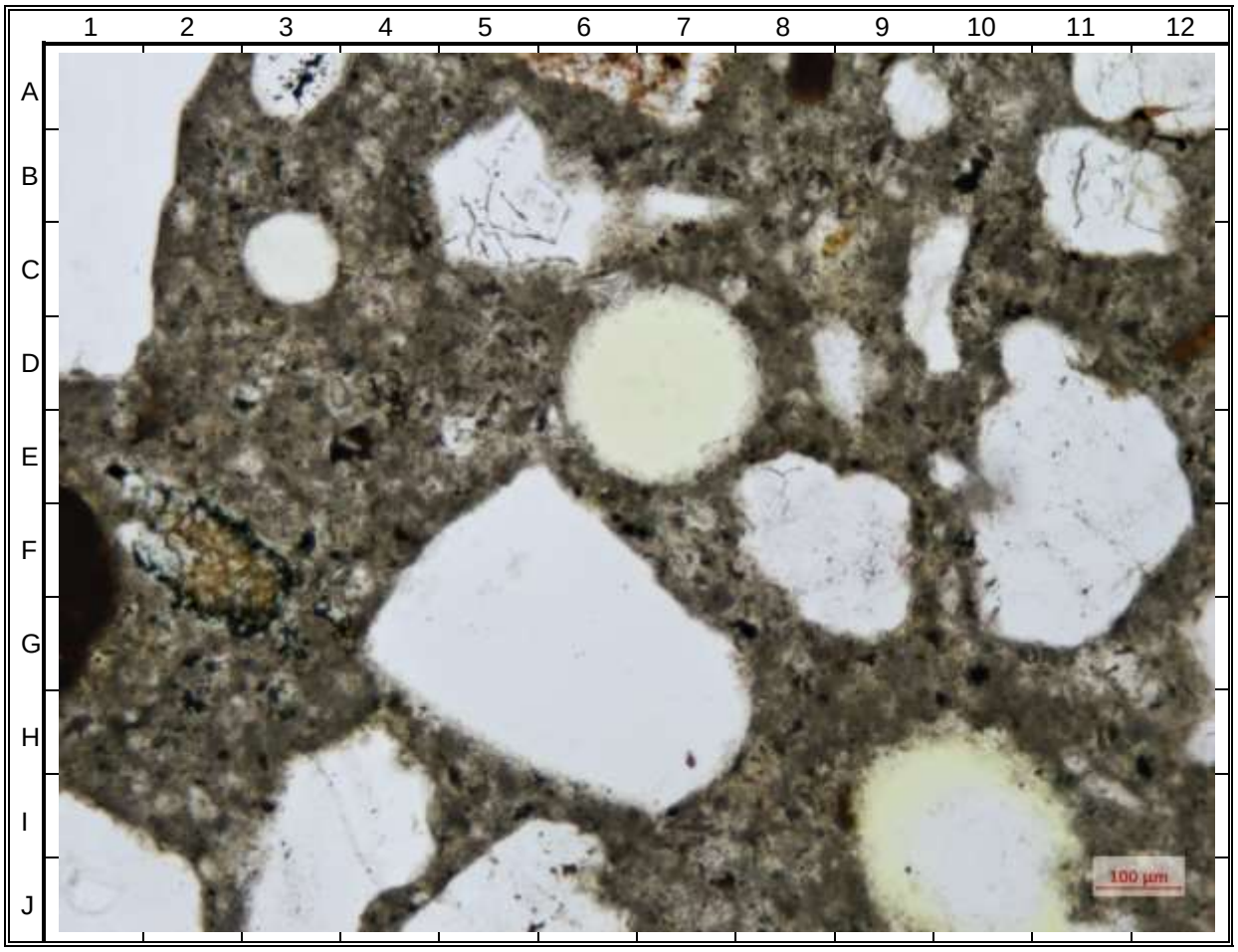
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete - outer surface	**Viewing Light**	Circular-polarised
Description	General view of the outer surface of the concrete (C1-D12), showing quartzitic sandstone (grey/black/white, I6) coarse aggregate and quartz (grey/white/black, e.g. D3), limestone (dark brown, D11) and quartzite (grey, D/E1-2) fine aggregate particles, bound by carbonated (yellowish brown, B4) and uncarbonated (black, e.g. F1-2) Portland-type cement matrix.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

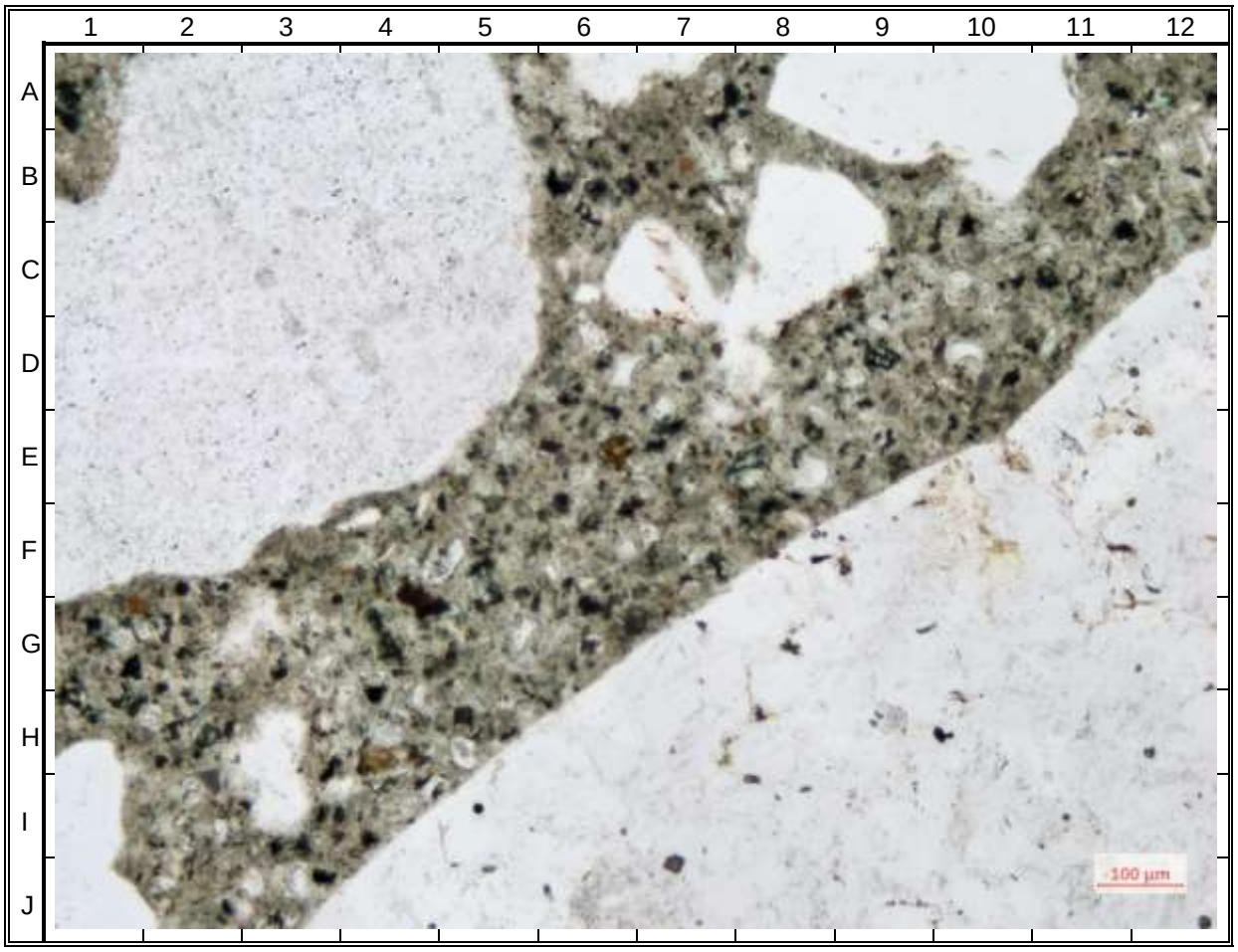
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Concrete (16-72 mm)	**Viewing Light**	Plane-polarised
Description	Detailed view of the concrete, showing quartz (white, e.g. G5), ironstone (dark brown, A8) and sandstone (pale brown, A6-7) fine aggregate particles, bound by Portland-type CEM II cement matrix (greyish brown, e.g. D5) exhibiting stained relict cement grains (dark yellowish brown/ black/greenish black, e.g. F2), ash kernels (black, e.g. B10), GGBS kernels (white, e.g. C6 & D3).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

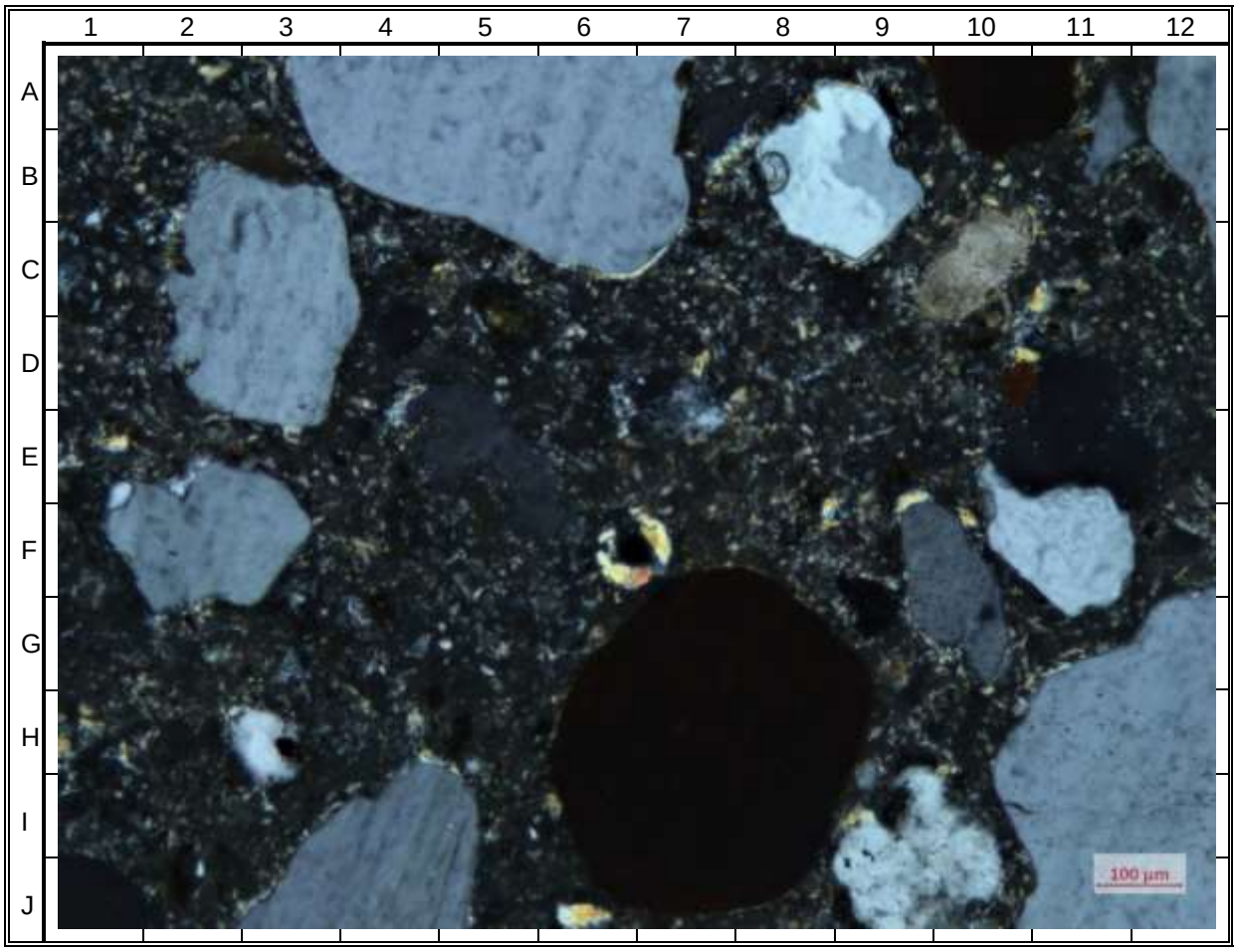
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Concrete 170-220 mm	**Viewing Light**	Plane-polarised
Description	Detailed view of the concrete, showing quartz-rich sandstone (white/black speckles, H9) coarse aggregate and quartz (white, e.g. I1 & A9) fine aggregate particles, bound by a Portland CEM II-type cement matrix. Within the matrix relict grains appear white/brown/black (e.g. H4), GGBS kernels appear white/black/greyish green (e.g. D9, F/G4) and ashy particles appear black (e.g. C11).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

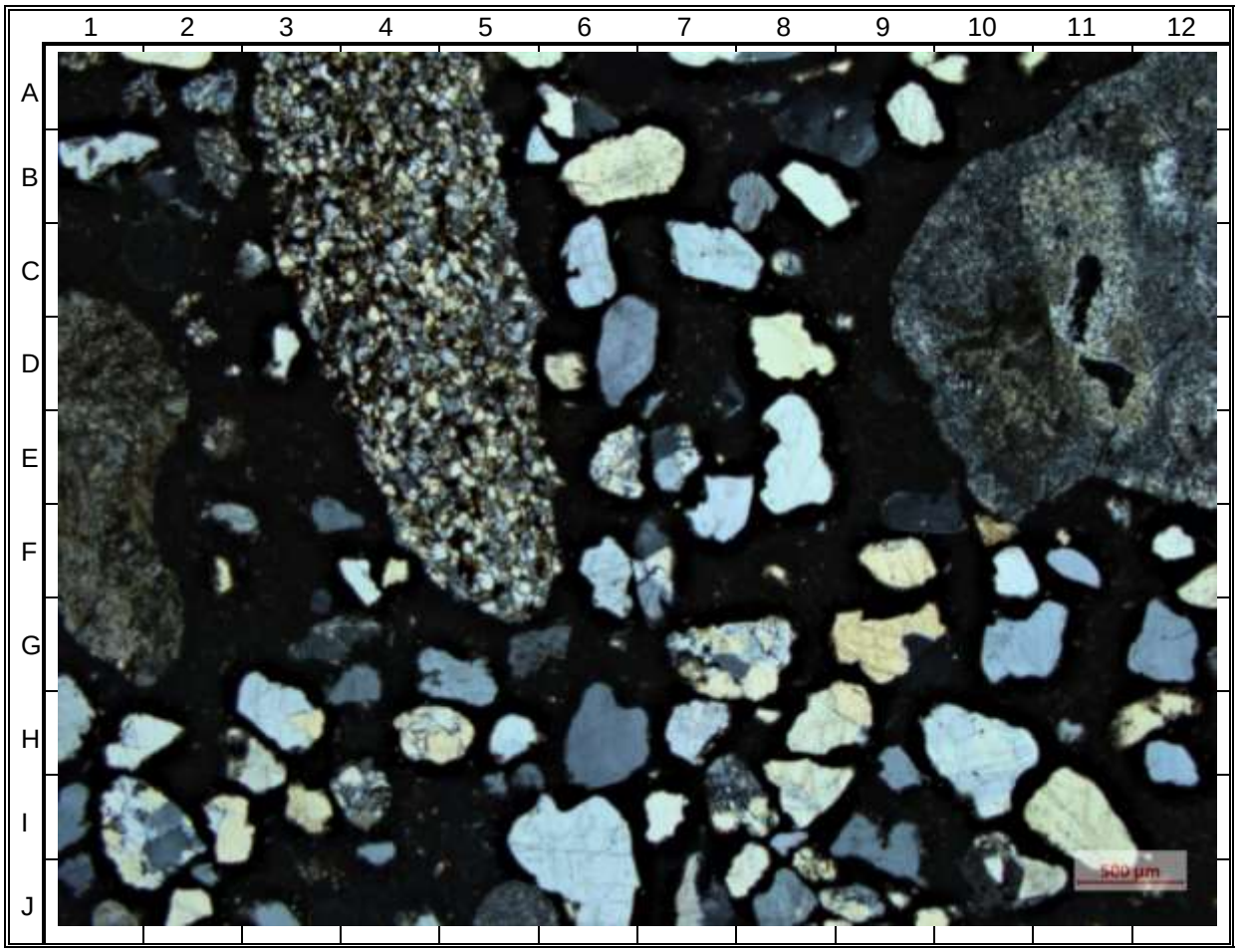
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Concrete 16-72 mm	**Viewing Light**	Circular-polarised
Description	Detailed view of the concrete, showing secondary portlandite lining rare air voids (orange/pink, e.g. F6-7) and formed around sporadic aggregate particles (yellow/grey, e.g. F9-10). Air voids appear black/dark grey (J1).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

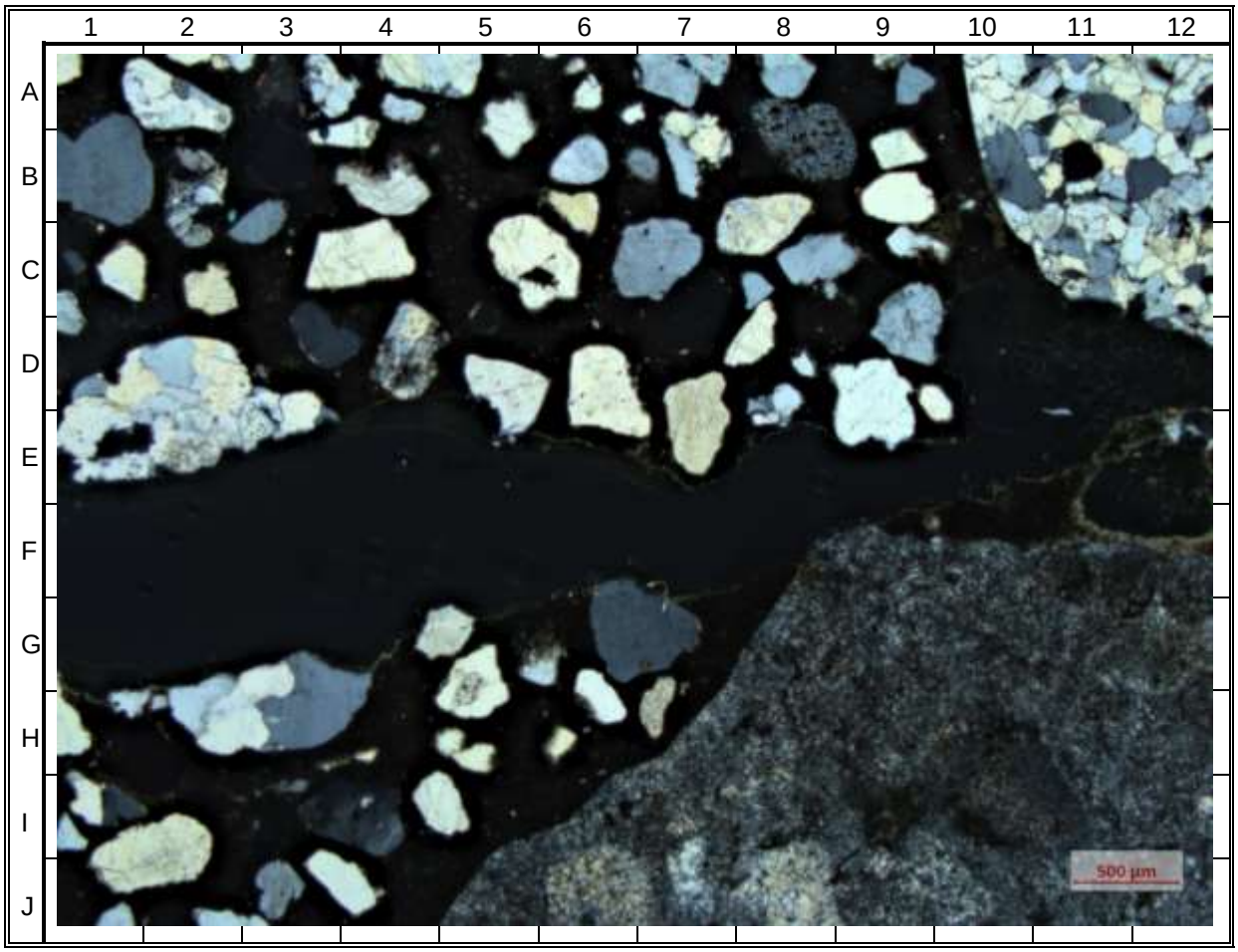
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 580-630 mm	**Viewing Light**	Circular-polarised
Description	General view of the concrete, showing rhyolite (speckled grey, E1) and chert (speckled grey, C11) coarse aggregate and sandstone (speckled grey/black/dark brown, C4), quartz (grey/pale yellow/dark grey, e.g. A9-10), quartzite (grey/white/pale yellow, A1-2) fine aggregate particles, bound by CEM II type cement matrix (black, e.g. E8-9).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

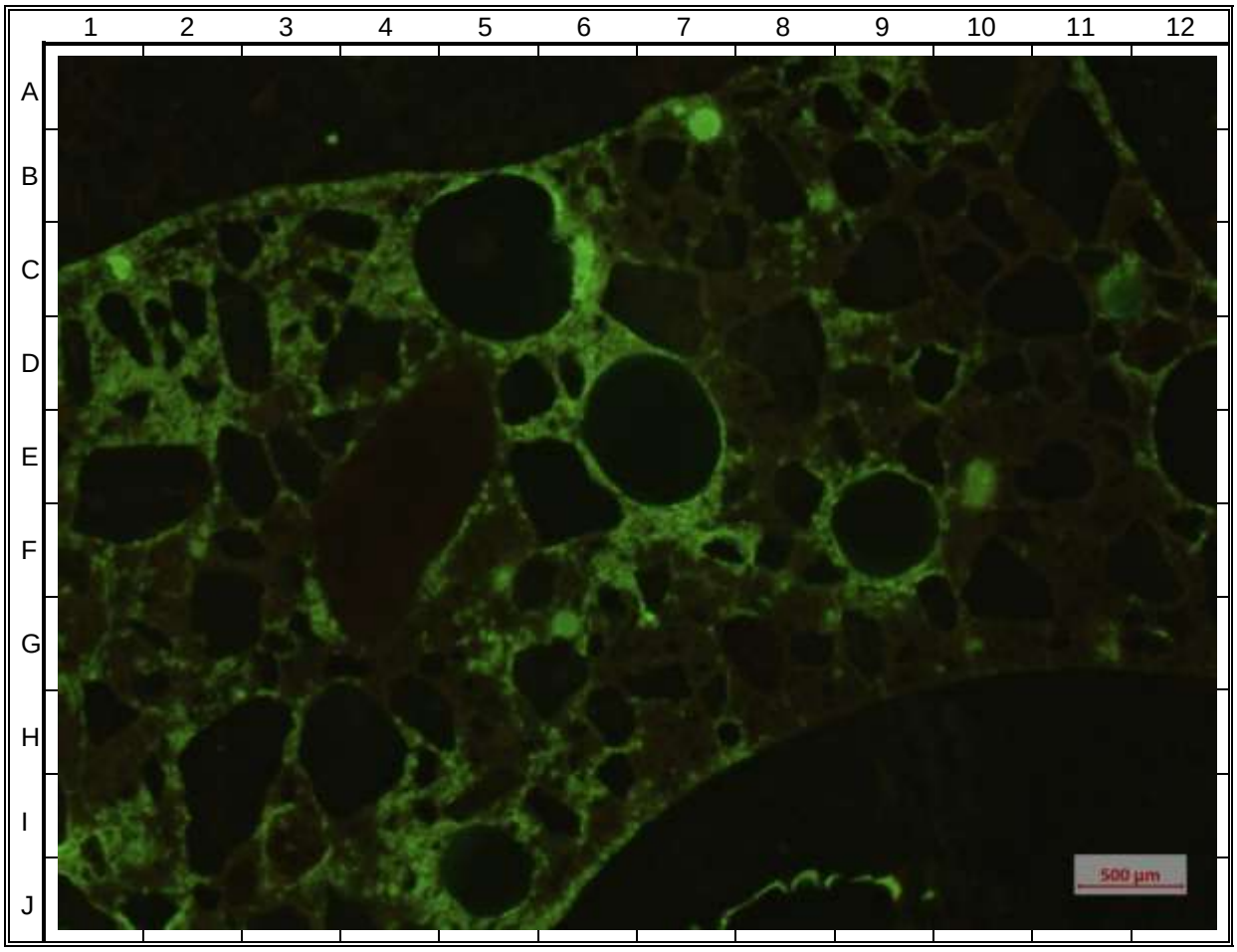
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 580-630 mm	**Viewing Light**	Circular-polarised
Description	General view of the sub-horizontal fracture (dark grey, F1-D12) at 598-614 mm depth from the upper surface of the core.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

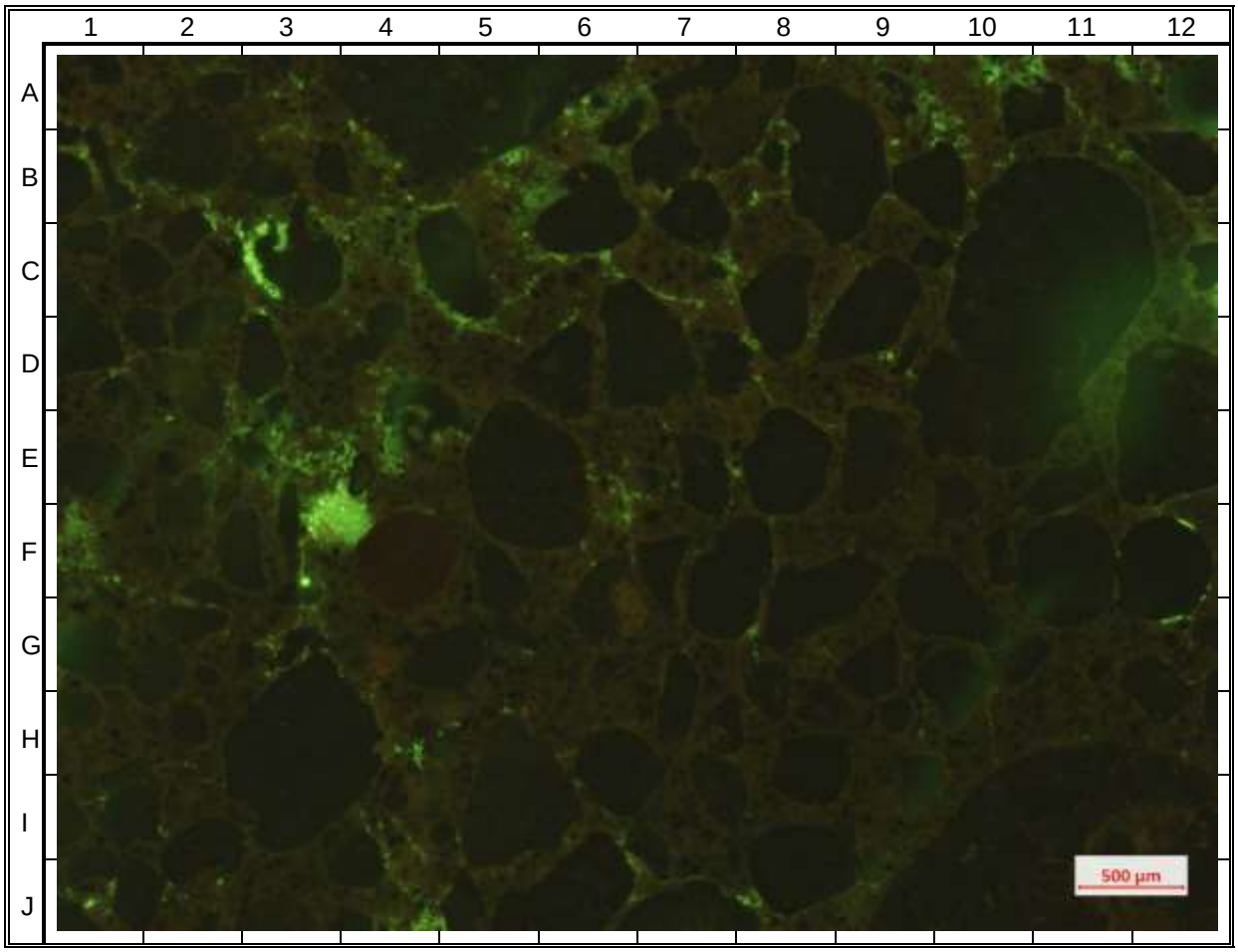
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 16-72 mm	**Viewing Light**	Reflected fluorescent
Description	General view of the concrete, showing the variable microporosity of the concrete from low (dark green, e.g. E10-11) to high (bright green, D2). The microporosity of the concrete is affected by the presence of mineral additions making any water/cement ratio estimation unreliable.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

