GEOENVIRONMENTAL GROUND INVESTIGATION

Piccadilly Basin
Manchester

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CONFIDENTIALITY STATEMENT

This report is addressed to and may be relied upon by the following:

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This report has been prepared for the sole use and reliance of the above named parties. This report shall not be relied upon or transferred to any other parties without the express written authorisation of JPG (Leeds) Limited. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

DOCUMENT HISTORY

VERSION	PURPOSE/DESCRIPTION	DATE
1	Final – For issue to Client	February 2017

EXECUTIVE SUMMARY

Site Address	**Piccadilly Basin, Manchester**
Current Site Use	The site is used as a pay and display car park.
Proposals	It is proposed to re-develop the site with a nine-storey hotel.
Previous Report	A desk study report for the site has been prepared by JPG, which should be read in conjunction with this report.
Fieldwork	The fieldwork was carried out during October and November 2016 and included three cable percussion boreholes two of which were extended by rotary cored drilling and a total of 12 windowless dynamic sampling boreholes.
Ground and Groundwater Conditions	The geological map indicates superficial deposits to comprise glacial till. These materials are underlain by bedrock of sandstone; part of the Chester Pebble Beds Sandstone Formation of the Triassic Period. During the investigation the sequence encountered generally comprised made ground overlying superficial deposits of clay with sand layers, overlying bedrock of sandstone. **Made Ground** – The made ground was generally subdivided into upper layers of coarse soils and lower layers of clay and extended to depths up to 2.5m. Made ground of coarse soils was encountered at all locations to depths between 0.80 and 2.30m. These soils were generally described as sandy gravel or gravelly sand with cobbles including brick and concrete. Gravel included brick, concrete, ash, tarmac and clinker. Twelve SPT 'N' values in made ground of coarse soils ranged from 3 to greater than 50. A total of four SPT 'N' values of 12, 18, 19 and 43 were recorded in made ground of clay. **Superficial deposits** – Superficial deposits were encountered across the site at depths of between 1.00m and 2.50m. The materials predominantly comprised clay, but occasional layers of coarse soils were also encountered. The majority of the materials were described as brown slightly sandy, slightly gravelly clay. Field descriptions of clay strengths were noted as firm, stiff and very stiff, predominantly very stiff with depth. SPT 'N' values were obtained within clay, with an overall range from 7 to >50. The 'N' values generally increase with depth, but also the values indicate a twofold sub-division of the clay. An upper layer appears to extend to depths about 12m to 13m with an increase in 'N', generally to values greater than 60 (extrapolated to 300mm penetration), below these depths. **Bedrock** – Sandstone bedrock was encountered beneath superficial deposits in boreholes at depths in the range 23.00 to 26.80m. UCS tests on sandstone core recorded values of 6.1, 9.0 and 9.9MN/m2. These values indicate weak material. Axial point load test have been used to derive UCS values in the range 1.8 to 6.6MPa, with an average about 3.6MPa. These values indicate very weak and weak material. SPT 'N' values in sandstone recorded either >50 or >100 blows. Full penetration was not achieved on these tests. Extrapolation of values to 300mm penetration indicates values equivalent to the range 143 to 1667 blows for 300mm. From SPT values, lower bound strengths in the order of 1.4 to 16.7MN/m2 are obtained which indicate very weak and weak material. Overall the strength data, either obtained from direct measurement or derived from indirect tests, is all consistent with very weak and weak rock. Groundwater was encountered in a single borehole at a depth of 26.80m at the boundary between clay and the underlying sandstone bedrock Groundwater was not encountered in any of the other exploratory holes during the fieldwork period. Long term monitoring has recorded some shallow water at depths around 1n below ground level, in the superficial deposits.
Geotechnical and Engineering Assessment	**Foundations** – It is recommended that a piled foundation solution is utilised to transfer structural loads to competent strata. Depending on the magnitude of structural loads, piles may either be supported within the superficial deposits or extend to sandstone bedrock. Assuming bored concrete piles the following lengths have been estimated for piles to achieve the required SWL at different diameters: • 300mm diameter pile – Piles to extend to bedrock at depths about 25m for both 750kN and 1500kN SWL. • 450mm diameter piles – 750kN SWL piles to extend to approximately 17m. 1500kN SWL piles to extend to bedrock at depths about 25m. • 600mm diameter piles – 750kN SWL piles to extend to approximately12m. 1500kN SWL piles to extend to approximately 22.50m. These preliminary estimates of pile length should be reviewed depending on pile diameter, type and installation method adopted. **Excavations** – It is considered that excavations to less than 1.00m may not stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations. Groundwater should be expected in shallow excavations for foundations or services. This may be due to perched groundwater in the made ground overlying clay. Hydraulic continuity between the made ground of coarse soils and the adjacent canal should be considered. De-watering of excavations and/or groundwater cut off measures may be required. However, if such works are required, these should be designed to minimise effects on the surrounding

	waterways. **Road and Hard Standing** – Laboratory testing recorded CBR values of 52% and 64% on made ground of gravel and CBR values of 0.7, 0.8 and 1.0% on made ground of clay. The design CBR values will depend on the proposed formation depth and the type of made ground. For design purposes it would be prudent to assume made ground of clay with a CBR of <2%. **Chemical Attack on Buried Concrete** – Based on the laboratory test results it is considered that a Design Sulphate Class may be taken as DS-1. An ACEC class for the site of AC-1 would be appropriate.
Environmental Risk Assessment	**Risk Assessment – Human Health** – The guidelines for a commercial/industrial end use have been adopted for assessment. The results of the soil chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document. The results have been compared in the first instance to screening levels produced in accordance with current and best practice legislation and guidance. **Chemical Test Results** – Where the concentrations determined on site are at or below the respective screening level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated. The elevated concentrations of some PAH compounds were encountered in made ground noted to contain tarmac, ash and clinker fragments. The proposed development will result in the site being covered with buildings and hardstanding. Based on the nature of the development, the ground conditions encountered, the conservative nature of the modelling and therefore the screening levels, these concentrations of PAH are not considered to warrant any further consideration and are not deemed to represent any significant risk to human health. **Asbestos** – Asbestos was identified as chrysotile in one sample of made ground with a moisture content of 9.7%. No visual evidence of bulk asbestos contamination was noted during site works. A quantification analysis of this sample recorded 0.002% chrysotile fibres. The soil moisture contents within the made ground, if they were maintained would greatly inhibit the release of fibres to the atmosphere. Considering the isolated occurrence of asbestos, extremely low fibre concentrations and moisture contents in relation to the proposed development, there is not considered to be a significant risk to end-users or construction workers. **Risk Assessment - Controlled Waters** – The risk assessment to controlled waters has been carried out on the basis of results of groundwater analysis on 4 samples from monitoring wells. Metals and some PAH compounds are noted to be elevated within groundwater with respect to some EQS guidelines and Drinking Water Standards with higher values recorded in the made ground than in the sandstone. There is no evidence within the laboratory testing undertaken on soils, of a significant potential on site source for the elevated groundwater concentrations. Further the sandstone is separated from the near surface made ground by a substantial thickness of low permeability clay. It is considered that the results of groundwater analysis are likely to be representative of the underlying regional groundwater and not specific to the proposed development site. The urban location of the site, together with the historical industrial site use and the presence of made ground is consistent with slightly elevated concentrations of some contaminants in groundwater at shallow depths. These values are likely to be representative of a regional groundwater regime and may not be confined to the site. Significant concentrations of contaminants were not encountered in groundwater from sandstone. TPH compounds were not recorded at concentrations above test detection limits. It is recommended that the Environment Agency may be consulted in light of the fact that there is no current guideline TPH parameter within the Water Supply Regulations 2000. Given the ground conditions encountered at the site, the nature of the proposed development, the conservative nature of the Drinking Water Standards and the results of this contamination assessment, it is considered unlikely that further assessment of the risks to controlled waters may be required.
Hazardous Gas	Six gas monitoring visits have identified a peak methane concentration of 5.2%v/v and a maximum carbon dioxide concentration of 8.9%v/v. Depleted oxygen concentrations have been consistently recorded in WS03 with values as low as 6.3%v/v. Flow rates have been zero or slightly negative. As flow rates were zero a nominal value of 0.11/hr has been adopted to enable calculation of gas screening values. On this basis approximately GSV values if 0.0009 l/hr for CO_2 and 0.0005 l/hr for CH_4 may be calculated. The calculated GSV are consistent with a Very Low Risk gas regime (Characteristic Situation 1). The maximum concentrations of CH_4 and CO_2 both exceed the typical maximum concentrations of 5% and 1% for a Very Low Risk gas regime. The maximum concentrations indicate that a minimum risk Classification of Low Risk (Characteristic Situation 2) should be assigned to the site.
This sheet is intended as a summary only of the assessment of the site in relation to ground condition. It does not provide a definitive engineering analysis.	

1.0 INTRODUCTION

1.1 Introduction

JPG (Leeds) Limited has been instructed by Evans Dakota Hotels Limited to carry out a geoenvironmental ground investigation for a proposed hotel on a site at Piccadilly Basin, Manchester.

1.2 Objectives

The main objective of the geoenvironmental ground investigation was to identify potential geotechnical and environmental issues that may represent constraints to the proposed redevelopment of the site.

1.3 Site Location

The site is situated close to Manchester City centre and may be located by National Grid Reference SJ 848 982.

1.4 Site Description

The site comprises a triangular parcel of land bounded to the south by Ducie Street and to the north west by the Rochdale Canal (Dale Street Basin).

Piccadilly Basin limits the western tip of the site. The northern boundary of the site is not physically delineated. The car park extends beyond this boundary to the north.

The site is used as a pay and display car park, with access from the south off Ducie Street.

The site slopes gently towards the north. The surface of the site comprises a combination of tarmac (at the entrance to the site), concrete (in the south west corner of the site) and compacted crushed stone.

The western tip of the site lies adjacent to the Rochdale Canal. At the southern end of this boundary, the site is approximately 4m higher than the canal, with the slope formed by a grassed bank. This reduces to approximately 1m at the northern end of this boundary; the earth is retained by a brick wall.

The eastern part of the southern boundary of the site is formed by a high wooden fence and several advertising hoardings. The western end of this boundary is formed by a low wooden fence. The site is approximately 1m lower than the pavement along Ducie Street.

The Rochdale Canal, an apartment block and a car park lie beyond the western boundary of the site. There is a footbridge across the canal, connecting the site with the land to the north west.

Beyond the southern boundary of the site are several apartment blocks and hotels, with shops and bars/restaurants on the ground floor. A large office block lies immediately south west of the site.

1.5 Development Proposals

It is proposed to re-develop the site with a nine-storey hotel.

A proposed area plan has been provided which is referenced below and a copy is presented in Appendix A.

- KPP Architects. Proposed Area Plan. Piccadilly Basin, Manchester. Project 2019-02, Drawing No. 201, Dated October 2016.

1.6 Previous Reports

A desk study report for the site has been prepared by JPG, which is referenced below:

- JPG. December 2016.Geoenvironmental Desk Study Report. Proposed Hotel Development, Piccadilly Basin, Manchester. RM/DS/4908.v2.

The desk study report should be read in conjunction with this report.

1.7 Limitations

The general limitations to the nature of the investigation are outlined in Appendix I.

1.8 Geological Setting

Details of the geology underlying the site were obtained from the British Geological Survey map, Sheet No. 85, 'Manchester', solid and drift edition, 1:50,000 scale, published 2010.

The geological map indicates superficial deposits to comprise glacial till. These materials are underlain by bedrock of sandstone; part of the Chester Pebble Beds Sandstone Formation of the Triassic Period.

The site is within an urban area and although not indicated as present on the site from the geological maps, made ground may be present on site.

A review of historical geological records was undertaken during the preparation of the desk study report.

This review determined the following:

- There are records of 13 boreholes drilled in 1987 for the Central Retail Park on Great Ancoats Street. These are shown to be located on and close to the northern boundary of the site. However, the exact locations of the boreholes cannot be determined.
- Ground conditions are shown to comprise made ground underlain by stiff and very stiff boulder clay, with thin bands of sand, and proven to depths of between 10m and 15m.
- The base of the made ground was proven in 11 boreholes to depths of between 0.50m and 3.00m.

In the remaining two boreholes, BH 04 and BH 11, the made ground was proven to depths of 3.80m and 8.50m respectively. In borehole BH 04 the made ground comprised bricks, concrete and wood to 2.90m, underlain by black odorous ashes, concrete and clay. In borehole BH 11 it comprised very loose ashes with soft clay bands and brick fill.

2.0 SITE WORK

The site work was carried out between 24 October and 1 November 2016 by Ian Farmer Associates.

The ground investigation was undertaken in accordance with techniques outlined in BS 5930:1999, Amendment 2; 2010, at the positions shown on the Exploratory Hole Location Plan, which is presented as Figure 2 in Appendix A. The exploratory hole records are contained in Appendix B. The drilling works was carried out under the supervision of an engineer from JPG.

The locations of the exploratory holes were amended on site, where required, due to the operational requirements of the car park and underground services.

The following exploratory holes were undertaken during site works:

- CP01 and CP03: Cable percussion boreholes.
- CP02: Cable percussion borehole extended by rotary cored drilling.
- RT01 and RT02: Rotary open hole and cored boreholes.
- WS02 to WS13 & WS07A: Windowless dynamic sampling boreholes.

Representative disturbed and undisturbed samples were taken at the depths shown on the records and despatched to the laboratory. Standard penetration tests were carried out in boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records.

A photographic record of the core is presented in Appendix H.

Samples for environmental purposes were collected in amber glass jars and kept in a cool box.

Perforated standpipes, surrounded by pea shingle and protected by a stopcock cover were installed in boreholes WS03, WS04, WS13, CP02 and RT02, as detailed in the borehole records.

The ground levels at the borehole and trial pit locations, were determined by survey to National Grid and Ordnance Datum.

Six site visits were undertaken subsequent completion of fieldwork to carry out gas monitoring, groundwater monitoring and groundwater sampling.

3.0 LABORATORY TESTING

3.1 Geotechnical Testing

Schedules for geotechnical testing were prepared by Ian Farmer Associates and forwarded to JPG Engineer for amendment and approval.

Soil samples for testing were prepared in accordance with BS1377: Part One: 1990 and representative sub-samples were taken for testing. The following tests were carried out:

- 15 No. Moisture contents.
- 8 No. Plasticity indices.
- 5 No. Particle size distribution by wet sieving.
- 2 No. Particle size distribution by pipette analysis.
- 8 No Undrained shear strength by triaxial test.
- 7 No. Oedometer consolidation.
- 2 No. Equivalent shear stress by hand vane.
- 3 No. California Bearing Ratio (CBR).
- 5 No. Water soluble sulphate.
- 5 No pH value.
- 2 No. Water soluble chloride.

The results of the soil tests are given in Appendix C, Test Reports PSL16/5273 and 16-83839.

Rock samples for geotechnical testing were prepared and tested in accordance with ISRM Suggested Methods which is referenced as follows:

Brown, E. T. Rock Characterization, Testing and Monitoring: ISRM Suggested Methods. 1981. Pergamon Press.

The following tests were carried out:

- 24 No. Point Load Index Test (PLT).
- 3 No. Uniaxial Compressive Strength (UCS).

Rock test results are presented in Reports PSL16/5564 in Appendix C.

3.2 Chemical Testing

Schedules for chemical analysis were prepared by Ian Farmer Associates and forwarded to JPG for amendment and approval.

The following suite of chemical analysis was carried out on twelve samples of soil:

- As, Cd, Cr, Hg, Pb, Se, Cu, Ni, Zn, free cyanide, monohydric phenol, speciated PAH (16), pH, water soluble sulphate.
- CrVI, Soil organic matter (SOM), total chloride, total sulphate, total sulphide, ammoniacal nitrogen, asbestos screen.

In addition to the above analysis suite speciated TPH (TPHCWG) was determined on three soil samples and quantification of asbestos was carried out on one soil sample.

The results of chemical analysis of soils are presented in reports 611478, 613320 and 614965.

The following suite of chemical analysis was carried out on three samples of water:

- As, Cd, Cr, Hg, Pb, Se, Cu, Ni, Zn, free cyanide, phenol, speciated PAH (16), pH, sulphate, speciated TPH (TPHCWG).

The results of chemical analysis of water are presented in reports 616951 contained in Appendix D.

4.0 GROUND CONDITIONS ENCOUNTERED

4.1 Sequence

The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the desk study information.

The sequence encountered generally comprised made ground overlying superficial deposits of clay with sand layers. This in turn overlies bedrock of sandstone.

SPT 'N' values are plotted against depth in Figures A1.4 and A1.5.

4.2 Made Ground

Made ground was encountered at all locations and was generally subdivided into upper layers of coarse soils and lower layers of clay.

Made ground of coarse soils was encountered at all locations to depths between 0.80 and 2.30m. These upper coarse soils were generally described as sandy gravel or gravelly sand with cobbles including brick and concrete. Gravel included brick, concrete, ash, tarmac and clinker.

A total of 12 SPT 'N' values in made ground of coarse soils ranged from 3 to greater than 50. These values indicate highly variable material ranging from very loose through loose and medium dense to dense. The highest values are likely to represent obstructions and may not reflect the relative density of the material.

Made ground of clay was locally encountered at depths between 0.25m and 1.80m extending to depths between 1.50m and 2.50m.

This material was generally described as firm and stiff sandy gravelly clay becoming slightly sandy and slightly with depth. Anthropogenic fragments included brick, concrete and clinker.

A total of four SPT 'N' values of 12, 18, 19 and 43 were recorded in made ground of clay. These values are consistent with the field descriptions of firm and stiff.

4.3 Superficial Deposits

Superficial deposits were encountered across the site at depths of between 1.00m and 2.50m. The materials predominantly comprised clay, but occasional layers of coarse soils were also encountered.

The top of the superficial deposits may have been re-worked resulting in a transition between made ground and natural strata.

The majority of the materials were described as brown slightly sandy, slightly gravelly clay. Locally the material tended to clayey silt. Occasional cobbles and boulders were noted within the clay and laminated horizons were also noted.

Field descriptions of clay strengths were noted as firm, stiff and very stiff, predominantly very stiff with depth.

Moisture content and Atterberg limit tests on clay are summarised in Table 4.3.1.

Table 4.3.1 – Summary of Atterberg Limit Tests

	Number of values	Minimum	Maximum	Mean
Moisture content %	15	8	18	15
Plastic limit %	7	17	20	18
Liquid limit %	7	34	40	37
Plastic Index	7	17	21	19

Moisture contents were between 1 and 3 percentage points below plastic limit values.

Based on these tests, the material may be classified as clay of low plasticity (one sample) and intermediate plasticity (six samples).

One further limits test recorded non-plastic material at 12.50m in borehole CP 02.

The results of these tests indicate that the clay is low and medium volume change potential as defined by the National House Building Council. Changes in moisture content may result in small or moderate changes in volume. It is recommended that for design purposes, medium volume change potential should be adopted.

Triaxial testing and hand vane tests on samples of clay recorded undrained shear strength (C_U) values that may be summarised in Table 4.3.2.

Table 4.3.2 – Summary of Undrained Shear Strength Tests

	Number of values	Minimum	Maximum	Mean
Moisture content %	8	8.7	18	14
Triaxial Cu kPa	8	175	543	310
Bulk density Mg/m3	8	2.12	2.27	2.17
Dry density Mg/m3	8	1.8	2.08	1.91
Hand vane Cu kPa	2	-	-	>140

Oedometer tests were carried out on seven samples of clay. Coefficients of compressibility (mv) for the pressure stage rising from overburden ranged from 0.163 to 0.037m^2/MN. Values of mv generally decreased with depth.

The m_v values rising from overburden pressure are consistent with very low, low and medium compressibility clay. Compressibility generally decreases with depth.

A total of 84 SPT 'N' values were obtained within clay, with an overall range from 7 to >50.

The SPT 'N' values generally increase with depth, but also the values indicate a twofold sub-division of the clay. An upper layer appears to extend to depths about 12m to 13m with an increase in 'N', generally to values greater than 60 (extrapolated to 300mm penetration), below these depths.

SPT 'N' values may be used in conjunction with plasticity data to provide an approximation of C_U values in over consolidated clay.

Based on the average plastic limit, an f1 value about 6.5 is indicated.

Comparison of the strength values from triaxial testing suggests that an f1 value of 7 may be more appropriate for this site. Figure A1.5 presents SPT 'N' values (uncorrected) together with C_U (triaxial)/7 for comparison.

Borehole CP01 encountered gravel from 12.00m to 13.00m and sand from 14.00m to 14.30m. Borehole CP03 encountered sand from 14.00 to 15.50m and borehole CP02 encountered very sandy clay with sand pockets from 14.00m to 15.50m.

Rotary borehole RT 01 recorded sand and gravel from 11.10 to 12.40m and from 13.50 to 19.50m. Rotary borehole RT 02 recorded sand and gravel between 12.00m and 15.00m and sand from 15.00m to 15.80m. These strata were tentatively identified from flush returns during open hole drilling.

The base of these layers of coarse soils is generally consistent with the increase in 'N' values between the upper and lower clay.

One SPT 'N' value of 50 blows for 150mm penetration was recorded in sand. This value indicates very dense material.

The superficial deposits are consistent with glacial till as noted on the geological records and historical boreholes.

The base of the superficial deposits was encountered in boreholes CP 01, CP 02, CP 03, RT 01 and RT 02 at depths in the range 23.00m to 26.80m.