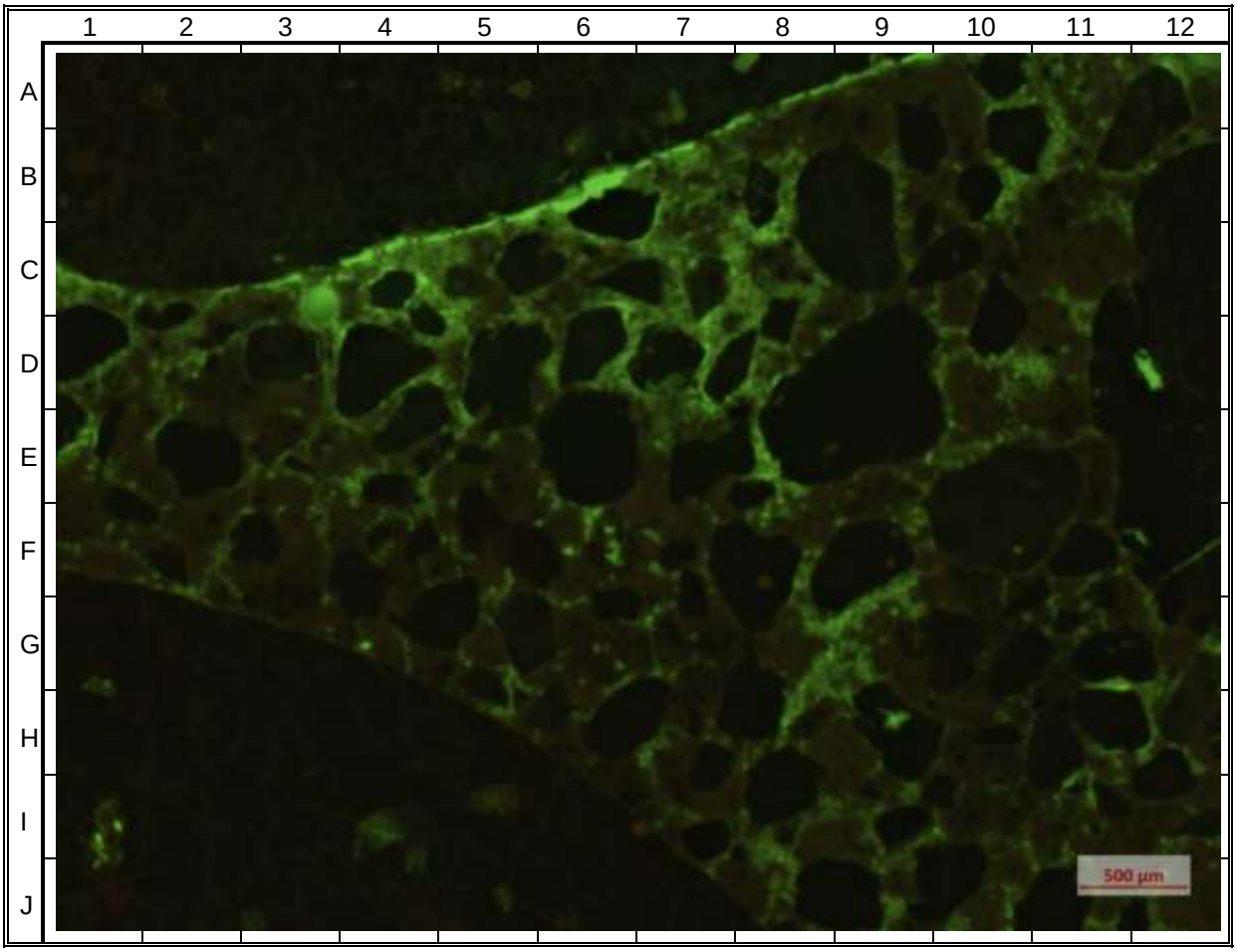
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 170-220 mm	**Viewing Light**	Reflected fluorescent
Description	General view of the concrete, showing the low microporosity of the concrete (dark green, e.g. G5-6) and microcracks running through the cement matrix (B1-D8). The microporosity of the concrete is affected by the presence of mineral additions making any water/cement ratio estimation unreliable.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C1	**Client Sample Ref**	435401-002, 28.00-29.30m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 580-630 mm	**Viewing Light**	Reflected fluorescent
Description	General view of the concrete, showing the low microporosity of the cement matrix and rare areas of high microporosity (green/bright green, C7), the concrete is affected by the presence of mineral additions making any water/cement ratio estimation unreliable. Microcracks and fine cracks also appear bright green e.g. C1-A9 & B6-E8.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

Methods of Examination

The submitted concrete sample was subjected to a petrographic examination following methods recommended by ASTM C856/C856M-20, Standard Practice for Petrographic Examination of Hardened Concrete. Estimation of excess voidage was carried out in accordance with BS EN 12504-1, Testing concrete in structures, Part 1: Cored specimens – Taking, examining and testing in compression. The examination was supplemented (where required) by the determination of the cement type following methods given in BS 1881: Part 124: 2015. When the concrete is suspected to contain high alumina cement, the examination is supplemented by taking guidance from BRE Digest 392, Assessment of existing high alumina cement concrete construction in the UK, March 1994.

The sample was first visually and low-power microscopically examined using a high quality Leica MZ8 binocular zoom microscope employing magnifications up to x50. A record colour photograph of the sample was prepared along with a diagram illustrating the main features of interest. A low-power photomicrograph (a photograph taken through the microscope) is sometimes prepared to illustrate certain features of importance.

The initial examination was used to determine the most appropriate location for a medium-area (45 x 30 mm) thin-section to be taken for further, more detailed microscopical examination. The thin-section was prepared from a diamond sawn slice which had been both consolidated with, and vacuum impregnated by, an epoxy resin usually containing an ultraviolet light sensitive fluorescent dye. In some cases (eg concretes suspected to contain thaumasite), a pair of thin-sections is produced, one using fluorescent dye and one free of fluorescent dye. Where the specific cement type (eg 'ordinary' Portland or 'sulfate-resisting' Portland) was required a highly polished specimen was also prepared for examination of the matrix in reflected light.

Both the thin-section and polished specimen were examined using a high quality Zeiss axioscope multi-functional microscope employing various magnifications up to x630. The thin-section was examined using transmitted plane-polarised and cross-polarised illuminations. The polished specimen was examined using reflected, polarised and brightfield illuminations. One or more record colour photomicrographs were prepared to illustrate certain microscopical features of importance. The thin-section was also examined under reflected ultraviolet illumination to allow an assessment of the void and micropore structure, evidence of cracking and any other features of relevance. The highly polished specimen was etched using appropriate solutions and vapours to assist with the identification of residual particles of unhydrated cement and any non-reacted mineral additions.

Glossary of Terms Used in the Descriptions

Cracks	Fine microcracks (<1μm wide); Microcracks (1-10μm wide); Fine cracks (10-100μm wide); Cracks (100μm-1mm wide); Large cracks (>1mm wide).
Voids	Entrapped: typically irregular in shape and >1mm in diameter; Entrained: typically round in shape and <100μm in diameter (taken to be all voids <1mm diameter when undertaking air content analyses).
Compaction	Related to 'excess voidage': ≤0.5% = very good >0.5% - ≤3.0% = good (i.e. normal for satisfactory quality structural concrete) >3.0% – ≤5.0% = medium >5.0% - ≤10.0% = poor >10.0% = very poor
Carbonation	Complete – no residual cement matrix other than occasional unreacted relics; Partial – evidence of mixed carbonate crystallites with isotropic matrix; Faint – occasional carbonate crystallites, <25% of the area.
Portlandite (Matrix)	Small (<20μm); Medium (20-60μm); Large (60-100μm); Very large (>100μm). Sizes given are for the average measurement across the crystallites.
Relict cement	Small (<20μm); Medium (20-60μm); Large (60-100μm); Very large (>100μm). Sizes given are for the average measurement across the grains.
Water/cement ratio	Low (<0.35); Normal (0.35-0.65); High (>0.65).
Frequency	Increasing Frequency ↓ Rare - only found by thorough searching Sporadic - only occasionally observed during normal examination Common - easily observed during normal examination Frequent - easily observed with minimal examination Abundant - immediately apparent to initial examination
Hardness	Very soft: can be penetrated easily by a finger; Soft: scores with a fingernail; Moderately soft: scores using a copper coin; Moderately hard: scores easily with a penknife; Hard: not easily scored with a penknife; Very hard: cannot be scored with a steel point or knife.

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UKAS TESTING 0278

Certificate of Examination
ASTM C856/C856M-20
Petrographic Examination of Hardened Concrete

Your Ref.	325389	**RSK Sample Ref.**	19528/C2
Site	Rockingham Phase 3	**Client Sample Ref.**	435401-003, 22.2 m
Client	RSK Geosciences	**Sample Type**	Rock/Concrete core
	18 Frogmore Road	**Location**	435401-003
	Hemel Hempstead	**Orientation**	Vertical, downwards
	HP3 9RT	**Sampled by/Date**	GDC/24.06.2021
		Date of Receipt	16.07.2021
	On behalf of Coal Authority	**Examined by/Date**	AS/23.07.2021-10.08.2021

SAMPLE

The sample comprised a nominal 70 mm diameter concrete core, approximately 780 mm in length. The diameter of the submitted core was less than that preferred by the standard (ideally 152 mm diameter). The concrete section of the core was advised to have been recovered between 26.05-28.10 m (MBGL) of the borehole with a 0.75 m recovery. However, other probe holes at this location encountered the concrete mine shaft cap at 22.2 m.

METHODS OF EXAMINATION

A full description of the examination methods, including a glossary of descriptive terms, is given on the final page of this certificate.

EXAMINATION FINDINGS

The detailed petrographic examination findings are given in the following sheets of this certificate along with a record colour photograph and selected photomicrographs (photographs taken through the microscope). An overview of the findings is given below.

SUMMARY OVERVIEW

See page 2.

NOTE

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

Certificate prepared by

Alex Smith
Senior Geomaterials Scientist

Certificate reviewed and authorised by

Bradley Staniforth
Senior Geomaterials Scientist

Date of issue: 20 August 2021

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

SUMMARY OVERVIEW			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m

	Concrete I	Concrete II
Concrete type		
Composition and Constituents	Nominal 14 mm, partially crushed heterogeneous quartzitic gravel coarse aggregate and quartzitic sand fine aggregate, bound by a Portland CEM-II-type cement matrix containing GGBS and ashy particles equivalent to an estimated 40-50 % binder replacement when compared to reference samples.	Nominal 14 mm, partially crushed heterogeneous quartzitic gravel coarse aggregate and natural quartzitic sand fine aggregate, bound by a Portland CEM-II-type cement matrix containing GGBS and ashy particles equivalent to an estimated 20-35 % binder replacement when compared to reference samples.
Mix Quality	Apparently well mixed and exhibiting good to normal compaction. Excess voidage 3-4 %. Apparent water/cement ratio was estimated as being at the lower end of the normal range (based on the low microporosity). However, the observation of microporosity and associated water/cement ratio estimation can be made unreliable by the inclusion of the mineral additions such as ash/GGBS etc.	Apparently well mixed and exhibiting normal compaction. Excess voidage 4-5 %. Apparent water/cement ratio was estimated as being at the lower end of the normal range (based on the low microporosity). However, the observation of microporosity and associated water/cement ratio estimation can be made unreliable by the inclusion of the mineral additions such as ash/GGBS etc.
Condition	The concrete exhibited multiple fractures, possibly related to the method of extraction. Common microcracks ran through the cement matrix in a polygonal pattern.	The concrete exhibited multiple fractures, possibly related to the method of extraction. Bleed channels sporadic with common microcracks.
Other Remarks	The end surfaces were worn and exhibited evidence of drilling and coring.	Fragments were recorded in an order which does not appear to be consistent with accurate recovery of layers.

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

RECORD PHOTOGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Description	As received photo of the concrete portion of the core as received. The depth from 22.2 m borehole depth.		



1st Reinforcement bar	2nd Reinforcement bar
	

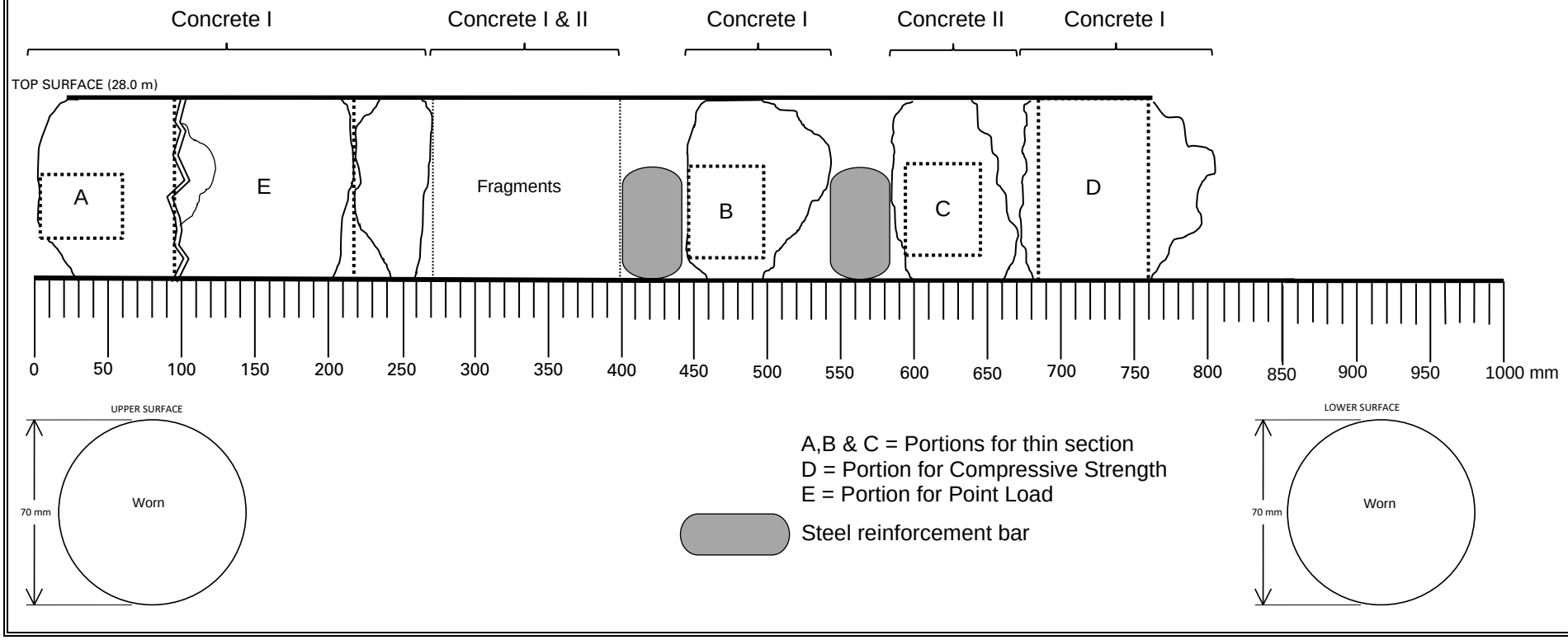
Amendment: Depths of core recovery changed

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

SAMPLE/CORE SKETCH

RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m

Core layout as received within core box. Log depths do not necessary relate to depth below ground surface.



Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

RECORD PHOTOGRAPHS			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Description	Views of the upper and lower surfaces of the core. Core diameter is 70 mm.		

UPPER SURFACE



LOWER SURFACE



Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

AS-RECEIVED CONCRETE CORE DETAILS			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Maximum Length, mm	832	**Diameter, mm**	70
Minimum Length, mm	818	**Number of Pieces**	12 + fragments
Nature of Upper Surface	Drilled worn/rebar	**Nature of Lower Surface**	Worn/freshly fractured/rebar
Portion Described	Representative thin-sections sawn from 0-50 mm, 220-270 mm and 590-640 mm depth from the upper surface. Two concretes present, Concrete I without white fine aggregate particles and Concrete II with white fine aggregate particles.		

Concrete type	Concrete I	
AGGREGATE DETAILS		
Coarse Aggregate *(incl. type, nominal max. size, shape, grading, distribution and orientation)*	Partially crushed heterogenous quartzitic gravel, nominal 14 mm maximum sized, very angular to well rounded, continuously graded, evenly distributed and randomly orientated particles.	
Coarse Aggregate, Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major	QUARTZITE – Very hard to hard, pale grey/pale greyish brown/reddish pink/dusky red/pale yellow sub-crystalline to crystalline siliceous rock. Evidence of grain size reduction and recrystallisation. Sporadic particles exhibit a mild foliation and sporadic opaque mineral content. Sporadic natural fractures in sporadic particles. 30-40 %. SANDSTONE – Reddish brown/dusky red mottled, quartzitic, iron-rich clastic rock, with minor opaque mineral content and traces of iron oxide, phyllosilicate and calcite. Grain supported but exhibiting iron oxide rims of grains and low pore space. 20-30 %. CHERT – Very hard, pale yellow/reddish brown/dark brown/brown coloured crypto/micro-crystalline. 10-20 %.
	Minor	SLAG – Moderately hard, ashy, glassy, black 5 %
	Trace	IRONSTONE
Cement:Aggregate Bond	Good	
Additional Observations *(incl. evidence of deterioration etc)*	None.	
Fine Aggregate *(incl. type, nominal max. size, shape, grading, distribution and orientation)*	Quartzitic sand, 5 mm nominal maximum sized, angular to well rounded, continuous graded, evenly distributed and randomly orientated particles.	
Fine Aggregate, Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major	QUARTZ – Hard, silica grains. 40-50 %. QUARTZITE - Very hard to hard, crystalline silica rocks, with rare foliation and minor to trace iron content. 20-30 %.
	Minor	SANDSTONE – Hard, quartzitic sedimentary rocks with minor iron and phyllosilicate. 5-10 %. SILTSTONE – Moderately hard, very fine quartzitic sedimentary rock. 3-4 %. CHERT – Very hard, micro/cryptocrystalline rock 3-4 %.
	Trace	MUSCOVITE MICA. LIMESTONE. RHYOLITE. IRONSTONE. METAMORPHIC ROCK FRAGMENT. CALCITE. LIMESTONE.
Cement:Aggregate Bond	Good, only sporadic interfacial partings in evidence.	
Additional Observations *(incl. evidence of deterioration etc)*	None.	

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

AGGREGATE DETAILS			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Concrete type	Concrete II		
Coarse Aggregate *(incl. type, nominal max. size, shape, grading, distribution and orientation)*	Partially crushed heterogenous quartzitic gravel, nominal 14 mm maximum sized, very angular to well rounded, continuously graded, evenly distributed and randomly orientated particles.		
Coarse Aggregate, Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major: SANDSTONE – Reddish brown/dusky red mottled, quartzitic, iron-rich clastic rock. 50-60 %. QUARTZITE – Very hard to hard, pale grey/pale greyish brown/reddish pink/dusky red/pale yellow crystalline silica. Minor iron content and mudstone inclusions. 30-40 %. Minor: CHERT – Very hard, pale yellow/reddish brown/dark brown/brown coloured crypto/micro-crystalline. 5-10 %.		
Cement:Aggregate Bond	Good		
Additional Observations *(incl. evidence of deterioration etc)*	None.		
Fine Aggregate *(incl. type, nominal max. size, shape, grading, distribution and orientation)*	Quartzitic sand, 5 mm nominal maximum sized, angular to well rounded, continuous graded, evenly distributed and randomly orientated particles.		
Fine Aggregate, Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major: QUARTZ – Hard, silica grains. 50-60 %. QUARTZITE – Very hard to hard, crystalline silica rocks, with rare foliation and minor to trace iron content. 20-30 %. Minor: SANDSTONE – Hard, quartzitic sedimentary rocks with minor iron and phyllosilicate content. 8-10 %. METAMORPHIC ROCK FRAGMENT – Hard, silica-rich igneous rock fragments not classified as quartzite, minor mica content and opaque mineral content. 8-10 % Trace: RHYOLITE (White Mottled). MICROGRANITE. PLAGIOCLASE FELDSPAR. ALKALI FELDSPAR. IGNEOUS ROCK FRAGMENT. LIMESTONE. MUSCOVITE MICA.		
Cement:Aggregate Bond	Good, only rare interfacial partings in evidence.		
Additional Observations *(incl. evidence of deterioration etc)*	None.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

CONCRETE FEATURES			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 22.2 m
Concrete Type	Concrete I		
Apparent Cement Type and Matrix Details *(Portland, High Alumina, White, PBC, etc and incl. hardness, colour, colour distribution and matrix distribution)*	Moderately hard, mid olive grey/brownish grey/dark greenish grey/black, evenly distributed suspected CEM II Portland-type cement matrix. Exhibiting common, typically small to very large, sized, randomly distributed, unhydrated relict cement grains, these were often stained by the presence of GGBS ash.		
Mineral Additions• *(incl. type, size, relative abundance, distribution and shape)*	Frequent, angular to very angular GGBS kernels present throughout the cement matrix. Equivalent to a 40-50% cement replacement when compared to reference samples. Common, very angular to sub-rounded shaped, opaque ash particles present.		
Air Void Details and Compaction *(incl. air void max. size, shape, distribution, orientation, presence of entrainment, excess voidage)*	10 mm maximum, typically 0.5-3.0 mm sized, irregular to spherical, variably distributed and randomly orientated entrapped air voids. Estimated excess voidage 3-4 %. The presence of frequent/abundant, <0.5 mm sized, spherical air voids suggests the presence of an admixture imparting some degree of entrainment.		
Microporosity and Water/Cement Ratio# *(incl., microporosity variations and relation to other features; assessment of original water/cement ratio)*	The observation of microporosity and associated water/cement ratio estimation can be made unreliable by the inclusion of the mineral additions such as ash/GGBS etc. The cement paste typically exhibited low microporosity. However, areas of high microporosity were observed associated with porous aggregate particles, microcracks and sporadic bleeding channels.		
Carbonation* *(incl. depths, variations and relation to surface cracking)*	The upper surface of the concrete was carbonated to a maximum depth of 1.9 mm.		
Portlandite *(incl. size, shape, abundance and distribution of crystallites)*	The uncarbonated cement matrix exhibited sporadic to common, small to medium sized, portlandite crystallites that were variable in abundance and typically present around aggregate particles and air voids.		
Other Concrete Details *(incl. applied finishes, inclusions and impurities)*	The core represented 2.05 m of drilling depth, which suggested over 50 % of the concrete core was not retrieved. Continuous core was retrieved from 0-222 mm depth from the upper surface of the concrete core. The upper and lower surfaces of the concrete were worn and exhibited evidence of drilling. Concrete I was present between 0-257 mm within the fragments between 257-400 mm, between 440-546 mm and 670-805 mm depths from the upper surface of the core recovery.		
Reinforcement *(incl. types, sizes, depths, orientations, evidence of corrosion)*	Fresh to minor surface corroded (possibly after extraction), 40 mm diameter, ribbed steel reinforcement bars were present at 400-440 mm and 546-584 mm depths from the upper surface.		
Evidence of Cracking *(incl. crack styles, abundance and relation to other features)*	Core fractures were present at 92-132 mm, 218-242 mm, 257-271 mm, 445-454 mm, 496-546 mm and 582-605 mm depths from the upper surface. Fragments were present at 257-400 mm. Common microcracks ran through the cement matrix in a sub-polygonal pattern.		
Presence of Deposits *(incl. gel, sulfates, carbonates, oxides, soot and their location, abundance and distribution)*	None observed.		
Other Observations *(incl. sweaty patches, matrix alteration, bleeding, segregation, plastic settlement, loss of bond, embedded items)*	The concrete exhibited variable levels of GGBS and ash binder replacement/mineral addition but appeared generally sound without significant evidence of deterioration apart from cracking and fracturing is likely attributed to extraction.		

† cement type by reflected light microscopy
• some mineral additions are not easily identified by optical microscopy (eg. microsilica, metakaolin)
* sometimes assisted by phenolphthalein indicator solution
# Estimated by fluorescence microscopy and based upon reference slides and images in D, Poole, A & Sims, I, *Concrete Petrography, A handbook of investigative techniques (second edition)*, Arnold, London, 2015.

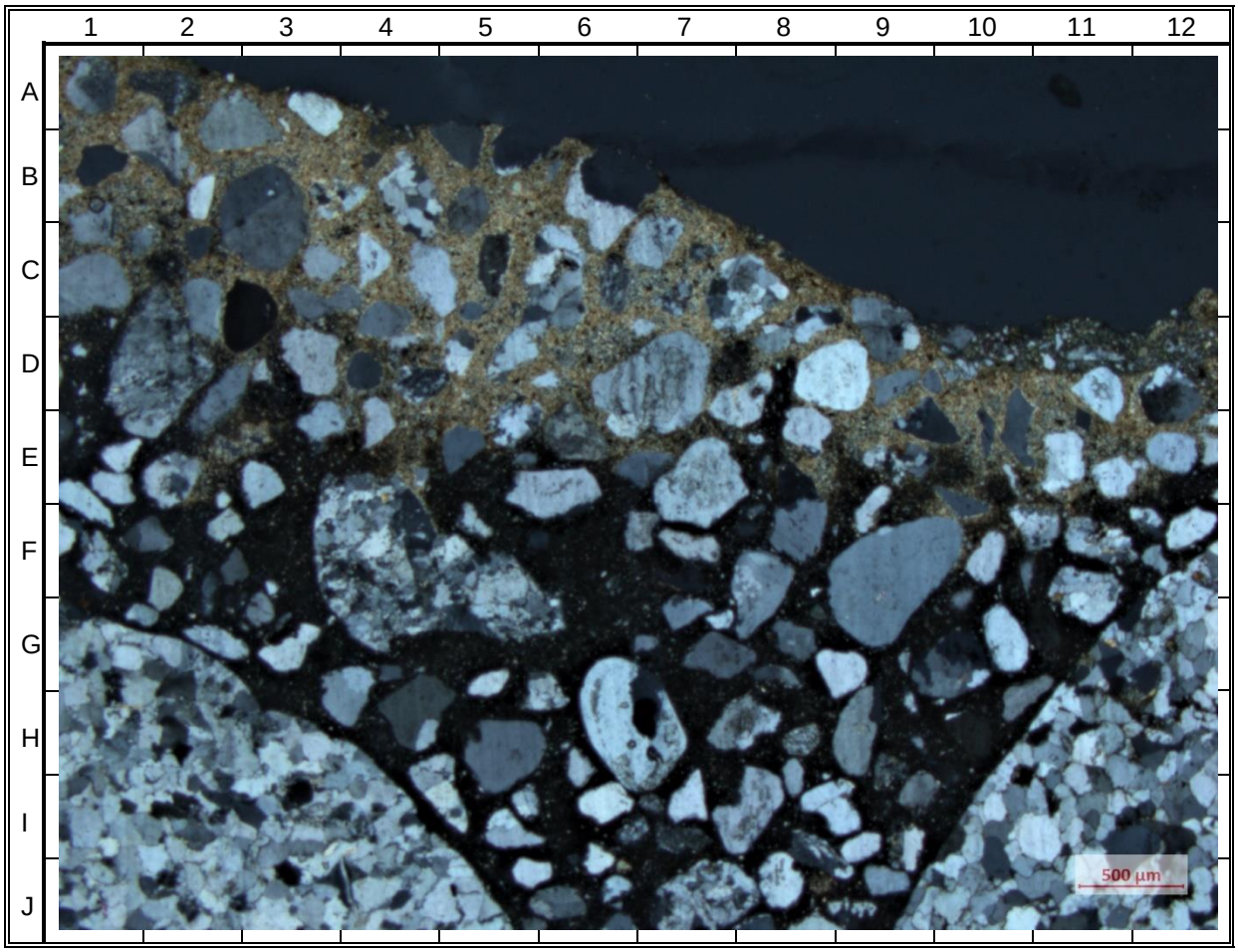
Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

CONCRETE FEATURES			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 22.2 m
Concrete Type	Concrete II		
Apparent Cement Type and Matrix Details *(Portland, High Alumina, White, PBC, etc and incl. hardness, colour, colour distribution and matrix distribution)*	Moderately hard, mid olive grey/brownish grey, evenly distributed suspected CEM II Portland-type cement matrix. Exhibiting rare to sporadic, typically small to very large sized, randomly distributed, unhydrated and cement grains stained by GGBS/ash mineral additions. The matrix exhibited a more homogeneous/amorphous appearance than Concrete I in thin section.		
Mineral Additions• *(incl. type, size, relative abundance, distribution and shape)*	Frequent, angular to very angular GGBS kernels were evenly distributed throughout the cement matrix. Equivalent to a 20-35% cement replacement when compared to reference samples.		
Air Void Details and Compaction *(incl. air void max. size, shape, distribution, orientation, presence of entrainment, excess voidage)*	15 mm maximum, typically 0.5-2.0 mm sized, irregular to spherical, variably distributed and randomly orientated entrapped air voids. Estimated excess voidage 4-5 %. The presence of frequent/abundant, <0.5 mm sized, spherical air voids suggests the presence of an admixture imparting some degree of entrainment.		
Microporosity and Water/Cement Ratio# *(incl., microporosity variations and relation to other features; assessment of original water/cement ratio)*	The observation of microporosity and associated water/cement ratio estimation can be made unreliable by the inclusion of the mineral additions such as ash/GGBS etc. The cement paste typically exhibited low microporosity. However, areas of high microporosity were observed associated with porous aggregate particles, microcracks and sporadic bleeding channels.		
Carbonation* *(incl. depths, variations and relation to surface cracking)*	The upper surface of the concrete fragment was partially carbonated to a maximum depth of 1.5 mm.		
Portlandite *(incl. size, shape, abundance and distribution of crystallites)*	The uncarbonated cement matrix exhibited rare to sporadic, small to large sized, portlandite crystallites that were evenly distributed sporadically around aggregate particles.		
Other Concrete Details *(incl. applied finishes, inclusions and impurities)*	Concrete II was present within the fragmented recovery (between 257-400 mm and at 584-670 mm. The recovery of Concrete II doesn't not appear consistent with a reliable recovery order due to the separation of concrete types.		
Reinforcement *(incl. types, sizes, depths, orientations, evidence of corrosion)*	Fresh to minor surface corroded (possibly after extraction), 40 mm diameter, ribbed steel reinforcement bars were present at 400-440 mm and 546-584 mm depths from the upper surface.		
Evidence of Cracking *(incl. crack styles, abundance and relation to other features)*	Frequent microcracks ran through the cement matrix and aggregate particles. Sporadic fine cracks ran through the cement matrix between coarse aggregate particles. The concrete was present in multiple fragments and not in continuous core recovery, suggesting the recovery is not completely representative of the in-place concrete.		
Presence of Deposits *(incl. gel, sulfates, carbonates, oxides, soot and their location, abundance and distribution)*	None observed.		
Other Observations *(incl. sweaty patches, matrix alteration, bleeding, segregation, plastic settlement, loss of bond, embedded items)*	The concrete appeared exhibited a higher degree of cracking and fracturing than Concrete I, which may be related to extraction.		