4.4 Sandstone

Sandstone bedrock was encountered beneath superficial deposits in Boreholes CP 01, CP 02, CP 03, RT 01 and RT 02 at depths in the range 23.00 to 26.80m. The base of the sandstone was not proven.

Boreholes CP 01 and CP 03 were terminated at depths of 24.00m and 27.00m respectively in sandstone. Boreholes CP 02, RT 01 and RT 02 were terminated at depths of 35.50m, 40.50m and 37.00m respectively in sandstone.

UCS, point load tests (PLT) and SPT were carried out on the sandstone strata.

The laboratory and in situ tests carried out on sandstone may be summarised in Table 4.4.1.

Table 4.4.1 – Summary of Test Results on Sandstone Strata

	Number of values	Minimum	Maximum	Mean
UCS MPa	3	6.1	9.9	8.3
SPT 'N'*	21	143	1667	687
PLT Is(50) MPa (Axial)	12	0.09	0.33	0.18
PLT Is (50) MPa (Diametral))	12	0.04	0.15	0.09

***SPT 'N' extrapolated to 300mm penetration**

UCS tests on sandstone core recorded values of 6.1, 9.0 and 9.9MN/m^2. These values indicate weak material.

The PLT values indicate axial strengths about twice the diametral strength.

The PLT $I_s(50)$ values may be used to derive UCS values. Correlations of the form $I_s(50)$ multiplied by 20 = UCS are often applied. On this basis the axial $I_s(50)$ values may be used to derive UCS values in the range 1.8 to 6.6MPa, with an average about 3.6MPa. These values indicate very weak and weak material.

A site-specific correlation between UCS and PLT data is not considered appropriate. The test sample requirements for UCS favour more competent material, whereas PLT may be carried out on smaller samples from weaker materials.

A total of 21 SPT 'N' values in sandstone recorded either >50 or >100 blows.

Full penetration was not achieved on these tests. Extrapolation of values to 300mm penetration indicates values equivalent to the range 143 to 1667 blows for 300mm.

The unconfined compressive strength of the bedrock may be approximated from SPT 'N' values based on the following relationship:

- $\sigma_c > 10N$ (kN/m^2).
- where σ_c = unconfined compressive strength (UCS); and
- N = SPT 'N' value.

This approach is presented in CIRIA Report 143 and is considered to represent a lower bound value of UCS.

On this basis, lower bound strengths in the order of 1.4 to 16.7MN/m^2 are indicated for the sandstone. These values indicate very weak and weak material.

Overall the strength data, either obtained from direct measurement or derived from indirect tests, is all consistent with very weak and weak rock.

4.5 Groundwater

Borehole CP 03 encountered groundwater at a depth of 26.80m at the boundary between clay and the underlying sandstone bedrock. Water level rose from 26.80m to 26.00m during a 20 minute monitoring period.

Groundwater was not encountered in any of the other exploratory holes during the fieldwork period.

Groundwater levels monitored after the fieldwork period may be summarised in Table 4.5.1.

Table 4.5.1 – Summary of Groundwater Levels in Borehole Standpipes

	09/11/2016	23/11/2016	30/11/2016
WS03	1.17	1.05	1.33
WS04	Dry	Dry	Dry
WS13	-	1.02	1.44
CP02	-	1.23	1.14
RT02	-	20.40	20.45

Wells in boreholes WS 03, WS 04 and CP 02 were installed to shallow depths through made ground. The instrument in borehole WS 13 was installed to a depth of 5m in clay and in RT 02 was installed within bedrock.

5.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

5.1 Proposed Development

It is understood that the proposed development consists of a new six-storey hotel.

The new hotel will occupy most of the site with paved curtilage to the west and north west. The proposed site layout is indicated on development plan contained in in Appendix A.

The design is proceeding based on piled foundations to support structural loads. Piles are required to achieve a safe working load (SWL) of 750kN and 1500kN.

The comments and discussion below do not fall within the requirements of EC7 (ref. 9.5) and are offered for guidance. The comments and recommendations below should be reviewed as development details become available.

5.2 Foundations

The investigation has proved made ground to depths up to about 2.50m.

Spread foundations are not considered suitable for the support of structural loads due to the required depth of excavation, proximity of the canal and potential for groundwater.

It is recommended that a piled foundation solution is utilised to transfer structural loads to competent strata. Depending on the magnitude of structural loads, piles may either be supported within the superficial deposits or extend to sandstone bedrock. Guidelines for the design of piles are given in Appendix D.

Assuming bored concrete piles the following lengths have been estimated for piles to achieve the required SWL at different diameters:

- 300mm diameter pile – Piles to extend to bedrock at depths about 25m for both 750kN and 1500kN SWL.
- 450mm diameter piles – 750kN SWL piles to extend to approximately 17m. 1500kN SWL piles to extend to bedrock at depths about 25m.
- 600mm diameter piles – 750kN SWL piles to extend to approximately12m. 1500kN SWL piles to extend to approximately 22.50m.

These preliminary estimates of pile length should be reviewed depending on pile diameter, type and installation method adopted.

The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art are often employed before they reach the public domain, perhaps several years down the line. It is recommended that specialist Piling Contractors should be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.

If piles extend to bedrock then design should consider any potential for creating migration pathways to the underlying sandstone Principal Aquifer.

Subject to the design imposed load, then ground floor slabs may be supported on pile caps by a network of beams to minimise any differential settlement between the floor and the piled structure. Alternatively a ground bearing floor slab may be constructed following re-engineering/compaction of suitable made ground materials.

5.3 Excavation

Based on observations on site, together with the results of in situ and laboratory tests, it is considered that excavations to less than 1.00m may not stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations.

Groundwater should be expected in shallow excavations for foundations or services. This may be due to perched groundwater in the made ground overlying clay.

Hydraulic continuity between the made ground of coarse soils and the adjacent canal should be considered. De-watering of excavations and/or groundwater cut off measures may be required. However, if such works are required, these should be designed to minimise effects on the surrounding waterways.

Reference should be made to CIRIA Report C515, ref 9.32, for recommendations concerning groundwater.

5.4 Road and Hard Standing

The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, CBR scale.

Laboratory testing recorded CBR values of 52% and 64% on made ground of gravel from borehole CP 01 at 1.20m.

Laboratory testing recorded CBR values of 0.7, 0.8 and 1.0% on made ground of clay from boreholes CP 02 and CP 03 at 1.20m.

The design CBR values will depend on the proposed formation depth and the type of made ground. For design purposes it would be prudent to assume made ground of clay with a CBR of <2%.

Formations should be proof rolled and inspected and any areas of soft or deleterious material should be excavated and replaced with a properly compacted granular fill.

5.5 Chemical Attack on Buried Concrete

The site has been classified in accordance with BRE Special Digest 1, and the laboratory testing undertaken.

It is recommended that the groundwater should be regarded as mobile.

The results of chemical testing indicate sulphate concentration between <10 and 150mg/l as 2:1 water/soil extract, with pH values between 7.8 and 9.3.

Soluble chloride in the range 1.5 to 21mg/l and Ammoniacal Nitrogen in the range 7.3 to 13mg/l were also recorded.

Based on the laboratory test results it is considered that a Design Sulphate Class may be taken as DS-1. An ACEC class for the site of AC-1 would be appropriate.

6.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

6.1 Contaminated Land

The definition of 'contaminated land', along with the relevant details on legislation and guidance is set out in Appendix F.

6.2 Site History

The site history has been determined from the desk study and is briefly summarised below.

By 1848 the canals and canal basin were in place with surrounding housing, stores, wharves, stables and warehouses. The commercial activities on and around the site evolved through the second half of the 19th century with extension of the canal network, saw mill and travelling crane.

The layout of on-site buildings evolved through the 20th century. Areas around the site were progressively cleared and redeveloped from the 1970's onwards. The site had been cleared of buildings sometime between 2002 and 2010.

6.3 Risk Assessment – Human Health

The proposed development consists of a hotel. In the absence of guidance values for this land use, the guidelines for a commercial/industrial end use have been adopted for assessment. Should the proposed development be changed in the future then further risk assessment may be required.

The results of the soil chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document 'Guidance on Comparing Soil Contamination Data with a Critical Concentration'. The results have been compared in the first instance to screening levels produced in accordance with current and best practice legislation and guidance, as detailed in Appendix F.

Where the concentrations determined on site are at or below the respective screening level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.

Those contaminants with observed concentrations above the screening levels are detailed below:

Location	Depth (m)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
WS09	0.80	Benzo(b)fluoranthene	85	44
WS09	0.80	Benzo(a)pyrene	79	35
WS09	0.80	Dibenzo(ah)anthracene	9.8	3.5

The elevated concentrations of some PAH compounds were encountered in made ground noted to contain tarmac, ash and clinker fragments.

The proposed development will result in the site being covered with buildings and hardstanding. Based on the nature of the development, the ground conditions encountered, the conservative nature of the modelling and therefore the screening levels, these concentrations of PAH are not considered to warrant any further consideration and are not deemed to represent any significant risk to human health.

Asbestos was identified as chrysotile in one sample of made ground from WS05 at 0.50m with a moisture content of 9.7%. No visual evidence of bulk asbestos contamination was noted during site works. A quantification analysis of this sample recorded 0.002% chrysotile fibres.

The soil moisture contents within the made ground ranged from 6.7% to 15%, levels at which if they were maintained would greatly inhibit the release of fibres to the atmosphere. Considering the isolated occurrence of asbestos, extremely low fibre concentrations and moisture contents in relation to the proposed development, there is not considered to be a significant risk to end-users or construction workers, although this is subject to certain conditions as set out in Chapter 7.

6.4 Risk Assessment - Controlled Waters

The site is located on a Principal Aquifer, but is not within a groundwater source protection zone and there are no groundwater abstractions within 500m of the site.

The nearest surface watercourse comprises the canal forming the north west boundary of the site.

An initial assessment of the risk to controlled waters has been carried out on the basis of results of groundwater analysis on 4 samples from monitoring wells.

The groundwater results have been screened against the screening levels tabulated and detailed within Appendix F. As there is no TPH guideline parameter, the level of 10µ g/l within the Water Supply Regulations 1989, has been adopted as a conservative approach.

Metals and some PAH compounds are noted to be elevated within groundwater with respect to some EQS guidelines and Drinking Water Standards with higher values recorded in the made ground than in the sandstone.

There is no evidence within the laboratory testing undertaken on soils, of a significant potential on site source for the elevated groundwater concentrations. Further the sandstone is separated from the near surface made ground by a substantial thickness of low permeability clay.

It is considered that the results of groundwater analysis are likely to be representative of the underlying regional groundwater and not specific to the proposed development site.

The urban location of the site, together with the historical industrial site use and the presence of made ground is consistent with slightly elevated concentrations of some contaminants in groundwater at shallow depths. These values are likely to be representative of a regional groundwater regime and may not be confined to the site.

Significant concentrations of contaminants were not encountered in groundwater from sandstone.

TPH compounds were not recorded at concentrations above test detection limits. It is recommended that the Environment Agency may be consulted in light of the fact that there is no current guideline TPH parameter within the Water Supply Regulations 2000.

Given the ground conditions encountered at the site, the nature of the proposed development, the conservative nature of the Drinking Water Standards and the results of this contamination assessment, it is considered unlikely that further assessment of the risks to controlled waters may be required.

6.5 Gas Generation

Six gas monitoring visits have been undertaken to date, where possible during periods of low or falling atmospheric pressure. The results of the gas monitoring are included within Appendix B.

A peak methane concentration, CH4, of 5.2%v/v has been recorded with a maximum carbon dioxide concentration, CO_2 of 8.9%v/v. Depleted oxygen concentrations have been consistently recorded in WS03 with values as low as 6.3%v/v.

Flow rates have been zero or slightly negative.

In accordance with the methodology published in CIRIA Document C665, ref. 9.49, the maximum recorded values should be taken to calculate a Gas Screening Value (GSV) for the site. As flow rates were zero a nominal value of 0.11/hr has been adopted to enable calculation of gas screening values.

On this basis approximately GSV values if 0.0009 l/hr for CO_2 and 0.0005 l/hr for CH_4 may be calculated.

The calculated GSV are consistent with a Very Low Risk gas regime (Characteristic Situation 1).

The maximum concentrations of CH_4 and CO_2 both exceed the typical maximum concentrations of 5% and 1% for a Very Low Risk gas regime. The maximum concentrations indicate that a minimum risk Classification of Low Risk (Characteristic Situation 2) should be assigned to the site.

On this basis gas protection measures consist with Characteristic Situation 2 would be required for the development.

The site is not in a radon affected area. Radon protection measures are therefore not required.

6.6 Risk Evaluation

The conceptual model formed within the Phase 1 Desk Study has been updated to reflect the findings of the contamination risk assessment and the revised conceptual model, detailing the relevant pollutant linkages, is tabulated below:

Source	Potential Contaminants of Concern	Potential Pathways	Receptor Group	Risk
Made ground	PAH in soil	Ingestion of contaminated soil	Humans • Site users	Negligible
		Entry of contaminants by skin or eye contact	• Construction workers	Negligible[1,2]
		Inhalation of contaminated dust	• Neighbouring site users	Negligible[2]
	Metals and PAH in groundwater	Migration Surface run-off	Controlled waters • Surface water • Groundwater	Very Low
Asbestos in soil	Asbestos	Inhalation of fibres	Humans • Site users[1] • Construction workers[2] • Maintenance workers[1] • Neighbouring site users[2]	Very Low
Ground Gases	Methane Carbon dioxide	Migration Ingression	Humans and buildings • Gas ingress into buildings • Site occupants	Low

1 – Assumes that PPE is worn at all times
2 – Pathway exists only during the construction period

6.7 Summary of Risk Evaluation

The above assessment identifies that the 'source – pathway – receptor' linkage potentially occurs with ground gas impacting upon the identified receptors. Therefore, it would be necessary to manage the risk at this location by either eliminating one of the links or by minimising the potential effects.

Gas protection measures consistent with a Low Risk Gas regime should be installed to eliminate any potential pathway between the ground gas source and the site occupants receptor group.

7.0 MANAGEMENT OF CONTAMINATION

7.1 Remediation and Verification

The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, is applicable to the redevelopment of sites that may be affected by contamination.

The risk management process set out in the Model Procedures has three main components:

- Risk assessment.
- Options appraisal.
- Implementation.

Chrysotile asbestos has been identified within made ground at one location, at an extremely low concentration. The proposed development and ground conditions already negate much of the risk to receptors.

In areas that are to be covered by buildings or hard standing, no pathway is likely to exist between the source and end-users of the site and no further remediation is deemed necessary, although there may be residual risk within areas of landscaping around the boundaries of the site.

It is assumed that topsoil will be required to be imported to these areas of landscaping simply as a growing medium, based on the shallow made ground known to be present. As such, it is recommended that a minimum thickness of 300mm of clean imported material is emplaced within the areas of landscaping.

Since there is no specific requirement for remediation from chemical contamination, it is considered that validation testing of imported soil would not be necessary for this development. However, as a minimum, imported soil should be certified at source to confirm that it is fit for purpose, with the documentation supplied in advance for approval.

It is suggested that a minimum of three samples are independently tested once stockpiled on site to confirm that the material supplied is representative of the certification supplied and that once emplaced, the thickness of the deposited material is validated in approximately six locations across the site.

The gas risk assessment has identified the presence of elevated methane and carbon dioxide. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.

The results of initial gas monitoring determined the presence of methane at a concentration of up to 5.2%v/v and carbon dioxide of up to 8.9%v/v with negligible flow rates.

This indicates a characteristic situation 2, Low Risk Gas regime. For Situation A, being any development other than low rise residential with suspended floor slab and ventilated void, gas protective measures are given in Appendix G.

7.2 Management of Unidentified Sources of Contamination

There is the possibility that other sources of contamination may be present on the site, which were not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.
- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.
- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

7.3 Consultation

During the development of a contaminated site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.
- **Environment Agency.** Where a site is within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.

Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

8.0 RISK MANAGEMENT DURING SITE WORKS

During ground works, some simple measures may have to be put in place to mitigate the risk of contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.
- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.
- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.
- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.
- Site drainage should be prevented from entering any adjacent watercourse.

Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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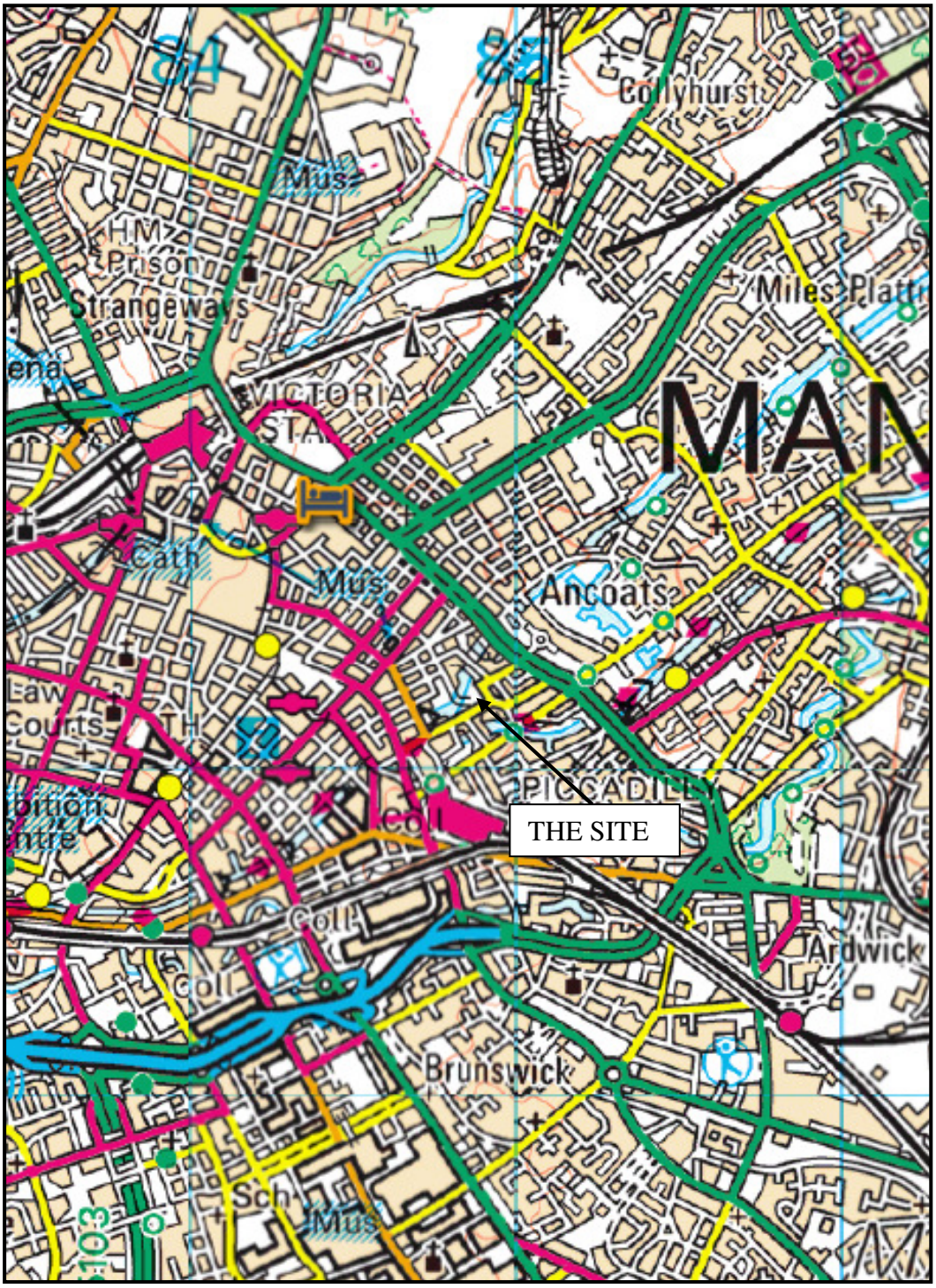
For and on behalf of JPG (Leeds) Limited

February 2017

Appendix A Figures



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PROJECT: 41973 Piccadilly Basin	
FIGURE No. A1.1	**SCALE: Not to Scale**
TITLE: Site Location Plan	
IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	

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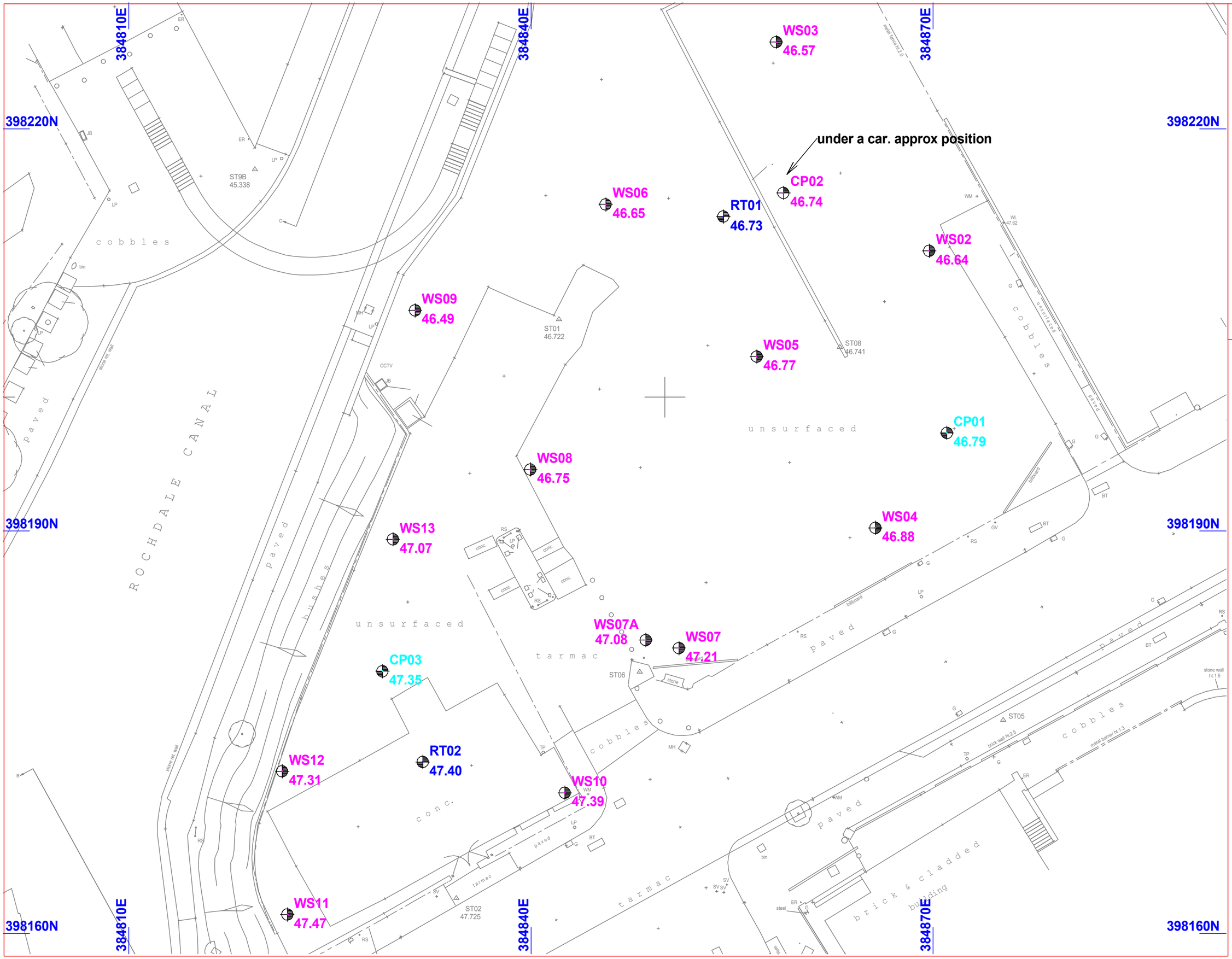

Key: heights refer to code with same colour

WS(Window sample)

Rbh (Rotary Borehole)

CBH
CP
(Cable Percussive)

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construction line

Client: Ian Farmer Associates
PROJECT: 41973

FIGURE No.A1.2
TITLE: Exploratory Hole Location Plan

THE SURVEY ASSOCIATION

Additional Comments:
To extn15osgm15 see spec
all work to see spec, some by gps
contact us for details

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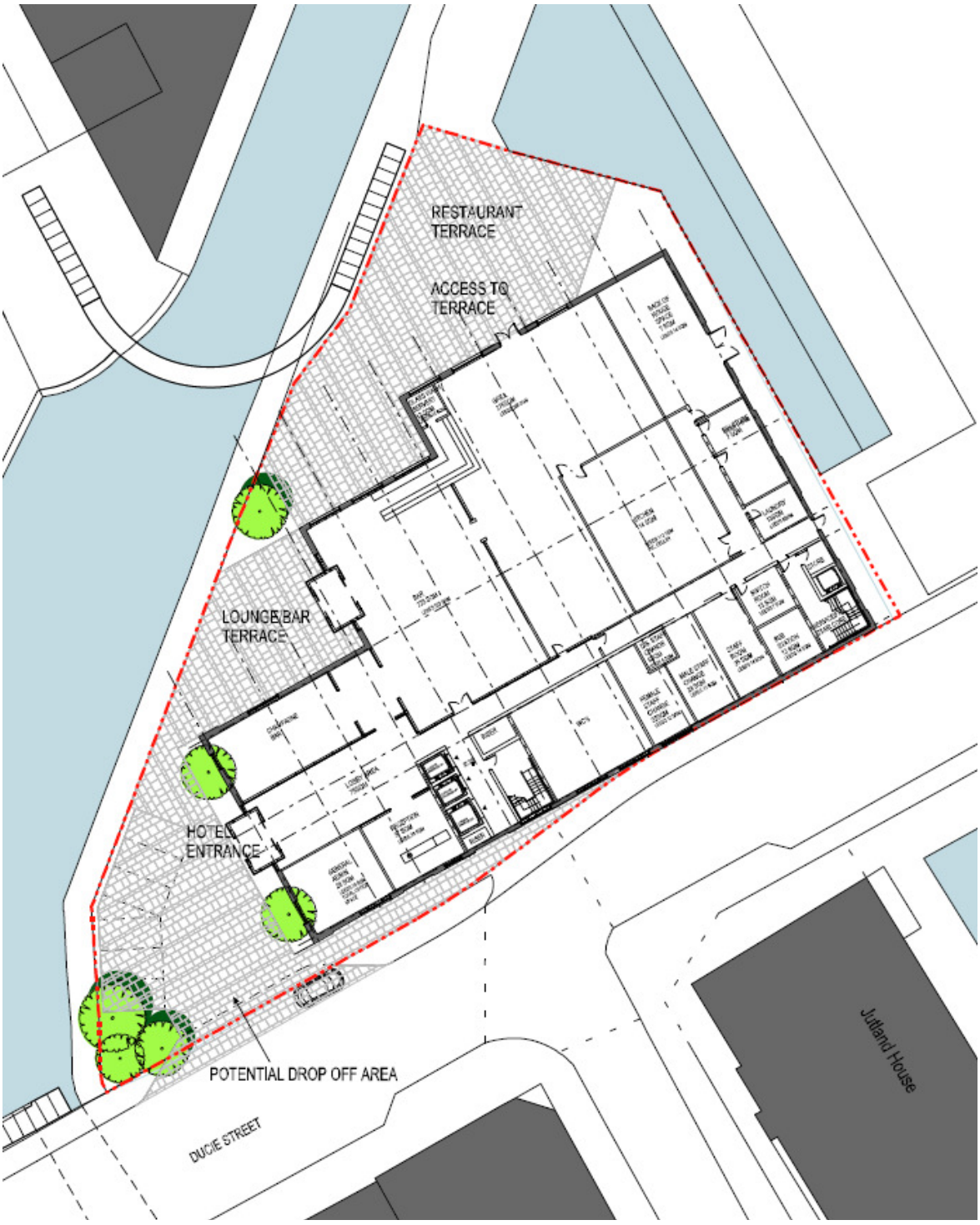
Revision: A
Drawn By: AH
Checked By: HW
Date: 25/11/2016
Scale 1:250, A3



PROJECT: 41973 Piccadilly Basin	
FIGURE No. A1.3	**SCALE: Not to Scale**
TITLE: Proposed Development Layout	
IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	

Figure A1.4 Piccadilly Basin
SPT 'N' vs Depth: All data

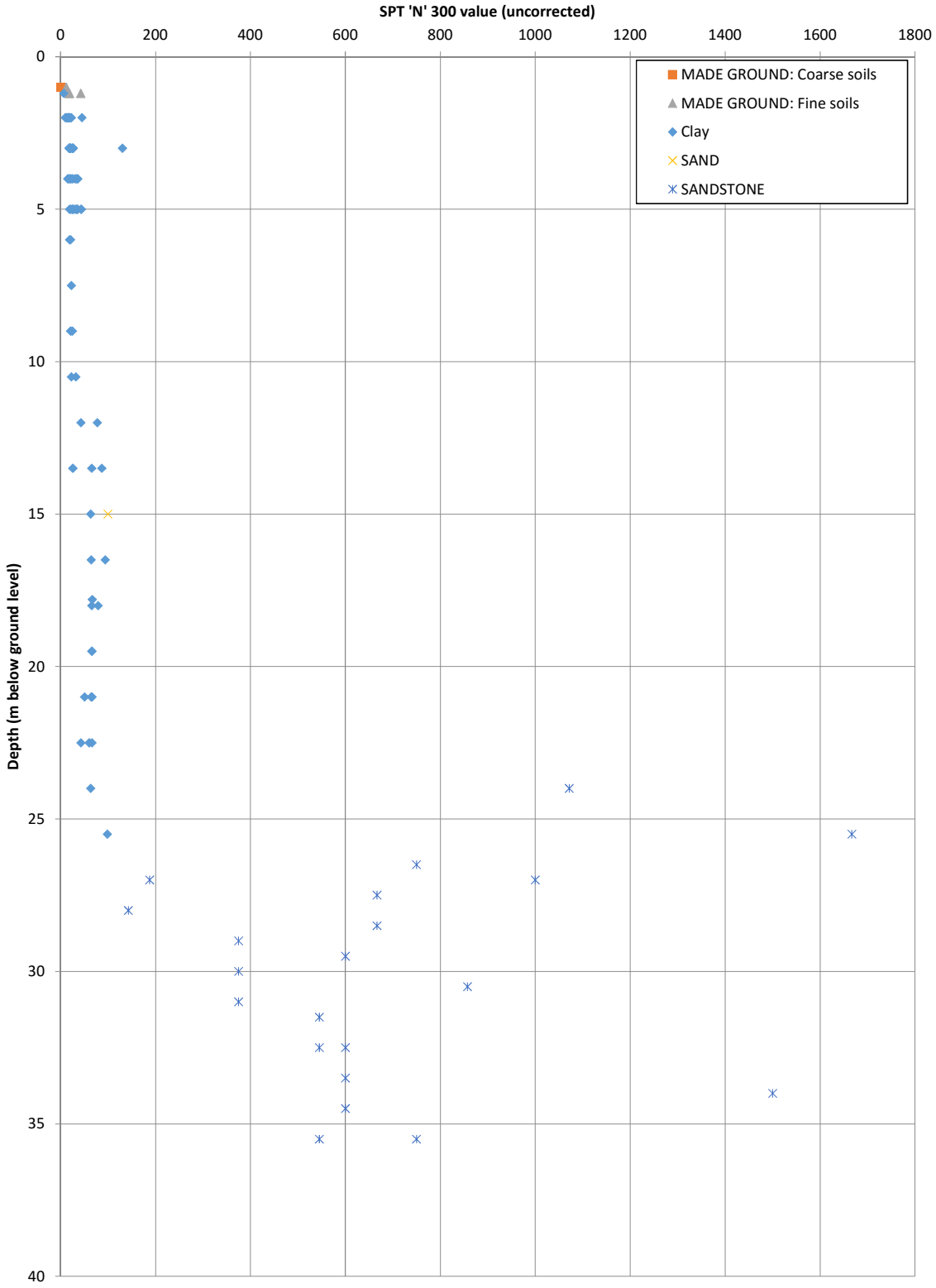
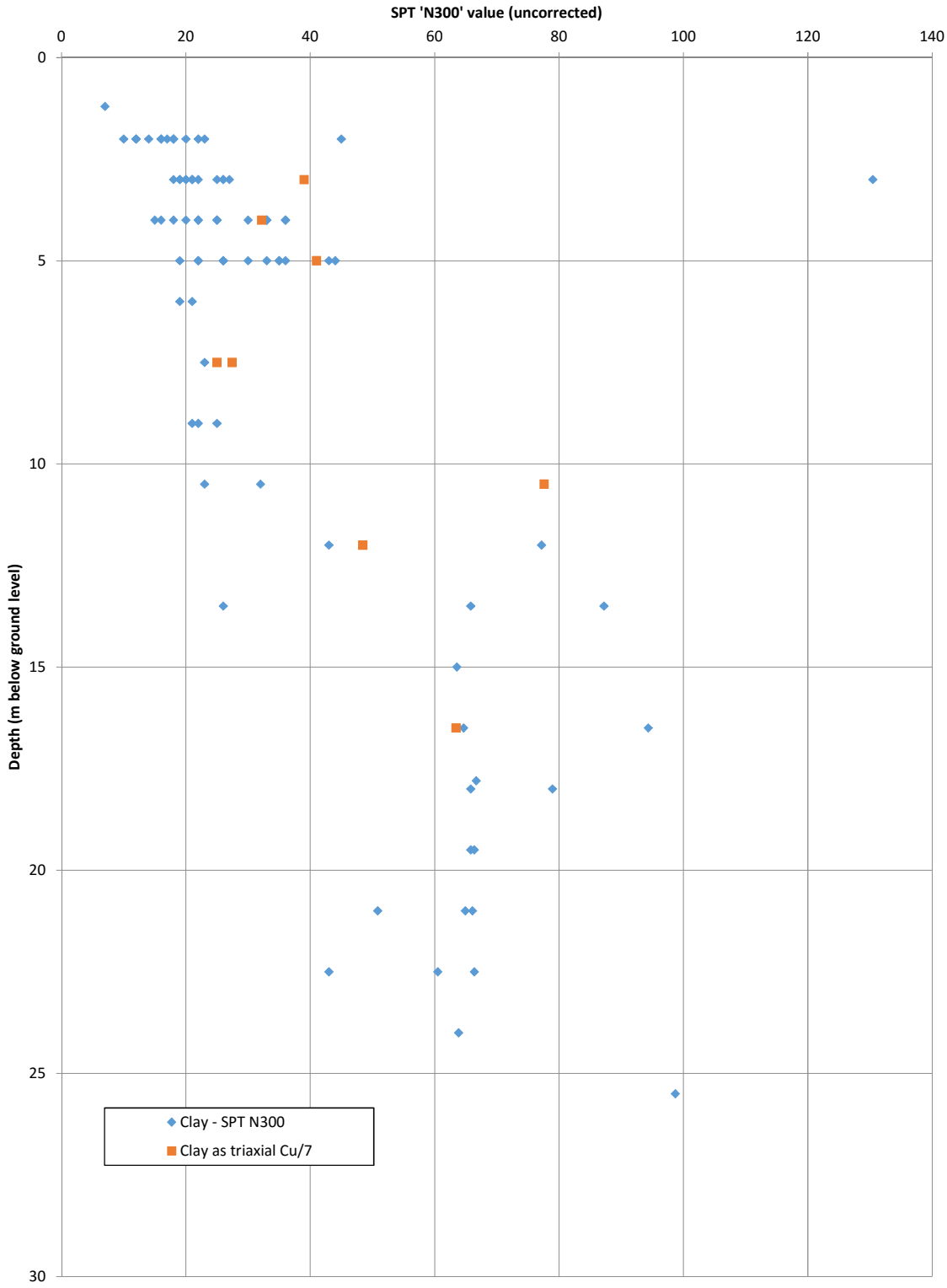


Figure A1.5 Piccadilly Basin
SPT & Triaxial vs Depth: Glacial Till



Appendix B Site Work

GENERAL NOTES ON SITE WORKS

General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 9.5 and BS

Light Cable Percussion Boring
For routine soil exploration to depths in excess of 3m, the light cable percussion rig is generally employed for boring through soils and weak rocks, refs 9.4, 9.5 and 9.6. It consists of a powered winch and tripod frame, with running wheels that are permanently attached so that the rig may be towed behind a suitable vehicle. The rig is towed into position and set up using its own winching system.

The locations of services are checked to make sure the borehole is not situated unacceptably near any services. Regardless of the proximity of services, a CAT scan is undertaken at the borehole location and a trial hole dug to 1.20m by hand.

Boreholes are advanced in soil by the percussive action of the cable tool. The force of the cylindrical tool as it is dropped a short distance cuts a plug of cohesive soil that is removed by the tool.

In non-cohesive soils, the borehole is advanced by a 'shell', otherwise known as a 'bailer' or 'sand pump', which incorporates a clack valve. Material is transferred into the shell and retained by the clack valve. The water level in a borehole is maintained above that in the surrounding granular soil to allow for temporary reductions in the head of water as the shell is withdrawn from the borehole. Water should flow from the borehole into the surrounding soil at all times to prevent 'piping' and loosening the soil at the base of the hole. The casing is always advanced with the borehole in granular soil so that material is drawn from the base rather than the borehole sides.

Obstructions to boring are overcome by fitting a serrated chiselling ring to the base of the percussion tool. For large obstructions, a heavy chisel with a hardened cutting edge may have to be used.

Disturbed samples are taken in polythene bags, jars or tubs that are sealed against air or water loss.

Undisturbed samples are generally taken in cohesive materials at changes in strata and at one metre intervals to 5m then at 1.5m intervals to the full depths of the borehole. The general purpose open-tube sampler is suitable for firm to stiff clays, but is often used to retrieve disturbed samples of weak rocks, soft or hard clay and also clayey sand or silts. This has been adopted for routine use, and usually consists of a 100mm internal diameter tube (U100), which is capable of taking soil samples up to 450mm in length. The undisturbed samples are sealed at each end using micro-crystalline wax to prevent drying.

Standard penetration tests are generally carried out in non-cohesive soils but also in stiff clays and soft rocks at frequencies similar to that of undisturbed sampling.

Drive-in Window Sampler
The drive-in window sampler, ref 9.8, consists generally of a track mounted window sampler and a series of cylindrical sample tubes, generally varying in diameter from 98mm to 35mm. A cutting shoe is fitted to the bottom of each tube, while a window, representing about a quarter of the circumference, is cut along the length of the tube. Soil samples are extracted through the window of the tube.

The borehole is extended by using progressively smaller diameter tubes.

Alternatively, undisturbed samples may be collected in plastic liners, known as *windowless sampling*.

IN SITU TESTS

Standard Penetration Test
The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref 9.5, BS 1377, Part 9, 1990 ref 9.11 and ISO 22476 ref 9.6.

The standard penetration test, SPT, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60 degree apex solid cone replacing the split spoon sampler, CPT.

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of 300mm is achieved. The penetration for 50 blows is recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.
- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.
- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

SAMPLES

U Represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded. U fail indicates undisturbed sample not recovered.

HV Represents Hand Vane test with equivalent undrained shear strength in kN/m^2.

PP Represents Pocket Penetrometer test with equivalent undrained shear strength in kN/m^2.

CBR represents California Bearing Ratio test.

B Represents large bulk disturbed samples.

D Represents small disturbed sample.

A Represents amber jar contamination sample.

V Represents vial contamination sample.

W Represents Water Sample.

$\underline{\nabla}$ Represents water strike.

$\underline{\blacktriangledown}$ Represents level to which water rose.

DESCRIPTION OF SOILS AND ROCKS A2.4.1

General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref 9.9, and ISO 14689, ref 9.10, supplemented by section 6 of BS 5930, ref. 9.4 have been used in the descriptions of soils and rocks contained within this report.