† cement type by reflected light microscopy
• some mineral additions are not easily identified by optical microscopy (e.g. microsilica, metakaolin)
* sometimes assisted by phenolphthalein indicator solution
# Estimated by fluorescence microscopy and based upon reference slides and images in D, Poole, A & Sims, I, *Concrete Petrography, A handbook of investigative techniques (second edition)*, Arnold, London, 2015.

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

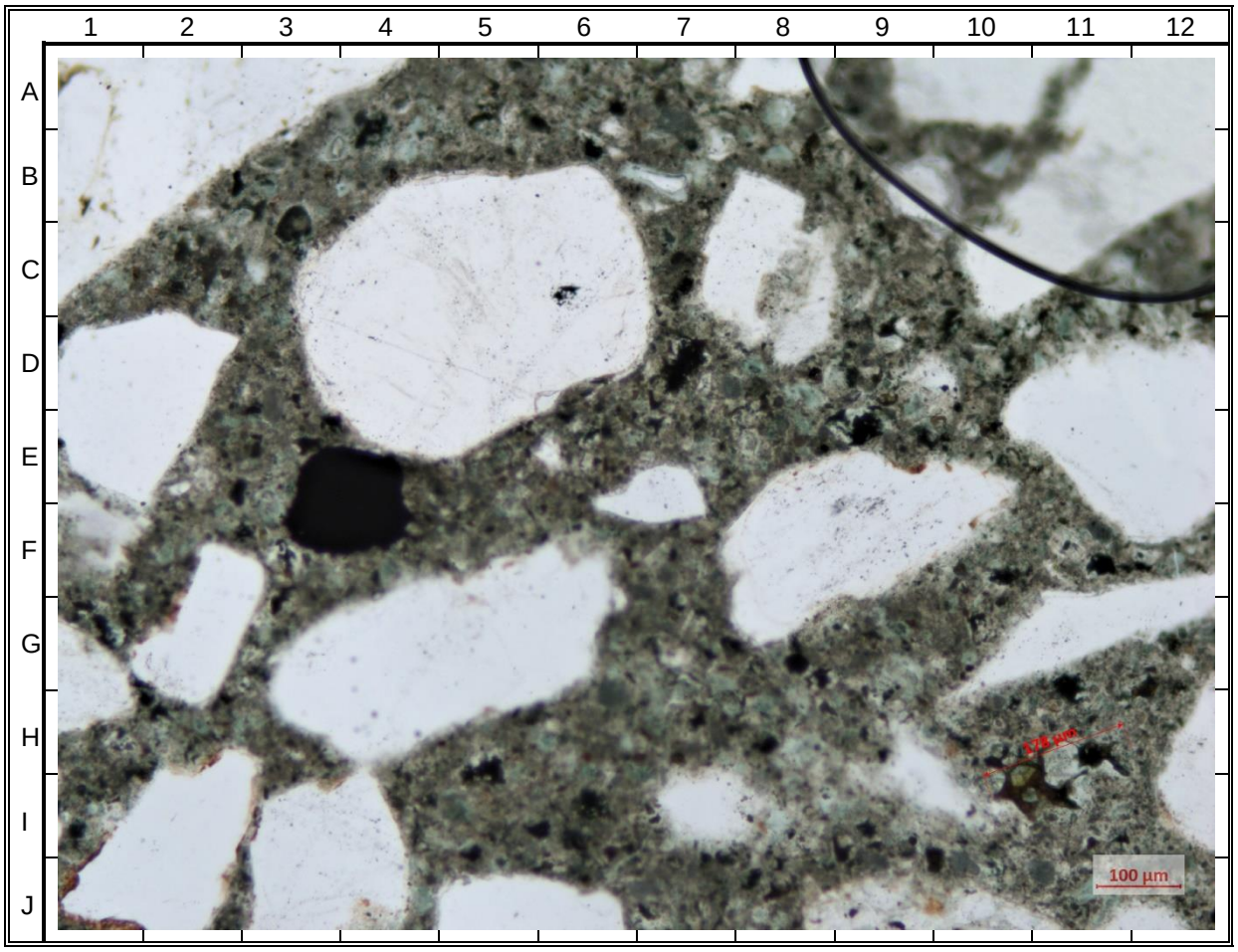
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete I 0-50 mm	**Viewing Light**	Circular-polarised
Description	General view of the upper surface of the concrete (A2-C12), showing quartzite/quartzitic sandstone (grey/black/dark brown, e.g. I2 & H11) coarse aggregate and quartz (grey, e.g. F9) and quartzite (grey, F4) fine aggregate particles, bound by carbonated/oxidised (pale brown, e.g. C4-5) and non-carbonated/non-oxidised (black, F6) CEM II-type cement matrix.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

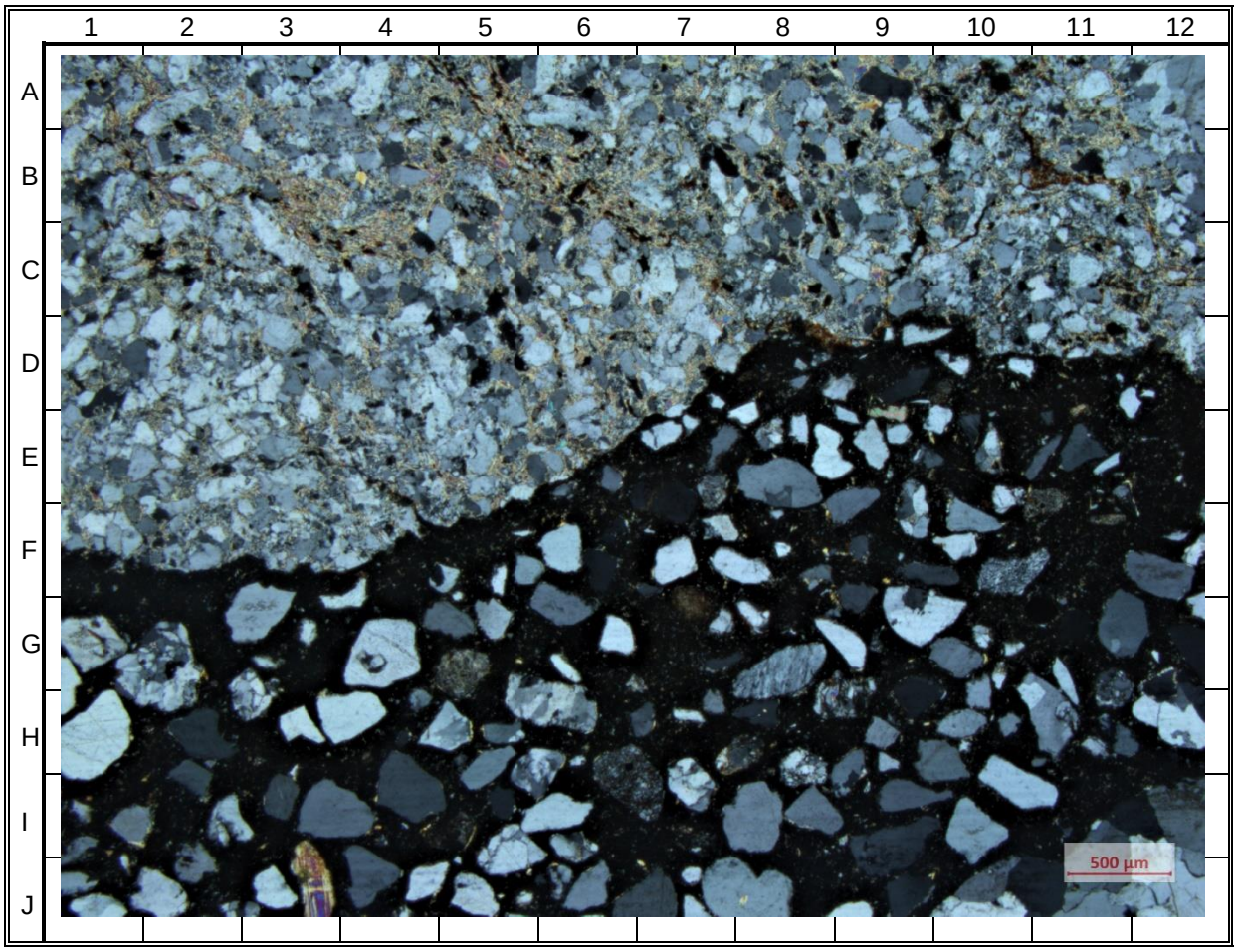
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Concrete I -0-50 mm	**Viewing Light**	Plane-polarised
Description	Detailed view of the concrete, showing quartzitic fine aggregate (white, e.g. C1 & E11), bound by CEM II cement matrix (speckled greenish grey, A5) exhibiting ashy particles (black, e.g. E/F3-4 & D7), GGBS kernels (white/pale green/black, e.g. B6-7) and stained relict Portland-cement grains (pale greenish grey/black/white/pale brown, e.g. H-I10-11 & B/C3). A thin section defect appears black/transparent/blurred, e.g. B11).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

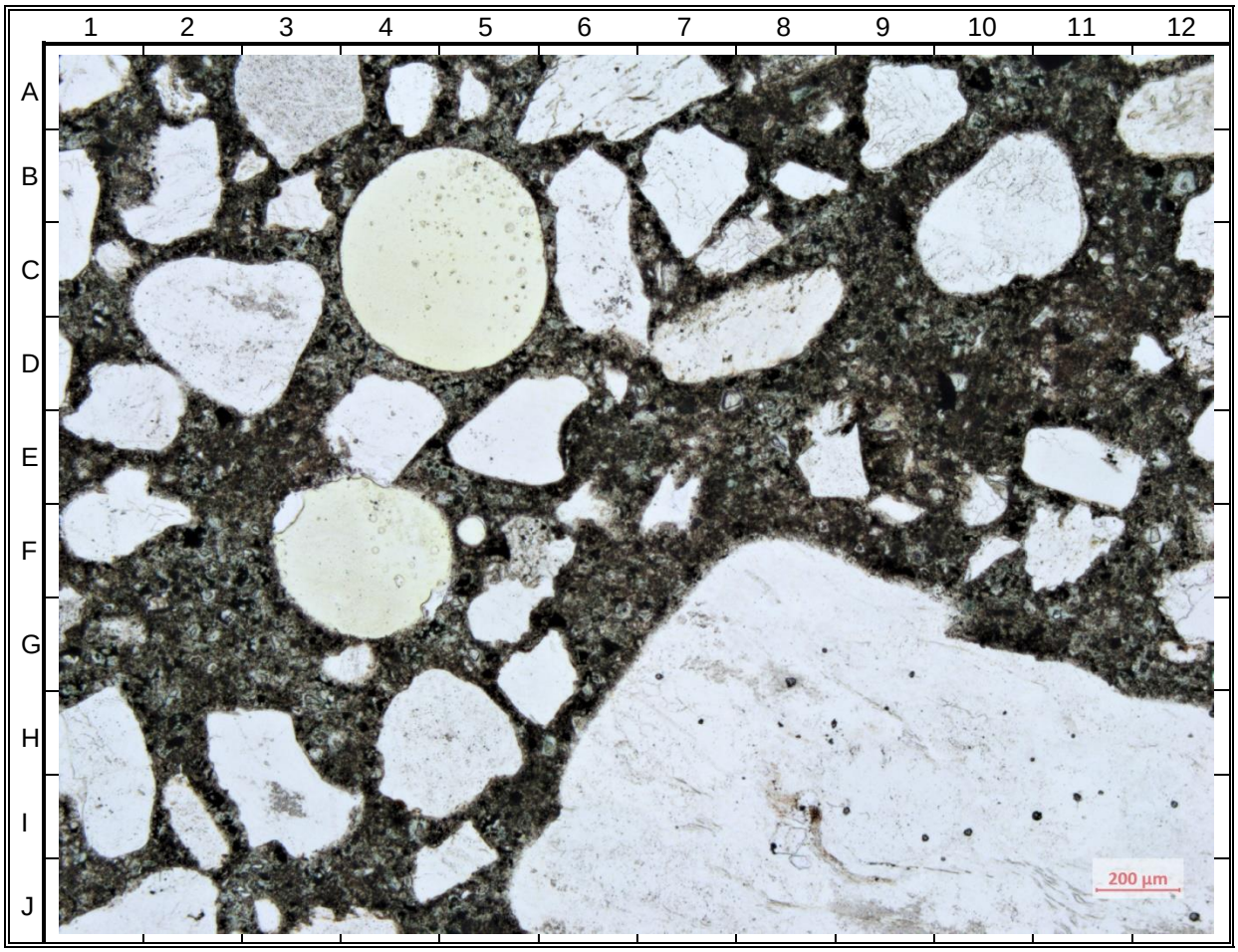
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete I 220-270 mm	**Viewing Light**	Circular-polarised
Description	General view of concrete, showing sandstone (grey/pale brown/black, F1-A12) coarse aggregate and quartz (grey, e.g. H1 & I8), quartzite (grey/black, G8), metamorphic rock fragment (purple/grey/orange, e.g. J3) and rhyolite (grey, H/I6-7) fine aggregate particles, bound by CEM II-type cement matrix (black, E12).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

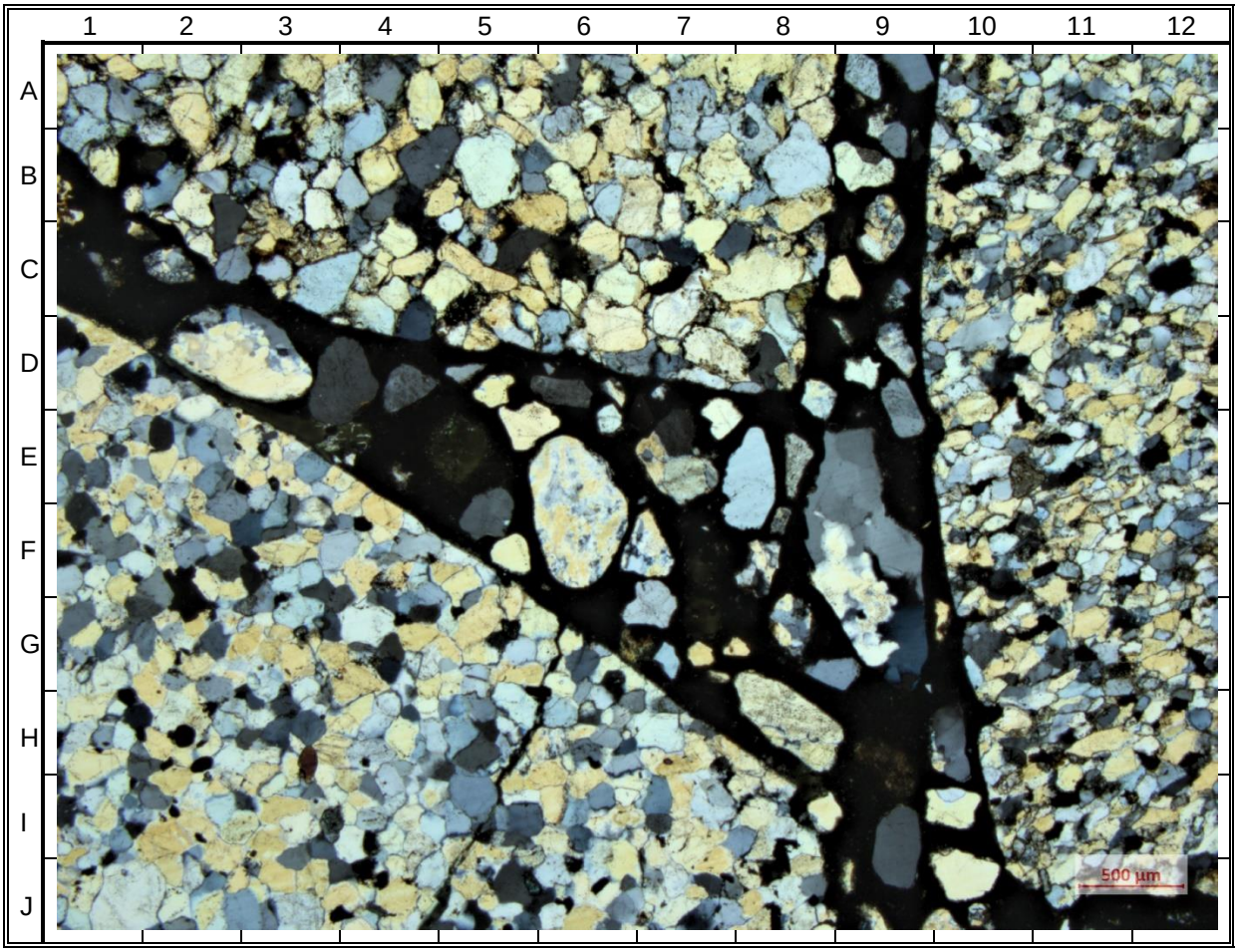
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×31.5	**Approx. Scale**	10 mm = 180 µm
Portion Described	Concrete I	**Viewing Light**	Plane-polarised
Description	View of the concrete, showing spherical entrained air voids (pale yellow, e.g. C4 & F4) and a CEM II-type cement matrix (speckled greenish grey brown, G2).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

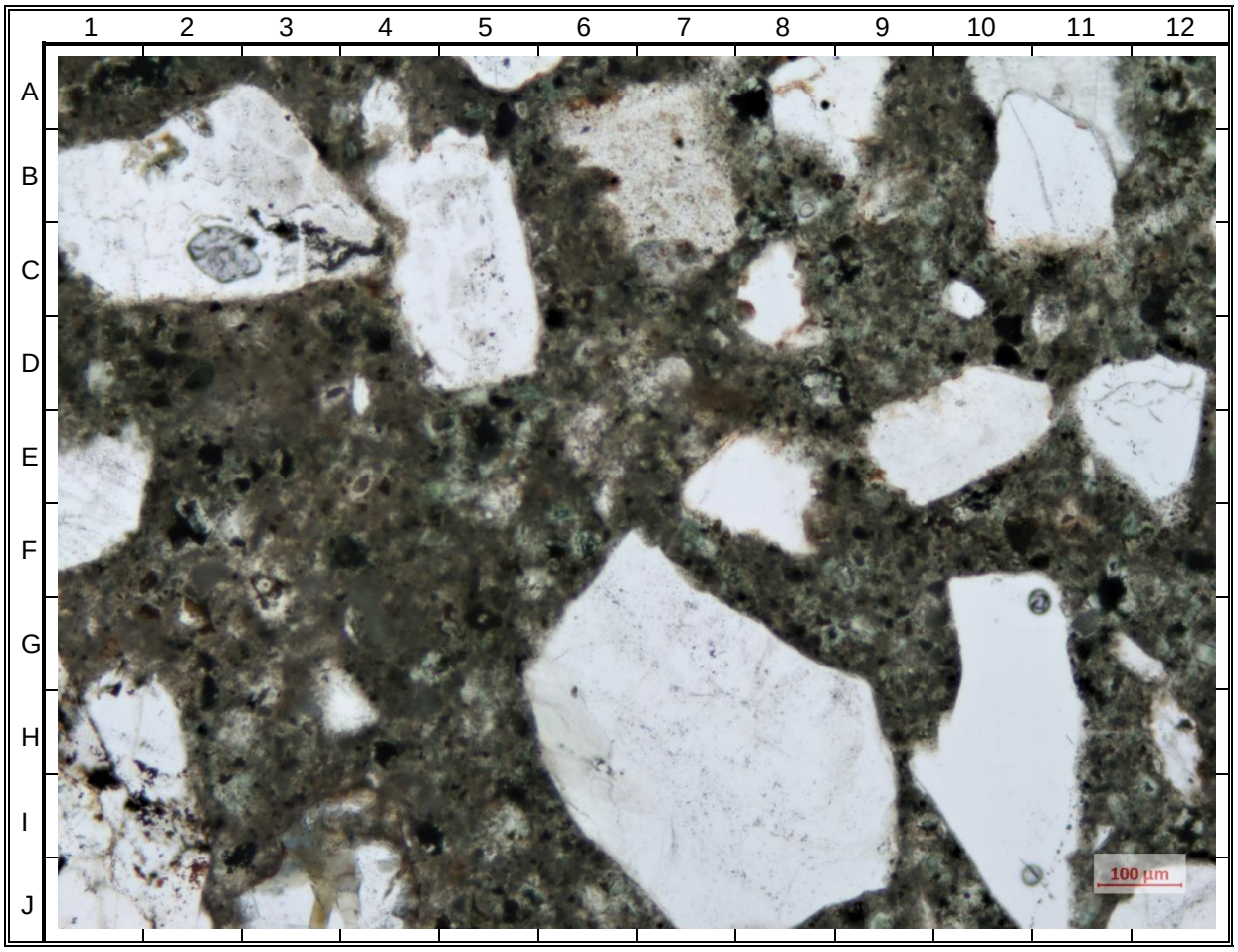
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete II 590-640 mm	**Viewing Light**	Circular-polarised
Description	General view of concrete, showing sandstone/quartzite (grey/dark brown/pale yellow/ black, H3, B5 & E11) coarse aggregate and quartz (grey, e.g. E7-8 & A9) and quartzite (grey/black, E/F5-6) fine aggregate particles, bound by CEM II-type cement matrix (black, e.g. C1).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

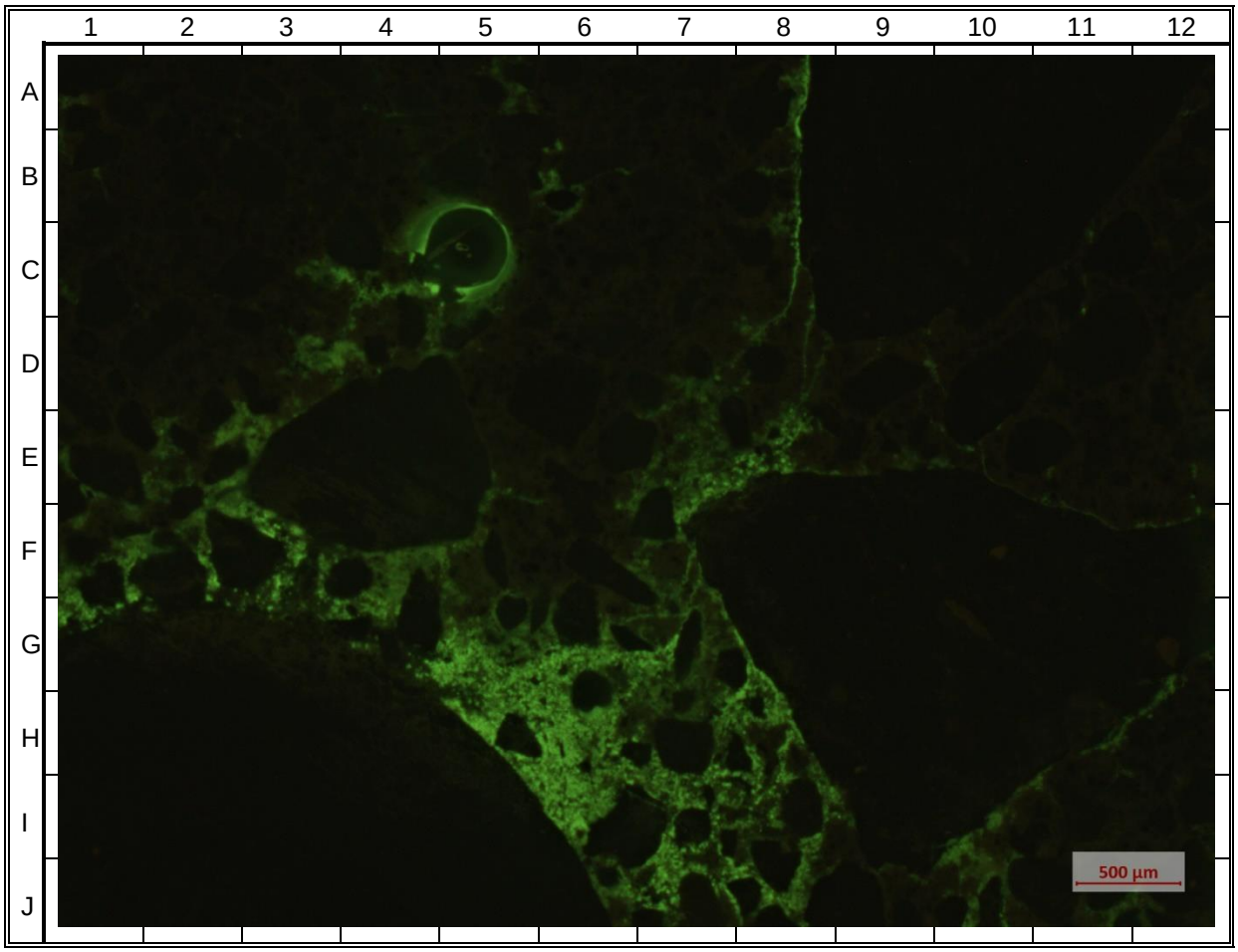
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Concrete II 590-640 mm	**Viewing Light**	Plane-polarised
Description	View of the concrete, showing spherical entrained air voids (pale yellow, e.g. C4 & F4) and a CEM II-type cement matrix (speckled greenish grey brown, G2) exhibiting ashy and crystalline GGBS kernels (black/white, D3-4 & D10-11) and relict cement matrix (dark brown, F/G2-3).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

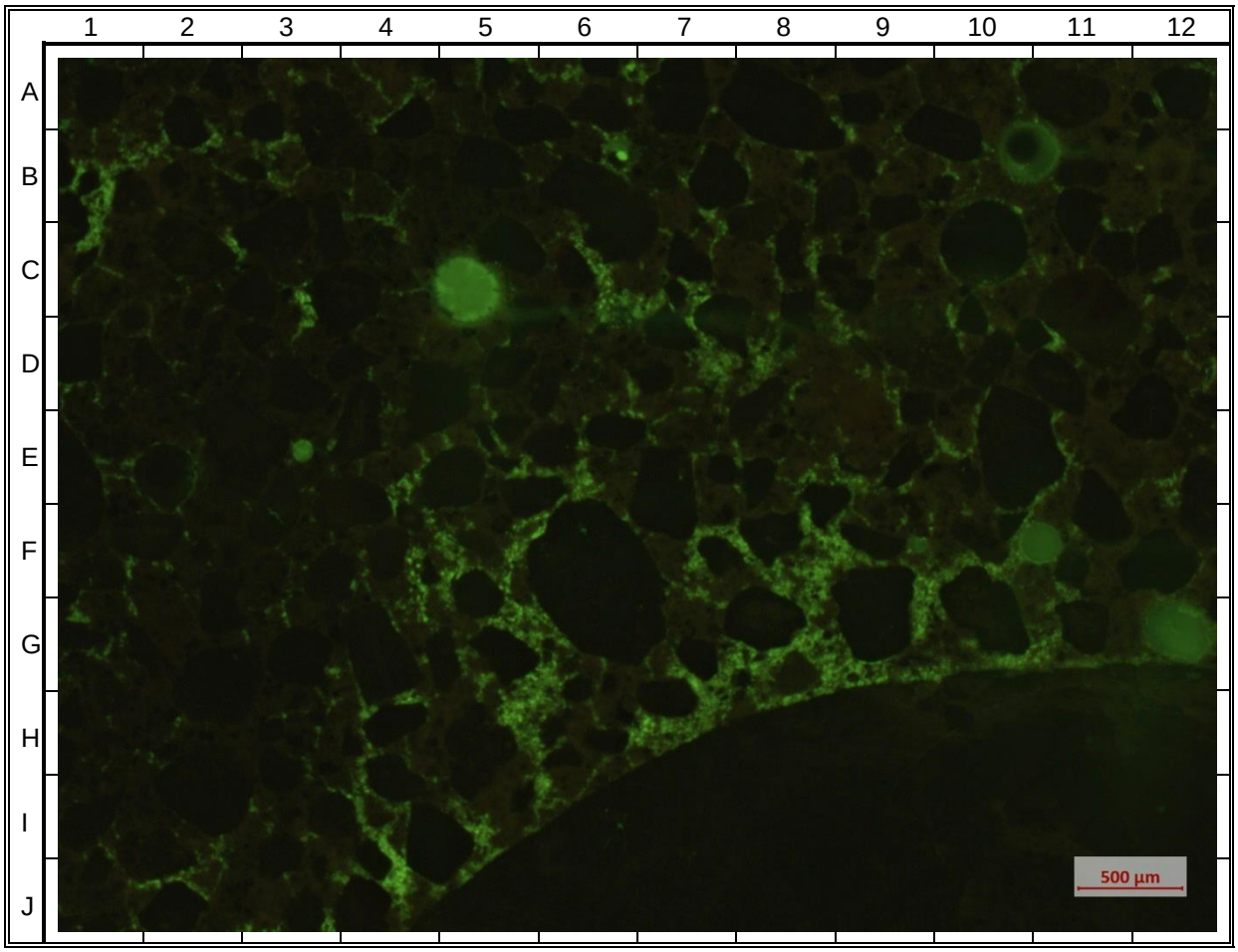
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 1 0-50 mm	**Viewing Light**	Reflected fluorescent
Description	General view of the concrete, showing the variable microporosity of the concrete from low (dark green, e.g. A7) to high (bright green, H6). The microporosity of the concrete is affected by the presence of mineral additions making any water/cement ratio estimation unreliable. Cracking appears bright green (A8-J8).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

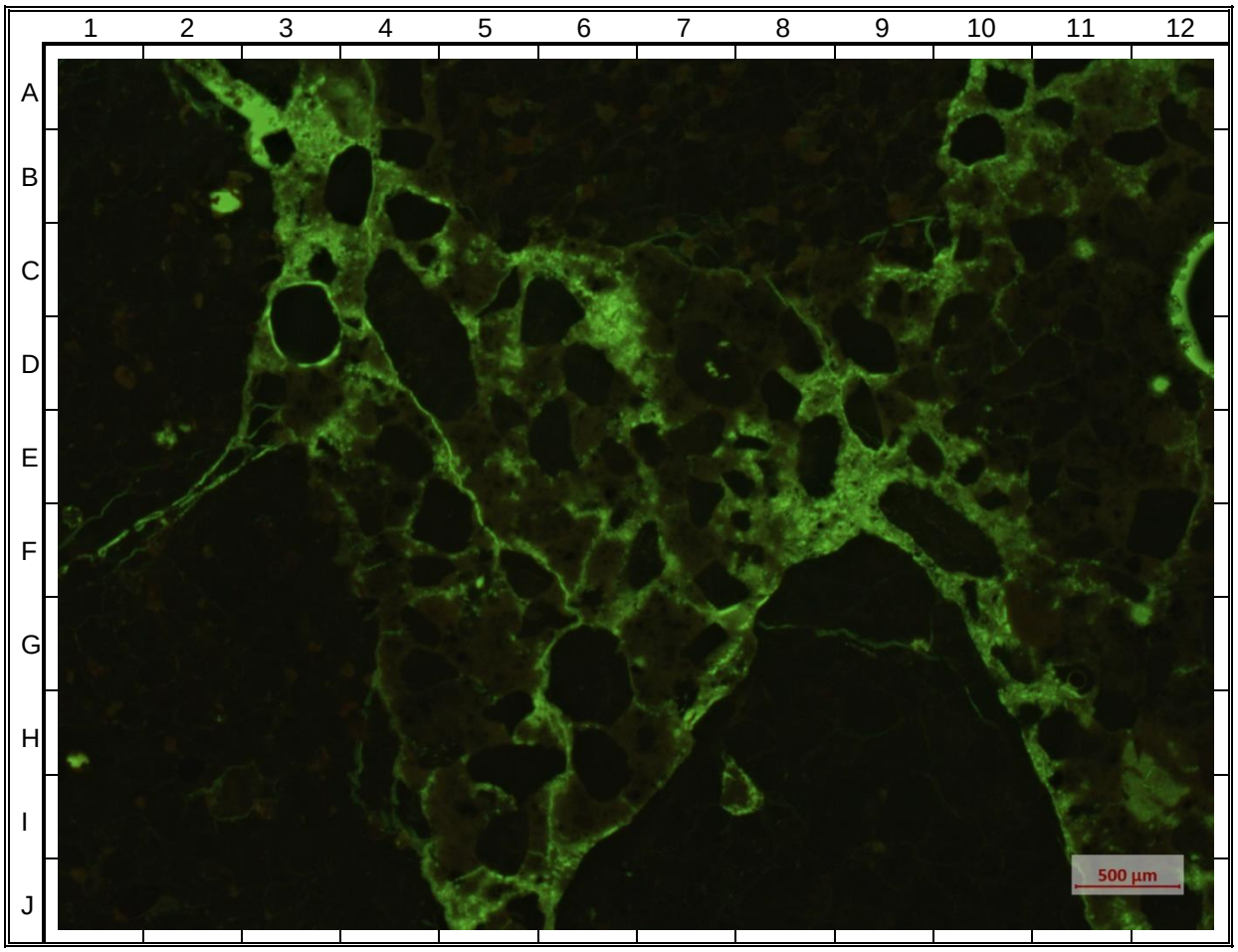
PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete 1 170-220 mm	**Viewing Light**	Reflected fluorescent
Description	General view of the concrete, showing the low microporosity of the cement matrix (dark green, e.g. B5), higher microporosity of the cement matrix of the cement matrix around an aggregate particle (dark green/black, e.g. I10) and microcracks running through the cement matrix (bright green, B8-E10). The microporosity of the concrete is affected by the presence of mineral additions making any water/cement ratio estimation unreliable.		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
High-Power Microscopical Observations

PHOTOGRAPH TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 22.2 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Concrete II 580-630 mm	**Viewing Light**	Reflected fluorescent
Description	General view of the concrete, showing the variable microporosity of the cement matrix with low microporosity (dark green, e.g. D11) and bleed channels exhibiting high microporosity (green/bright green, A2-D6), the concrete is affected by the presence of mineral additions making any water/cement ratio estimation unreliable. Microcracks also appear bright green e.g. F1-J6. Aggregate particles appear black (e.g. C1 & A7).		

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

Methods of Examination

The submitted concrete sample was subjected to a petrographic examination following methods recommended by ASTM C856/C856M-20, Standard Practice for Petrographic Examination of Hardened Concrete. Estimation of excess voidage was carried out in accordance with BS EN 12504-1, Testing concrete in structures, Part 1: Cored specimens – Taking, examining and testing in compression. The examination was supplemented (where required) by the determination of the cement type following methods given in BS 1881: Part 124: 2015. When the concrete is suspected to contain high alumina cement, the examination is supplemented by taking guidance from BRE Digest 392, Assessment of existing high alumina cement concrete construction in the UK, March 1994.

The sample was first visually and low-power microscopically examined using a high quality Leica MZ8 binocular zoom microscope employing magnifications up to x50. A record colour photograph of the sample was prepared along with a diagram illustrating the main features of interest. A low-power photomicrograph (a photograph taken through the microscope) is sometimes prepared to illustrate certain features of importance.

The initial examination was used to determine the most appropriate location for a medium-area (45 x 30 mm) thin-section to be taken for further, more detailed microscopical examination. The thin-section was prepared from a diamond sawn slice which had been both consolidated with, and vacuum impregnated by, an epoxy resin usually containing an ultraviolet light sensitive fluorescent dye. In some cases (e.g. concretes suspected to contain thaumasite), a pair of thin-sections is produced, one using fluorescent dye and one free of fluorescent dye. Where the specific cement type (e.g. 'ordinary' Portland or 'sulfate-resisting' Portland) was required a highly polished specimen was also prepared for examination of the matrix in reflected light.

Both the thin-section and polished specimen were examined using a high quality Zeiss axioscope multi-functional microscope employing various magnifications up to x630. The thin-section was examined using transmitted plane-polarised and cross-polarised illuminations. The polished specimen was examined using reflected, polarised and brightfield illuminations. One or more record colour photomicrographs were prepared to illustrate certain microscopical features of importance. The thin-section was also examined under reflected ultraviolet illumination to allow an assessment of the void and micropore structure, evidence of cracking and any other features of relevance. The highly polished specimen was etched using appropriate solutions and vapours to assist with the identification of residual particles of unhydrated cement and any non-reacted mineral additions.

Glossary of Terms Used in the Descriptions

Cracks	Fine microcracks (<1μm wide); Microcracks (1-10μm wide); Fine cracks (10-100μm wide); Cracks (100μm-1mm wide); Large cracks (>1mm wide).
Voids	Entrapped: typically irregular in shape and >1mm in diameter; Entrained: typically round in shape and <100μm in diameter (taken to be all voids <1mm diameter when undertaking air content analyses).
Compaction	Related to 'excess voidage': ≤0.5% = very good >0.5% - ≤3.0% = good (i.e. normal for satisfactory quality structural concrete) >3.0% – ≤5.0% = medium >5.0% - ≤10.0% = poor >10.0% = very poor
Carbonation	Complete – no residual cement matrix other than occasional unreacted relics; Partial – evidence of mixed carbonate crystallites with isotropic matrix; Faint – occasional carbonate crystallites, <25% of the area.
Portlandite (Matrix)	Small (<20μm); Medium (20-60μm); Large (60-100μm); Very large (>100μm). Sizes given are for the average measurement across the crystallites.
Relict cement	Small (<20μm); Medium (20-60μm); Large (60-100μm); Very large (>100μm). Sizes given are for the average measurement across the grains.
Water/cement ratio	Low (<0.35); Normal (0.35-0.65); High (>0.65).
Frequency	Increasing Frequency ↓ Rare - only found by thorough searching Sporadic - only occasionally observed during normal examination Common - easily observed during normal examination Frequent - easily observed with minimal examination Abundant - immediately apparent to initial examination
Hardness	Very soft: can be penetrated easily by a finger; Soft: scores with a fingernail; Moderately soft: scores using a copper coin; Moderately hard: scores easily with a penknife; Hard: not easily scored with a penknife; Very hard: cannot be scored with a steel point or knife.

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HP3 9RT

UKAS TESTING 0278

Certificate of Examination
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods
Petrographic Examination of Rock

Your Ref.	325389	**RSK Sample Ref.**	19528/C2
Site	Rockingham Phase 3	**Client Sample Ref.**	435401-003, 25.05-26.05 m
Client	RSK Geosciences 18 Frogmore Road Hemel Hempstead HP3 9RT	**Sampled by/Date**	GDC/24.06.2021
		Date Received	16.07.2021
		Examined by/Date	AS/29.07.2021-
		Advised Source	435401-003, 26.05-26.05 m

SAMPLE

The sample comprised a cored rock sample between 25.05-26.05 mbgl present above the concrete mine shaft cap. The GDC sampling core log describes this depth of recovery as concrete (reinforced).

METHODS OF EXAMINATION

A full description of the examination methods, including a glossary of descriptive terms, is given on the final sheet of this certificate.

EXAMINATION FINDINGS

The detailed petrographic examination findings are given on the following sheets of this certificate.

SUMMARY OF FINDINGS

Geological Classification	IMPURE QUARTZ-WACKE SANDSTONE with MUDSTONE/SHALE HORIZONS.
Major Minerals	Quartz and phyllosilicates.
Minor Minerals	Opaque minerals, clay and iron oxide.
Textural Features	Cross-bedding, shale/mud horizons, blocky fracture.
Other Details	Weak splitting planes in mud-rich core sections.

Prepared by

Alex Smith
Senior Geomaterials Scientist

Certificate reviewed and authorised by

Dr Jennifer Murgatroyd
Senior Geomaterials Scientist

Date of issue: 12 August 2021

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

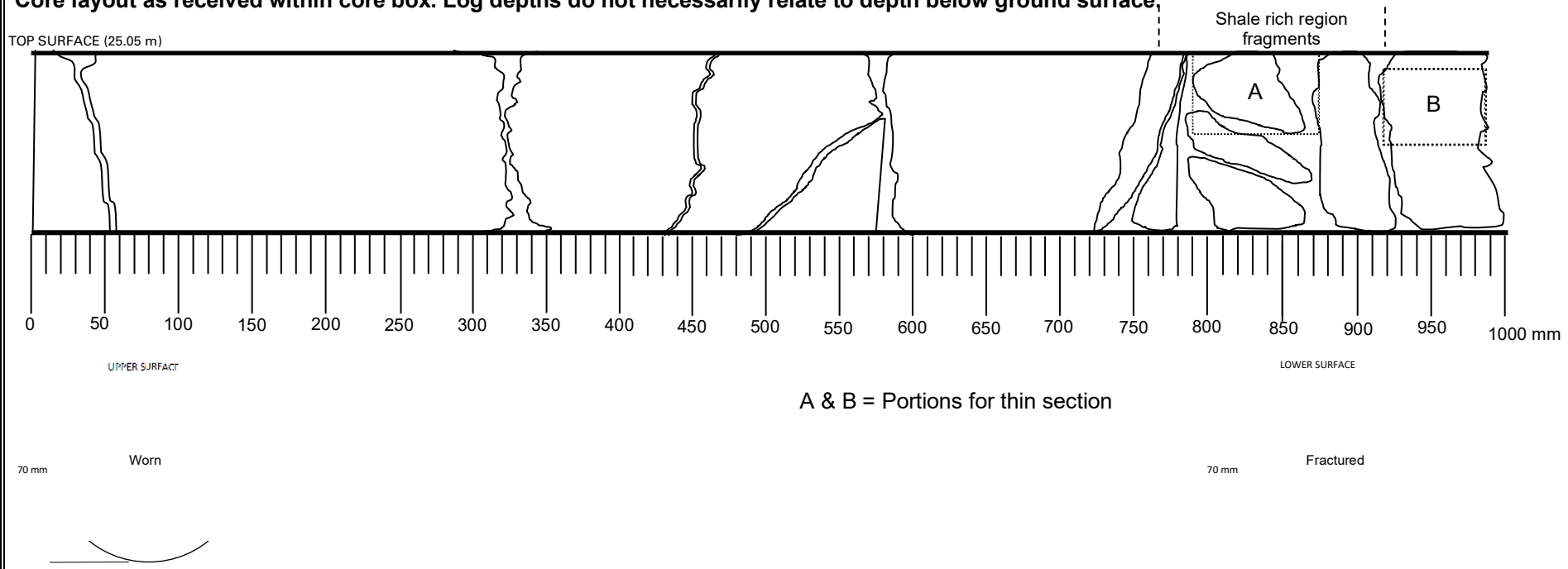
RECORD PHOTOGRAPHS			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 25.05-26.05 m
Description	As received photos of the rock portion of the core as received. The upper photo is dry and the lower photo is wet. The depth from 25.05-26.05 m borehole depth.		



Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
Visual and Low-Power Microscopical Observations

SAMPLE/CORE SKETCH			
RSK Sample Ref	19528/C2	**Client Sample Ref**	435401-003, 25.05-26.05 m

Core layout as received within core box. Log depths do not necessarily relate to depth below ground surface.



HAND SPECIMEN DESCRIPTION	
Description	Moderately hard, pale yellowish grey coloured fine to very fine sandstone rock with black to dark grey finer shale/mudstone horizons spaced at 5-35 mm. Evidence of cross bedding (defined by shaley layers). Between 750-925 mm depth from the upper surface of the core muddy/shaley horizons were more fractured and may present some recovery loss. Rare blocky fracture was present at the end surface where fractured. The rock was relatively weak and split along the mud/shale-rich horizons.

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Sample Details			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 25.05-26.05 m
Condition on Receipt	Dry fractured rock with some regions of continuous recovery.		
Thin-Section Details	Thin sections prepared from a slice sawn perpendicular to the coring direction at 790-830 mm and 940-990 mm depth from the upper surface of the core.		

Material Component	Volume % (Estimated)	Range Of Crystal/Grain Size	Origin[1]
Quartz	25-80[2]	<4 µm – 100 µm	Primary
Phyllosilicates	15-80[2]	<4 µm – 100 µm	Primary-Secondary
Opaque minerals	1-5	<4 µm – 250 µm	Primary
Clay	1-4	<4 µm	Primary
Iron oxide	1	<4 µm	Secondary

1. Primary - originally part of the rock/stone; Secondary - an alteration/weathering product.
2. Wide range accommodates changes in lithology from quartz-rich silt dominated sandstone to phyllosilicate dominated shale

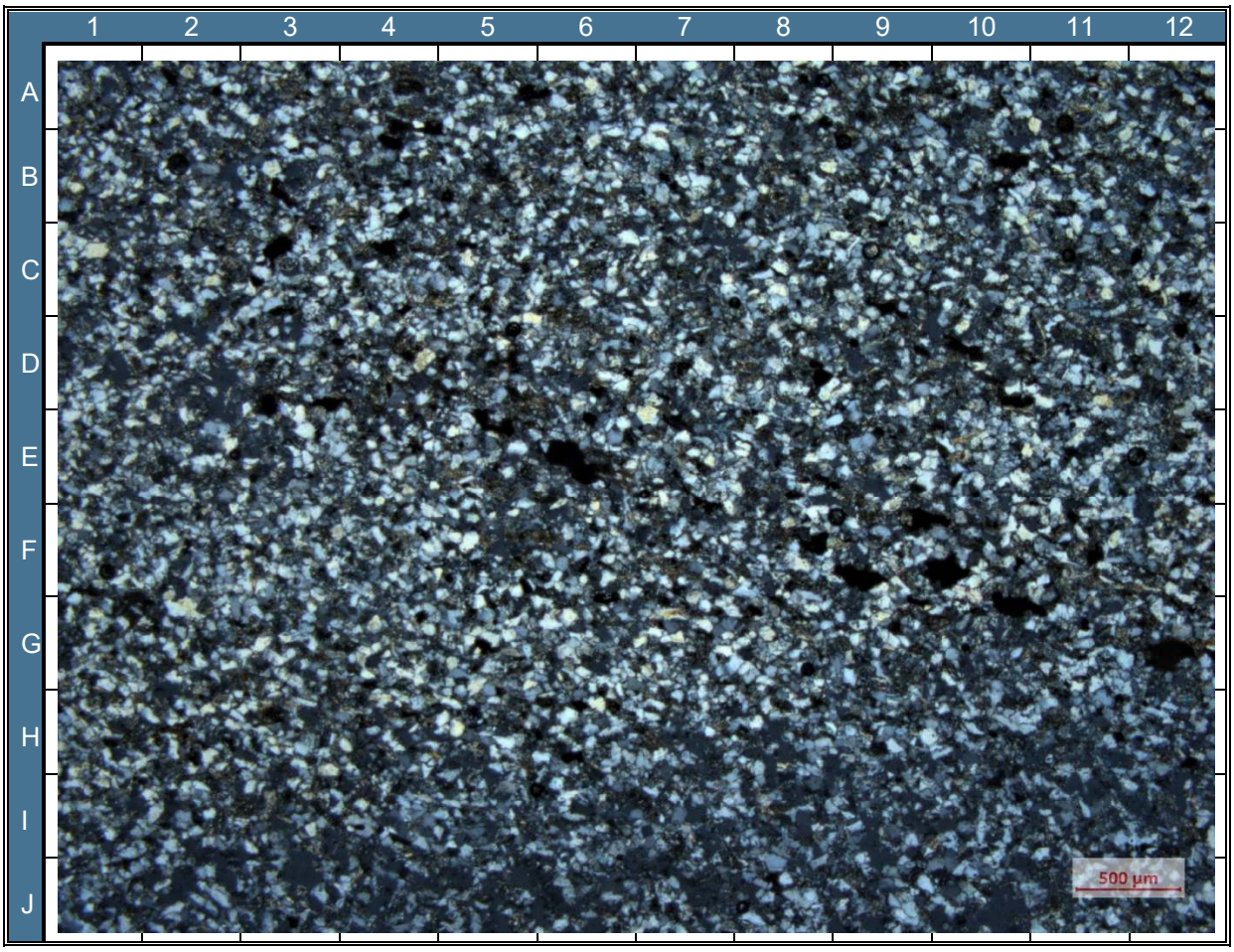
Material Component	Petrographic Details
Quartz	Hard, strong silica, often angular to irregular shaped grains concentrated within paler layers. Abundant in silt-rich regions and sporadic in phyllosilicate-rich regions
Phyllosilicates	Very fine to fine platy micaceous minerals including muscovite mica, chlorite, biotite mica and other phyllosilicates. Forming the majority of the rock in darker mud-rich regions of the rock and rarer in . The platy minerals are aligned parallel to bedding and the planes of weakness within the rock core. Including wavy lenses of phyllosilicates.
Opaque minerals	Iron-rich opaque minerals including pyrite and other sulfides and oxides.
Clay	Very fine amorphous material, present within lenses and as discrete particles within muddy/shale rich areas.
Iron oxide	Iron oxides present around weathered opaque minerals in mud-rich shale areas.

Material Description
Paler yellowish grey regions primarily composed of angular to very angular fine grains of quartz with major amounts of phyllosilicates, minor amounts of opaque minerals and trace amounts of clay materials. The darker layering picking out bedding, laminations and cross-bedding is picked out by opaque minerals, clay minerals and phyllosilicate-rich layers. Dark grey to greyish brown coloured. Mud and clay-rich shale layers formed planes of weakness within the rock and were highly concentrated in a fractured zone between 750-925 mm depth from the upper surface of the core. The shale areas contained >50 % phyllosilicates and a higher abundance of clay mineral horizons and lenses. The rock exhibited a weak foliation/cleavage. The rock could be classified as a poorly indurated, silty to fine grained CROSS BEDDED IMPURE QUARTZ-WACKE SANDSTONE with MUDSTONE/SHALE HORIZONS.

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope

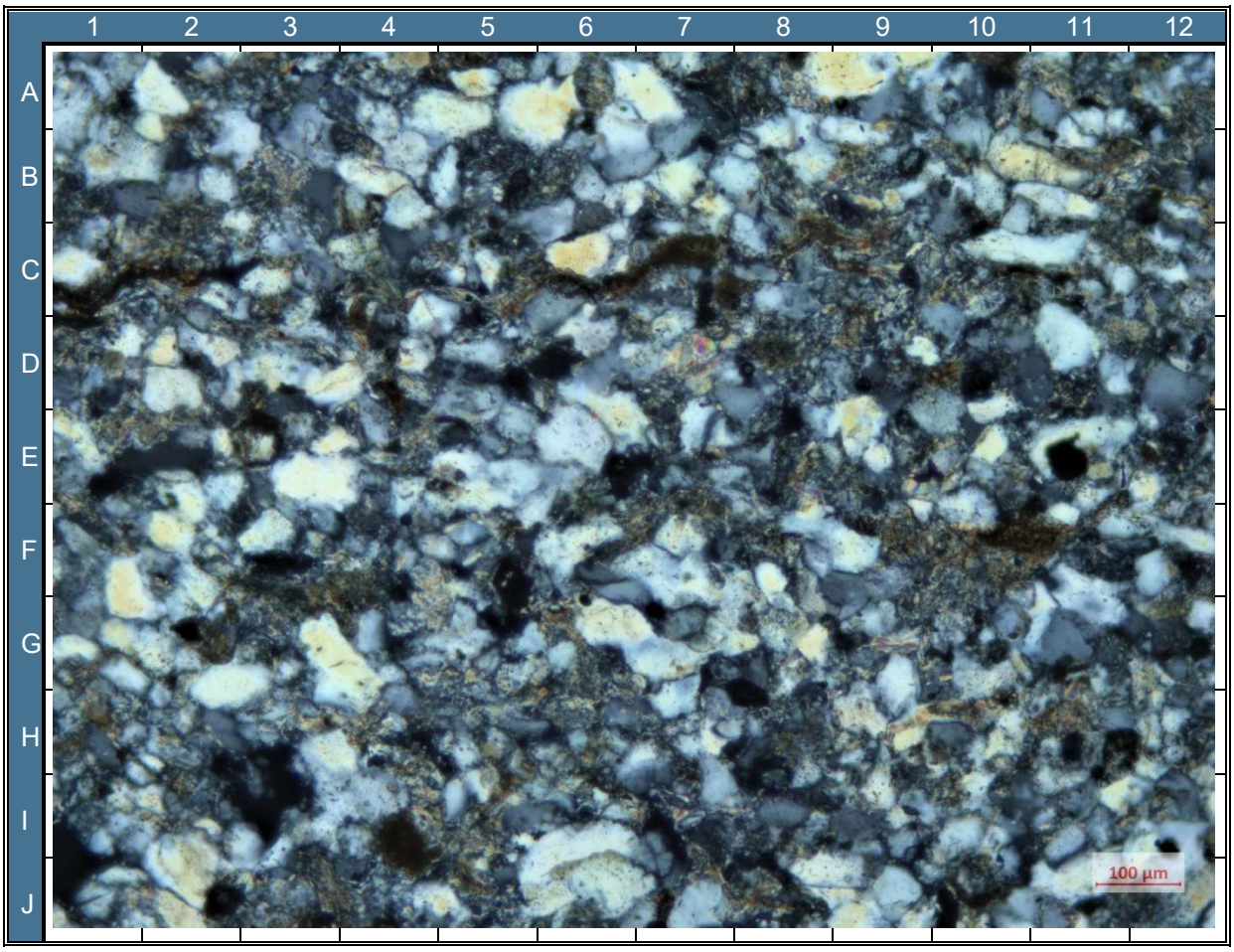


Photomicrograph			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 25.05-26.05 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Sandstone	**Viewing Light**	Circular-Polarised
Description	General view of the impure quartz-wacke sandstone, showing quartz (pale grey/white, e.g. F2 & B9-10), phyllosilicates (dark grey, greenish grey, e.g. F5 & D11) and opaque minerals (black, e.g. E6). A weak alignment of grains can be seen running top left to bottom right (e.g. D3-G12).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope

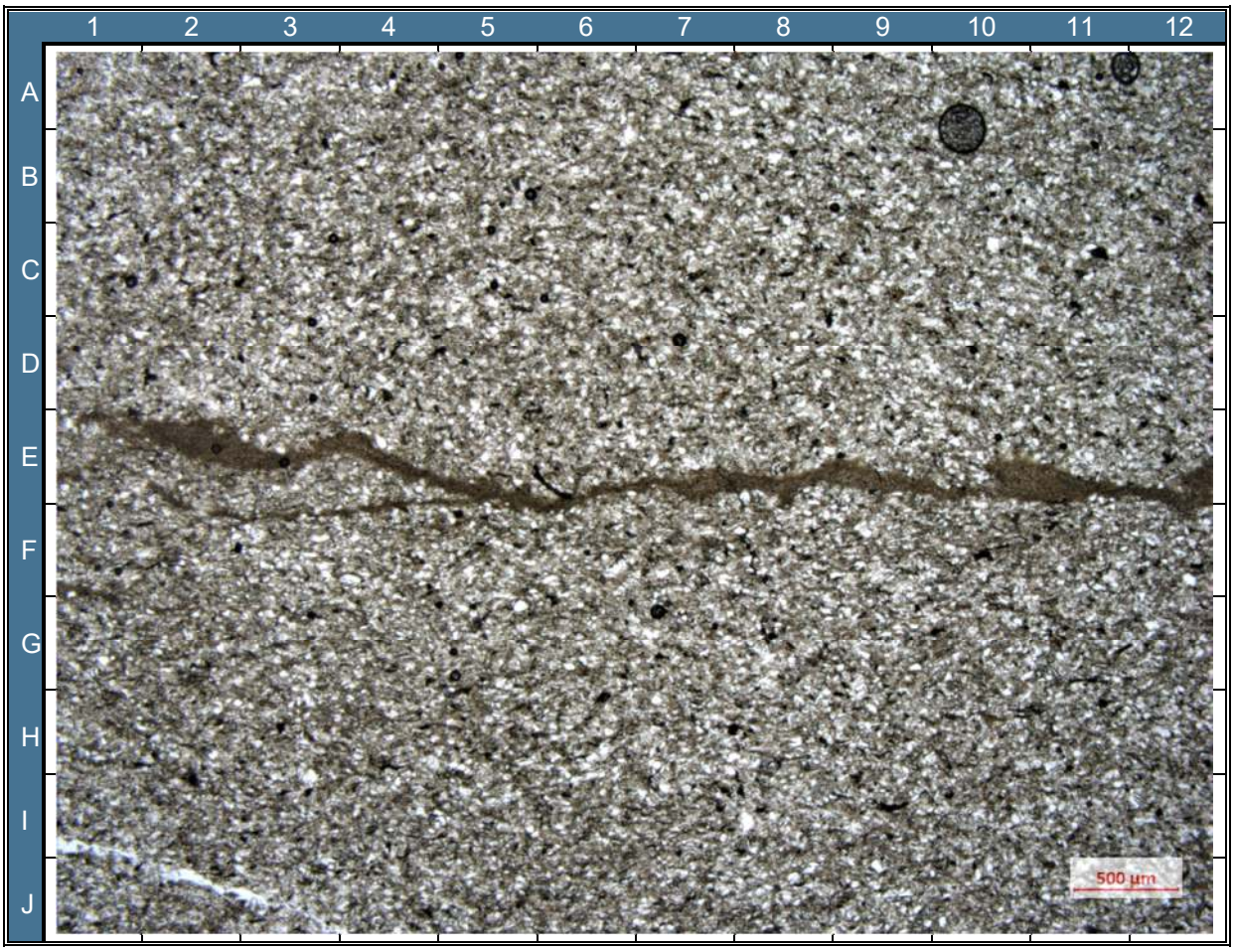


Photomicrograph			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 25.05-26.05 m
Approx. Mag^{n}	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Impure quartz- wacke sandstone.	**Viewing Light**	Circular-Polarised
Description	Detailed view of the sandstone, showing quartz (white/grey, E5), phyllosilicates (yellow/grey, D8) and opaque minerals (black, D5).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope