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.		Borehole ID: CP01
	Contract Number: 41973	Date Started: 24/10/2016	Logged By:	Checked By:	Status: DRAFT
Cable Percussion Borehole Log	Easting: 384871.0	Northing: 398197.3	Ground Level: 46.79mOD	Plant Used:	Print Date: 25/01/2017
					Sheet 1 of 3
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.00 - 1.20	B1					MADE GROUND: Dark brown, mottled orange, very gravelly, fine to coarse SAND with high cobble content. Gravel and cobbles are angular to subrounded including brick and concrete.		
0.20	ES2							
0.50	ES3							
1.00	ES4			(2.10)				
1.20		SPT(S) N=6 (2,2/1,2,2,1)						
1.20 - 1.65	B5							
1.20 - 1.65	D6							
2.00		SPT(S) N=14 (3,3/3,4,3,4)						
2.00	ES7		44.69	2.10		Stiff, dark brown, mottled bluish grey, slightly sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse including various lithologies, sandstone, brick and quartzite.. Possibly re-worked at top of stratum.		
2.00 - 2.45	B8							
2.00 - 2.45	D9							
				(1.40)				
3.00	ES11							
3.00 - 3.45	U10	39 blows. 100% recovery						
3.50	D12		43.29	3.50		Stiff, thinly laminated, fissured, brown mottled, bluish grey, slightly sandy, slightly gravelly CLAY. Fissures are generally, subvertical and closely spaced. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, siltstone, coal and mudstone.		
4.00		SPT(S) N=16 (3,3/3,4,4,5)						
4.00 - 4.45	B13							
4.00 - 4.45	D14							
5.00 - 5.45	U15	43 blows. 100% recovery						
5.50	D16					*At 5.50m: laminae of reddish brown, fine sand.*		
				(4.50)				
6.00		SPT(S) N=21 (4,4/5,5,5,6)						
6.00 - 6.45	B17							
6.00 - 6.45	D18							
7.50 - 7.95	U19	44 blows. 100% recovery						
8.00	D20		38.79	8.00		Stiff, dark brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, coal and quartzite.		
9.00		SPT(S) N=22 (4,5/5,5,6,6)		(4.00)				
9.00 - 9.45	B21							
9.00 - 9.45	D22							

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
					24.00	150	24.00	150

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Water Strikes					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: CP01
	Contract Number: 41973	Date Started: 24/10/2016	Logged By:	Checked By:	Status: DRAFT	Sheet 2 of 3
Cable Percussion Borehole Log	Easting: 384871.0	Northing: 398197.3	Ground Level: 46.79mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						Stiff, dark brown, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, coal and quartzite.		
10.50		SPT(S) N=23 (4,5/5,6,6,6)						
10.50 - 10.95	B23							
10.50 - 10.95	D24							
11.00	B25							
12.00		SPT(S) N=62 (7,10/62 for 241mm)	34.79	12.00		Very dense brown silty very sandy fine to coarse GRAVEL including quartzite.		
12.00 - 12.45	B26							
12.00 - 12.45	D27			(1.00)				
13.00	D28		33.79	13.00		Stiff, dark brown, gravelly, sandy CLAY. Gravel is subrounded, coarse including quartzite.		
13.50		SPT(S) N=26 (5,7/7,6,6,7)		(1.00)				
13.50 - 13.95	B29							
13.50 - 13.95	D30		32.79	14.00 (0.30)		Light brown, fine SAND.		
14.30	D31		32.49	14.30		Stiff, dark brown, sandy, gravelly CLAY with medium cobble content. Gravel and cobbles are subangular to subrounded of various lithologies including sandstone and quartzite.		
15.00		SPT(S) 50 (10,15/50 for 150mm)		(1.70)				
15.00 - 15.45	B32							
15.50	B33							
			30.79	16.00		Stiff, dark brown, thinly laminated, sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including mudstone and sandstone.		
16.50		SPT(S) 50 (7,8/50 for 159mm)		(1.00)				
16.50 - 16.95	B35							
16.50 - 16.95	D34		29.79	17.00		Very stiff, dark brown, sandy, gravelly CLAY with medium cobble content. Gravel and cobbles are subangular to subrounded of various lithologies including sandstone and quartzite.		
17.80		SPT(S) 50 (25 for 85mm/50 for 152mm)						
17.80	B37							
17.80	D36							
				(6.00)				
19.50		SPT(S) N=50 (5,8/50 for 226mm)						
19.50 - 19.95	B39							

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
					24.00	150	24.00	150

Chiselling			
From (m)	To (m)	Duration	Remarks
17.00	17.80	01:00	
17.80	17.90	00:30	

Installation			
Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			CP01
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 3 of 3
41973	24/10/2016			DRAFT	
Cable Percussion Borehole Log	Easting: 384871.0	Northing: 398197.3	Ground Level: 46.79mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
19.50 - 19.95	D38					Very stiff, dark brown, sandy, gravelly CLAY with medium cobble content. Gravel and cobbles are subangular to subrounded of various lithologies including sandstone and quartzite.		
21.00		SPT(S) N=50 (5,8/50 for 231mm)						
21.00 - 21.45	B41							
21.00 - 21.45	D40							
22.50		SPT(S) N=50 (4,11/50 for 226mm)						
22.50 - 22.95	B43							
22.50 - 22.95	D42		23.79	23.00		Weathered SANDSTONE recovered as reddish brown, gravelly, fine to coarse sand. Gravel is angular to subangular, fine to coarse of extremely weak sandstone.		
23.00	D44							
23.00 - 24.00	B45			(1.00)				
24.00		SPT(S) 50 (25 for 23mm/50 for 14mm)	22.79	24.00		End of Borehole at 24.00m		
24.00	D46							

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
					24.00	150	24.00	150

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)
23.70	24.00	01:00					

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES

Contract Name:	Client:	Borehole ID:
Piccadilly Basin	JPG (Leeds) Ltd.	CP02

Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 4
41973	27/10/2016			DRAFT	

Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
	384858.8	398215.2	46.74mOD		25/01/2017	1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.00 - 0.50	B1					MADE GROUND: Dark brown mottled orange, clayey, sandy gravel with high cobble content. Gravel and cobbles are angular to subrounded, fine to coarse of concrete, limestone and brick		
0.20	ES1			(0.60)				
0.50	ES2							
0.50 - 1.20	B2		46.14	0.60				
1.00	ES3					MADE GROUND: Dark grey and black mottled, very silty very clayey very sandy GRAVEL with low cobble content and pockets of ash. Gravel is angular to subrounded, fine to coarse of clinker, concrete and ceramic. Cobbles are subangular of brick.		
1.20		SPT(C) N=8 (1,1/1,2,4,1)				*From 1.20m: Becoming loose*		
1.20 - 1.65	B3			(1.40)		*From 1.50m: Becoming clayey*		
2.00		SPT(S) N=12 (2,2/3,3,3,3)	44.74	2.00		Firm and stiff, dark brown mottled blueish grey, sandy, gravelly clay. Sand is fine to coarse. Gravel is angular to subrounded of various lithorelicts including sandstone, mudstone. Possible re-worked at top of stratum.		
2.00	ES4							
2.00 - 2.45	B4							
2.00 - 2.45	D1			(1.00)				
3.00		SPT(S) N=18 (3,4/4,4,5,5)	43.74	3.00		Stiff, thinly laminated, fissured, dark brown mottled grey, slightly sandy, gravelly CLAY. Fissures are subvertical and closely spaced. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone, quartzite and coal.		
3.00	ES5							
3.00 - 3.45	B5							
3.00 - 3.45	D2							
4.00 - 4.45	U1	28 blows. 90% recovery						
4.50	D3							
5.00		SPT(S) N=19 (3,4/4,5,5,5)						
5.00 - 5.45	B6							
5.00 - 5.45	D4							
6.00		SPT(S) N=19 (4,4/5,4,5,5)						
6.00 - 6.45	B7							
6.00 - 6.45	D5			(7.50)				
7.50 - 7.95	U2	33 blows. 100% recovery						
8.00	D6							
9.00		SPT(S) N=21 (4,4/5,5,5,6)						
9.00 - 9.45	B8							
9.00 - 9.45	D7							

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter

Depth (m)	Dia (mm)
12.00	200
25.95	150

Casing Diameter

Depth (m)	Dia (mm)
12.00	200
25.50	150

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Chiselling

From (m)	To (m)	Duration	Remarks

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	6.00	PLAIN	
6.00	24.00	SLOTTED	

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES

Contract Name:	Client:	Borehole ID:
Piccadilly Basin	JPG (Leeds) Ltd.	CP02

Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 2 of 4
41973	27/10/2016			DRAFT	

Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
	384858.8	398215.2	46.74mOD		25/01/2017	1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						Stiff, thinly laminated, fissured, dark brown mottled grey, slightly sandy, gravelly CLAY. Fissures are subvertical and closely spaced. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone, quartzite and coal.		
10.50		SPT(S) N=32 (3,5/7,7,9,9)	36.24	10.50				
10.50 - 10.95	B9							
10.50 - 10.95	D8							
						Very stiff, dark brown, gravelly, sandy CLAY with some laminations and occasional pockets of sand. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, quartzite and mudstone. Sand is fine to coarse. Locally tending to gravelly sandy silt.		
12.00 - 12.45	U3	38 blows. 100% recovery						
				(3.50)				
12.50	D9							
13.50		SPT(S) N=50 (7,11/50 for 228mm)						
13.50 - 13.95	B10							
13.50 - 13.95	D10		32.74	14.00				
						Dark brown, very sandy CLAY with some pockets of sand.		
				(1.50)				
15.00		SPT(S) N=50 (6,8/50 for 236mm)						
15.00 - 15.45	B10							
15.00 - 15.45	D10		31.24	15.50				
						Very stiff, dark brown, gravelly, sandy CLAY with some laminations and occasional pockets of sand. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, quartzite and mudstone. Sand is fine to coarse		
16.50 - 16.95	U4	50 blows. 90% recovery						
17.00	D11							
				(6.50)				
18.00		SPT(S) N=50 (8,10/50 for 228mm)						
18.00 - 18.45	B11							
18.00 - 18.45	D12							
19.50 - 19.95	U5	66 blows. 95% recovery						
20.00	D13							

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter		Casing Diameter	
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
12.00	200	12.00	200
25.95	150	25.50	150

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Chiselling			
From (m)	To (m)	Duration	Remarks

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	6.00	PLAIN	
6.00	24.00	SLOTTED	

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.		Borehole ID: CP02
	Contract Number: 41973	Date Started: 27/10/2016	Logged By:	Checked By:	Status: DRAFT
Cable Percussion Borehole Log	Easting: 384858.8	Northing: 398215.2	Ground Level: 46.74mOD	Plant Used:	Print Date: 25/01/2017
					Sheet 3 of 4
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R	Scale: 1:50

Samples & In Situ Testing						Strata Details				Groundwater	
Depth	Sample ID	Test Result	TCR	SCR	RQD	Fracture	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
										Very stiff, dark brown, gravelly, sandy CLAY with some laminations and occasional pockets of sand. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, quartzite and mudstone. Sand is fine to coarse		
21.00		SPT(S) N=50 (10,11/50 for 227mm)										
21.00 - 21.45	B12											
21.00 - 21.45	D14											
							24.74	22.00				
										Very stiff, thinly laminated, dark brown, slightly sandy, slightly gravelly CLAY with lenses of sand. Sand is fine to medium. Gravel is angular to subrounded, fine to coarse of various lithologies including mudstone, sandstone and quartzite		
22.50		SPT(S) N=43 (10,9/10,9,12,12)										
22.50 - 22.95	B13											
22.50 - 22.95	D15											
								(2.80)				
24.00		SPT(S) N=50 (9,12/50 for 235mm)										
24.00 - 24.45	B14											
24.00 - 24.45	D16											
							21.94	24.80				
										Weathered SANDSTONE recovered as very dense, reddish brown, gravelly, fine to coarse sand. Gravel is angular to subrounded, fine to coarse of extremely weak sandstone and occasional quartzite.		
								(0.70)				
25.50		SPT(S) 50 (25 for 18mm/50 for 9mm)					21.24	25.50				
25.50 - 25.95	D17											
						10				Extremely weak reddish brown, medium grained SANDSTONE with rare clasts < 8mm of quartz and limestone. Discontinuities 1) 0 degrees to 5 degrees, very close to medium spaced, planar and undulating, rough clean with no infill. 2). irregular, medium to widely spaced undulating, rough.		
25.50 - 26.50	100	56	14		NI	12						
					NI	3						
26.50 - 27.50	90	73	28		12	AZCL						
					NI	8		(3.75)				
27.50 - 28.50	100	74	18		NI	18						
					NI	2						
28.50 - 29.50	90	63	42		16	AZCL	17.49	29.25				
					AZCL	NI				Extremely weak reddish brown, medium and coarse grained, indistinctly very thinly bedded SANDSTONE with rare clasts <8mm of quartz and limestone. Discontinuities 1) 0 degrees - 9 degrees, planar and stepped, rough clean with no infill, medium to closely spaced.		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
					12.00	200	12.00	200
					25.95	150	25.50	150

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Chiselling			
From (m)	To (m)	Duration	Remarks
25.30	25.50	01:00	

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	6.00	PLAIN	
6.00	24.00	SLOTTED	

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: CP02
	Contract Number: 41973	Date Started: 27/10/2016	Loggged By:	Checked By:	Status: DRAFT	Sheet 4 of 4
Rotary Core Drilling Log	Easting: 384858.8	Northing: 398215.2	Ground Level: 46.74mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
29.50 - 30.50	90	75	40					Between 29.25m and 29.40m: occasional flat clasts of reddish brown mudstone <4 x 30 x 30mm.		
30.50 - 31.50	100	74	62	NI 50 5 2						
31.50 - 32.50	90	60	41	NI 4 NI 17 AZCL AZCL NI 9				Below 31.70m, extremely to very weak. At 32.18m: 5mm band of reddish brown mudstone.		
32.50 - 33.50	95	85	77	NI 5		(6.25)				
33.50 - 34.50	100	83	40	8						
34.50 - 35.50	100	82	67	NI 4 9	11.24	35.50		End of Borehole at 35.50m		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter	
Depth (m)	Dia (mm)
12.00	200
25.95	150

Casing Diameter	
Depth (m)	Dia (mm)
12.00	200
25.50	150

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	6.00	PLAIN	
6.00	24.00	SLOTTED	

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: CP03
	Contract Number: 41973	Date Started: 31/10/2016	Logged By:	Checked By:	Status: DRAFT	Sheet 1 of 3
Cable Percussion Borehole Log	Easting: 384828.9	Northing: 398179.6	Ground Level: 47.35mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
			47.25	0.10		MADE GROUND: Tarmac		
0.20	ES1					MADE GROUND: Light grey, sandy, angular to subrounded, fine to coarse gravel of limestone, concrete ash and clinker.		
0.20 - 1.00	B1							
0.50	ES2			(0.90)				
1.00	ES3		46.35	1.00		Firm, dark grey, gravelly, sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse of limestone and concrete.		
1.20		SPT(S) N=7 (1,1/1,2,2,2)						
1.20 - 1.65	B2							
1.20 - 1.65	D1							
2.00	ES4			(2.00)				
2.00 - 2.45	U1	18 blows. 50% recovery						
2.50	D2							
3.00		SPT(S) N=21 (3,4/5,5,5,6)	44.35	3.00		Firm to stiff, fissured, brown mottled blueish grey, slightly sandy, slightly gravelly CLAY, with occasional fibrous peat. Fissures are very closely spaced. Gravel is angular to subrounded, fine to coarse of quartzite and sandstone		
3.00 - 3.45	B3							
3.00 - 3.45	D3			(1.00)				
4.00		SPT(S) N=22 (4,4/5,5,6,6)	43.35	4.00		Stiff, dark brown, slightly gravelly, sandy CLAY with very closely spaced thin laminae of silt. Gravel is subrounded, fine to coarse of quartzite and sandstone. Sand is fine.		
4.00 - 4.45	B4							
4.00 - 4.45	D4							
5.00		SPT(S) N=22 (4,5/5,6,6,5)						
5.00 - 5.45	B5							
5.00 - 5.45	D5			(3.50)				
6.00 - 6.45	U2	43 blows. 95% recovery						
7.50		SPT(S) N=23 (4,6/6,5,6,6)	39.85	7.50		Stiff, thinly laminated, dark brown mottled blueish grey, slightly sandy, slightly gravelly CLAY, with occasional lenses of sand. Sand is fine. Gravel is subrounded, fine of various lithologies including quartzite and sandstone		
7.50 - 7.95	B6							
7.50 - 7.95	D6							
9.00		SPT(S) N=25 (5,6/6,7,6,6)		(3.50)				
9.00 - 9.45	B7							
9.00 - 9.45	D7							

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
					12.00	200	12.00	200
					27.45	150	27.00	150

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.80	26.80		20	26.00	

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: CP03
	Contract Number: 41973	Date Started: 31/10/2016	Logged By:	Checked By:	Status: DRAFT	Sheet 2 of 3
Cable Percussion Borehole Log	Easting: 384828.9	Northing: 398179.6	Ground Level: 47.35mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						Stiff, thinly laminated, dark brown mottled blueish grey, slightly sandy, slightly gravelly CLAY, with occasional lenses of sand. Sand is fine. Gravel is subrounded, fine of various lithologies including quartzite and sandstone		
10.50 - 10.95	U3	52 blows. 80% recovery						
11.00	D8		36.35	11.00		Stiff, dark brown, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse of sandstone, siltstone and quartzite. Locally tending to clayey silt.		
				(1.00)				
12.00		SPT(S) N=43 (6,7/9,10,10,14)	35.35	12.00		Stiff brown slightly gravelly sandy CLAY. Gravel is sub angular fine to coarse including quartzite and sandstone.		
12.00 - 12.45	B8							
12.00 - 12.45	D9							
				(2.00)				
13.50		SPT(S) 50 (7,7/50 for 172mm)						
13.50 - 13.95	B9							
13.50 - 13.95	D10		33.35	14.00		Dark brown, silty, fine SAND		
				(1.50)				
15.00 - 15.45	U4	66 blows. 40% recovery						
15.50	D11		31.85	15.50		Stiff, dark brown, gravelly, sandy CLAY with low cobble content and occasional laminae of clay. Gravel is subrounded, fine to medium of quartzite, siltstone and sandstone. Cobbles are subrounded of sandstone.		
16.50		SPT(S) N=50 (5,9/50 for 232mm)						
16.50 - 16.95	B10							
				(7.00)				
18.00		SPT(S) 50 (4,8/50 for 154mm)						
18.00 - 18.45	B11							
18.00 - 18.45	D12							
19.00 - 19.45	B12							
19.50		SPT(S) N=50 (5,10/50 for 228mm)						
19.50 - 19.95	D13							

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter	
Depth (m)	Dia (mm)
12.00	200
27.45	150

Casing Diameter	
Depth (m)	Dia (mm)
12.00	200
27.00	150

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Chiselling			
From (m)	To (m)	Duration	Remarks

Installation			
Top (m)	Base (m)	Type	Dia (mm)

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.80	26.80		20	26.00	

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: CP03
	Contract Number: 41973	Date Started: 31/10/2016	Logged By:	Checked By:	Status: DRAFT	Sheet 3 of 3
Cable Percussion Borehole Log	Easting: 384828.9	Northing: 398179.6	Ground Level: 47.35mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						Stiff, dark brown, gravelly, sandy CLAY with low cobble content and occasional laminae of clay. Gravel is subrounded, fine to medium of quartzite, siltstone and sandstone. Cobbles are subrounded of sandstone.		
21.00 - 21.45	B13							
21.00 - 21.45	D14							
22.50		SPT(S) N=50 (5,9/50 for 248mm)	24.85	22.50		Very stiff, dark brown, slightly sandy, slightly gravelly CLAY with occasional lenses of fine sand, Gravel is angular to subrounded, fine to medium of various lithologies including sandstone, mudstone and quartzite		
22.50 - 22.95	B14							
22.50 - 22.95	D15							
24.00 - 24.95	U43	65 blows. 100% recovery						
24.50	D16			(4.30)				
25.50		SPT(S) 50 (8,12/50 for 152mm)						
25.50 - 25.95	B15							
25.50 - 25.95	D17							
26.80 - 27.00	B16		20.55	26.80		Weathered SANDSTONE recovered as very dense, brown, slightly fine to coarse sand. Gravel is angular to subrounded, fine to coarse of extremely weak sandstone and occasional quartzite		
27.00		SPT(S) 50 (25 for 36mm/50 for 15mm)		(0.65)				
27.00 - 27.45	D18		19.90	27.45		End of Borehole at 27.45m		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
					12.00	200	12.00	200
					27.45	150	27.00	150

Chiselling				Installation			
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.80	26.80		20	26.00	

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			RT01
Contract Number:	Date Started:	Loggged By:	Checked By:	Status:	Sheet 1 of 5
41973	25/10/2016	DO		DRAFT	
Rotary Core Drilling Log	Easting: 384854.4	Northing: 398213.5	Ground Level: 46.73mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: Termination:

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						(1.20)		MADE GROUND: Dark brown, mottled orange, very gravelly SAND with high cobble content. Gravel and cobbles are angular to subrounded of brick and concrete.		
					45.53	1.20		Stiff, brown, sandy boulder CLAY. (Drillers description).		
						(9.90)				

1 2 3 4 5 6 7 8 9 10

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	26.50	26.50	0		medium flow rate

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			RT01
Contract Number:	Date Started:	Loggged By:	Checked By:	Status:	Sheet 2 of 5
41973	25/10/2016	DO		DRAFT	
Rotary Core Drilling Log	Easting: 384854.4	Northing: 398213.5	Ground Level: 46.73mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50
Weather:		Termination:			

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
								Stiff, brown, sandy boulder CLAY. (Drillers description).		
					35.63	11.10		Red, clayey SAND and GRAVEL. (Drillers description).		
						(1.30)				
					34.33	12.40		Sandy, brown boulder CLAY. (drillers description).		
						(3.10)				
					31.23	15.50		Yellow SAND and GRAVEL. (Drillers description).		
						(4.00)				
					27.23	19.50		Very stiff, brown, sandy boulder CLAY. (Drillers description).		

11 12 13 14 15 16 17 18 19 20

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	26.50	26.50	0		medium flow rate

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.		Borehole ID: RT01
	Contract Number: 41973	Date Started: 25/10/2016	Loggged By: DO	Checked By:	Status: DRAFT
Rotary Core Drilling Log	Easting: 384854.4	Northing: 398213.5	Ground Level: 46.73mOD	Plant Used:	Print Date: 25/01/2017
					Sheet 3 of 5
Weather:		Termination:			Scale: 1:50

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						(5.30)		Very stiff, brown, sandy boulder CLAY. (Drillers description).		
					21.93	24.80		Red SANDSTONE with some gravel in top of the weathered sandstone. (Drillers description).		
						(2.20)				
27.00 - 28.50	100	83	59	5 8 11	19.73	27.00		Weak, locally extremely weak, thinly laminated to medium bedded, reddish brown, fine and medium grained, pebbly SANDSTONE. Weathered, partially weathered to fresh. Discontinuities are 1) 0 - 5 degrees, extremely closely to medium spaced planar, rough clean. 2) 10 - 15 degrees closely to widely spaced planar, rough clean. *Between 27.00m and 27.05m: extremely weak.* *Between 27.25m and 27.44m: extremely weak.* *Between 27.84 and 27.85m: extremely*		
						(6.00)				
28.50 - 30.00	67	67	65	6						

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	26.50	26.50	0		medium flow rate

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.		Borehole ID: RT01
	Contract Number: 41973	Date Started: 25/10/2016	Loggged By: DO	Checked By:	Status: DRAFT
Rotary Core Drilling Log	Easting: 384854.4	Northing: 398213.5	Ground Level: 46.73mOD	Plant Used:	Print Date: 25/01/2017
					Sheet 4 of 5
Weather:		Termination:			Scale: 1:50

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
30.00 - 31.50	100	83	0	17 12 12				Between 30.66m and 30.71m: extremely weak. Between 30.96m and 31.11m: extremely weak. Between 31.45m and 31.50m: extremely weak.		
31.50 - 33.00	87	81	47	10 12 8				Between 32.84m and 32.89m: non intact recovered as fine to coarse gravel.		
33.00 - 34.50	23	20	53	AZCL NI	13.73	33.00		Extremely weak to very weak, thinly laminated to medium bedded, reddish brown, locally light grey, fine and medium grained, pebbly SANDSTONE. Weathering partially weathered to fresh. Discontinuities 1) 0 degrees - 15 degrees very closely to medium spaced planar, rough clean. 2) 50 degrees to 60 degrees, undulating, smooth, clayey infill <1mm. Between 33.00m and 34.15m: assumed zone of core loss.		
34.50 - 36.00	80	75	47	AZCL 14 7		(3.55)		Between 34.50m and 34.70m: assumed zone of core loss. Non intact recovered as fine to coarse gravel. Between 36.00m and 36.55m: assumed zone of core loss.		
36.00 - 37.50	63	46	24	AZCL 12 NI 13 NI	10.18	36.55		Weak, locally extremely weak thinly laminated to medium bedded, reddish brown, fine and medium grained pebbly SANDSTONE. Weathering, fresh to partially weathered. Discontinuities 1) 0 degrees - 5 degrees, very closely spaced planar, rough clean/ 2) 30 degrees widely spaced, undulation planar rough clean. 3) 70 degrees - 80 degrees, planar rough. clay infill <0.1mm. Between 37.10m an d 37.28m: extremely weak. Between 37.12m and 37.28m: non intact recovered as sand, fine to coarse gravel. Between 37.40m and 37.50m: non intact recovered as sandy fine to coarse gravel.		
37.50 - 39.00	80	77	47	AZCL 25 NI 7		(2.45)		Between 37.40m and 37.90m: extremely weak. Between 38.01m and 38.06m: extremely weak.		
					7.73	39.00 (1.50)		No recovery. SANDSTONE. (Drillers description).		