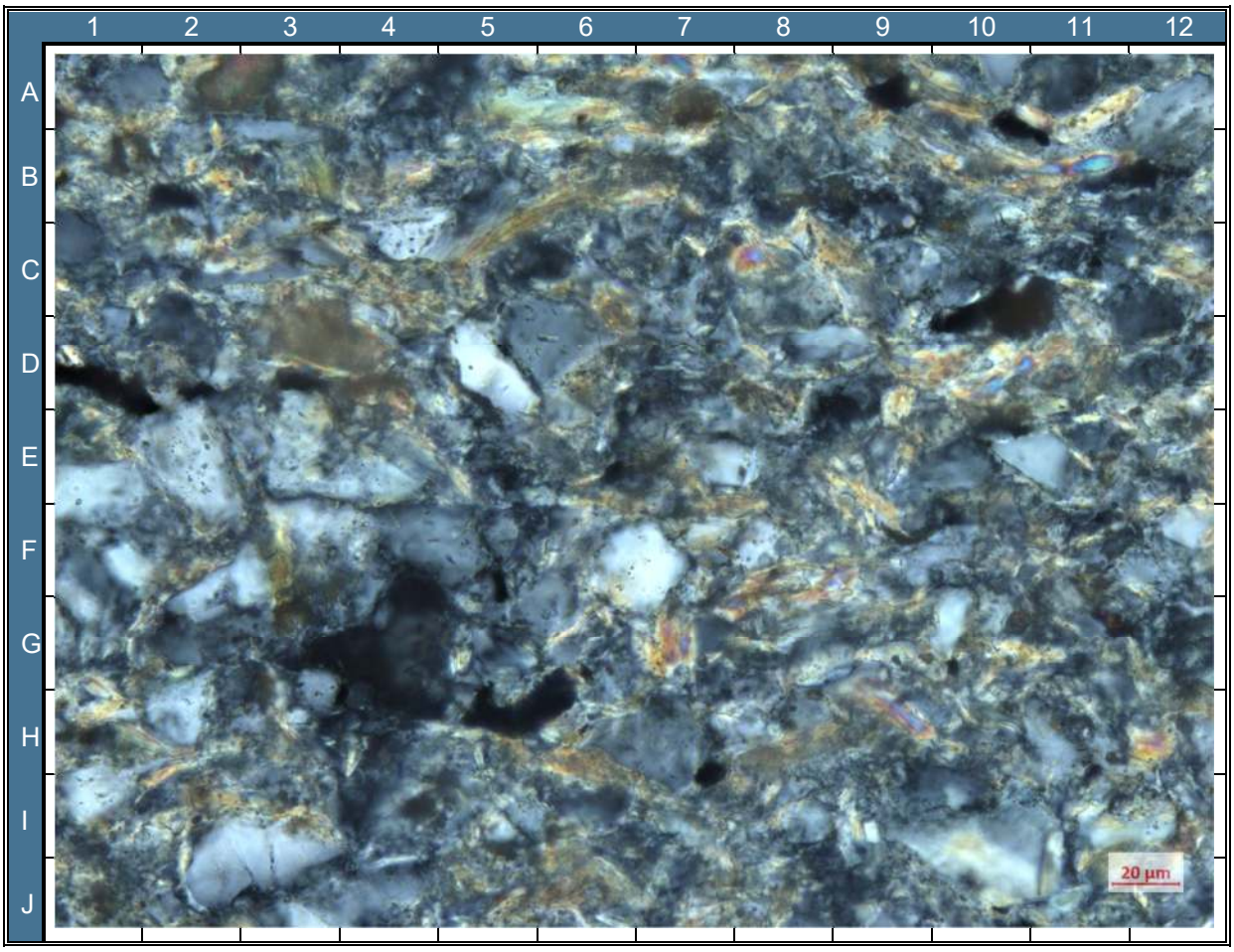


Photomicrograph			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 25.05-26.05 m
Approx. Mag^{n}	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Mud/shale region	**Viewing Light**	Plane-polarised
Description	General view of the shale mud-rich region of the core, showing phyllosilicates (dark brownish grey, e.g. C12 & G10), quartz (white, C8 & F3), opaque minerals (black, C11 & D2) and clay lenses & layers (greyish brown, E1-12).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope



Photomicrograph			
RSK Sample Ref.	19528/C2	**Client Sample Ref.**	435401-003, 25.05-26.05 m
Approx. Mag^{n}	×252	**Approx. Scale**	10 mm = 21 µm
Portion Described	Mud/shale region	**Viewing Light**	Circular-Polarised
Description	Detailed view of the shale mud-rich region of the core, showing phyllosilicates (yellowish grey/purple/orange, e.g. F8-9 & J6), quartz (grey, E2 & F10) and opaque minerals (black, D1 & C10).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

Investigation Methods

The submitted sample was subjected to a petrographic examination following RSK Environment procedure TP 573 which is based on methods given by the International Society for Rock Mechanics in "Rock Characterization, Testing and Monitoring, Suggested Method for Petrographic Description of Rocks". The description and classification were carried out taking additional guidance from BS EN ISO 14689:2018 Geotechnical investigation and testing – Identification, description and classification of rock.

A visual and low-power microscopic examination was carried out assisted by a Leica MZ8 binocular zoom microscope employing magnifications up to x50. This examination was supported by a variety of simple physical and chemical tests. Low-power photomicrographs (photographs taken through the microscope) were prepared to illustrate general character. The examination was used to select specimens for the preparation of a thin-section and, where applicable, a highly polished specimen, for high-power microscopical examination.

Thin sections were prepared after impregnation of the sample with an epoxy resin containing an ultraviolet light sensitive fluorescent dye. Highly polished specimens (where applicable) were prepared by grinding with successively finer abrasives finishing with a ¼µm diamond paste. Thin-section examination was carried out in both plane and cross polarised light and reflected ultraviolet light. Highly polished specimens (where applicable) were examined in reflected polarised light and brightfield illumination. High-power photomicrographs were prepared to illustrate microscopical features of importance.

Glossary Of Common Terms Used In The Descriptions

Proportions	**Major**: constituent present at 10% level and above; **Minor**: constituent present at 2% to 10% level; **Trace**: constituent present at below the 2% level
Frequency	Increasing Frequency ↓ **Rare** - only found by thorough searching **Sporadic** - only occasionally observed during normal examination **Common** - easily observed during normal examination **Frequent** - easily observed with minimal examination **Abundant** - immediately apparent to initial examination
Size	**Mega**: >60mm; **Macro**: 2-60mm; **Meso**: 60µm-2mm; **Micro**: 2-60µm; **Crypto**: <2µm; **Glassy**: without visible crystallinity
Hardness	**Very soft**: can be penetrated easily by a finger; **Soft**: scores with a fingernail; **Moderately soft**: scores using a copper coin; **Moderately hard**: scores easily with a penknife; **Hard**: not easily scored with a penknife; **Very hard**: cannot be scored with a steel point or knife.
Strength	**Very weak**: indented by thumbnail; **Weak**: can be peeled with a pocket knife; **Moderately weak**: shallow indentations made by firm blow with the point of a geological hammer; **Moderately strong**: specimen fracture by single firm blow of geological hammer, cannot be peeled with a pocket knife; **Strong**: specimen requires more than one blow to fracture it; **Very strong**: specimen requires several blows to fracture it; **Extremely strong**: specimen can only be chipped with a geological hammer.
Weathering/ alteration	Grade I (**Fresh**): Unchanged from original state; Grade II (**Slightly Weathered**): Slight discoloration, slight weakening; Grade III (**Moderately Weathered**): Considerably weakened, penetrative discoloration, large pieces cannot be broken by hand; Grade IV (**Highly Weathered**): large pieces can be broken by hand, does not readily disaggregate (slake) when dry sample immersed in water; Grade V (**Completely Weathered**): considerably weakened, slakes, original texture apparent; Grade VI (**Residual Soil**): soil derived by in-situ weathering but retaining none of the original texture or fabric.
Bedding/Layering	**Thick**: >600mm; **Medium**: 200-600mm; **Thin**: 60-200mm; **Very thin**: 20-60mm
Lamination	**Thick**: 6-20mm; **Thin**: 2-6mm; **Very thin**: 600µm-2mm; **Extremely thin**: <600µm
Cleavage	**Extremely wide**: >2mm; **Very wide**: 600µm-2mm; **Wide**: 200-600µm; **Medium**: 60-200µm; **Close**: 20-60µm; **Very close**: 6-20µm; **Extremely close**: <6µm.
Voids	**Sporadic**: <1%; **Occasional**: 1-5%; **Frequent**: 5-10%; **Abundant**: 10-25%; **Honeycombed**: >25%

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UKAS TESTING 0278

Certificate of Examination
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods
Petrographic Examination of Rock

Your Ref.	325389	**RSK Sample Ref.**	19528/C3
Site	Rockingham Phase 3	**Client Sample Ref.**	435401-003, Rockhead Core, 25.40-28.40 m
Client	RSK Geosciences 18 Frogmore Road Hemel Hempstead HP3 9RT	**Sampled by/Date**	GDC/24.06.2021
		Date Received	05.07.2021
		Examined by/Date	AS/29.07.2021-11.08.2021
		Advised Source	435401-003, 25.40-28.40 m

SAMPLE

The sample comprised a cored rock sample between 25.05-26.05 mbgl, at 435401-003 Rockhead Core. The GDC sampling core log describes this depth of recovery as sandstone.

METHODS OF EXAMINATION

A full description of the examination methods, including a glossary of descriptive terms, is given on the final page of this certificate.

EXAMINATION FINDINGS

The detailed petrographic examination findings are given on the following pages of this certificate.

SUMMARY OF FINDINGS

Geological Classification	SILTY MUDSTONE with MUDSTONE/SHALE HORIZONS.
Major Minerals	Phyllosilicates and quartz
Minor Minerals	Opaque minerals
Trace Minerals	Clay and iron oxide
Textural Features	Laminations, shale/mud horizons, blocky fracture,
Other Details	Weak splitting planes in mud-rich core sections.

Prepared by

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Senior Geomaterials Scientist

Certificate reviewed and authorised by

Dr Jennifer Murgatroyd
Senior Geomaterials Scientist

Date of issue: 12 August 2021

Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20

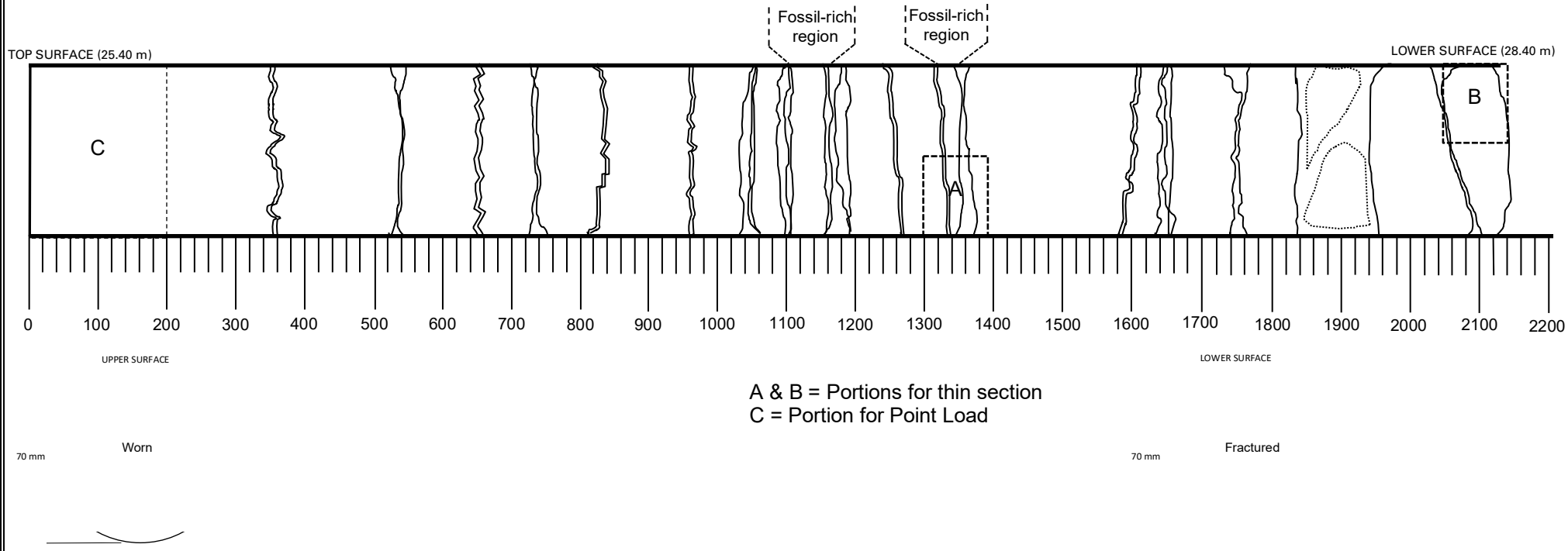
RECORD PHOTOGRAPHS			
RSK Sample Ref	19528/C3	**Client Sample Ref**	435401-003, Rockhead Core, 25.40-28.40 m
Description	As received photos of the rock portion of the core as received. The upper photo is dry and the lower photo is wet. The depth from 25.40-28.40 m borehole depth.		



Petrographic Examination of Hardened Concrete - ASTM C856/C856M-20
Visual and Low-Power Microscopical Observations

SAMPLE/CORE SKETCH			
RSK Sample Ref	19528/C3	**Client Sample Ref**	435401-003, Rockhead Core, 25.40-28.40 m

Core layout as received within core box. Log depths do not necessarily relate to depth below ground surface.



HAND SPECIMEN DESCRIPTION	
Description	Moderately soft to moderately hard, mid-grey to mid-greenish grey coloured, homogeneous mud and silt-rich clastic rock, with rare quartzitic inclusions, fossils with sub-blocky and conchoidal fracture surfaces. Rare horizons at 1085-1184 mm and 1330-1355 mm depths from the upper surface of the core contained black to brown iron-rich fossils, which were often exhibited on splitting planes. Horizons of fine shale/mudstone were present within the rock, with variations in composition picking out fine to normal laminations within the rock.

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Sample Details			
RSK Sample Ref.	19528/C3	**Client Sample Ref.**	435401-003, Rockhead Core, 25.40-28.40 m
Condition on Receipt	Dry, weak easily split, fractured rock with some regions of continuous recovery.		
Thin-Section Details	Thin sections prepared from a slice sawn perpendicular to the coring direction at 1320-1355 mm and 2100-2150 mm depths from the upper surface of the core.		

Material Component	Volume % (Estimated)	Range Of Crystal/Grain Size	Origin[1]
Phyllosilicates	70-80	<4 µm – 30 µm	Primary
Quartz	10-15	<4 µm – 40 µm	Primary-Secondary
Opaque minerals	4-10	<4 µm – 3 cm	Primary/Secondary
Clay	1-2	<4 µm	Primary
Iron oxide	<1	<4 µm	Secondary

1. Primary - originally part of the rock/stone; Secondary - an alteration/weathering product.

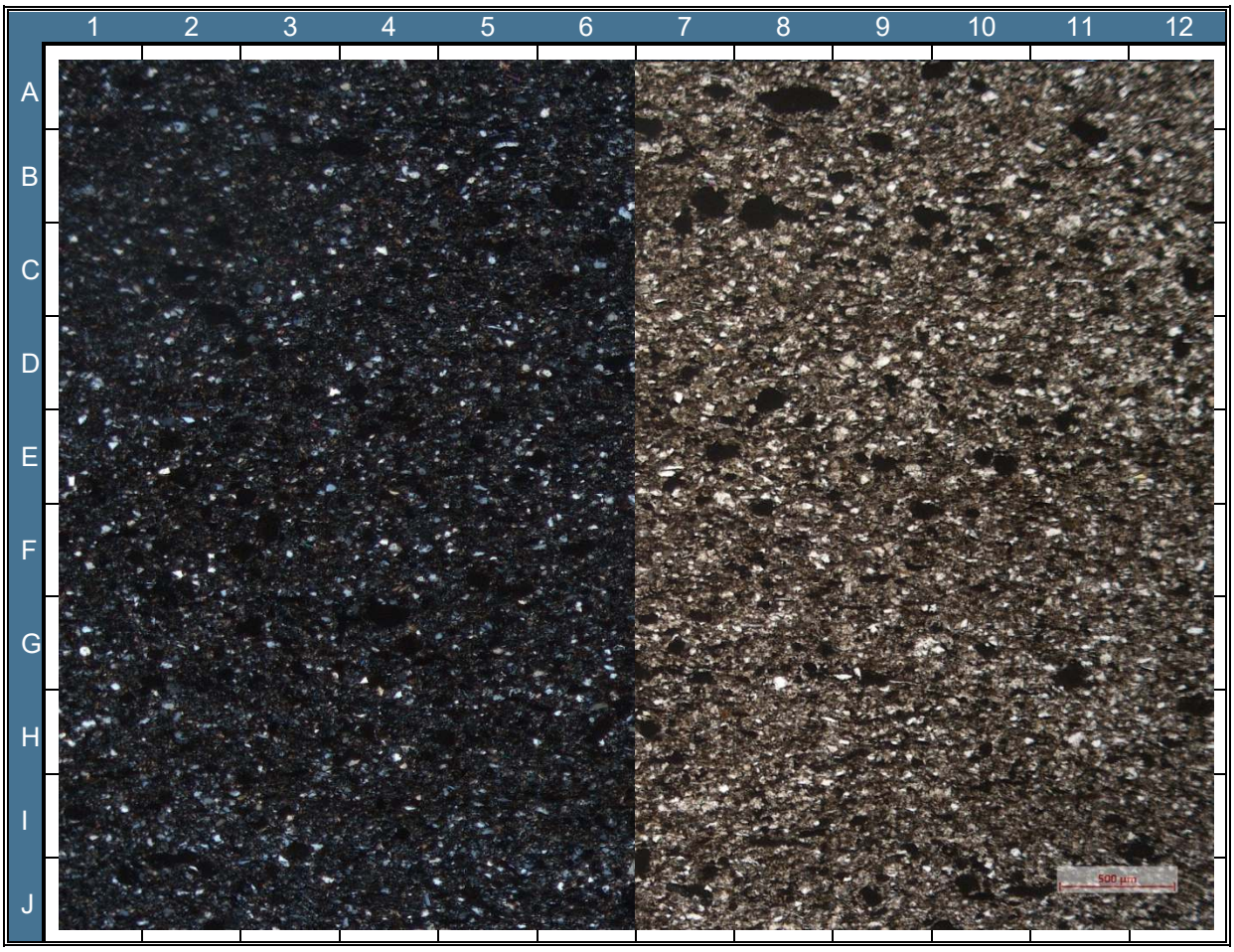
Material Component	Petrographic Details
Phyllosilicates	Very fine to fine platy micaceous minerals primarily composed of muscovite mica with lesser amounts of other phyllosilicates. Forming the majority of the darker shale mudstone horizons within the rock. The platy minerals are sub-randomly orientated within the rock core.
Quartz	Hard, strong silica, often angular to irregular shaped grains concentrated within paler layers and less abundant within shale/mudstone horizons.
Opaque minerals	Iron-rich opaque minerals including pyrite and other sulfides and oxides. Evenly distributed throughout the majority of the rock but concentrated within fossil-rich areas, where fossils were composed of opaque minerals including pyrite.
Clay	Very fine amorphous material, present as discrete particles within muddy/ shale rich areas.
Iron oxide	Iron oxides present around weathered opaque minerals in mud-rich shale areas.

Material Description
Primarily composed of mud-sized phyllosilicates and silt-sized angular to very angular quartz grains with a weak foliation/cleavage and bedding resulting in a massive appearance in core. Opaque minerals were part of the rock matrix and fossils aligned parallel to apparent bedding. Rare, darker, mud-rich shale laminations were more phyllosilicate-rich with a finer clay-rich grain size. Fracture planes composed of phyllosilicate-rich layers with iron oxide and significantly reduced quartz content. The rock could be classified as a poorly indurated, interbedded SILTSTONE/MUDSTONE with fossiliferous and compositional variation picking out depositional features.

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope

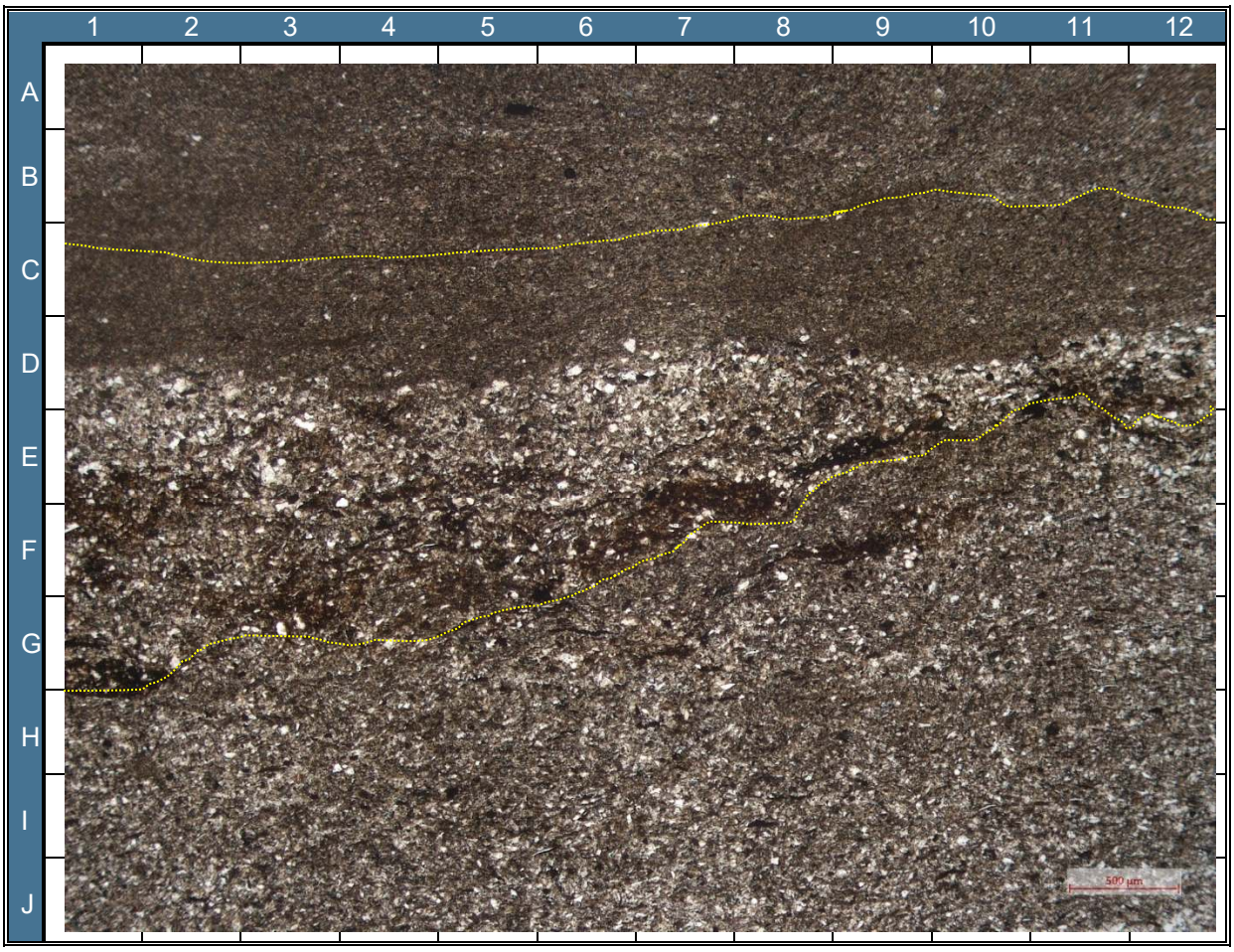


Photomicrograph			
RSK Sample Ref.	19528/C3	**Client Sample Ref.**	435401-003, Rockhead Core, 25.40-28.40 m
Approx. Mag^{n}	×16.75	**Approx. Scale**	10 mm = 355 μm
Portion Described	Silty mudstone	**Viewing Light**	Cross-Polarised (L)/ Plane-Polarised (R)
Description	General view of the silty mudstone, showing quartz (pale grey/white, e.g. G1 & D9), phyllosilicates (pale to dark brownish grey, e.g. B1 & I10) and opaque minerals (black, e.g. B7-8).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope

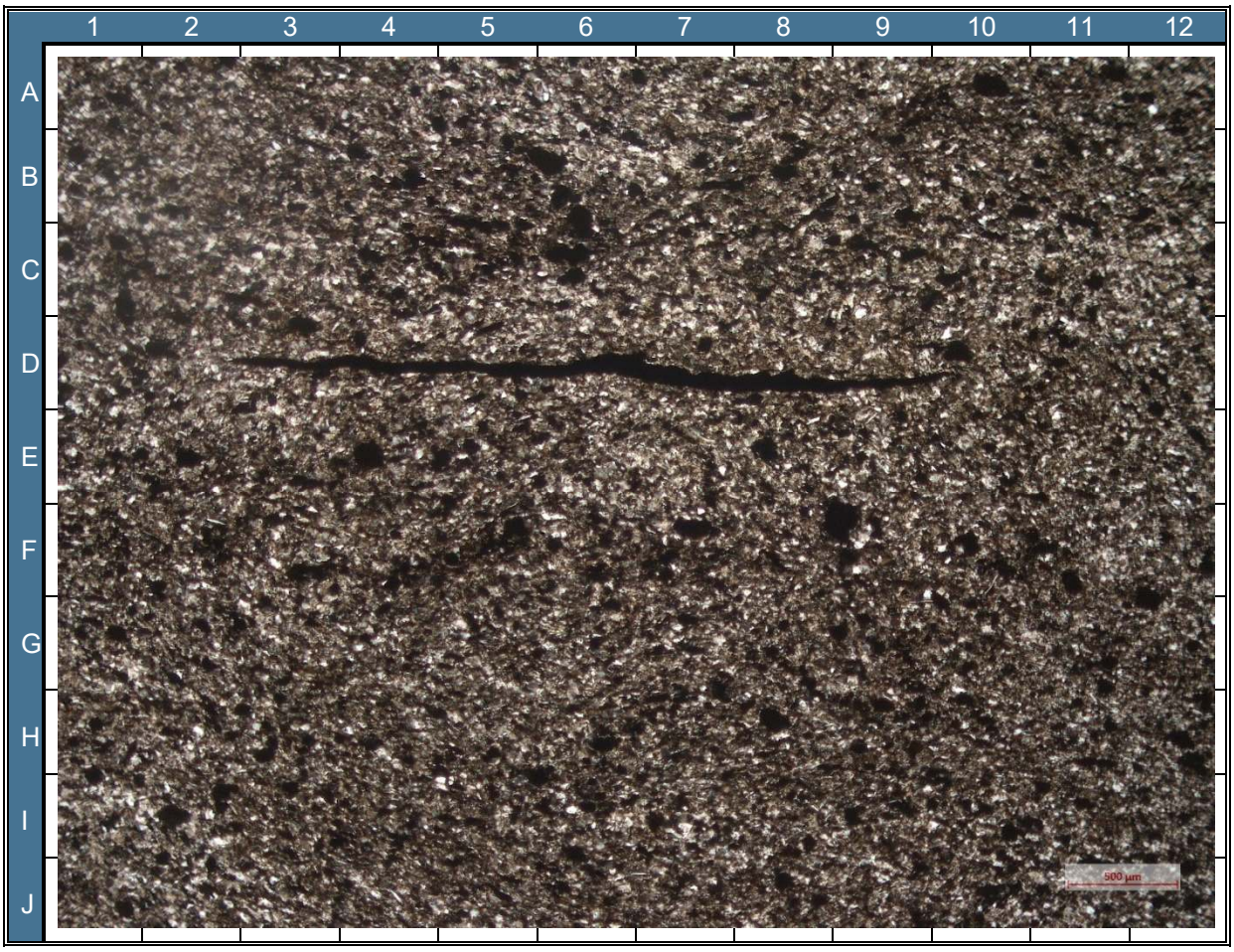


Photomicrograph			
RSK Sample Ref.	19528/C3	**Client Sample Ref.**	435401-003, Rockhead Core, 25.40-28.40 m
Approx. Mag^{n}	×16.75	**Approx. Scale**	10 mm = 355 µm
Portion Described	Mudstone/shale/silty mudstone	**Viewing Light**	Plane-polarised
Description	General view of purer mudstone/shale horizon (dark greyish brown, rows A-D) and opaque mineral-rich horizons (black, E1-D12). A weak to moderately weak cleavage can be seen running right to left (dotted yellow lines, e.g. C1-12 & H1-E12).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope

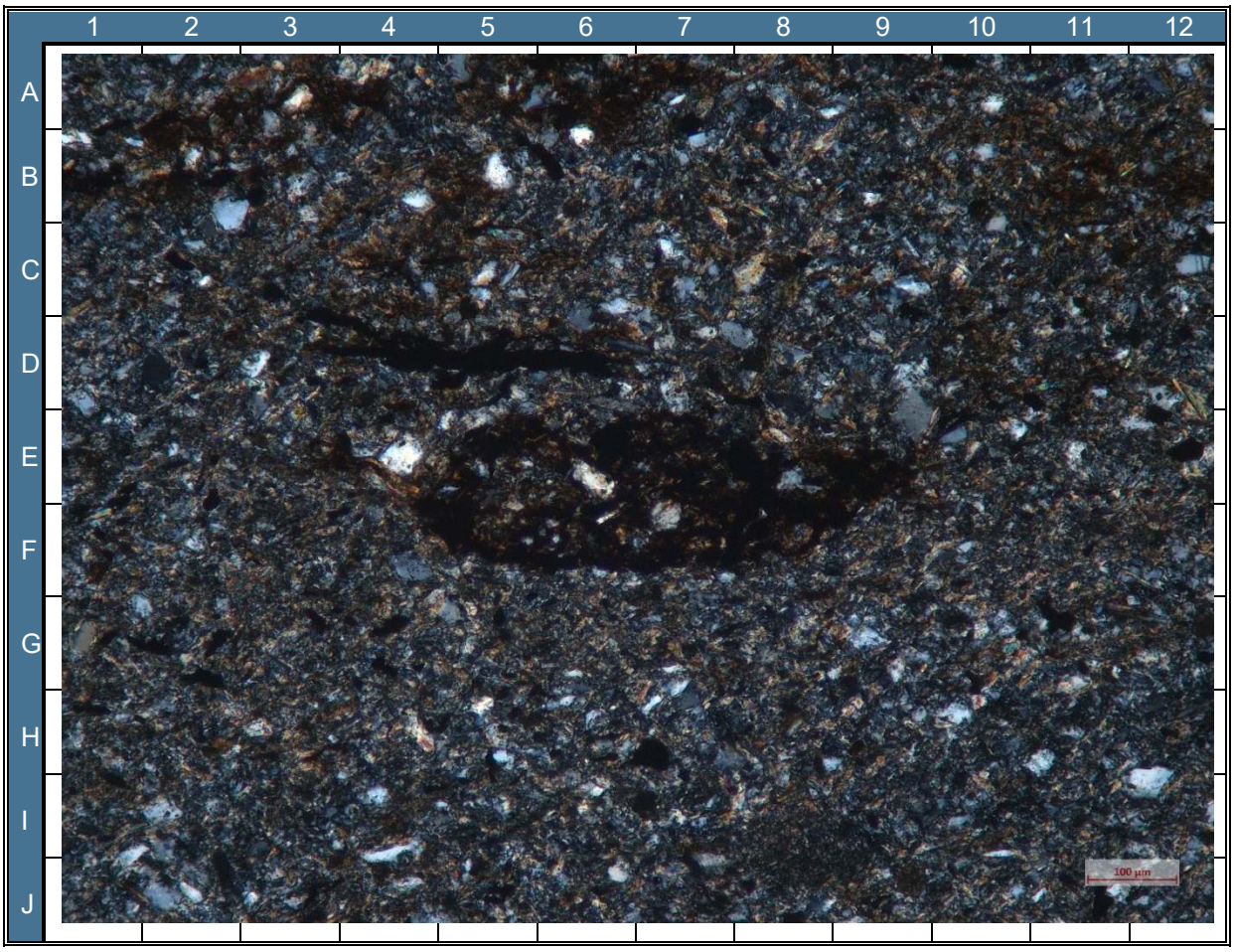


Photomicrograph			
RSK Sample Ref.	19528/C3	**Client Sample Ref.**	435401-003, Rockhead Core, 25.40-28.40 m
Approx. Mag^{n}	×16.75	**Approx. Scale**	10 mm = 355 µm
Portion Described	Silty mudstone	**Viewing Light**	Plane-polarised
Description	General view of the silty mudstone, exhibiting opaque mineral-rich region (black, e.g. F8-9 & B/C6) and a pyrite-rich fossil (black, D2-E10).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

High-Power Microscopical Observations

Photograph Taken Using Zeiss Axioscope



Photomicrograph			
RSK Sample Ref.	19528/C3	**Client Sample Ref.**	435401-003, Rockhead Core, 25.40-28.40 m
Approx. Mag^{n}	×67	**Approx. Scale**	10 mm = 87 µm
Portion Described	Silty mudstone	**Viewing Light**	Circular-Polarised
Description	Detailed view of the silty mudstone, showing opaque mineral-rich lens (black, E6) surrounded by a phyllosilicate-rich matrix (greyish orange, F3).		

Petrographic Examination of Rock
TP 573 based on BS EN ISO 14689:2018 and ISRM Suggested Methods

Investigation Methods

The submitted sample was subjected to a petrographic examination following RSK Environment procedure TP 573 which is based on methods given by the International Society for Rock Mechanics in "Rock Characterization, Testing and Monitoring, Suggested Method for Petrographic Description of Rocks". The description and classification were carried out taking additional guidance from BS EN ISO 14689:2018 Geotechnical investigation and testing – Identification, description and classification of rock.

A visual and low-power microscopic examination was carried out assisted by a Leica MZ8 binocular zoom microscope employing magnifications up to x50. This examination was supported by a variety of simple physical and chemical tests. Low-power photomicrographs (photographs taken through the microscope) were prepared to illustrate general character. The examination was used to select specimens for the preparation of a thin-section and, where applicable, a highly polished specimen, for high-power microscopical examination.

Thin sections were prepared after impregnation of the sample with an epoxy resin containing an ultraviolet light sensitive fluorescent dye. Highly polished specimens (where applicable) were prepared by grinding with successively finer abrasives finishing with a ¼µm diamond paste. Thin-section examination was carried out in both plane and cross polarised light and reflected ultraviolet light. Highly polished specimens (where applicable) were examined in reflected polarised light and brightfield illumination. High-power photomicrographs were prepared to illustrate microscopical features of importance.

Glossary Of Common Terms Used In The Descriptions

Proportions	**Major**: constituent present at 10% level and above; **Minor**: constituent present at 2% to 10% level; **Trace**: constituent present at below the 2% level
Frequency	Increasing Frequency ↓ **Rare** - only found by thorough searching **Sporadic** - only occasionally observed during normal examination **Common** - easily observed during normal examination **Frequent** - easily observed with minimal examination **Abundant** - immediately apparent to initial examination
Size	**Mega**: >60mm; **Macro**: 2-60mm; **Meso**: 60µm-2mm; **Micro**: 2-60µm; **Crypto**: <2µm; **Glassy**: without visible crystallinity
Hardness	**Very soft**: can be penetrated easily by a finger; **Soft**: scores with a fingernail; **Moderately soft**: scores using a copper coin; **Moderately hard**: scores easily with a penknife; **Hard**: not easily scored with a penknife; **Very hard**: cannot be scored with a steel point or knife.
Strength	**Very weak**: indented by thumbnail; **Weak**: can be peeled with a pocket knife; **Moderately weak**: shallow indentations made by firm blow with the point of a geological hammer; **Moderately strong**: specimen fracture by single firm blow of geological hammer, cannot be peeled with a pocket knife; **Strong**: specimen requires more than one blow to fracture it; **Very strong**: specimen requires several blows to fracture it; **Extremely strong**: specimen can only be chipped with a geological hammer.
Weathering/ alteration	Grade I (**Fresh**): Unchanged from original state; Grade II (**Slightly Weathered**): Slight discoloration, slight weakening; Grade III (**Moderately Weathered**): Considerably weakened, penetrative discoloration, large pieces cannot be broken by hand; Grade IV (**Highly Weathered**): large pieces can be broken by hand, does not readily disaggregate (slake) when dry sample immersed in water; Grade V (**Completely Weathered**): considerably weakened, slakes, original texture apparent; Grade VI (**Residual Soil**): soil derived by in-situ weathering but retaining none of the original texture or fabric.
Bedding/Layering	**Thick**: >600mm; **Medium**: 200-600mm; **Thin**: 60-200mm; **Very thin**: 20-60mm
Lamination	**Thick**: 6-20mm; **Thin**: 2-6mm; **Very thin**: 600µm-2mm; **Extremely thin**: <600µm
Cleavage	**Extremely wide**: >2mm; **Very wide**: 600µm-2mm; **Wide**: 200-600µm; **Medium**: 60-200µm; **Close**: 20-60µm; **Very close**: 6-20µm; **Extremely close**: <6µm.
Voids	**Sporadic**: <1%; **Occasional**: 1-5%; **Frequent**: 5-10%; **Abundant**: 10-25%; **Honeycombed**: >25%

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0278

Certificate of Examination
TP 573
Petrographic Examination of Material

Your Ref.	325389	**RSK Sample Ref.**	19528/C2-O2
Site	Rockingham Phase 3	**Client Sample Ref.**	435401-003 35.00 mbgl
Client	RSK Geosciences 18 Frogmore Road Hemel Hempstead HP3 9RT *On behalf of Coal Authority*	**Advised Sample Type**	Ablated material core recovery
		Location	435401-003
		Sampled by/Date	GDC/23.06.2021
		Date of Receipt	16.07.2021
		Examined by/Date	AS/30.07.2021-12.08.2021

SAMPLE

The sample comprised fine grained material from bore hole 435401-003 at 35.00 mbgl from Rockingham.

METHODS OF EXAMINATION

A full description of the examination methods, including a glossary of descriptive terms, is given on the final sheet of this certificate.

EXAMINATION FINDINGS

The detailed petrographic examination findings are given in the following sheets of this certificate.

SUMMARY

Material Description	The sample comprised a <2.5 mm sized heterogeneous material, comprising colliery and mining waste products. The material contained burnt shale consistent with some features present with and possible fired clay brick material.
Condition	Uncertainty resulted from the sampling technique, which resulting in a pulverised/ablated sample, however some diagnostic shale features were observed.

NOTE

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

Prepared by



Alex Smith
Senior Geomaterials Scientist

Certificate reviewed and authorised by



Dr Jennifer Murgatroyd
Senior Geomaterials Scientist

Date of Issue: 12 August 2021

Petrographic Examination of Material – TP 573

Visual And Microscopical Observations

RECORD PHOTOGRAPHS			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl

AS-RECEIVED SAMPLE



Petrographic Examination of Material – TP 573

Visual And Microscopical Observations

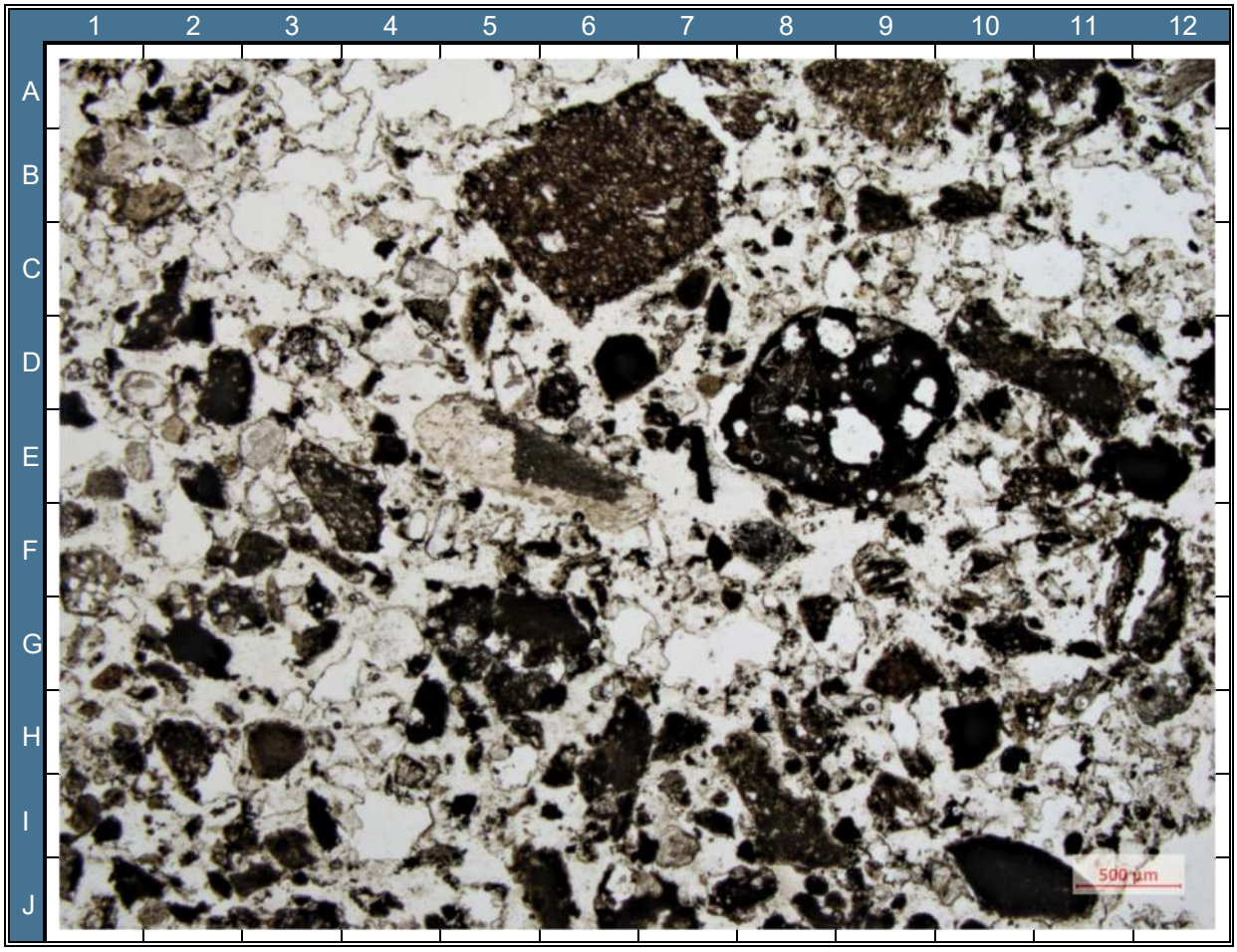
AS-RECEIVED SAMPLE DETAILS			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl
Portion Described	The sample comprised a small tub of wet fine sand sized material of variable composition.		

MATERIAL DESCRIPTION		
Fine material description *(incl. type, nominal max. size, shape, grading, sorting, distribution and orientation)*	Heterogeneous fine to very fine, <2.5 mm nominal maximum sized, very angular to sub-angular, poorly sorted, evenly distributed and randomly orientated particles. Moderately bimodal size distribution; coarse particles typically 450 µm, with fine particles typically 50-75 µm.	
Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major	FIRED AND BURNT CLAY MATERIAL – Dark reddish brown to pale orangish brown coloured, fired clay material chiefly homogeneous, non-calcareous optically inactive and chiefly partially to fully sintered/burnt matrix containing sporadic to frequent quartz aggregate inclusions. The dark reddish brown to reddish brown coloured material was reminiscent of fired clay bricks with a relatively evenly distributed very fine quartzitic sand temper, irregular air voids and quartz and opaque aplastic inclusions. The paler orangish brown particles were consistent with more variable burnt shale particles with a higher clay content and rare reddish rims. Burnt shale particles exhibited splitting along relict shale laminations. *BURNT SHALE – 30-50 %. Possible FIRED CLAY BRICK content.5-10 %.* QUARTZ/QUARTZITE – Hard to very hard, silt to sand sized silica grains and microcrystalline silica grains 10-20%. SLAG – Black, vesicular, very angular to sub-angular, opaque, glassy to ashy slag material. Spherical to angular vesicles were chiefly empty with rare vesicles infilled with quartz. Glassy particles exhibited common needle-like mellite crystals. Rare particles included quartz fine aggregate. 10-20 % CERAMIC MATERIAL/CLINKER – pale brownish yellow ceramic glassy chiefly homogeneous material. 10 %.
	Trace	DOLOMITE. SANDSTONE.

Petrographic Examination of Material – TP 573

High-Power Microscopical Observations

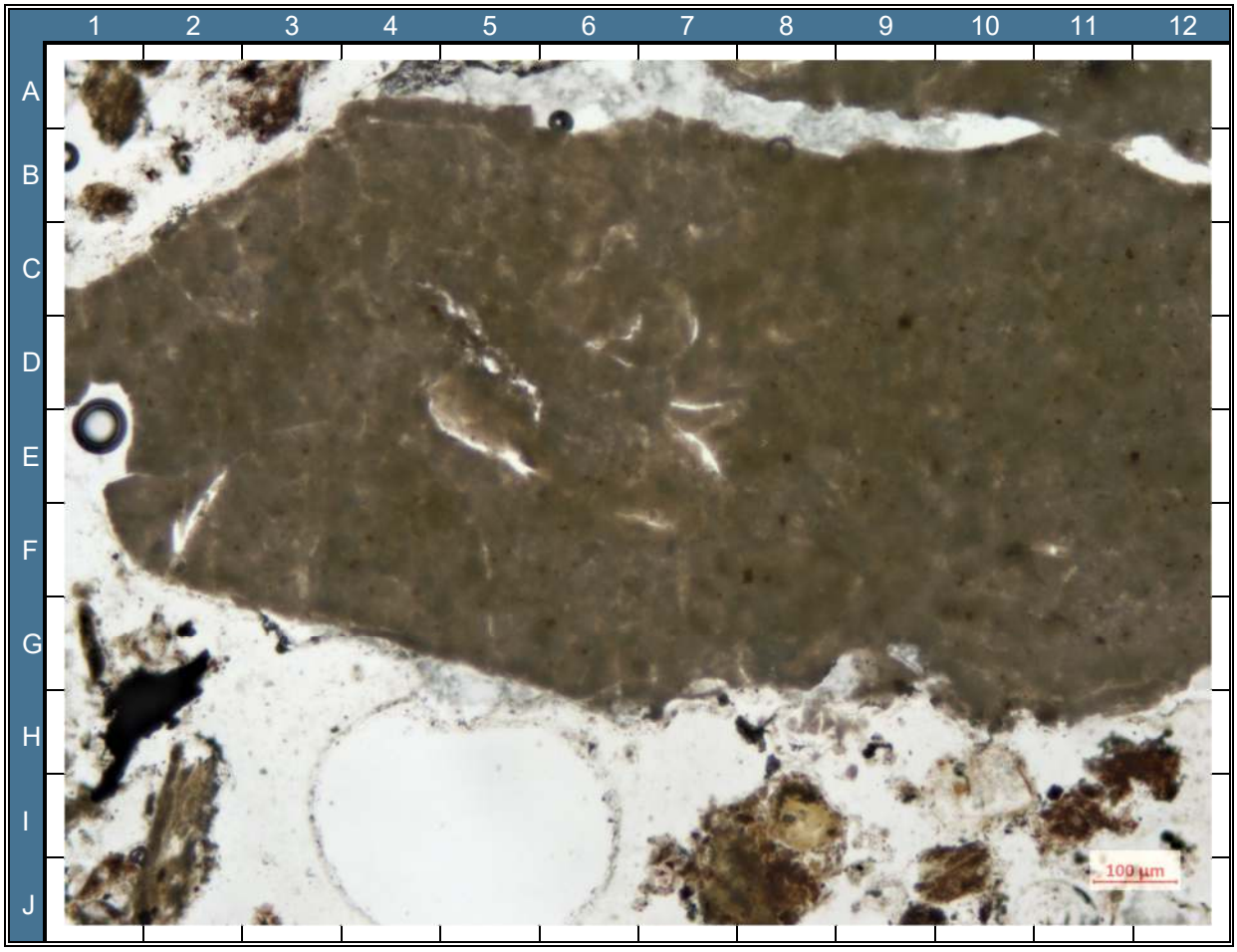
PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Retrieved material	**Viewing Light**	Plane-polarised
Description	General view of the material suspended in clear resin (white, e.g. A5 & G7), showing fired/burnt clay/shale material (dark brown, e.g. A9), possible fired clay brick (speckled dark brown, B6), glassy slag (black, D/E8-9), ceramic/clinker (white/pale brown, E4-5 & B1-2) and quartz/quartzite (white, e.g. C4).		

Petrographic Examination of Material–
TP 573
High-Power Microscopical Observations

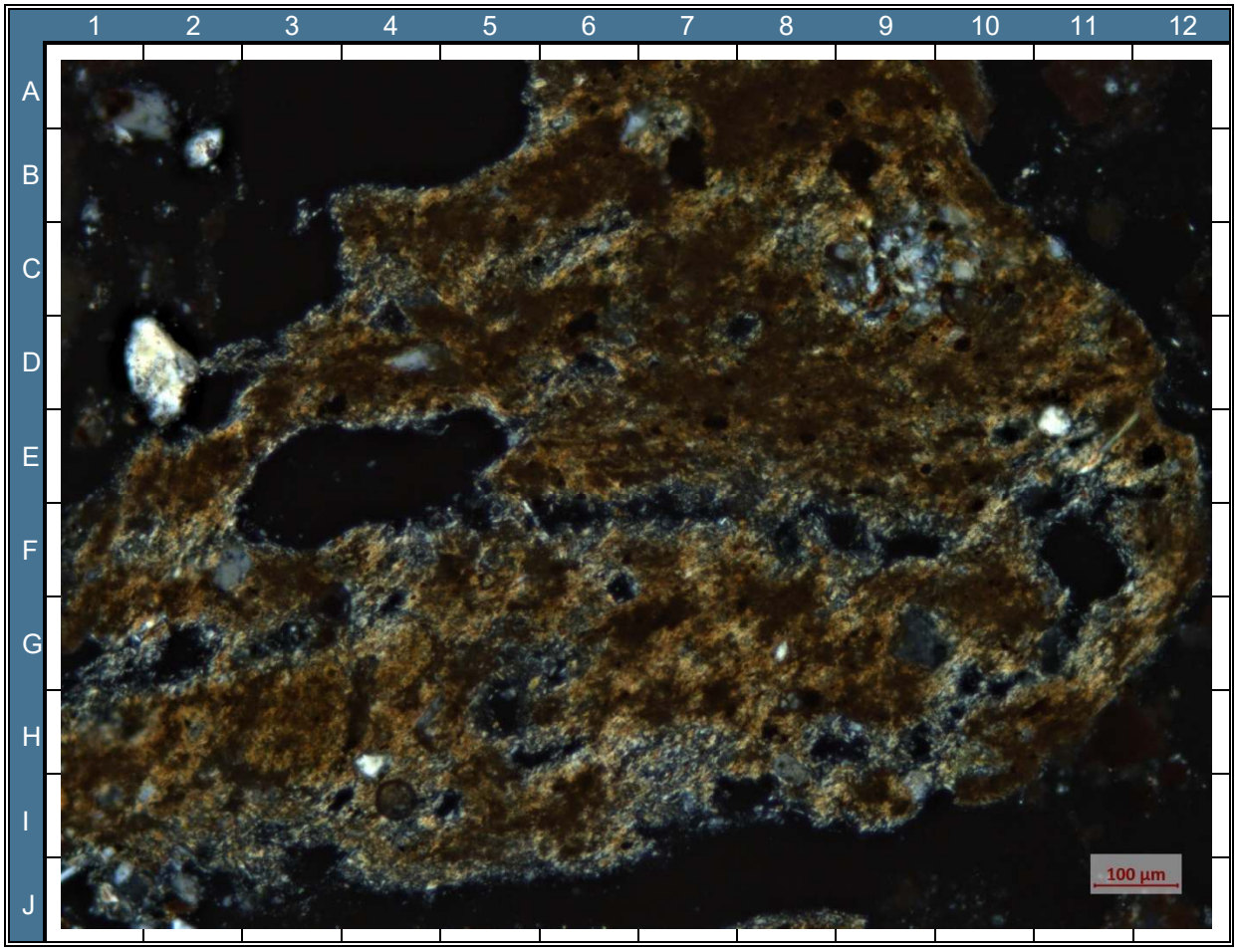
PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl
Approx. Magⁿ	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Ceramic/clinker	**Viewing Light**	Plane-polarised
Description	Detailed view of ceramic/clinker particle showing homogeneous matrix (greyish brown, D10) with evidence of shrinkage cracking (white, e.g. D5).		

Petrographic Examination of Material–
TP 573
High-Power Microscopical Observations

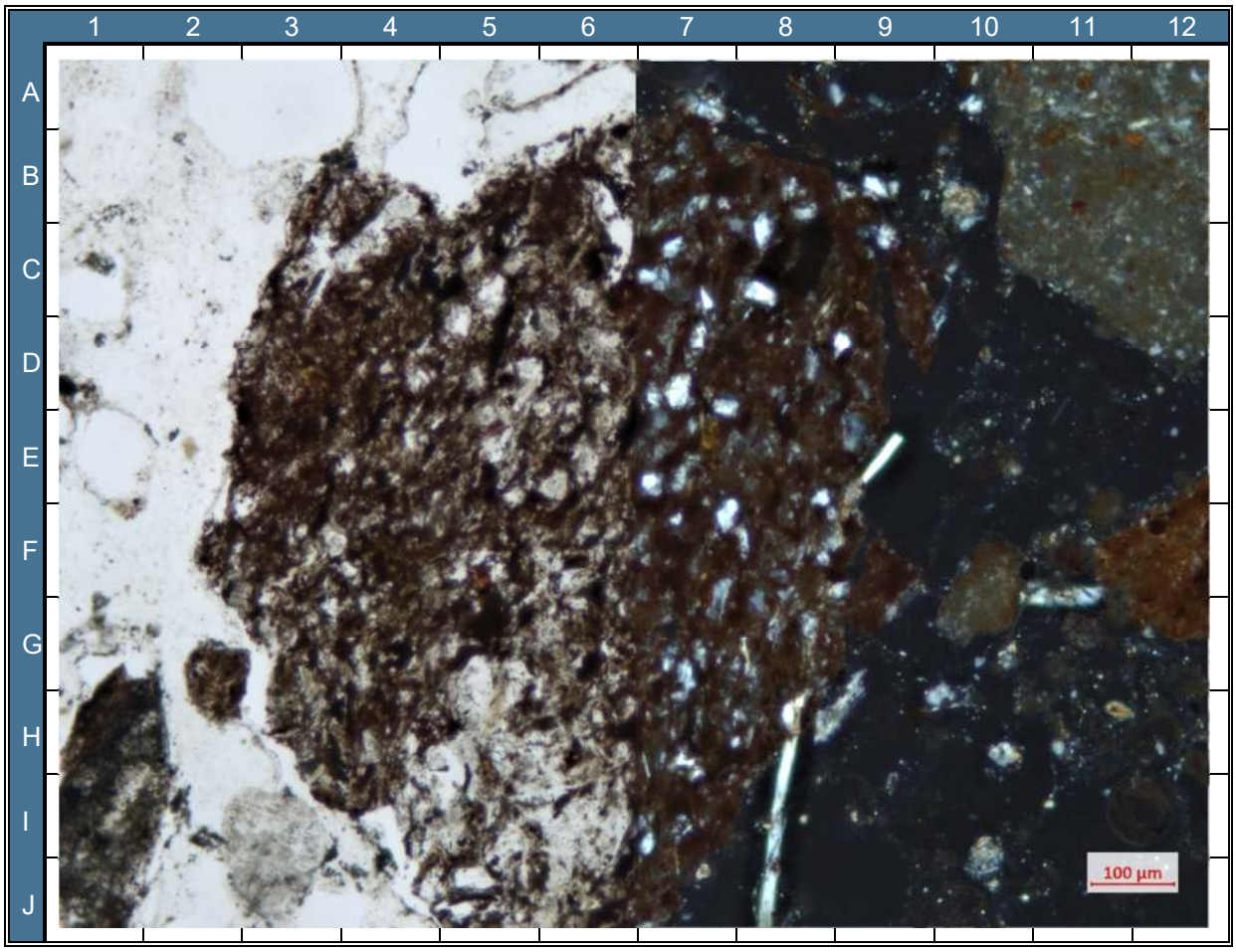
PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl
Approx. Magⁿ	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Burnt Shale	**Viewing Light**	Cross-polarised
Description	Detailed view of a burnt shale particle showing clay minerals (yellowish brown, e.g. G7 & B8), quartz grains (white/grey, e.g. E11) and relict shale lamination (sub-horizontal, F1-E12).		