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	26.50	26.50	0		medium flow rate

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IFA RC Issue Number: 2 Issue Date: 13/07/16

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			RT01
Contract Number:	Date Started:	Loggged By:	Checked By:	Status:	Sheet 5 of 5
41973	25/10/2016	DO		DRAFT	
Rotary Core Drilling Log	Easting: 384854.4	Northing: 398213.5	Ground Level: 46.73mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: Termination:

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
				NR	6.23	40.50		No recovery. SANDSTONE. (Drillers description).		
								End of Borehole at 40.50m		

41 42 43 44 45 46 47 48 49 50

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)

Remarks:
Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	26.50	26.50	0		medium flow rate

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: RT02
	Contract Number: 41973	Date Started: 27/10/2016	Loggged By: DO	Checked By:	Status: DRAFT	Sheet 1 of 4
Rotary Core Drilling Log	Easting: 384831.9	Northing: 398172.8	Ground Level: 47.40mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
					47.30	0.10		Very strong, light grey CONCRETE 5mm rebar.		
						(1.10)		MADE GROUND: Light grey, black mottled, slightly clayey, sandy GRAVEL with high cobble content. Gravel and cobbles are angular to subrounded of brick and concrete.		
					46.20	1.20		Brown, boulder CLAY (driller's description).		
						(10.80)				

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)
					0.00	27.00	PLAIN	
					27.00	37.00	SLOTTED	

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	25.00	26.50	0		Fast

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: RT02
	Contract Number: 41973	Date Started: 27/10/2016	Loggged By: DO	Checked By:	Status: DRAFT	Sheet 2 of 4
Rotary Core Drilling Log	Easting: 384831.9	Northing: 398172.8	Ground Level: 47.40mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
								Brown, boulder CLAY (driller's description).		
					35.40	12.00		Red SAND and GRAVEL (driller's description).		
						(3.00)				
					32.40	15.00		Yellow SAND (driller's description).		
						(0.80)				
					31.60	15.80		Sandy, red brown, boulder CLAY (driller's description).		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter	
Depth (m)	Dia (mm)

Casing Diameter	
Depth (m)	Dia (mm)

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	27.00	PLAIN	
27.00	37.00	SLOTTED	

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	25.00	26.50	0		Fast

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: RT02
	Contract Number: 41973	Date Started: 27/10/2016	Loggged By: DO	Checked By:	Status: DRAFT	Sheet 3 of 4
Rotary Core Drilling Log	Easting: 384831.9	Northing: 398172.8	Ground Level: 47.40mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
						(10.20)		Sandy, red brown, boulder CLAY (driller's description).		
					21.40	26.00		Red SAND with small gravel (driller's description).		
						(1.00)				
27.00 - 28.00	0	0	0		20.40	27.00		No recovery SANDSTONE assumed.		
						(1.40)				
28.00 - 29.00	60	45	22	NI 10	19.00	28.40		Extremely weak to very weak, thinly laminated to medium bedded, reddish brown, fine and medium grained, pebbly SANDSTONE. Weathering partially weathered to fresh. Discontinuities 1) 0 degrees - 15 degrees very closely to medium spaced generally closely spaced planar rough, brown staining clean. 2) Widely spaced planar rough, brown staining clean. 3) 70 degrees to 80 degrees undulating rough clean.		
29.00 - 30.00	60	60	21	AZCL 18				*non intact drilling induced recovered as gravelly, fine an d medium sand.* *Between 29.00m and 29.40m: assumed zone of core loss.*		

21 22 23 24 25 26 27 28 29 30

Start & End of Shift Observations					Borehole Diameter		Casing Diameter	
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)

Flush Information					Installation			
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)
					0.00	27.00	PLAIN	
					27.00	37.00	SLOTTED	

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	25.00	26.50	0		Fast

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.			Borehole ID: RT02
	Contract Number: 41973	Date Started: 27/10/2016	Loggged By: DO	Checked By:	Status: DRAFT	Sheet 4 of 4
Rotary Core Drilling Log	Easting: 384831.9	Northing: 398172.8	Ground Level: 47.40mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Coring Details					Strata Details				Groundwater	
Depth	TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
30.00 - 31.00	60	51	26	AZCL NI 10 NI				Between 30.00m and 30.40m: assumed zone of core loss. Non intact drilling induced, recovered as sandy, fine to coarse gravel. Non intact drilling induced, recovered as sandy, fine to coarse gravel.		
31.00 - 32.50	83	81	56	AZCL 8 NI 28				Between 31.00m and 31.25m: assumed zone of core loss. Non intact drilling induced, recovered as gravelly, fine and medium sand.		
32.50 - 34.00	87	81	40	AZCL 11 NI 2 NI 10		(8.60)		Assumed zone of core loss. Non intact drilling induced, recovered as slightly sandy, coarse gravel. Non intact drilling induced, recovered as slightly sandy, coarse gravel. Assumed zone of core loss.		
34.00 - 35.50	80	80	67	AZCL AZCL 6				Assumed zone of core loss.		
35.50 - 37.00	87	67	36	NI 28 NI 18 NI 7				Non intact drilling induced, recovered as gravelly, fine and medium sand. Non intact drilling induced, recovered as sandy, fine to coarse gravel. Non intact drilling induced, recovered as sandy, fine to coarse gravel.		
					10.40	37.00		End of Borehole at 37.00m		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)

Borehole Diameter	
Depth (m)	Dia (mm)

Casing Diameter	
Depth (m)	Dia (mm)

Flush Information				
Top (m)	Base (m)	Flush Type	Return	Flush Colour

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	27.00	PLAIN	
27.00	37.00	SLOTTED	

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
26.50	25.00	26.50	0		Fast

Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS02
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	25/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384869.7	Northing: 398210.9	Ground Level: 46.64mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.30	ES1					MADE GROUND: Dark brown mottled orange, sandy gravel with high cobble content. Sand is fine to coarse. Gravel and cobbles are angular to subrounded of brick, concrete ash and clinker.		
0.50 - 1.00	B1							
0.80	ES2							
1.00 - 1.80	B2			(1.80)				
1.20		SPT(S) N=4 (1,1/1,1,1,1)						
			44.84	1.80				
2.00 - 3.00	B3		44.64	2.00		MADE GROUND: Firm to stiff, dark brown mottled black, gravelly, sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse of brick, concrete ash and clinker. Low cobble content. Cobble is subangular of brick		
2.00		SPT(S) N=18 (2,3/3,3,5,7)						
2.50	ES3					Stiff, dark brown mottled blueish grey, slightly sandy, slightly gravelly clay. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone. Rare brick near top of strata. (Possibly re-worked at top)		
3.00	D1			(1.50)				
3.00 - 3.45	D2							
3.00 - 4.00	B4							
3.00		SPT(S) N=26 (3,3/4,6,6,10)	43.14	3.50		Very stiff, thinly laminated, brown mottled blueish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Sand is fine to medium. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone, siltstone and quartzite		
4.00 - 4.45	D3							
4.00 - 5.00	D4							
4.00		SPT(S) N=25 (3,3/3,5,7,10)		(1.95)				
5.00 - 5.45	D5							
5.00		SPT(S) N=36 (3,4/6,9,9,12)						
			41.19	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS03
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	27/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384858.3	Northing: 398226.5	Ground Level: 46.57mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
			46.49	0.08		MADE GROUND: Light grey, sandy, angular to subrounded, fine to coarse GRAVEL including concrete, clinker and limestone.		
0.30	ES13							
0.50 - 1.00	B10					MADE GROUND: Dark brown, mottled black, clayey, gravelly, fine to coarse SAND with medium cobble and occasional pockets of clay. Gravel is angular to subrounded, fine to coarse including brick, concrete, clinker and wood.		
				(1.42)				
1.00	D11							
1.00	ES12							
1.00		SPT(C) N=37						
1.20 - 1.65	D9	(3,13/13,10,7,7)						
1.50	D8		45.07	1.50		MADE GROUND: Firm to stiff, brown, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including sandstone, mudstone and brick.		
2.00 - 2.45	D7			(1.00)				
2.00		SPT(S) N=20 (2,3/4,5,5,6)						
2.50	D6		44.07	2.50		Stiff, brown mottled, bluish grey, sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone. Rare brick at top. (Possibly re-worked at top of stratum).		
2.50	ES5			(0.50)				
3.00 - 3.45	D4		43.57	3.00		Stiff, thinly laminated, dark brown, sandy, gravelly CLAY with occasional lenses of fine sand. Gravel is angular to subrounded, fine to coarse of various lithologies including mudstone, sandstone, coal and quartzite.		
3.00		SPT(S) N=19 (2,3/4,5,5,5)						
3.50	D3							
4.00 - 4.45	D2							
4.00		SPT(S) N=18 (2,3/4,5,3,6)		(2.45)				
4.50	D1							
5.00 - 5.45	D14							
5.00		SPT(S) N=26 (3,4/3,6,7,10)						
			41.12	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type
		0.00	0.50		PLAIN
		0.50	3.50		SLOTTED

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS04
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	27/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384865.7	Northing: 398190.2	Ground Level: 46.88mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.50	ES1					MADE GROUND: Dark brown, mottled orange, gravelly, fine to coarse SAND with high cobble content. Gravel and cobbles are angular to subrounded of brick and occasional concrete.		
0.50 - 1.00	B2			(1.50)				
1.00	ES3							
1.20 - 1.65	D4							
1.20		SPT(C) N=46						
1.50 - 2.00	B5	(1,2/2,11,13,20)	45.38	1.50		MADE GROUND: Firm to stiff, dark brown, mottled bluish grey, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including brick and mudstone.		
2.00 - 2.45	C6		44.88	(0.50) 2.00		Stiff, dark brown mottled, bluish grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone .		
2.00		SPT(C) N=18 (4,5/3,4,5,6)						
2.50	D7			(1.00)				
3.00 - 3.45	D9		43.88	3.00		Very stiff, dark brown, mottled bluish grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies.		
3.00 - 4.00	B8							
3.00		SPT(S) N=27 (2,5/6,5,6,10)						
3.50	ES10							
4.00 - 4.45	D12					*Between 4.00m and 5.00m: occasional lenses of fine to coarse sand.*		
4.00 - 5.00	B11							
4.00		SPT(S) N=30 (3,5/6,5,9,10)		(2.45)				
5.00 - 5.45	D13							
5.00		SPT(S) N=30 (4,5/6,7,7,10)						
			41.43	5.45		End of Borehole at 5.45m		

1 2 3 4 5 6 7 8 9 10

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type
		0.00	0.50		PLAIN
		0.50	2.00		SLOTTED

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS05
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	27/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384856.8	Northing: 398203.0	Ground Level: 46.77mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.50	ES1					MADE GROUND: Dark brown, mottled orange, very gravelly, fine to coarse SAND with high cobble content. Gravel and cobbles are angular to subrounded of brick, concrete ash and clinker.		
0.50 - 1.20	B2							
1.00	ES3							
1.20		SPT(S) N=4 (1,1/1,1,1,1)		(2.30)				
2.00 - 2.45	C4							
2.00		SPT(C) N=18 (9,6/8,4,3,3)						
2.30 - 3.00	B5		44.47	2.30		MADE GROUND: Stiff, dark brown mottled, bluish grey, sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including brick, concrete, sandstone and quartzite. (Re-worked natural clay).		
3.00 - 3.45	D6			(1.10)				
3.00		SPT(S) N=21 (3,4/5,5,5,6)						
3.50	D7		43.37	3.40		Stiff, thinly laminated, dark brown, mottled, bluish grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, siltstone, coal and mudstone.		
3.60	ES8							
4.00 - 4.45	D10							
4.00 - 5.00	B9							
4.00		SPT(S) N=36 (4,4/5,7,13,11)		(2.05)				
5.00 - 5.45	D11							
5.00		SPT(S) N=35 (4,5/6,7,11,11)						
			41.32	5.45		End of Borehole at 5.45m		

1 2 3 4 5 6 7 8 9 10

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS06
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	27/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384845.6	Northing: 398214.4	Ground Level: 46.65mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.50	ES1					Dark brown, mottled orangish brown, gravelly, fine to coarse SAND with low cobble content. Gravel and cobbles are subangular of brick and concrete.		
0.50 - 1.00	B2			(1.30)				
1.00	ES3							
1.20 - 1.65	C4							
1.20		SPT(S) N=43	45.35	1.30				
1.30 - 2.00	B5	(9,16/15,12,9,7)				MADE GROUND: Firm to stiff, dark brown mottled, bluish grey, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including brick, sandstone and mudstone.		
				(0.70)				
2.00 - 2.45	D7		44.65	2.00				
2.00 - 3.00	B6					Stiff, dark brown, mottled bluish grey, slightly sandy, slightly gravelly CLAY with occasional laminae of fine sand. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone.		
2.00		SPT(S) N=23 (1,3/4,6,6,7)						
				(1.20)				
3.00	ES8							
3.00 - 3.45	D10		43.45	3.20				
3.00 - 4.00	B9					Very stiff, thinly laminated, fissured, dark brown, mottled bluish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Fissures are subvertically orientated, very closely spaced. Gravel is angular to subrounded fine to coarse of various lithologies including sandstone, mudstone and quartzite.		
3.00		SPT(S) N=22 (2,3/4,6,6,6)						
4.00 - 4.45	D12							
4.00 - 5.00	B11							
4.00		SPT(S) N=25 (3,4/5,5,5,10)		(2.25)				
5.00 - 5.45	D13							
5.00		SPT(S) N=22 (5,6/5,5,5,7)						
			41.20	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS07
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	25/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384851.0	Northing: 398181.3	Ground Level: 47.21mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
				(1.50)		MADE GROUND: Dark brown mottled orange speckled black, sandy gravel with medium cobble content. Gravel and cobbles are subrounded of brick and concrete		
1.20		SPT(C) N=30 (2,3/4,4,6,16)	45.71	1.50				
				(0.50)		MADE GROUND: Dark brown and black mottled, very gravelly, fine to coarse sand with medium cobble content. Gravel is angular to subrounded, medium to coarse of brick and concrete. Cobbles are subangular of brick		
2.00		SPT(C) 50 (2,3/50 for 20mm)	45.21	2.00		End of Borehole at 2.00m		

1 2 3 4 5 6 7 8 9 10

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m. Terminated at 2.00m on obstruction.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS07A
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	28/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384848.6	Northing: 398181.9	Ground Level: 47.08mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.30	ES1					MADE GROUND: Dark brown mottled orange speckled black, sandy gravel with high cobble content. Gravel and cobbles are angular to subrounded of brick and concrete		
0.50 - 1.00	B1			(1.20)				
0.80	ES2							
1.20 - 2.00	B3		45.88	1.20		MADE GROUND: Dark brown and black mottled, very gravelly fine to coarse sand with low to medium cobble content. Gravel is angular to subrounded, fine to coarse of brick and concrete. Cobbles are angular to subrounded of brick		
1.20		SPT(C) N=20 (2,3/5,6,3,6)		(0.80)				
2.00 - 2.80	B3		45.08	2.00		Stiff, dark brown mottled blueish grey, slightly sandy, slightly GRAVELLY angular to subrounded, fine to coarse of various lithorelicts including sandstone, mudstone.		
2.00		SPT(C) N=45 (1,2/4,17,15,9)						
2.50	ES3			(0.80)				
3.00 - 3.45	D1		44.28	2.80		Very stiff, thinly laminated, fissured dark brown mottled blueish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Fissures are subverticle and closely spaced. Sand is fine to coarse. Gravel is angular to subrounded, fine to coarse of various lithorelicts including sandstone, mudstone, coal and quartzite		
3.00 - 4.00	B4							
3.00		SPT(S) N=25 (2,3/3,4,5,13)						
4.00 - 4.45	D2							
4.00		SPT(S) N=22 (1,4/4,4,7,7)		(2.65)				
5.00		SPT(S) N=43 (6,7/8,12,11,12)						
			41.63	5.45		End of Borehole at 5.45m		

1 2 3 4 5 6 7 8 9 10

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS08
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	27/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384839.9	Northing: 398194.6	Ground Level: 46.75mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.50	ES16					MADE GROUND: Dark brown mottled orange, gravelly, fine to coarse SAND with high cobble content. Gravel and cobbles are angular to subrounded of brick and occasional concrete.		
0.50 - 1.00	B14			(1.50)				
1.00	ES15							
1.20 - 1.65	D13							
1.20		SPT(C) N=4 (1,0/1,1,1,1)						
1.50 - 2.00	B12		45.25	1.50		MADE GROUND: Firm to stiff, dark brown mottled, bluish grey, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including sandstone, mudstone and brick.		
				(0.50)				
2.00 - 2.45	D11		44.75	2.00		Stiff, thinly laminated, dark brown mottled, bluish grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone.		
2.00 - 2.50	B10							
2.00		SPT(S) N=22 (1,2/3,4,5,10)		(0.80)				
2.60	ES9							
2.80 - 3.00	B8		43.95	2.80		Very stiff, thinly laminated, fissured, dark brown mottled, bluish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone and quartzite.		
3.00 - 3.45	D7							
3.00		SPT(S) 50 (25 for 90mm/50 for 115mm)		(0.65)				
			43.30	3.45		End of Borehole at 3.45m		