Petrographic Examination of Material–
TP 573
High-Power Microscopical Observations

PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE

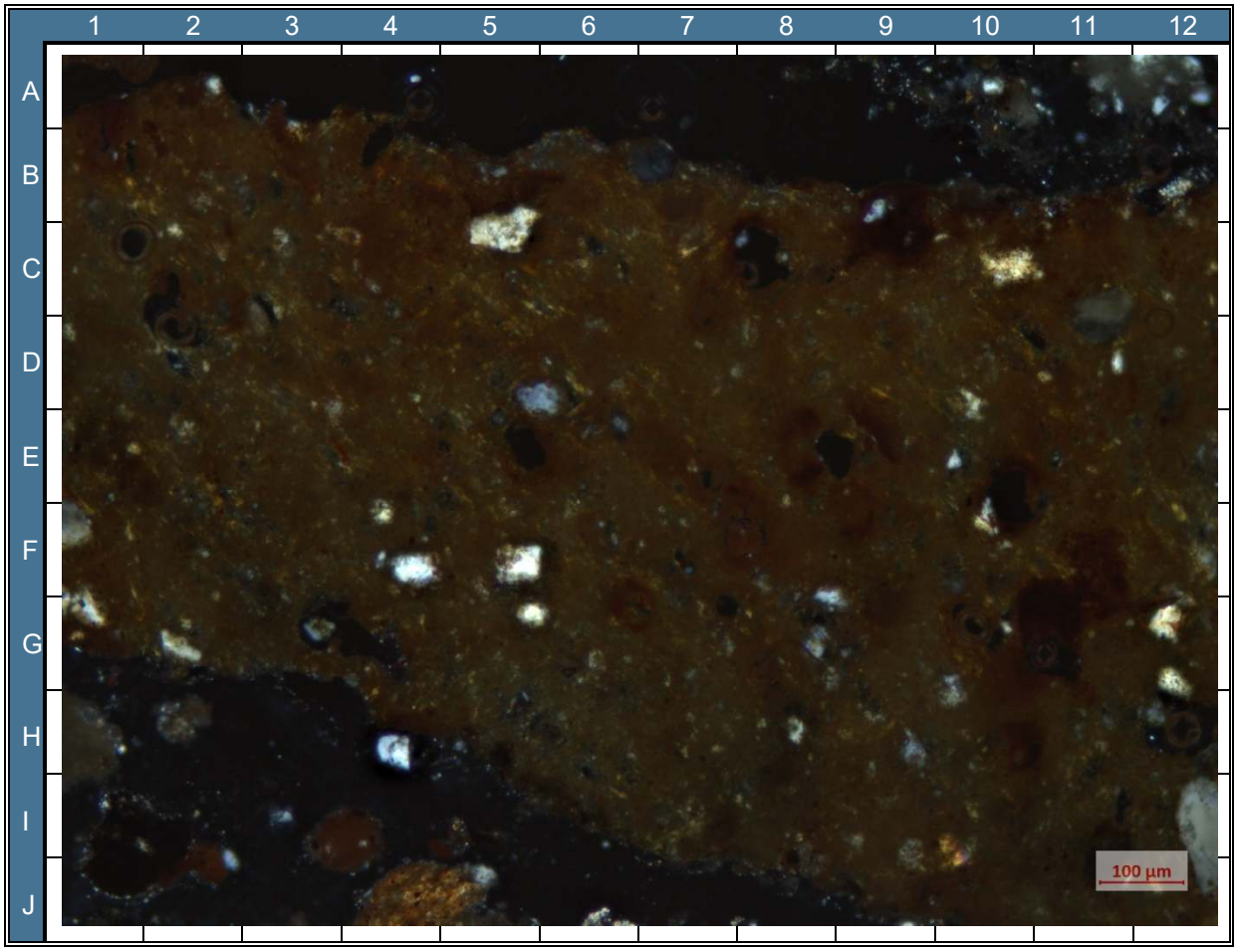


PHOTOMICROGRAPH			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl
Approx. Magⁿ	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Burnt shale/Brick	**Viewing Light**	Plane-polarised (L) /Cross-polarised (R)
Description	View of possible burnt shale or fired clay brick, however not enough distinguishing features are present to distinguish the material.		

Petrographic Examination of Material – TP 573

High-Power Microscopical Observations

PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref.	19528/C2-O2	**Client Sample Ref.**	435401-003 35.00 mbgl
Approx. Magⁿ	×63	**Approx. Scale**	10 mm = 90 µm
Portion Described	Burnt shale	**Viewing Light**	Plane-polarised/Cross-polarised
Description	View of possible burnt shale particle, showing heterogeneous composition clay rich matrix (dark brown/reddish brown, e.g. E2 & F11), quartz grains (white/grey/pale yellow, C10) and iron-rich grains (black, E10).		

Petrographic Examination of Material – TP 573

Methods of Examination

The sample was subjected to a petrographic examination generally following RSK documented in-house procedure TP 573 which is based on various methods including ASTM C856-20, Standard Practice for the Petrographic Examination of Hardened Concrete and BS EN 12407:2019, Natural stone test methods — Petrographic examination. This particular portion of TP 573 draws specific guidance from *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section* (Quinn, 2013). The sample was firstly subjected to visual and low-power microscopical examination using a binocular microscope. This initial examination was used to determine the most appropriate location for a thin-section to be taken for further, more detailed microscopical examination. The thin-section was prepared from a diamond sawn slice, which had been both consolidated with and vacuum impregnated by an epoxy resin.

The thin-section was examined in transmitted plane-polarised and cross-polarised light using a Zeiss Axioscope petrological microscope employing various magnifications up to x630. A record colour photomicrograph was prepared to illustrate the general character of the material.

Glossary of Terms Used in the Descriptions

Void types	**Vesicles** (equant, spherical, with smooth edges), **Vughs** (irregular, non-spherical, non-parallel sides), **Channels** (elongate, parallel sides, rounded ends, can be curved), **Planar Voids** (elongate, parallel sides, pointed ends, straight).[1]
Void sizes	**Micro** (<0.05 mm); **Meso** (0.05 – 0.5 mm); **Macro** (0.5 – 2 mm); **Mega** (>2mm).
Frequency	Increasing Frequency ↓ **Rare** - only found by thorough searching **Sporadic** - only occasionally observed during normal examination **Common** - easily observed during normal examination **Frequent** - easily observed with minimal examination **Abundant** - immediately apparent to initial examination
Hardness	**Very soft**: can be penetrated easily by a finger; **Soft**: scores with a fingernail**;** **Moderately soft**: scores using a copper coin; **Moderately hard**: scores easily with a penknife; **Hard**: not easily scored with a penknife; **Very hard**: cannot be scored with a steel point or knife.
Optical activity	An **optically active** clay matrix will exhibit a mottled appearance under crossed polarized light, caused by differentially oriented clay particles going into and out of extinction. An **optically inactive** clay matrix will exhibit a consistent appearance under cross polarized light, indicating the clay has fully sintered and begun to vitrify.[2]
Sorting	**Very Well Sorted**, **Well Sorted**, **Moderately Well Sorted**, **Moderately Sorted**, **Poorly Sorted**, **Very Poorly Sorted**, or **Extremely Poorly Sorted**.[3]
Rock colour	**Munsell Color**. 2009, revised 2012. *Munsell Rock Color Book*. Grand Rapids: Munsell Color.

[1] Quinn, P.S. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section.* Oxford: Archaeopress.
[2] Quinn, P.S. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section.* Oxford: Archaeopress.
[3] Folk, R.L. and Ward, W.C., 1957. Brazos River bar: a study in the significance of grain size parameters. *Journal of Sedimentary Research*, *27*(1).

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Materials & Structures
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Hemel Hempstead
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UKAS TESTING
0278

Certificate of Examination
TP 573
Petrographic Examination of Fired Clay Material

Your Ref.	325389	**RSK Sample Ref.**	19528/O1
Site	Rockingham Phase 3	**Client Sample Ref.**	External Burnt Shale
Client	RSK Geosciences 18 Frogmore Road Hemel Hempstead HP3 9RT *On behalf of Coal Authority*	**Advised Sample Type**	Lump samples
		Location	None advised
		Sampled by/Date	RSK/Not advised
		Date of Receipt	16.07.2021
		Examined by/Date	AS/30.07.2021-12.08.2021

SAMPLE

The sample comprised three lumps of material, advised to be burnt shale, sampled by an RSK Geosciences Engineer on site.

METHODS OF EXAMINATION

A full description of the examination methods, including a glossary of descriptive terms, is given on the final sheet of this certificate.

EXAMINATION FINDINGS

The detailed petrographic examination findings are given in the following sheets of this certificate.

SUMMARY

Material Description	The sample comprised heterogeneous blocky/rough lumps of reddish orange brown, pale reddish brown to medium grey burnt clay material with pale yellow traces. Black, pale yellow, pale grey, greyish brown, dark grey, yellowish grey speckled inclusions were observed the sample. Apparently fresh but with variable levels of sintering/burning.
Fabric/Matrix	Faint traces of shale laminations were present in less burnt regions. Other areas of matrix exhibited a variable fabric based on the composition of the rock. Burnt, quartz-rich regions exhibited more lamination and less clay material, whilst clay-rich regions were more irregular with broken up relict fragment.
Aplastic Inclusions	Less than 1 mm sized, quartz, quartzite and ashy agglomerations/clinker were present. Quartzitic particles being mostly present within silty horizons in the original shale.
Voids	Partings around inclusions, vuggy voids within clay rich regions of the lumps and irregular voids within well burnt/sintered regions.
Condition	Lumps appear intact.

NOTE

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

Prepared by

Alex Smith
Senior Geomaterials Scientist

Certificate reviewed and authorised by

Dr Jennifer Murgatroyd
Senior Geomaterials Scientist

Date of Issue: 12 August 2021

Petrographic Examination of Fired Clay Material – TP 573

Visual And Microscopical Observations

RECORD PHOTOGRAPHS			
RSK Sample Ref.	19528/O1	**Client Sample Ref.**	External Burnt Shale



Petrographic Examination of Fired Clay Material – TP 573

Visual And Microscopical Observations

AS-RECEIVED SAMPLE DETAILS			
RSK Sample Ref.	19528/O1	**Client Sample Ref.**	External Burnt Shale
Maximum Length, mm	45	**Thickness, mm**	50
Maximum Width, mm	65	**Number of Pieces**	3
Portion Described	Slices for thin section taken for comparison.		

MATERIAL DESCRIPTION
The sample comprised blocky/rough lumps of very fine burnt shale varying from reddish orange brown, pale reddish brown to medium grey, with pale yellow traces. Black, pale yellow, pale grey, greyish brown, dark grey, yellowish grey speckled inclusions were observed the sample. Apparently fresh but with variable levels of sintering. Faint hints of relict laminations were present in two of the sample fragments.

MATRIX	
Fabric description	The fragments exhibited various levels of quartz silt/sand and burnt clay/clay matrix.
Matrix characteristics *(incl. calcareous/non-calcareous, ferrous/non-ferrous, heterogeneity, colour, etc.)*	Multiple different textures were present depending on the degree of sintering and natural variation in the shale host rock. The more burnt/sintered particles exhibited a reddish orange brown quartz sand fired/burnt clay fabric with distorted traces of relict shale laminations. More partially sintered areas of the particles exhibited more relict shale fabric and non-sintered/burnt clay deposits. Irregular iron-rich veins showed evidence of oxidisation. Blacker regions exhibited fragmented carbonaceous shale bound by clay/shale. Highly variable, non-calcareous, speckled grey, pale brown, dark greyish brown and dark reddish brown in PPL and reddish brown, brownish grey and grey in XPL.
Optical activity *(incl. presence and degree to estimate degree of sintering)*	Optically active to inactive and variably sintered.

INCLUSIONS		
Aplastic Inclusions *(incl. type, nominal max. size, shape, grading, sorting, distribution and orientation)*	Heterogeneous quartzitic sand, <1 mm nominal maximum sized, very-angular to sub-rounded, poorly sorted, evenly distributed and randomly orientated particles. Moderately bimodal size distribution; coarse particles typically 450 µm, with fine particles typically 50-75 µm.	
Constituents *(incl. hardness, colour and approx. percent of lithological types present, alteration, weathering and general features of engineering significance)*	Major	QUARTZ. 80-90 %. QUARTZITE. 10-15 %.
	Minor	ASHY AGGLOMERATIONS/CLINKER – Black, porous ash-rich larger particles with high porosity and common fracturing. 2-3 %.
Other Inclusions	Rare to sporadic greyish opaque to reddish brown clay pellets and inclusions, highly irregularly shaped sub-angular to rounded, up to 250 µm, typically 50 µm sized. Sporadic, angular to sub-rounded, black to dark grey coloured, fragments of carbonaceous shale, up to 4.5 mm in size.	
Additional Observations	The aplastic constituents commonly exhibited parting from the clay matrix in more burnt regions.	

Petrographic Examination of Fired Clay Material – TP 573

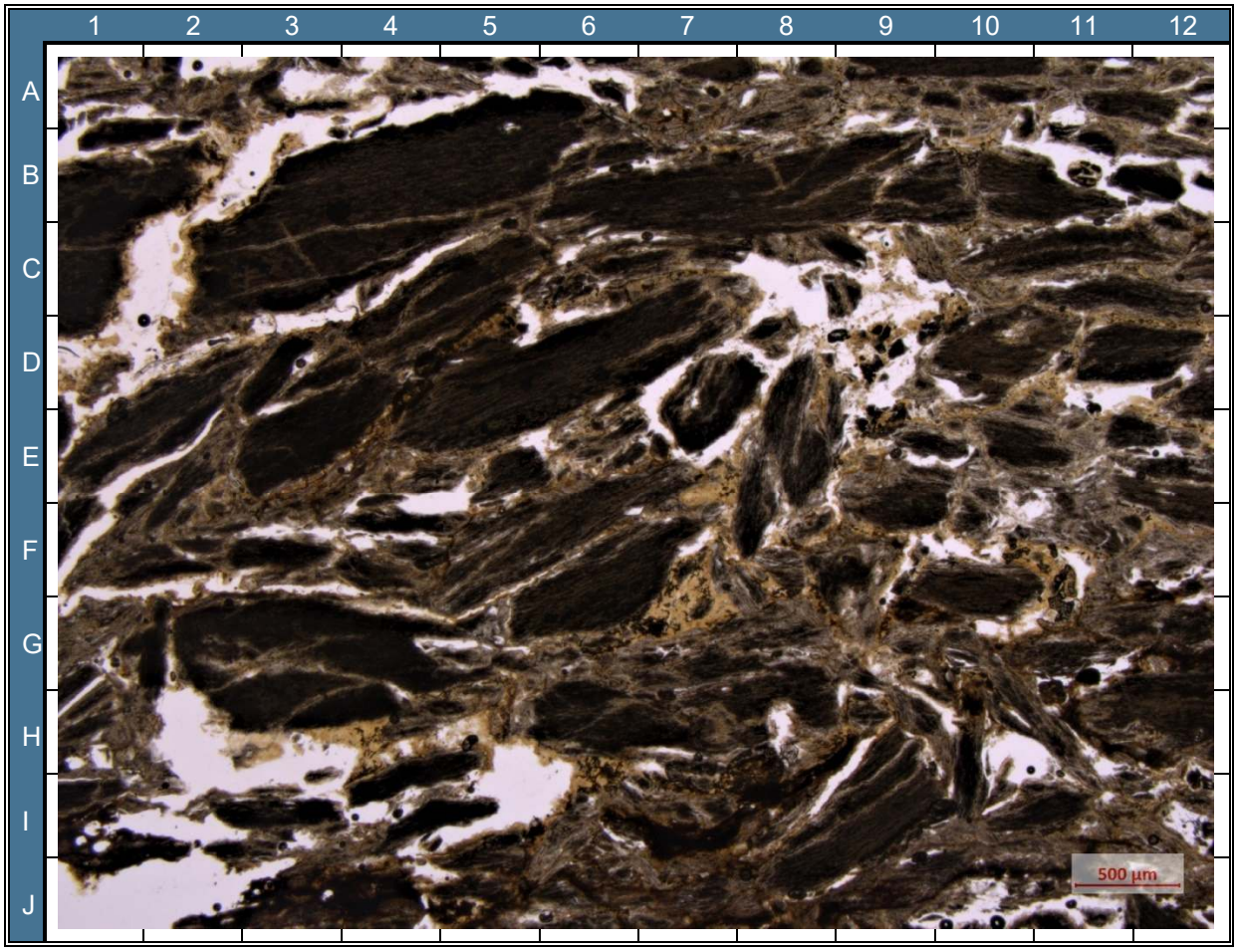
Visual And Microscopical Observations

VOIDS	
Void shapes and abundance *(incl. vesicles, vughs, channels, planar voids.)*	Common partings where shale texture was still present. Frequent to abundant vuggy voids were observed in iron-rich, well-burnt regions and in veins where significantly burnt. Rare irregular voids were present in well burnt regions.
Alignment	Elongate voids were aligned parallel to the relict shale textures and foliation.
Secondary deposits	None observed.

Petrographic Examination of Fired Clay Material – TP 573

High-Power Microscopical Observations

PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE

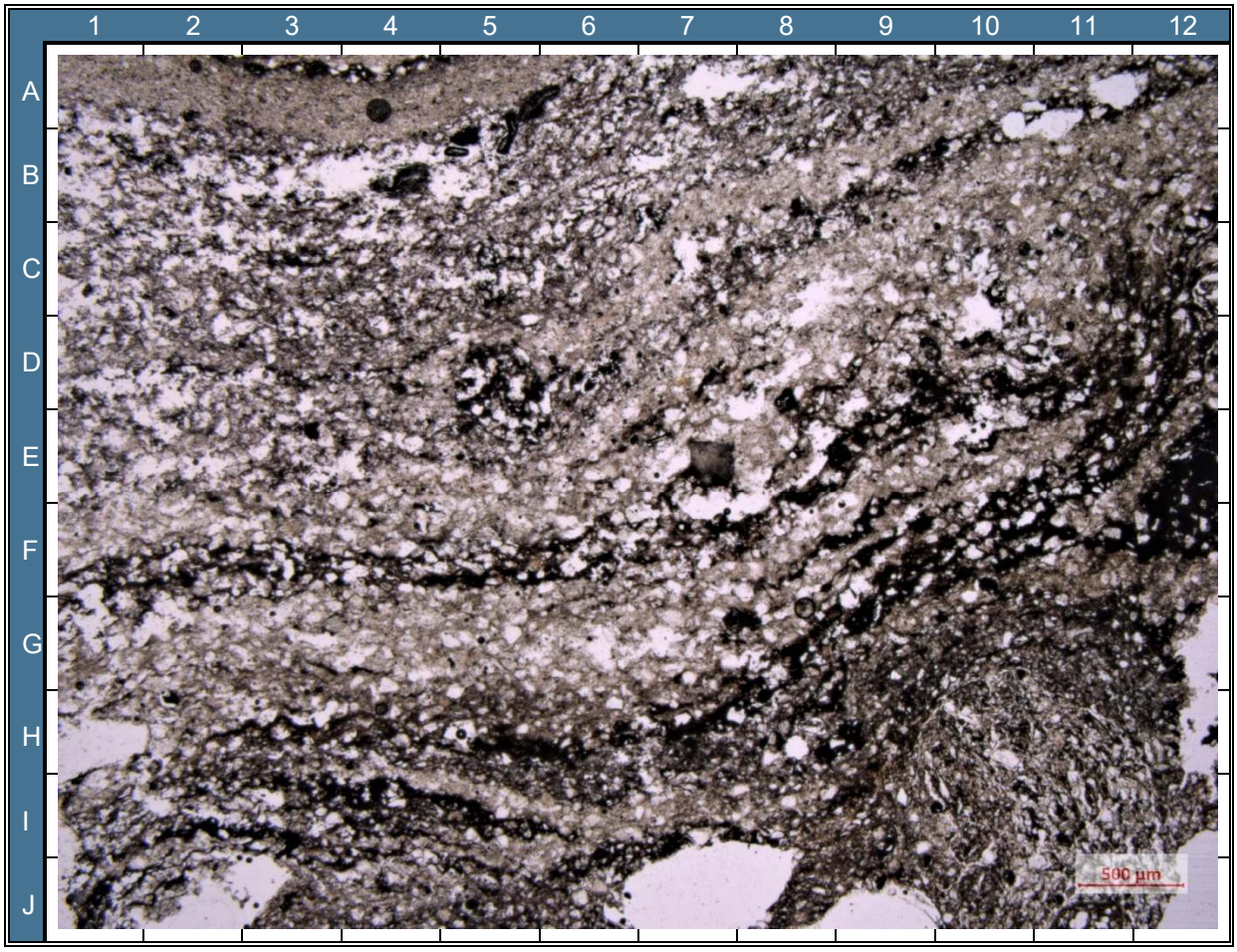


PHOTOMICROGRAPH			
RSK Sample Ref.	19528/O1	**Client Sample Ref.**	External Burnt Shale
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Burnt shale	**Viewing Light**	Plane-polarised
Description	General view of a grey region of a burnt shale particle, showing partially burnt fragments of shale (dark brown, e.g. B4, G3 & I9, surrounded by clay (yellowish brown, F/G7).		

Petrographic Examination of Fired Clay Material – TP 573

High-Power Microscopical Observations

PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE

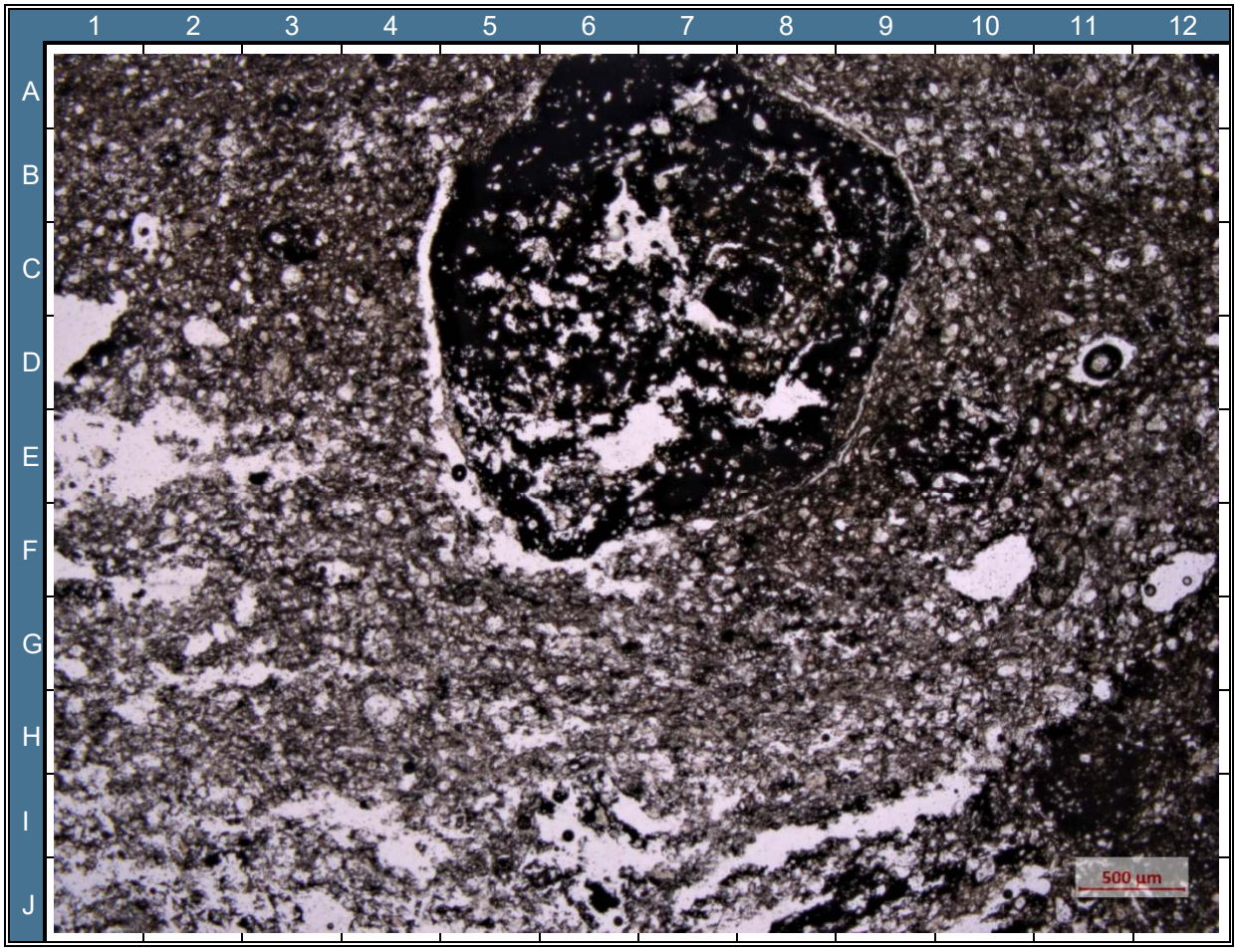


PHOTOMICROGRAPH			
RSK Sample Ref.	19528/O1	**Client Sample Ref.**	External Burnt Shale
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Burnt shale	**Viewing Light**	Plane-polarised
Description	General view of reddish orange burnt clay particle, showing silt sized quartzitic aggregate particles (white, e.g. C5) and more opaque horizons (black, F5-6) picking out the relict sedimentary layering of the shale/mudstone/siltstone rocks.		

Petrographic Examination of Fired Clay Material – TP 573

High-Power Microscopical Observations

PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE

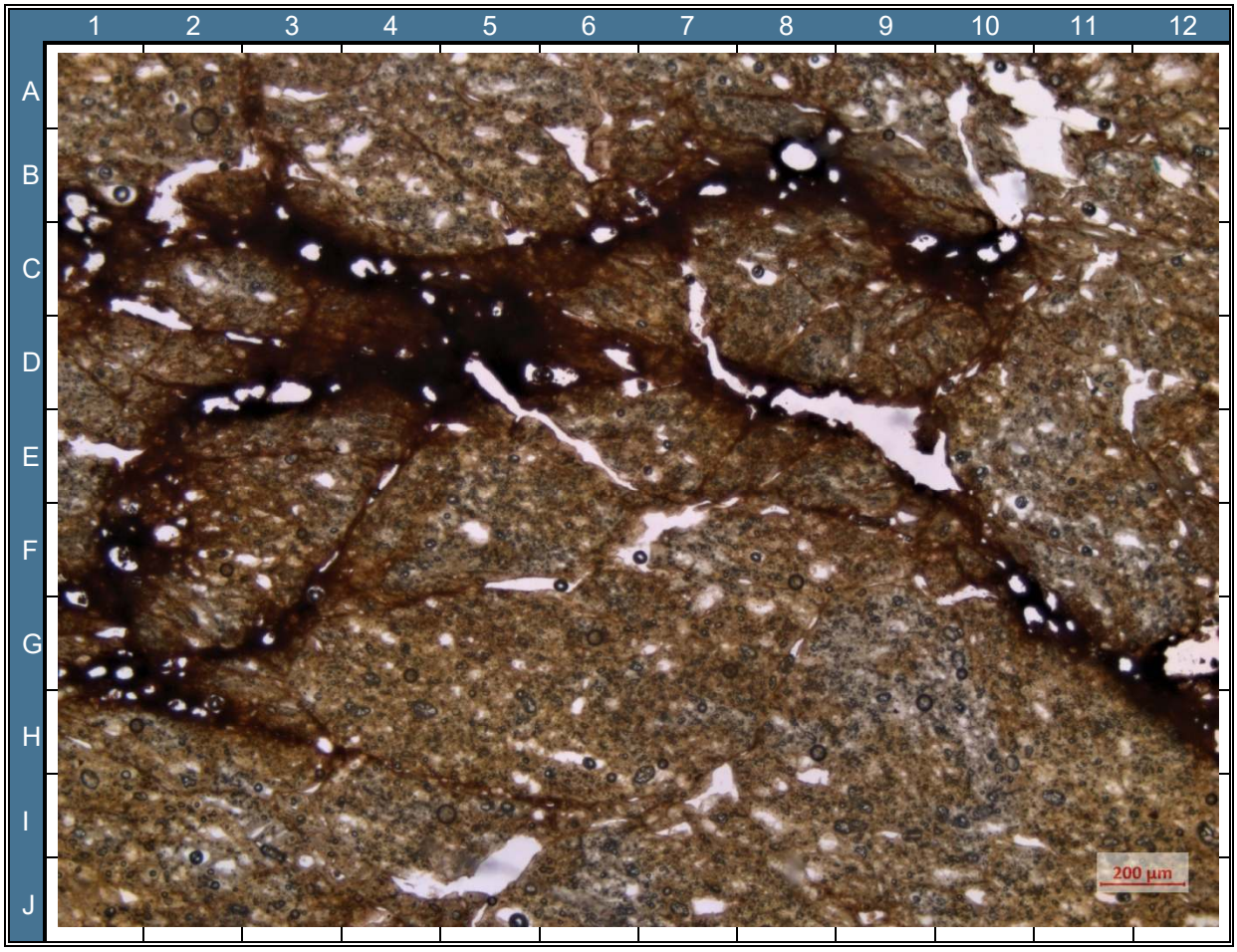


PHOTOMICROGRAPH			
RSK Sample Ref.	19528/O1	**Client Sample Ref.**	External Burnt Shale
Approx. Magⁿ	×15.75	**Approx. Scale**	10 mm = 360 µm
Portion Described	Burnt shale	**Viewing Light**	Plane-polarised
Description	View focussed on a black opaque shy agglomeration inclusion within the burnt shale (black, D6).		

Petrographic Examination of Fired Clay Material – TP 573

High-Power Microscopical Observations

PHOTOMICROGRAPHS TAKEN USING ZEISS AXIOSCOPE



PHOTOMICROGRAPH			
RSK Sample Ref.	19528/O1	**Client Sample Ref.**	External Burnt Shale
Approx. Magⁿ	×31.5	**Approx. Scale**	10 mm = 180 µm
Portion Described	Burnt shale	**Viewing Light**	Plane-polarised
Description	View of partially burnt clay-rich region with a burnt feature (black/dark brown, C/D4-5).		