1 2 3 4 5 6 7 8 9 10

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS09
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	28/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384831.4	Northing: 398206.5	Ground Level: 46.49mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.30	ES1					MADE GROUND: Dark brown and black mottled, very gravelly, fine to coarse SAND with high cobble content. Gravel and cobbles are angular to subrounded of brick, concrete, tarmac ash and clinker.		
0.50 - 1.00	B1			(1.00)				
0.80	ES2							
1.00 - 2.00	B2		45.49	1.00		MADE GROUND: Firm, dark grey mottled black, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse of brick, clinker, tarmac, concrete and sandstone.		
1.20		SPT(C) N=18 (4,5/6,6,3,3)						
				(1.20)				
2.00	ES3							
2.00 - 2.45	D1		44.29	2.20		Firm to stiff, thinly laminated, dark brown mottled blueish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Sand is fine. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone and rare brick (Reworked)		
2.00		SPT(S) N=10 (1,2/1,2,3,4)						
2.20 - 3.00	B3			(0.80)				
3.00 - 3.45	D2		43.49	3.00		Very stiff, thinly laminated, dark brown mottled blueish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Sand is fine to medium. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone and quartzite		
3.00 - 4.00	B4							
3.00		SPT(S) N=20 (2,3/4,4,6,6)						
4.00 - 4.45	D3							
4.00 - 5.00	B5			(2.45)				
4.00		SPT(S) N=15 (2,2/2,2,4,7)						
5.00 - 5.45	D4							
5.00		SPT(S) N=26 (2,3/4,5,6,11)						
			41.04	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS10
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	26/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384842.5	Northing: 398170.5	Ground Level: 47.39mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50
Weather:	Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
			47.24	0.15		MADE GROUND: light grey CONCRETE with reinforcement bar.		
0.30	D20					MADE GROUND: Dark brown mottled, orange, gravelly, fine to coarse SAND with high cobble content. Gravel is angular to subrounded, fine to coarse including brick and concrete. Cobbles are subangular of brick.		
0.30	ES21			(0.65)				
0.30 - 0.80	B19							
			46.59	0.80		MADE GROUND: Firm, orangish brown, mottled grey, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including brick, concrete ash and clinker.		
0.90	D17							
0.90	ES18							
1.00		SPT(S) N=12 (1,1/2,3,3,4)						
1.20 - 1.65	D16			(1.00)				
1.50	D15							
			45.59	1.80		MADE GROUND: Firm to stiff, dark grey speckled, black, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including sandstone, brick and clinker.		
2.00 - 2.45	D14			(0.35)				
2.00		SPT(S) N=12 (1,2/3,2,3,4)	45.24	2.15		Firm to stiff, brown mottled, bluish grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone.		
2.10	D13							
2.50	D12							
2.50	ES11			(0.85)				
3.00 - 3.45	D10		44.39	3.00		Stiff to very stiff, brown mottled, bluish grey, slightly sandy, slightly gravelly CLAY with occasional lenses of sand. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone and quartzite.		
3.00		SPT(S) N=19 (1,2/4,4,5,6)						
3.50	D9							
4.00 - 4.45	D8							
4.00		SPT(S) N=20 (1,2/3,4,6,7)		(2.45)				
4.50	D7							
5.00 - 5.45	D6							
5.00		SPT(S) N=33 (2,4/6,7,9,11)						
			41.94	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS11
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	24/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384821.8	Northing: 398161.4	Ground Level: 47.47mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.30	ES1					MADE GROUND: Dark brown, clayey, gravelly, fine to coarse SAND with medium cobble content. Gravel is angular to subrounded, fine to coarse including brick and concrete. Cobbles are angular to subrounded including brick.		
0.50 - 1.00	B2							
0.60	ES3			(1.50)				
1.00	D5							
1.00	ES4							
1.00		SPT(C) N=3 (1,2/1,0,1,1)						
1.20 - 1.65	C6		45.97	1.50				
1.80	D7			(0.50)		MADE GROUND: Brown, clayey, gravelly, fine to coarse SAND. Gravel is angular to subrounded, fine to coarse including brick, concrete and quartzite.		
2.00 - 2.45	D8		45.47	2.00				
2.00		SPT(C) N=16 (2,3/3,4,4,5)				Firm and stiff, brown mottled, orangish brown, grey, sandy, gravelly CLAY.		
2.50	D10			(1.00)				
2.50	ES9							
3.00 - 3.45	D11		44.47	3.00				
3.00		SPT(S) N=21 (3,4/5,5,5,6)				Stiff, thinly laminated, fissured, dark brown mottled, bluish grey, sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone and coal.		
3.50	D12							
4.00 - 4.45	D13					*Between 4.00m and 5.00m; occasional lenses of fine sand.*		
4.00		SPT(S) N=36 (4,4/5,7,13,11)		(2.45)				
4.50	D14					*Between 4.50m and 5.00m: speckled black.*		
5.00 - 5.45	D15							
5.00		SPT(S) N=35 (4,5/6,7,11,11)						
			42.02	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
Piccadilly Basin		JPG (Leeds) Ltd.			WS12
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
41973	26/10/2016	DO		DRAFT	
Dynamic Sample Borehole Log	Easting: 384821.4	Northing: 398172.1	Ground Level: 47.31mOD	Plant Used:	Print Date: 25/01/2017	Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
			47.20	0.11		MADE GROUND: Tarmacadam.		
0.30	ES1		47.06	0.25		MADE GROUND: Light brown, sandy, angular to subrounded, fine to coarse GRAVEL of limestone.		
0.50 - 1.00	B2					MADE GROUND: Dark brown, mottled black, clayey, gravelly, fine to coarse SAND with high cobble content. Gravel and cobbles are angular to subrounded of brick, concrete ash and clinker.		
0.60	ES3							
0.90	D6			(1.35)				
0.90	ES5							
1.20 - 1.65	D7							
1.20		SPT(S) N=19 (1,2/3,3,6,7)						
1.50	D8							
			45.71	1.60		MADE GROUND: Firm to stiff, yellowish brown, mottled orange, gravelly, sandy CLAY. Gravel is angular to subrounded, fine to coarse including brick, quartzite and concrete.		
				(0.40)				
2.00 - 2.45	D9		45.31	2.00		Stiff, thinly laminated, dark brown, mottled bluish grey, sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone.		
2.00		SPT(S) N=17 (1,3/3,5,4,5)						
2.50	D11			(0.80)				
2.50	ES10							
			44.51	2.80		Stiff to very stiff, thinly laminated, fissured, brown, sandy, gravelly CLAY. Fissures are subvertically orientated and very closely spaced.		
3.00 - 3.45	D12							
3.00		SPT(S) N=26 (2,3/6,6,7,7)						
3.50	D13							
4.00 - 4.45	D14					*Below 4.00m and 5.00m: occasional lenses of orange fine sand.*		
4.00		SPT(S) N=33 (3,6/6,7,9,11)		(2.65)				
4.50	D15							
5.00 - 5.45	D16							
5.00		SPT(S) N=26 (3,4/4,6,7,9)						
			41.86	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES	Contract Name: Piccadilly Basin		Client: JPG (Leeds) Ltd.		Borehole ID: WS13
	Contract Number: 41973	Date Started: 26/10/2016	Logged By: DO	Checked By:	Status: DRAFT
					Sheet 1 of 1
Dynamic Sample Borehole Log	Easting: 384829.7	Northing: 398189.4	Ground Level: 47.07mOD	Plant Used:	Print Date: 25/01/2017
					Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
			46.97	0.10		MADE GROUND: Tarmacadam.		
			46.82	0.25		MADE GROUND: Light brown, sandy, angular to subrounded, fine to coarse GRAVEL including limestone.		
0.50	ES1					MADE GROUND: Firm to stiff, yellowish, brown mottled orange, gravelly, sandy CLAY with high cobble content. Gravel and cobbles are subangular including brick, concrete and sandstone.		
0.50 - 1.00	B2			(1.25)				
1.00	D4							
1.00	ES3							
1.20 - 1.65	D5							
1.20		SPT(S) N=19 (2,4/4,5,4,6)						
1.50	D6		45.57	1.50		Firm to stiff, dark brown, mottled orange bluish grey, sandy, gravelly CLAY. Gravel is angular to subrounded, fine to coarse of various lithologies including sandstone, mudstone. (Possibly re-worked at top of stratum).		
2.00 - 2.45	D7			(1.00)				
2.00		SPT(S) N=16 (1,2/3,4,4,5)						
2.50	D8		44.57	2.50		Very stiff, thinly laminated, dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to coarse including sandstone and mudstone. *Between 2.60m and 4.00m: occasional lenses of fine sand.*		
2.50	D9							
3.00 - 3.45	D10							
3.00		SPT(S) N=20 (2,3/3,4,6,7)						
3.50	D11							
4.00 - 4.45	D12			(2.95)				
4.00		SPT(S) N=33 (3,3/4,6,9,14)						
4.50	D13							
5.00 - 5.45	D14							
5.00		SPT(S) N=44 (3,7/11,9,11,13)						
			41.62	5.45		End of Borehole at 5.45m		

Borehole Diameter		Installation			
Depth (m)	Dia (m)	Depth Top	Base (m)	Diameter	Pipe Type
		0.00	1.00		PLAIN
		1.00	2.00		SLOTTED

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Service inspection pit hand excavated from GL to 1.20m.

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Gas and Groundwater Monitoring Results

Contract Number:	*41973*	**Gas Monitor:**	*GA5000*
Contract Name:	*Picaddilly Basin*	**Readings Taken By:**	*DM*
Date:	*9th November 2016*	**Checked By:**	

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Dull, rain, breezy 5.c*					
	Ground Conditions (dry / wet etc):	*Wet*					
	Atmospheric Pressure (Start):	*995*	*21.3*	*0.0*	*0.0*	*0.0*	*0.0*
	Atmospheric Pressure (Finish):	*995*					
	(Start): 12.20	Time (Finish): 13					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Range	mBGL	mBGL	mBGL
WS03	*0.0*	*17.9*	*0.3*	*0.0*	*0.0*	*0*	*0*	*0.17*	*0.0*	*1.54*	*1.17*	*ND*
WS04	*0.0*	*21.0*	*0.1*	*0.0*	*0.0*	*0*	*0*	*0.22*	*0.0*	*2.10*	*Dry*	*ND*
WS13	*0.0*	*8.9*	*8.9*	*0.0*	*0.0*	*0*	*0*	*0.20*	*0.0*			
CP02												
R02												

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks: CP02 & R02 Car parked over well. WS13 unable to dip.

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Gas and Groundwater Monitoring Results

Contract Number:	*41973*	**Gas Monitor:**	*GA5000*
Contract Name:	*Picaddilly Basin*	**Readings Taken By:**	*DM*
Date:	*23rd Novmeber 2016*	**Checked By:**	*HH*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Dull & Mild*					
	Ground Conditions (dry / wet etc):	*Wet*					
	Atmospheric Pressure (Start):	*1015mb*	*21.2*	*0.0*	*0.0*	*0*	*0*
	Atmospheric Pressure (Finish):	*1014mb*					
	Time (Start): 09:45	Time (Finish): 10:45					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Range	mBGL	mBGL	mBGL
WS03	*0.0*	*6.5*	*1.0*	*5.2*	*5.2*	*0*	*0*	*0.10*	*0.0*	*1.53*	*1.05*	*ND*
WS04	*0.0*	*20.8*	*0.1*	*0.0*	*0.0*	*0*	*0*	*0.12*	*0.0*	*2.10*	*DRY*	*ND*
WS13	*0.0*	*18.8*	*3.9*	*0.0*	*0.0*	*0*	*0*	*0.02*	*0.0*	*1.95*	*1.02*	*ND*
CP02	*0.0*	*7.3*	*3.4*	*0.2*	*0.0*	*0*	*0*	*-3.77*	*-0.8*	*2.67*	*1.23*	*ND*
R02	*0.0*	*11.1*	*1.8*	*0.0*	*0.0*	*0*	*0*	*-0.17*	*-0.1*	*35.85*	*20.40*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:

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Gas and Groundwater Monitoring Results

Contract Number:	*41973*	**Gas Monitor:**	*GA5000*
Contract Name:	*Picaddilly Basin*	**Readings Taken By:**	*DM*
Date:	*30th November 2016*	**Checked By:**	*HH*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Dull & Breezy*					
	Ground Conditions (dry / wet etc):	*Damp*					
	Atmospheric Pressure (Start):	*1029mb*	*21.4*	*0.0*	*0.0*	*0*	*0*
	Atmospheric Pressure (Finish):	*1028mb*					
	Time (Start): 08:30	Time (Finish): 09:45					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Range	mBGL	mBGL	mBGL
WS03	*0.0*	*6.3*	*2.8*	*0.0*	*0.0*	*0*	*0*	*-0.25*	*-0.1*	*1.52*	*1.33*	*ND*
WS04	*0.0*	*21.3*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.03*	*0.0*	*2.14*	*DRY*	*ND*
WS13	*0.0*	*21.1*	*0.2*	*0.0*	*0.0*	*0*	*0*	*-0.22*	*0.0*	*2.05*	*1.44*	*ND*
CP02	*0.0*	*21.1*	*0.2*	*0.0*	*0.0*	*0*	*0*	*-0.08*	*0.0*	*2.65*	*1.14*	*ND*
R02	*0.0*	*20.0*	*0.5*	*0.0*	*0.0*	*0*	*0*	*-1.00*	*-0.1*	*35.75*	*20.45*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:

IAN FARMER ASSOCIATES
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Gas and Groundwater Monitoring Results

Contract Number:	*41973*	**Gas Monitor:**	*GA5000*
Contract Name:	*Piccadilly Basin*	**Readings Taken By:**	*DM*
Date:	*22nd December 2016*	**Checked By:**	*HH*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Dull, breezy 6 °c*					
	Ground Conditions (dry / wet etc):	*Wet*					
	Atmospheric Pressure (Start):	*1015mb*	*21.7*	*0.0*	*0.0*	*0*	*0*
	Atmospheric Pressure (Finish):	*1016mb*					
	Time (Start): 08:30 Time (Finish):	09:30					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Range	mBGL	mBGL	mBGL
WS03	*0.0*	*10.4*	*2.1*	*0.9*	*0.9*	*0*	*0*	*-0.10*	*0.0*	*1.60*	*1.22*	*ND*
WS04	*0.0*	*21.6*	*0.6*	*0.0*	*0.0*	*0*	*0*	*0.10*	*0.0*	*2.12*	*2.05*	*ND*
WS13	*0.0*	*21.7*	*0.1*	*0.0*	*0.0*	*0*	*0*	*0.12*	*0.0*	*1.98*	*1.16*	*ND*
CP02	*0.0*	*20.4*	*1.8*	*0.0*	*0.0*	*0*	*0*	*-0.07*	*0.0*	*2.65*	*1.15*	*ND*
R02	*0.0*	*14.4*	*0.6*	*0.0*	*0.0*	*0*	*0*	*0.00*	*0.0*	*35.77*	*20.52*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:

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Gas and Groundwater Monitoring Results

Contract Number:	*41973*	**Gas Monitor:**	*GFM430*
Contract Name:	*Piccadilly Basin*	**Readings Taken By:**	*NM*
Date:	*5th January 2017*	**Checked By:**	*HH*

Background Readings:			O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions:	*Dry & bright*					
	Ground Conditions (dry / wet etc):	*dry*					
	Atmospheric Pressure (Start):	*1026mb*	*21.2*	*0.0*	*0.0*	*0.0*	*0.0*
	Atmospheric Pressure (Finish):	*1026mb*					
	Time (Start): 10:00 Time (Finish):	10:40					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Range	mBGL	mBGL	mBGL
WS03	*0.0*	*7.9*	*0.0*	*0.0*	*0.0*	*1*	*0*	*0.00*	*0.0*	*2.34*	*2.01*	*N/D*
WS04	*0.0*	*21.1*	*0.0*	*0.0*	*0.0*	*0*	*0*	*0.00*	*0.0*	*2.11*	*dry*	*N/D*
WS13	*0.0*	*20.7*	*0.2*	*0.0*	*0.0*	*0*	*0*	*0.00*	*0.0*	*1.93*	*1.73*	*N/D*
CP02	CP02 obstructed by a car, unable to monitor											
R02	*0.0*	*21.0*	*0.1*	*0.0*	*0.0*	*0*	*0*	*0.00*	*0.0*	*36.15*	*14.59*	*N/D*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Gas and Groundwater Monitoring Results

Contract Number:	*41973*	**Gas Monitor:**	*GA5000*
Contract Name:	*Piccadilly Basin*	**Readings Taken By:**	*DM*
Date:	*19th January 2017*	**Checked By:**	*HH*

Background Readings:		O_2% v/v	CO_2% v/v	CH_4% v/v	CO ppm	H_2S ppm
	Weather Conditions: *Overcast*					
	Ground Conditions (dry / wet etc): *Wet*					
	Atmospheric Pressure (Start): *1031mb*	*21.4*	*0.0*	*0.0*	*0*	*0*
	Atmospheric Pressure (Finish): *1032mb*					
	Time (Start): 11:00 Time (Finish): 12:00					

Hole No:	VOC ppm	O_2% v/v	CO_2% v/v	CH_4% v/v		CO ppm	H_2S ppm	Rel Pressure (mb)	Gas flow Rate (l/hr)	Depth to base of well	SWL	LNAPL or DNAPL
	Steady	Steady	Steady	Peak	Steady	Steady	Steady	Steady	Range	mBGL	mBGL	mBGL
WS03	*0.0*	*12.5*	*0.7*	*2.4*	*0.0*	*0*	*0*	*0.10*	*0.0*	*1.55*	*1.05*	*ND*
WS04	*0.0*	*21.1*	*0.1*	*0.0*	*0.0*	*0*	*0*	*0.00*	*0.0*	*2.12*	*2.10*	*ND*
WS13	*0.0*	*21.2*	*0.1*	*0.0*	*0.0*	*0*	*0*	*-0.29*	*0.0*	*1.95*	*1.16*	*ND*
CP02	*0.0*	*21.4*	*0.0*	*0.0*	*0.0*	*0*	*0*	*-2.64*	*0.2*	*2.65*	*1.04*	*ND*
R02	*0.0*	*21.3*	*0.1*	*0.0*	*0.0*	*0*	*0*	*-0.41*	*0.0*	*35.70*	*20.55*	*ND*

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:

Appendix C Laboratory Tests

GENERAL NOTES ON LABORATORY TESTS ON SOILS

Where applicable all tests are carried out on accordance with the relevant British Standard. The laboratory test procedures are as below:

Test Name	Procedures BS1377:1990 Part: Clause
Moisture Content	2:3
Liquid Limit	2:4
Plastic Limit and Plastic Index	2:5
Particle Size Distribution	9:2
Sedimentation	9:4
Sulphate Content	3:5
pH Value	3:9
Compaction Test	4:3
California Bearing Ratio	4:7
Consolidation	5:3
Laboratory Vane Tests	7:3*
Triaxial Compression	
Total Stress Single-Stage	7:8
Total Stress Multi-Stage	7:9

Note 1 - BRE Information paper IP4 issued February 1993
* Tests are not included in UKAS accreditation

Where an external laboratory carried out testing, their report, including test methods is included in this Appendix.

A summary sheet of laboratory test results undertaken by Ian Farmer Laboratories is included, however where copies of the individual test results are required these will be provided on request.

Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

Moisture Content
Unless stated to the contrary, the moisture content of a soil sample was determined by the standard oven drying method, BS 1377, Part 1, Test 3. The result is reported to an accuracy of ±0.5%.

Atterberg Limits
The Liquid Limit, LL, is the moisture content at which the soil passes from the liquid to plastic state. Unless stated to the contrary, the Liquid Limit was determined using the four point, cone penetrometer method, Test 4. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

The Plastic Limit, PL, is the moisture content at which soil passes from the plastic to solid state and becomes too dry to remain in a plastic condition. The Plastic Limit was determined using the method described in Test 5. The value is reported to the nearest whole number, to an accuracy of ±0.5%.

The Plasticity Index, PI, is the numerical difference between the liquid and plastic limits, corresponding to the range of moisture contents over which a soil is in a plastic state. The determination of the Plasticity Index is covered by Test 5.

Soil Classification
Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as PI = 0.73(LL - 20).

This line is defined from experimental evidence and does not represent a well-defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.

Clays and silts are divided into five zones of plasticity:

- Low Plasticity (L) LL less than 35
- Intermediate Plasticity (I) LL between 35 and 50
- High Plasticity (H) LL between 50 and 70
- Very High Plasticity (V) LL between 70 and 90
- Extremely High Plasticity (E) LL greater than 90

In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

Shear Strength Tests
The shear strength tests have been carried out in accordance with the procedures given in BS1377, Part 7.

The type of test referred to is:

a) U1(100) - Undrained triaxial compression test on single specimen of 100mm diameter at a lateral pressure approximately equal to overburden pressure.

b) UM(100) - Multi-stage undrained triaxial compression test on a specimen of 100mm diameter. An initial low cell pressure is applied and the deviator stress increased until failure is imminent. The cell pressure is then increased and the procedure repeated until the failure stress at three different cell pressures have been determined.

c) U1(38) - Undrained triaxial compression test on a single specimen of 38mm diameter at a lateral pressure approximately equal to overburden pressure.

d) U(38) - Undrained triaxial compression test on set of three specimens of 38mm diameter at three differential lateral pressures.

e) Consolidated undrained triaxial – The Effective Stress Parameters were determined in accordance with the procedure detailed in BS1377: Part 8:1990 Clause 7 and the samples were prepared in accordance with clause 4.

f) Small shear box – The peak, and in some cases residual, shear stress parameters were determined in accordance with the procedure detailed in BS1377: Part 7: 1990 Clause 4 and the samples were prepared in accordance with clause 4.

Chemical Tests
The total sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3:1990, Test 5. The results are recorded to an accuracy of ±0.1%.

The water soluble sulphate content of soil was determined using the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The results are recorded to an accuracy of ±0.1g/l.

The sulphate content of groundwater was determined using the gravimetric method detailed in BS1377: Part 3: 1990, Test 5. The results are record to an accuracy of ±0.1g/l.

The pH value was determined electrometrically using the procedures given in BS 1377: Part 3: 1990, Test 9. The results are recorded to an accuracy of ±0.1 pH units.

The total sulphur content of soil was determined using the ignition in oxygen method detailed in TRL Report 447, Test 4B.

The organic content of soil was determined in accordance with the chemical method detailed in BS1377: Part 3:1990 Clause 3. The sample was prepared in accordance with Clause 3.4.2.

The organic content of soil was determined in accordance with the loss on ignition method detailed in BS1377: Part 3:1990 Clause 4. The sample was prepared in accordance with Clause 4.3.2.

Compaction Tests
Whenever soil is placed as fill, it is generally necessary to compact it into a dense state. Laboratory compaction tests are carried out to provide the basis for control procedures. Compaction tests provide the following information.

The relationship between the dry density and moisture content for a given degree of compactive effort.

The moisture content for the most efficient compaction. This is defined as the Optimum Moisture Content, OMC, being the moisture content of the soil at which a specified amount of compaction will produce the maximum dry density.

The Maximum Dry Density, being the dry density obtained using a specified amount of compaction at the optimum moisture content.

There are three basic laboratory compaction tests, these being as follows:

Type of test (BS1377:1990 Part 4)	Container	Rammer			
		mass (kg)	drop (mm)	No of Layers	Blows Per Layer
Light compaction	BS mould (1l) CBR mould	2.5 2.5	300 300	3 3	27 62
Heavy compaction	BS mould (1l) CBR mould	4.5 4.5	450 450	5 5	27 62
Vibrating hammer	CBR mould	32 to	vibro	3	(1 min)

The California Bearing Ratio is determined using the penetration test procedure detailed in BS1377: Part 4: 1990 Clause 7.4. The samples are prepared in accordance with BS1377: Part 4: 1990 Clause 7.2.4.4 method 5 using a 2.5kg/4.5kg rammer/intermediate effort. The force penetration curves are given in the corresponding figures. The curves include the percentage retained on the 20mm test sieve.