Petrographic Examination of Fired Clay Material – TP 573

Methods of Examination

The sample was subjected to a petrographic examination generally following RSK documented in-house procedure TP 573 which is based on various methods including ASTM C856-20, Standard Practice for the Petrographic Examination of Hardened Concrete and BS EN 12407:2019, Natural stone test methods — Petrographic examination. This particular portion of TP 573 draws specific guidance from *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section* (Quinn, 2013). The sample was firstly subjected to visual and low-power microscopical examination using a binocular microscope. This initial examination was used to determine the most appropriate location for a thin-section to be taken for further, more detailed microscopical examination. The thin-section was prepared from a diamond sawn slice, which had been both consolidated with and vacuum impregnated by an epoxy resin.

The thin-section was examined in transmitted plane-polarised and cross-polarised light using a Zeiss Axioscope petrological microscope employing various magnifications up to x630. A record colour photomicrograph was prepared to illustrate the general character of the material.

Glossary of Terms Used in the Descriptions

Void types	**Vesicles** (equant, spherical, with smooth edges), **Vughs** (irregular, non-spherical, non-parallel sides), **Channels** (elongate, parallel sides, rounded ends, can be curved), **Planar Voids** (elongate, parallel sides, pointed ends, straight).[1]
Void sizes	**Micro** (<0.05 mm); **Meso** (0.05 – 0.5 mm); **Macro** (0.5 – 2 mm); **Mega** (>2mm).
Frequency	Increasing Frequency ↓ **Rare** - only found by thorough searching **Sporadic** - only occasionally observed during normal examination **Common** - easily observed during normal examination **Frequent** - easily observed with minimal examination **Abundant** - immediately apparent to initial examination
Hardness	**Very soft**: can be penetrated easily by a finger; **Soft**: scores with a fingernail**;** **Moderately soft**: scores using a copper coin; **Moderately hard**: scores easily with a penknife; **Hard**: not easily scored with a penknife; **Very hard**: cannot be scored with a steel point or knife.
Optical activity	An **optically active** clay matrix will exhibit a mottled appearance under crossed polarized light, caused by differentially oriented clay particles going into and out of extinction. An **optically inactive** clay matrix will exhibit a consistent appearance under cross polarized light, indicating the clay has fully sintered and begun to vitrify.[2]
Sorting	**Very Well Sorted**, **Well Sorted**, **Moderately Well Sorted**, **Moderately Sorted**, **Poorly Sorted**, **Very Poorly Sorted**, or **Extremely Poorly Sorted**.[3]
Rock colour	**Munsell Color**. 2009, revised 2012. *Munsell Rock Color Book*. Grand Rapids: Munsell Color.

[1] Quinn, P.S. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section.* Oxford: Archaeopress.
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UKAS TESTING 0278

Compressive Strength of Concrete Cores
BS EN 12504-1:2019

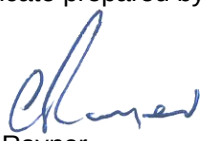
1283166 Rockingham Mine Shaft Cap Cores

Client Details			
RSK Environment Limited Spring Lodge 172 Chester Road Helsby Cheshire WA6 0AR			
Contact name	Sion Roberts		
Order reference	325389	Order date	16/06/2021

Sample Details			
Sample type	Concrete cores	Cast date	Not advised
Sampled by	Client	Age at test	Not advised
RSK batch No	19528	Sampling date	Not advised
Receipt date	19/07/2021	No of samples	2
Test date	26/07/2021		

Methods	
Test	The test was carried out in accordance with BS EN 12504-1:2019.
Notes	A 1:1 length to diameter ratio core may be compared to cube strength specifications. The procedures given in BS EN 12504-1:2019 NA.3 state that if a 1:1 core has less than 2% steel reinforcement by volume the compressive strength is not effected.
Deviations	None.

Results
The results are reported on page 2 of this certificate.

Certification			
Certificate prepared by  Clive Rayner Principal Technician		Certificate reviewed and authorised by  Dr Ian Blanchard Associate Director	
Testing by	CR	Certificate issue date	27/07/2021

The results given in this certificate relate only to those samples submitted and specimens tested and to any materials properly represented by those samples and specimens. Any opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

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Sample Details		
RSK reference	**Client reference / Location**	**Abnormalities/observations noted on visual inspection**
C1	C1	None
C2	C2	None

Results			
RSK sample reference		C1	C2
Estimated upper aggregate size (mm)		20	20
Estimated excess voidage (%)		8.0	8.0
As-received length (mm)		160	135
Air dry mass (g)		730	739
Saturated mass (g)		Not determined	Not determined
Air-dry density (kg/m^3)		2330	2360
Saturated density (kg/m^3)		Not determined	Not determined
Mean diameter (mm)		72	72
Mean prepared length (mm)		77	77
Portion tested in relation to as-received length (mm)		242-417	670-805
Sample preparation method		Grinding	Grinding
Length/diameter ratio		1.07	1.07
Storage conditions		Water	Water
Failure load (kN)		216.1	240.5
Assessment of type of failure		Satisfactory	Satisfactory
Unsatisfactory failure type		N/A	N/A
Compressive strength (N/mm^2)		53.1	59.1
Reinforcement (Y/N)		None	None
Total mass of reinforcement (g)		N/A	N/A
1st bar	Diameter (mm)		
	Distance from surface of core (mm)		
	Distance from nearest end of core (mm)		
2nd bar	Diameter (mm)		
	Distance from nearest end of core (mm)		
3rd bar	Diameter (mm)		
	Distance from nearest end of core (mm)		

End of Certificate

STRUCTURAL SOILS LTD

TEST REPORT

Report No. 584585-01 (00) 1774

Date	30-July-2021	Contract	325389 Rockingham Phase 3

Client RSK
Address 18 Frogmore Rd
Apsley
Hemel Hempstead
Hertfordshire
HP3 9RT
For the Attention of Clive Rayner

Samples submitted by client	27-July-2021	Client Reference	1283166
Testing Started	29-July-2021	Client Order No.	n/a
Testing Completed	30-July-2021	Instruction Type	Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests
10.06 Point Load Index ISRM:2007

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of .
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd 18 Frogmore Rd Hemel Hempstead HP3 9RT Tel.01442 416661 e-mail dimitris.xirouchakis@soils.co.uk

TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **30/07/2021 14:07:05**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory
Sharon Cairns (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU

STRUCTURAL SOILS LTD	Contract: **325389 Rockingham Phase 3**	Job No: **584585**

AGS

GINT_LIBRARY_V10_01.GLB LibVersion: v8_07_001 PrjVersion: v8_07 | GrfcText L - LAB VERIFICATION REPORT - V02 - A4P | 584585-325389-ROCKINGHAM-PHASE-3-RSK-1283166.GPJ - v10_01.
Structural Soils Ltd, Branch Office - Hemel Hempstead: 18 Frogmore Road, Hemel Hempstead, Hertfordshire, HP3 9RT. Tel: 01442 262323, Fax: 01442 262683, Web: www.soils.co.uk, Email: ask@soils.co.uk. | 30/07/21 - 14:11 | SC1 |

DETERMINATION OF POINT LOAD STRENGTH

In accordance with ISRM 1974-2006

Exploratory Position ID	Sample Ref	Depth (m)	Type of Test	Width or Length (W or L) (mm)	Platen Separation (D) (mm)	Failure Load (P) (kN)	Equivalent Diameter (D_e) (mm)	Point Load (I_s) (MN/m^2)	Size Factor (F)	Point Load Index ($I_{s(50)}$) (MN/m^2)	Water Content (%)	Rock Type	Lab location
435401-002	1	25.00	D	55	72	12.288	72	2.37	1.18	2.79 (✓)	4.7	CONCRETE	**H**
435401-002	1	25.00	A	71	45	7.000	64	1.72	1.12	1.92 (✓)	4.7	CONCRETE	**H**
435401-002	1	25.00	A	71	60	14.244	74	2.63	1.19	3.13 (✓)	4.7	CONCRETE	**H**
435401-002	1	25.00	D	25	40	0.758	40	0.47	0.90	0.43 (χ)	4.7	CONCRETE	**H**
435401-002	1	25.00	D	35	40	7.168	40	4.48	0.90	4.05 (✓)	4.7	CONCRETE	**H**
435401-002	1	25.00	D	30	34	5.788	34	5.01	0.84	4.21 (χ)	4.7	CONCRETE	**H**
435401-002	1	25.00	D	30	34	5.642	34	4.88	0.84	4.10 (✓)	4.7	CONCRETE	**H**

Results

$I_s(50)$ Mean Axial tests = **2.52** MN/m^2
$I_s(50)$ Mean Diametral tests = **3.65** MN/m^2
$I_a(50)$ Strength Anisotropy Index = **1.45** (calculated from highest and lowest diametral and axial $I_s(50)$ ratio)
Note:Size Correction Factor (F) calculated using $F = (D_e/50)^{0.45}$ (where D_e is equivalent core diameter).

Key

Type of Test column:, A = Axial, D = Diametral, I = Irregular, B = Block, L = Parallel, P = Perpendicular, [NS] denotes Non-standard Test.
Point Load Index column: (✓) = included in mean calculations, (χ) = excluded from mean calculations
Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

STRUCTURAL SOILS
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By		Date
SC	**SHARON CAIRNS**	**30.07.21**

Contract: **325389 Rockingham Phase 3**

Contract Ref: **584585**

AGS

DETERMINATION OF POINT LOAD STRENGTH

In accordance with ISRM 1974-2006

Exploratory Position ID	Sample Ref	Depth (m)	Type of Test	Width or Length (W or L) (mm)	Platen Separation (D) (mm)	Failure Load (P) (kN)	Equivalent Diameter (D_e) (mm)	Point Load (I_s) (MN/m^2)	Size Factor (F)	Point Load Index ($I_{s(50)}$) (MN/m^2)	Water Content (%)	Rock Type	Lab location
435401-003	2	23.20	D	55	75	9.694	75	1.72	1.20	2.07 (✓)	4.8	CONCRETE	**H**
435401-003	2	23.20	A	75	46	10.180	66	2.32	1.14	2.63 (✓)	4.8	CONCRETE	**H**
435401-003	2	23.20	A	75	67	11.944	80	1.87	1.24	2.31 (✓)	4.8	CONCRETE	**H**
435401-003	2	23.20	D	30	40	6.948	40	4.34	0.90	3.93 (✓)	4.8	CONCRETE	**H**
435401-003	2	23.20	D	40	37	4.109	37	3.00	0.87	2.62 (✓)	4.8	CONCRETE	**H**

Results

$I_s(50)$ Mean Axial tests = **2.47** MN/m^2
$I_s(50)$ Mean Diametral tests = **2.87** MN/m^2
$I_a(50)$ Strength Anisotropy Index = **1.16** (calculated from highest and lowest diametral and axial $I_s(50)$ ratio)
Note:Size Correction Factor (F) calculated using $F = (D_e/50)^{0.45}$ (where D_e is equivalent core diameter).

Key

Type of Test column:, A = Axial, D = Diametral, I = Irregular, B = Block, L = Parallel, P = Perpendicular, [NS] denotes Non-standard Test.
Point Load Index column: (✓) = included in mean calculations, (χ) = excluded from mean calculations
Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

STRUCTURAL SOILS
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By		Date
SC	**SHARON CAIRNS**	**30.07.21**

Contract: **325389 Rockingham Phase 3**

Contract Ref: **584585**

AGS

DETERMINATION OF POINT LOAD STRENGTH

In accordance with ISRM 1974-2006

Exploratory Position ID	Sample Ref	Depth (m)	Type of Test	Width or Length (W or L) (mm)	Platen Separation (D) (mm)	Failure Load (P) (kN)	Equivalent Diameter (D_e) (mm)	Point Load (I_s) (MN/m^2)	Size Factor (F)	Point Load Index ($I_{s(50)}$) (MN/m^2)	Water Content (%)	Rock Type	Lab location
435401-003	3	25.40	D	150	73	2.640	73	0.50	1.19	0.59 (✓)	1.1	SHALE	**H**
435401-003	3	25.40	D	82	73	3.986	73	0.75	1.19	0.89 (✓)	1.1	SHALE	**H**
435401-003	3	25.40	D	41	73	1.912	73	0.36	1.19	0.43 (✓)	1.1	SHALE	**H**
435401-003	3	25.40	D	38	73	1.352	73	0.25	1.19	0.30 (χ)	1.1	SHALE	**H**
435401-003	3	25.40	D	40	73	3.114	73	0.58	1.19	0.69 (✓)	1.1	SHALE	**H**
435401-003	3	25.40	D	40	73	5.158	73	0.97	1.19	1.15 (χ)	1.1	SHALE	**H**
435401-003	3	25.40	A	72	45	8.888	64	2.15	1.12	2.41 (χ)	1.1	SHALE	**H**
435401-003	3	25.40	A	72	37	2.862	58	0.84	1.07	0.90 (χ)	1.1	SHALE	**H**
435401-003	3	25.40	A	72	41	6.112	61	1.63	1.10	1.78 (✓)	1.1	SHALE	**H**
435401-003	3	25.40	A	72	40	6.834	61	1.86	1.09	2.03 (✓)	1.1	SHALE	**H**

Results

$I_s(50)$ Mean Axial tests = **1.91** MN/m^2
$I_s(50)$ Mean Diametral tests = **0.65** MN/m^2
$I_a(50)$ Strength Anisotropy Index = **2.94** (calculated from highest and lowest diametral and axial $I_s(50)$ ratio)
Note:Size Correction Factor (F) calculated using $F = (D_e/50)^{0.45}$ (where D_e is equivalent core diameter).

Key

Type of Test column:, A = Axial, D = Diametral, I = Irregular, B = Block, L = Parallel, P = Perpendicular, [NS] denotes Non-standard Test.
Point Load Index column: (✓) = included in mean calculations, (χ) = excluded from mean calculations
Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)

STRUCTURAL SOILS
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Compiled By		Date
SC	**SHARON CAIRNS**	**30.07.21**

Contract: **325389 Rockingham Phase 3**

Contract Ref: **584585**

AGS

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UKAS TESTING 0278

Cement and Sulfate Contents of Concrete
BS 1881-124:2015

1283166 Rockingham Mine Shaft Cap, Phase 3 (325389)

Client Details	
RSK Environment Limited Spring Lodge 172 Chester Road Helsby Cheshire WA6 0AR	
Contact name	Sion Roberts

Sample Details			
Sample type	Concrete cores		
Sampled by	RSK	Sampling date	30/06/2021
RSK batch no.	19528	No. of samples	2
Receipt date	19/07/2021	Test period	28/07/2021-06/08/2021

Methods	
Test	The analyses for insoluble residue, soluble silica and calcium oxide were carried out in accordance with BS 1881-124:2015, Clause 6. The analysis for sulfate was carried out in accordance with BS 1881-124:2015, Clause 12.2 and the result is expressed as sulfur trioxide, SO_3 by mass of sample and of cement. Cement content (kg/m^3) was calculated using determined air-dry densities (see RSK certificate 1283166/63587).
Precision	BS 1881-124:2015 suggests the following precision values for the determination of the cement content: Repeatability = 40 kg/m^3, Reproducibility = 60 kg/m^3 In-house duplicate testing derived repeatability limits of 30 and 20 kg/m^3 for cement content calculated from soluble silica and calcium oxide, respectively. Repeatability limit for sulfate content from duplicate testing = 0.06% by mass of sample.
Deviations	None.

Results
The results are reported on page 2 of this certificate.

Certification			
Certificate prepared by  Simona Mohammad Trainee Chemist Technician		Certificate reviewed and authorised by  Ben Stainton Principal Chemistry Technician	
Testing by	SM	Certificate issue date	11/08/2021

The results given in this certificate relate only to those samples submitted and specimens tested and to any materials properly represented by those samples and specimens. Any opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

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UKAS TESTING
0278

Results					
RSK sample reference	**Client sample reference**	**Determined Values (% by mass)**			
		Insoluble residue	**Soluble silica**	**Calcium oxide**	**Sulfate (SO_3)**
19528/C1	435401-002 Shaft	70.4	6.2	12.4	0.52
19528/C2	435401-003 Shaft	71.7	5.8	11.8	0.51

Calculated Values							
RSK sample reference	**(% by mass of sample)**				**(% by mass of cement)**	**Mix Proportions (ratio by mass)**	
	Portland cement		**Preferred cement content value**	**Aggregate content**	**Sulfate (SO_3)**	**Aggregate / cement ratio**	**Cement content (kg/m^3)**
	ex silica	**ex lime**					
19528/C1	29.4	19.2	19.2	76.4	2.7	4.0	447
19528/C2	27.4	18.3	18.3	77.5	2.8	4.2	432

Assumptions	
Soluble silica in cement (% by mass)	20.2
Calcium oxide in cement (% by mass)	64.5
Soluble silica in aggregate (% by mass)	0.4
Calcium oxide in aggregate (% by mass)	0.0
Water of hydration of concrete (% by mass)	23

End of Certificate

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UKAS TESTING 0278

Alkali Content of Concrete
In-house test procedure TP568

1283166 Rockingham Mine Shaft Cap, Phase 3 (325389)

Client Details	
RSK Environment Limited Spring Lodge 172 Chester Road Helsby Cheshire WA6 0AR	
Contact name	Sion Roberts

Sample Details			
Sample type	Concrete cores		
Sampled by	RSK	Sampling date	30/06/2021
RSK batch no.	19528	No. of samples	2
Receipt date	19/07/2021	Test period	05-10/08/2021

Methods	
Test	The analyses were carried out in accordance with our in-house documented test procedure TP568 which is based on BS EN 196-2:2013 Clauses 4.5.19 and 4.5.20. A portion of the analytical sub sample prepared to pass a 125 µm sieve was extracted with nitric acid solution. The sodium and potassium contents were then determined by atomic absorption/emission spectrophotometry.
Deviations	None.
Precision	Repeatability limit from duplicate testing = 0.024 % Na_2O_{eq} by mass of sample

Results
The results are reported on page 2 of this certificate.

Certification			
Certificate prepared by  Ben Stainton Principal Chemistry Technician		Certificate reviewed and authorised by  Dr Ian Blanchard Associate Director	
Testing by	BJS	Certificate issue date	11/08/2021

The results given in this certificate relate only to those samples submitted and specimens tested and to any materials properly represented by those samples and specimens. Any opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

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UKAS TESTING 0278

Sample Details	
RSK sample reference	**Client sample reference**
19528/C1	435401-002 Shaft
19528/C2	435401-003 Shaft

Results

RSK sample reference	**Determined values**		**Calculated values**		
	% by mass of sample		**Total alkalis as Na_2O equivalent**		
	Sodium oxide Na_2O	**Potassium oxide K_2O**	**% Mass of sample**	**% Mass of cement(1)**	**kg/m³ of concrete(2)**
19528/C1	0.05	0.18	0.17	0.88	3.9
19528/C2	0.07	0.16	0.17	0.92	4.0

(1) Obtained using determined cement contents (see RSK certificate 1283166/63646).
(2) Obtained using determined air-dry densities (see RSK certificate 1283166/63587).

End of Certificate

Quartz Scientific

UKAS TESTING 1586

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RSK Environment Ltd
18 Frogmore Road
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12 August 2021
RSK/18377/irg

CERTIFICATE of ANALYSIS

1283166

Chloride content of concrete samples

Date received	:	9 August 2021
Mass received	:	21 to 22 g
Type of sample	:	concrete dust
Date of analysis	:	11 August 2021
Method of testing	:	B.S.1881:Part 124:2015+A1:2021

Sample ref.	Client's ref.	Chloride content	
		% by mass of	
		sample	cement
13838	19528/C1	<0.01	<0.02
13839	19528/C2	<0.01	<0.02

Note: 14 % cement content was assumed for the calculations. Results apply to the samples as received.

End of results



Dr Ian Girling CChem MRSC
Quality Manager

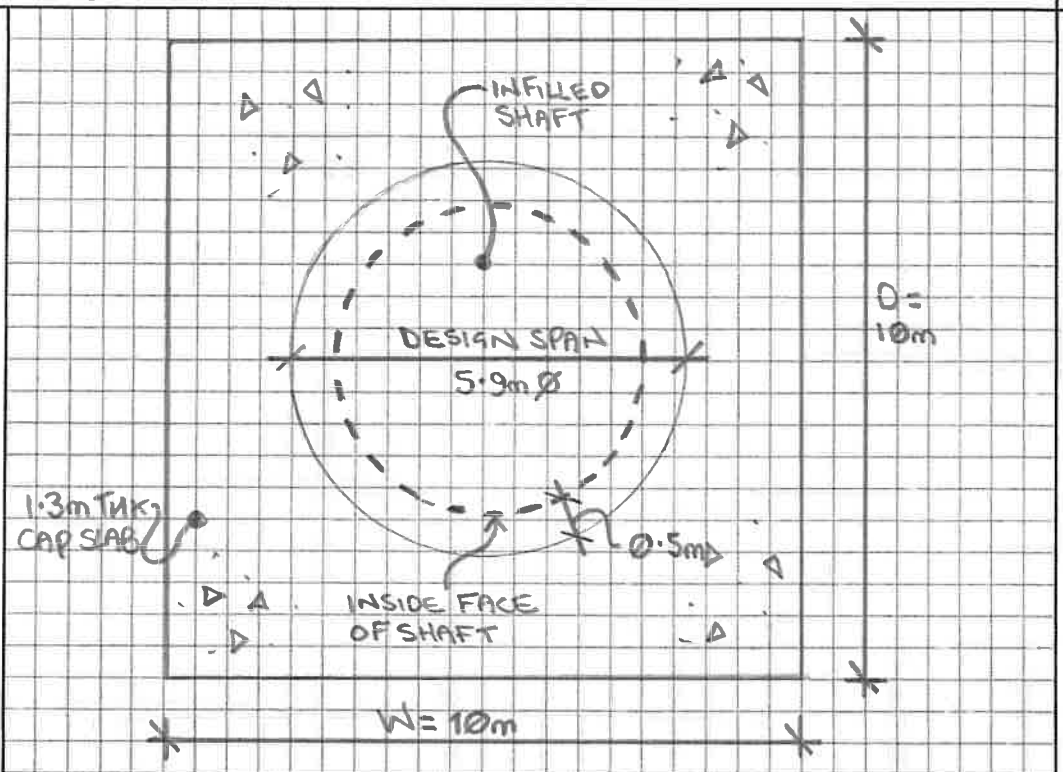
APPENDIX E
STRUCTURAL ANALYSIS

RSK

Job No.: 325389
Date: SEPT 21
Author/Calc by: DW
Checked by: SW

PROJECT NAME: SHAFT CAP-002 (WORST CASE)

SUBJECT: STRUCTURAL ASSESSMENT TO BS EN 1992



DESIGN DATA:

- 1.3m THICK C50/60 RC CAP WITH H40[15] @ 200 CTRS (BOTH DIRS) IN BOTTOM AND H16[5] TOP LOCATED AT ROCKHEAD.
- MIN 100mm CONCRETE COVER ASSUMED AND W/C EFFECTIVE DEPTH TAKEN THROUGHOUT DESIGN.
- INCREASED SPAN Ø OF 5.9m TAKEN AS CONTINGENCY.
- 200mm THICK GROUND BEARING RC SLAB ASSUMED AT SURFACE (TYPICAL).
- 2.5kN/m² NOMINAL VARIABLE LOAD ASSUMED AT 20mbgl.
- DEPTH FROM PROPOSED FFL TO TOP OF EXISTING CAP ASSUMED 24m MAX.

RSK

Job No.: 325389

Date: SEPT 21

Author/Calc by: AW

Checked by: SW

PROJECT NAME: SHAFT CAP - 002 (WORST CASE)

SUBJECT: EC2 SHEAR CAPACITY CHECK -

SHAFT DIAM = 5.9m (4.9m + 0.5m BEYOND SUPPORTS)

AREA = $\pi \times 5.9m^2/4 = 27.34m^2$

CAP SELFWEIGHT = $25kN/m^3 \times 1.3m = 32.5kN/m^2$

O/BURDEN = $19kN/m^3 \times 23.8m = 452.2kN/m^2$, SLAB = $25 \times 0.2m = 5kN/m^2$

VARIABLE LOAD = NOMINAL $2.5kN/m^2$ @ 24m DEPTH

ΣULT LOAD = $[(32.5 + 452.2 \times 1.0) + (5 \times 1.35) + (2.5 \times 1.5)]$

$\times 27.34m^2 = 13538.768kN$

APPLIED SHEAR = $13538.768kN/(\pi \times 5.9m) = 730.42kN$ PER m

SHEAR STRESS ON PERIMETER (V_{ED}) = $730.42kN \times 10^3/1300 \times 10^3 = 0.562N/mm^2$

$f_{ck} = 50N/mm^2$ (CONFIRMED BY TESTING).

$d = 1300mm - 100mm - 40mm - (40mm/2) = 1140mm$ (WORST CASE)

$k = 1 + (200/1140)^{0.5} = 1.419$ (< 2.0 ∴ OK)

$\gamma_c = 1.5$

$A_{s\,PROV} = 6283mm^2/m$ (H40 @ 200 CTRS).

$\rho_l = 6283mm^2/(1000mm \times 1140mm) = 0.0055$ (< 0.02 ∴ OK)

$V_{Rd,c} = (0.18/1.5) \times 1.419 \times (100 \times 0.0055 \times 50N/mm^2)^{0.333} \times 1000mm \times 1140mm \times 10^{-6}$ cl 6.2.2

$= 0.585N/mm^2$

$\geq 0.035 \times (1.419)^{1.5} \times (50N/mm^2)^{0.5} \times 1000mm \times 1140mm \times 10^{-5} = 0.477N/mm^2$

∴ $V_{Rd,c} = 0.585N/mm^2$

$V_{ED} = 0.562N/mm^2 < V_{Rd,c} = 0.585N/mm^2$

∴ SHEAR REINF NOT REQ'D

RSK

Job No.: 325389
Date: SEPT 21
Author/Calc by: DW
Checked by: SW

PROJECT NAME: SHAFT CAP-002 (WORST CASE)

SUBJECT: EC2 BENDING CHK

CHECK AS TWO WAY SPANNING (4NO EDGES DISCONTINUOUS)

SLAB THICKNESS = 13000mm (CONFIRMED BY BHOLE).

CAP SPAN = 4900mm SHAFT Ø + 500mm EACH SIDE
i.e 5900mm

CHARACTERISTIC PERM LOAD = 32.5 + 452.2 + 5 = 489.7kN/m²

CHARACTERISTIC VAR LOAD = 2.5kN/m²

γ_G=1.0 & 1.35, γ_Q=1.5, ψ_2(QUASI-PERM VAR) = 0.6 VEHICLES >30kN

DESIGN ULT LOAD = (484.7×1.0) + (5×1.35) + (2.5×1.5) = 495.2kN/m²

QUASI-PERM LOAD = (489.7×1.0) + (2.5×0.6) = 491.2kN/m²

f_{ck} = 50N/mm², γ_c = 1.5, α_{cc} = 0.85, f_{cd} = 28.3N/mm², d_g = 20mm — TABLE 2.1N cl 3.1.6 TABLE 3.1

MEAN AXIAL STRENGTH (f_{ctm}) = 0.3N/mm² × (50N/mm²)$^{2/3}$ = 4.1N/mm²

f_{yk} = 500N/mm², γ_s = 1.15 ∴ f_{yd} = 500/1.15 = 434.8N/mm² — TABLE 2.1N FIG 3.8 cl 6.1

BENDING COEFFICIENT β_{sx} = 0.056

BM MAX = 0.056 × 495.2kN/m² × (5.9m)² = 965.32kNm PERM

$A_{s PROV}$ = 6283mm²/m (H40 @ 200 CTRS)

d = 1140mm (WORST CASE)

$K = 965.32 \times 10^6 / (1000mm \times (1140mm)^2 \times 50N/mm^2) = 0.0148$

K' = 0.208 ∴ COMPRESSION REINF NOT REQ'D

z = 0.95 × 1140mm = 1083mm

$A_{S REQ'D} = 965.32kNm \times 10^6 / (434.8N/mm^2 \times 1083mm) = 2050mm^2$ PER m

$A_{s MIN}$ = 0.0013 × 1000mm × 1140mm = 1482mm² PER m
OR 0.26 × (4.1/500) × 1000 × 1140 = 2430mm² PER m

$A_{s PROV}$ = 6283mm²/m > $A_{S REQ}$ = 2430mm²/m

∴ BENDING REINF SATISFACTORY

RSK

Job No.: 325389
Date: SEPT 21
Author/Calc by: DW
Checked by: SW

PROJECT NAME: SHAFT CAP-002 (WORST CASE)

SUBJECT: EC2 SERVICEABILITY CHECKS

REINF SPACING CHECK (CRACK WIDTH):

$\sigma_{sy-P} = (500 N/mm^2 / 1.15) \times (2038 mm^2/m / 6283 mm^2/m) \times 489.3 \times 10^9 / 492.3 \times 10^9 = 140.2 N/mm^2$

MAX ALLOWABLE SPACING = 300mm — TABLE 7.3N

300mm > 200mm ∴ BAR SPACING SATISFACTORY

SPAN-TO-DEPTH CHECK:

ACTUAL SPAN/DEPTH RATIO = 5900mm / 1140mm = 5.18

∴ BY INSPECTION SPAN/DEPTH RATIO SATISFACTORY