LABORATORY REPORT

4043

Contract Number: PSL16/5273

Report Date: 28 November 2016

Client's Reference: 41973

Client Name: Ian Farmer Associates
4 Faraday Close
Washington
Tyne & Wear
NE38 9QJ

For the attention of: Tim Downes

Contract Title: Piccadilly Basin

Date Received: 10/11/2016
Date Commenced: 10/11/2016
Date Completed: 28/11/2016

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
D Lambe (Senior Technician)	S Royle (Senior Technician)	L Knight (Senior Technician)

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SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
CP01	5	B	1.20		MADE GROUND dark brown very sandy gravel.
CP01	10	U	3.00		Very stiff brown slightly gravelly sandy CLAY.
CP01	14	D	4.00		Brown slightly gravelly sandy CLAY.
CP01	15	U	5.00		Very stiff brown slightly gravelly sandy CLAY.
CP01	19	U	7.50		Very stiff brown slightly gravelly very sandy CLAY.
CP01	24	D	10.50		Brown slightly gravelly very sandy CLAY.
CP01	26	B	12.00		Brown very sandy clayey silty GRAVEL.
CP01	27	B	15.00		Brown gravelly very clayey silty SAND.
CP02	2	B	0.50		MADE GROUND dark grey very sandy very clayey very silty gravel.
CP02	3	B	1.20		MADE GROUND dark grey very gravelly very sandy CLAY.
CP02	4	D	2.00		Brown slightly gravelly sandy CLAY.
CP02	8	U	4.00		Very stiff brown slightly gravelly sandy CLAY.
CP02	9	D	4.50		Brown slightly gravelly sandy CLAY.
CP02	14	U	7.50		Very stiff brown slightly gravelly very sandy CLAY.
CP02	17	B	10.50		Brown gravelly very sandy CLAY.
CP02	20	U	12.00		Hard brown very sandy CLAY.
CP02	21	D	12.50		Brown silty SAND.
CP02	28	U	16.50		Hard brown very gravelly very sandy CLAY.
CP02	32	U	19.50		Hard brown gravelly very sandy CLAY.

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
CP03	3	B	1.20		Dark brown gravelly slightly sandy CLAY.
CP03	10	D	5.00		Brown slightly gravelly sandy CLAY.
CP03	14	D	7.50		Brown slightly gravelly very sandy CLAY.
CP03		U	10.50		Hard brown gravelly very sandy CLAY.
CP03		B	12.00		Brown slightly gravelly very sandy CLAY.
CP03		D	15.50		Brown slightly gravelly very sandy CLAY.
CP03		U	24.00		Very stiff brown slightly gravelly very sandy CLAY.

UKAS TESTING 4043

PSL Professional Soils Laboratory

Checked / Approved		Date	28/11/16	Contract No:
Piccadilly Basin				PSL16/5273
				Client Ref:
				41973

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

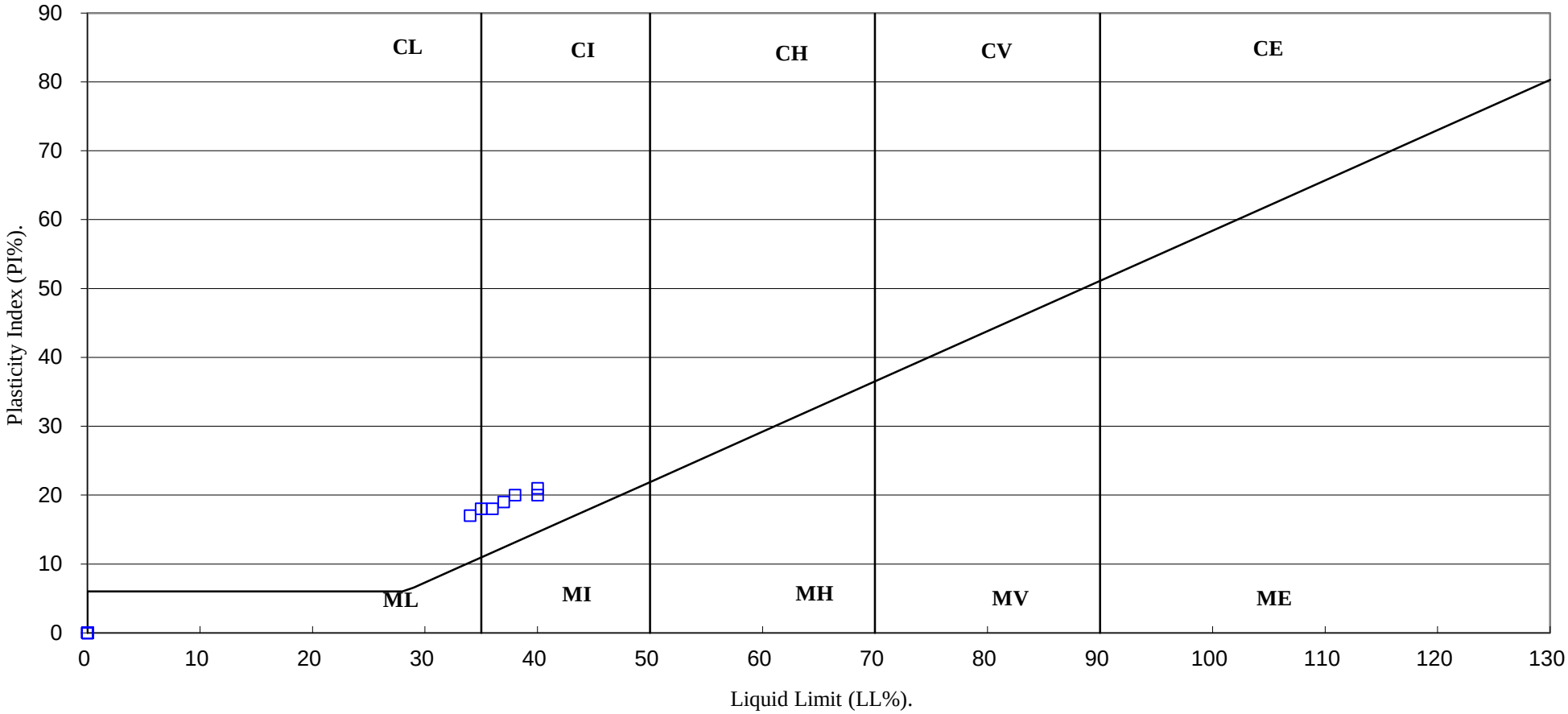
Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
CP01	10	U	3.00		17							
CP01	14	D	4.00		17			37	18	19	98	Intermediate plasticity CI.
CP01	15	U	5.00		18							
CP01	19	U	7.50		14							
CP01	24	D	10.50		17			36	18	18	98	Intermediate plasticity CI.
CP02	4	D	2.00		18			40	19	21	99	Intermediate plasticity CI.
CP02	8	U	4.00		18							
CP02	9	D	4.50		17			38	18	20	99	Intermediate plasticity CI.
CP02	14	U	7.50		14							
CP02	20	U	12.00		11							
CP02	21	D	12.50		8.8				NP			
CP02	28	U	16.50		8							
CP03	10	D	5.00		17			40	20	20	99	Intermediate plasticity CI.
CP03	14	D	7.50		15			35	17	18	99	Intermediate plasticity CI.
CP03		D	15.50		14			34	17	17	96	Low plasticity CL.

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved	Date 28/11/16	Contract No: PSL16/5273
		Piccadilly Basin		Client Ref: 41973

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked /Approved**		**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin				**PSL16/5273**
						Client Ref:
						41973

PARTICLE SIZE DISTRIBUTION TEST

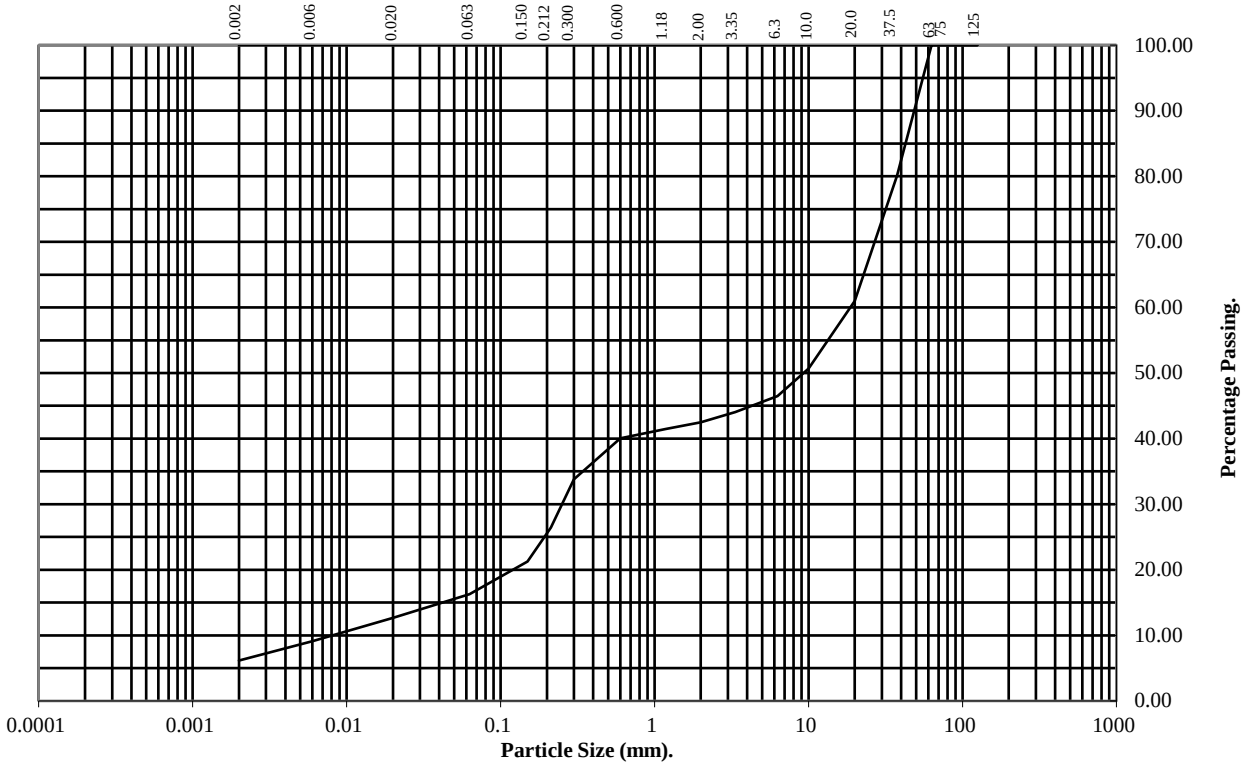
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **CP01** **Top Depth (m):** **12.00**

Sample Number: **26** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	80
20	61
10	51
6.3	46
3.35	44
2	42
1.18	41
0.6	40
0.3	34
0.212	26
0.15	21
0.063	16

Particle Diameter	Percentage Passing
0.02	13
0.006	9
0.002	6

Soil Fraction	Total Percentage
Cobbles	0
Gravel	58
Sand	26
Silt	10
Clay	6

Remarks:
See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin				**PSL16/5273**
						Client Ref:
						41973

PARTICLE SIZE DISTRIBUTION TEST

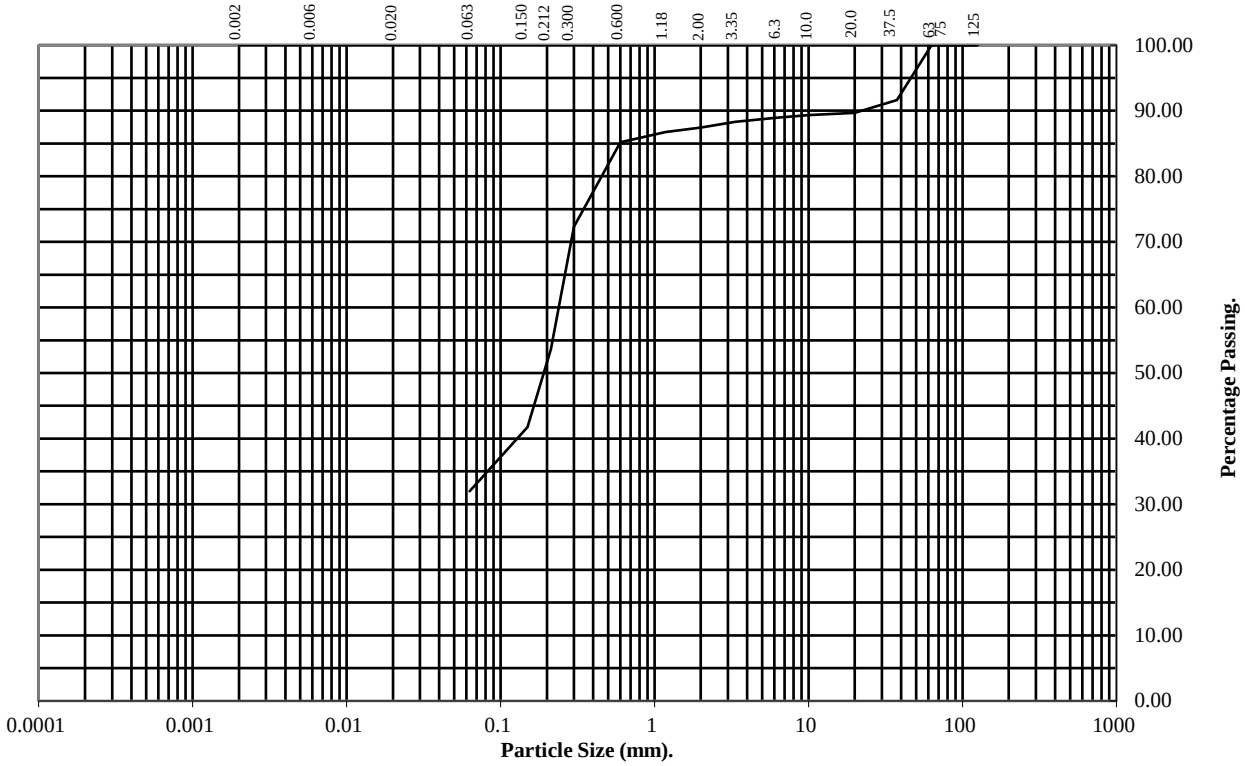
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **CP01** **Top Depth (m):** **15.00**

Sample Number: **27** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	92
20	90
10	89
6.3	89
3.35	88
2	87
1.18	87
0.6	85
0.3	72
0.212	54
0.15	42
0.063	32

Soil Fraction	Total Percentage
Cobbles	0
Gravel	13
Sand	55
Silt/Clay	32

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin				**PSL16/5273**
						Client Ref:
						41973

PARTICLE SIZE DISTRIBUTION TEST

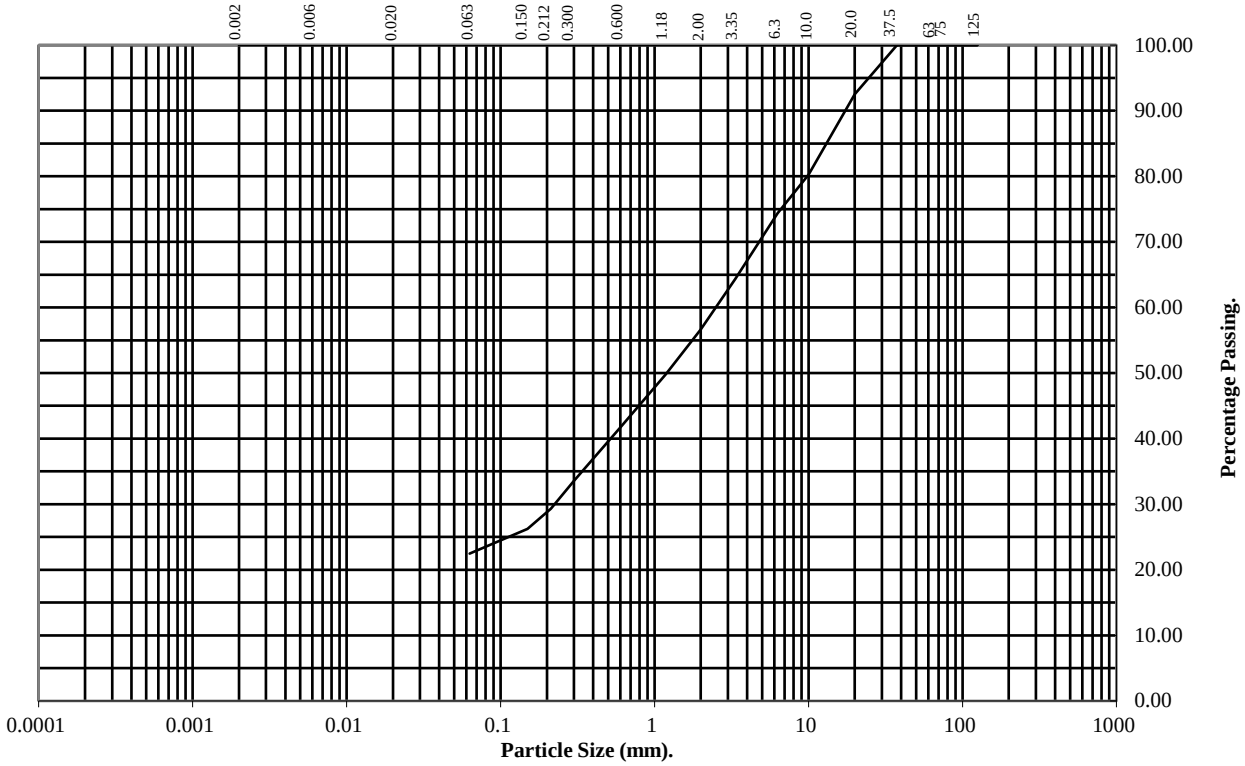
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **CP02** **Top Depth (m):** **0.50**

Sample Number: **2** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	92
10	80
6.3	74
3.35	64
2	57
1.18	50
0.6	42
0.3	34
0.212	29
0.15	26
0.063	22

Soil Fraction	Total Percentage
Cobbles	0
Gravel	43
Sand	35
Silt/Clay	22

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date** **28/11/16**	**Contract No:** **PSL16/5273**
		Piccadilly Basin			**Client Ref:** **41973**

PARTICLE SIZE DISTRIBUTION TEST

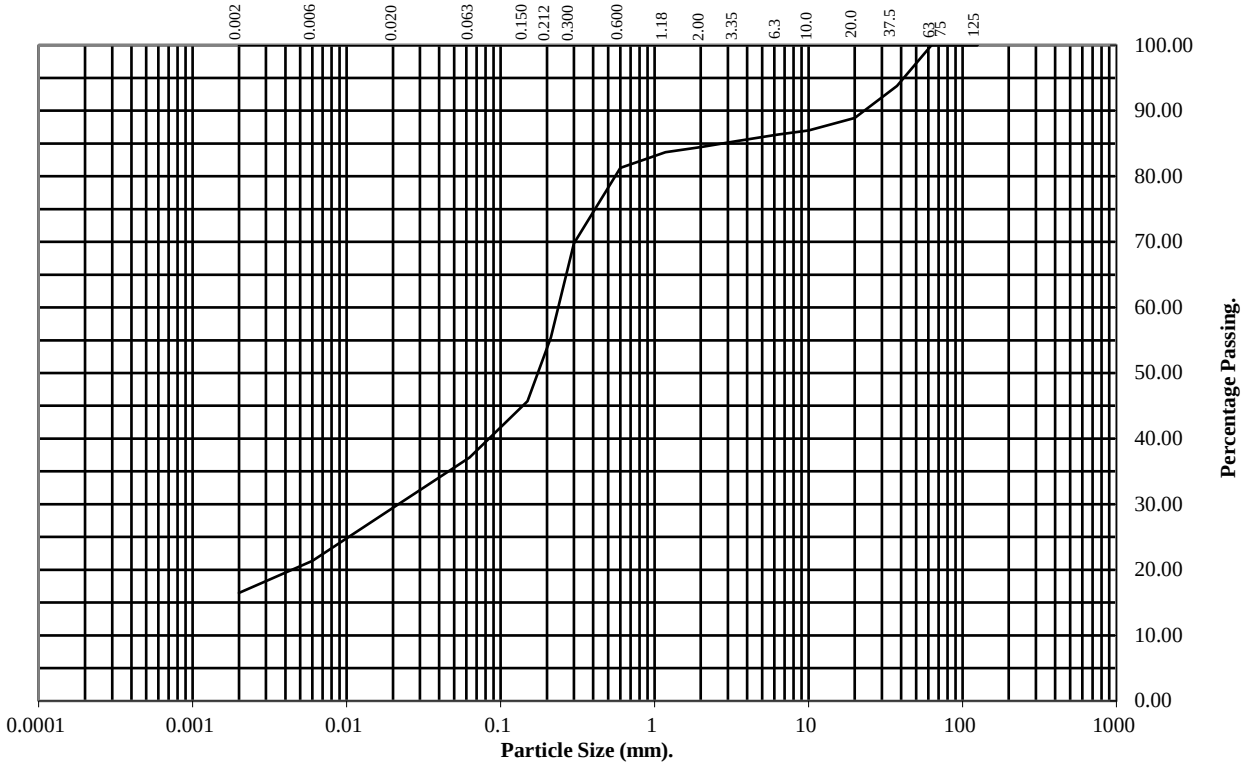
BS1377 : Part 2 : 1990

Wet Sieve & Pipette Analysis, Clause 9.2 & 9.4

Hole Number: **CP02** **Top Depth (m):** **10.50**

Sample Number: **17** **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	94
20	89
10	87
6.3	86
3.35	85
2	84
1.18	84
0.6	81
0.3	70
0.212	55
0.15	46
0.063	37

Particle Diameter	Percentage Passing
0.02	29
0.006	21
0.002	16

Soil Fraction	Total Percentage
Cobbles	0
Gravel	16
Sand	47
Silt	21
Clay	16

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin				**PSL16/5273**
						Client Ref:
						41973

PARTICLE SIZE DISTRIBUTION TEST

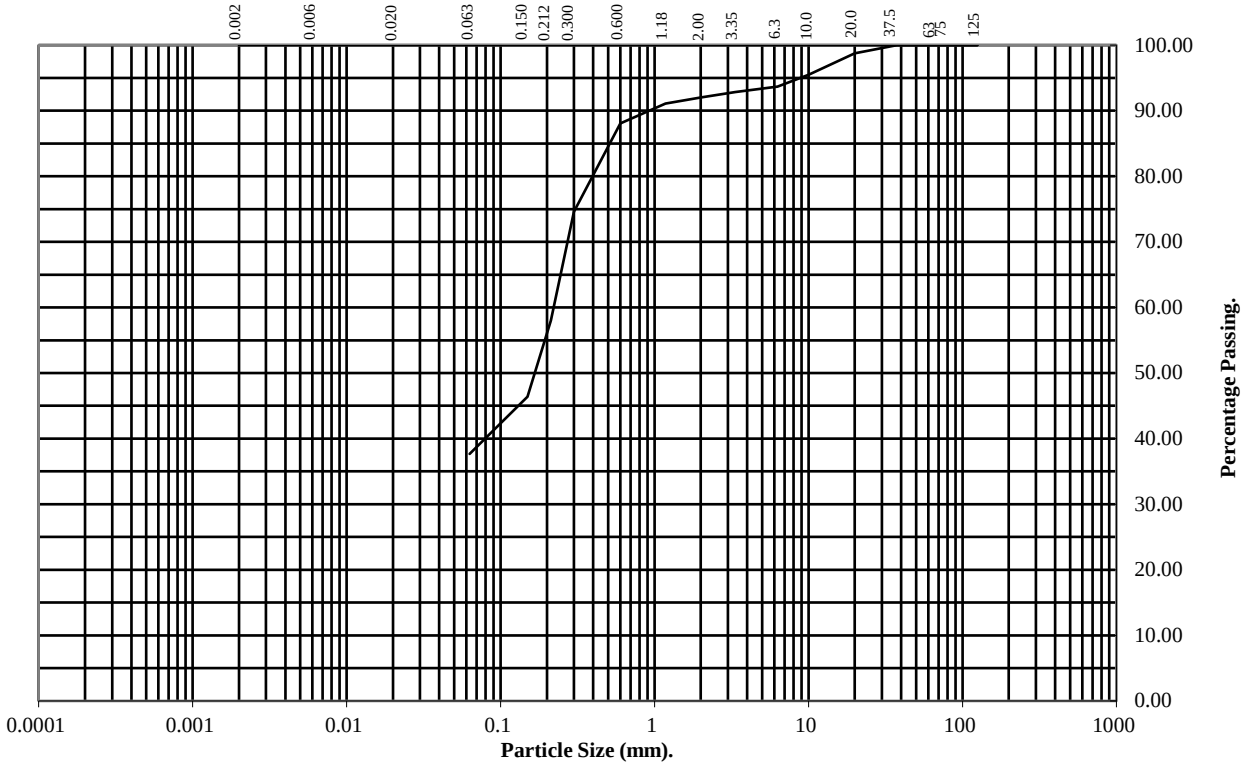
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **CP03** **Top Depth (m):** **12.00**

Sample Number: **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	99
10	95
6.3	94
3.35	93
2	92
1.18	91
0.6	88
0.3	75
0.212	58
0.15	46
0.063	38

Soil Fraction	Total Percentage
Cobbles	0
Gravel	8
Sand	54
Silt/Clay	38

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**		**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin				**PSL16/5273**
						Client Ref:
						41973

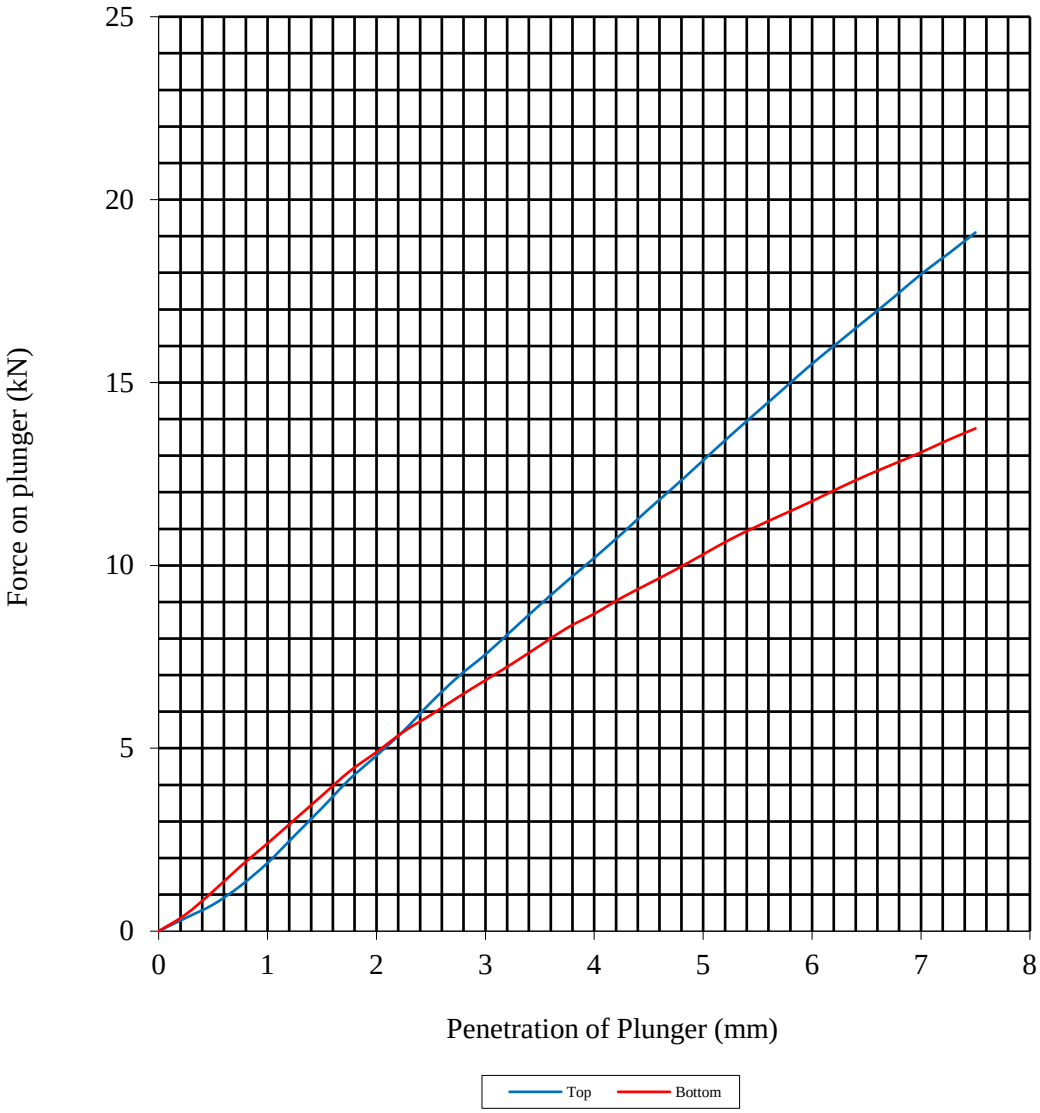
CALIFORNIA BEARING RATIO TEST

Non Compliance with BS 1377 : Part 4 : 1990

Hole Number: CP01 **Top Depth (m):** 1.20

Sample Number: 5 **Base Depth (m):**

Sample Type: B



Initial Sample Conditions		Sample Preparation		Final Moisture Content %		C.B.R. Value %	
Moisture Content:	15	Surcharge Kg:	4.20	Sample Top	15	Sample Top	64
Bulk Density Mg/m3:	1.88	Soaking Time hrs	0	Sample Bottom	15	Sample Bottom	52
Dry Density Mg/m3:	1.64	Swelling mm:	0	Remarks: See summary of soil descriptions.			
Percentage retained on 20mm BS test sieve:			36				
Compaction Conditions		2.5kg Rammer					

UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved	Date	28/11/16	Contract No: PSL16/5273
		Piccadilly Basin			Client Ref: 41973

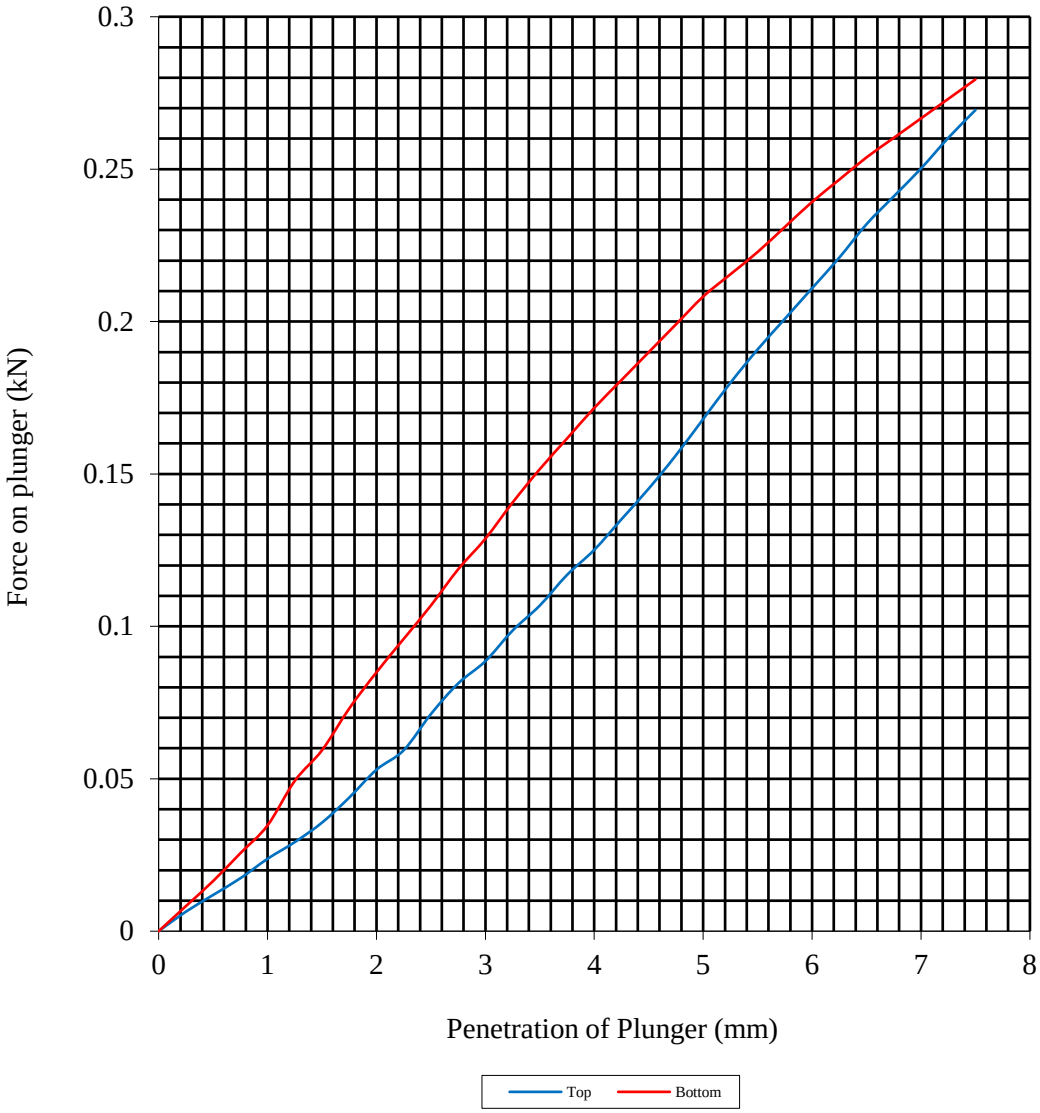
CALIFORNIA BEARING RATIO TEST

BS 1377 : Part 4 : 1990

Hole Number: CP02 **Top Depth (m):** 1.20

Sample Number: 3 **Base Depth (m):**

Sample Type: B



Initial Sample Conditions		Sample Preparation		Final Moisture Content %		C.B.R. Value %	
Moisture Content:	26	Surcharge Kg:	4.20	Sample Top	26	Sample Top	0.8
Bulk Density Mg/m3:	1.87	Soaking Time hrs	0	Sample Bottom	26	Sample Bottom	1.0
Dry Density Mg/m3:	1.48	Swelling mm:	0	Remarks: See summary of soil descriptions.			
Percentage retained on 20mm BS test sieve:			15				
Compaction Conditions		2.5kg Rammer					

UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved	[illegible]	Date 28/11/16	Contract No: PSL16/5273
		Piccadilly Basin			Client Ref: 41973

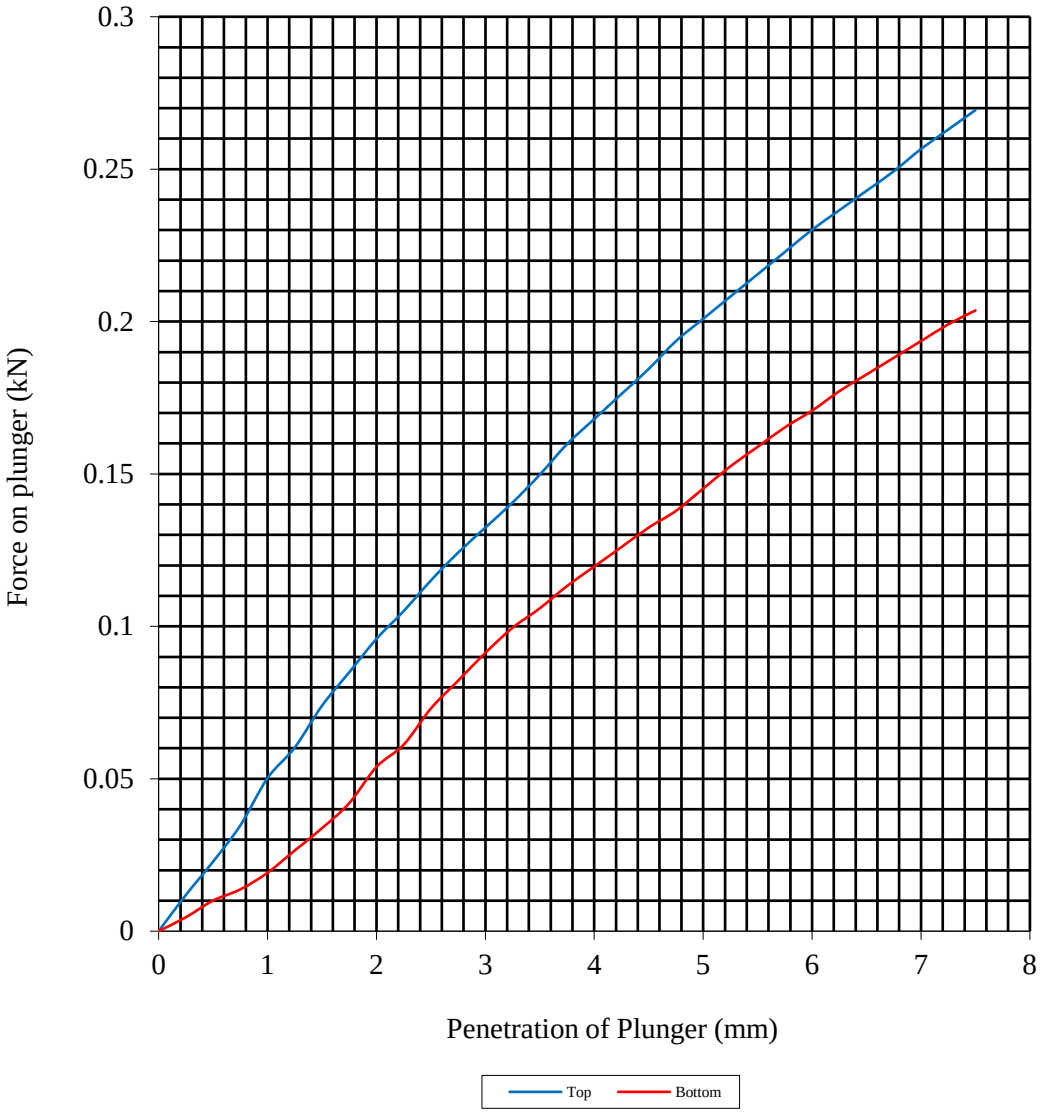
CALIFORNIA BEARING RATIO TEST

BS 1377 : Part 4 : 1990

Hole Number: CP03 **Top Depth (m):** 1.20

Sample Number: 3 **Base Depth (m):**

Sample Type: B



Initial Sample Conditions		Sample Preparation		Final Moisture Content %		C.B.R. Value %	
Moisture Content:	22	Surcharge Kg:	4.20	Sample Top	22	Sample Top	1.0
Bulk Density Mg/m3:	1.98	Soaking Time hrs	0	Sample Bottom	22	Sample Bottom	0.7
Dry Density Mg/m3:	1.62	Swelling mm:	0	Remarks: See summary of soil descriptions.			
Percentage retained on 20mm BS test sieve:			2				
Compaction Conditions		2.5kg Rammer					

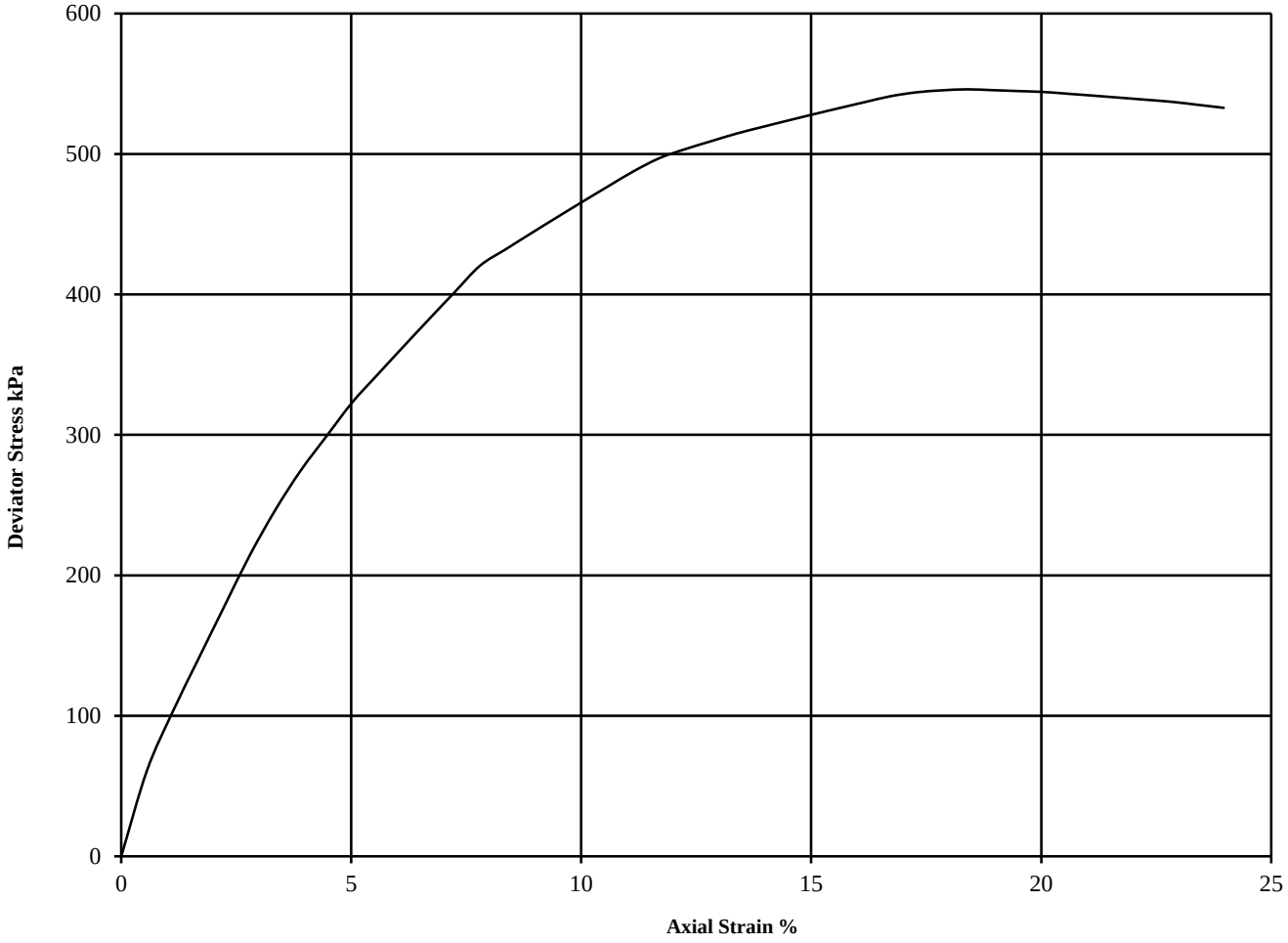
UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved	[illegible]	Date 28/11/16	Contract No: PSL16/5273
		Piccadilly Basin			Client Ref: 41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP01**	**Top Depth (m):**	**3.00**
Sample Number:	**10**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		183.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.34
1	17	2.12	1.82	60	546	273	18.4	Plastic	See summary of soil descriptions.

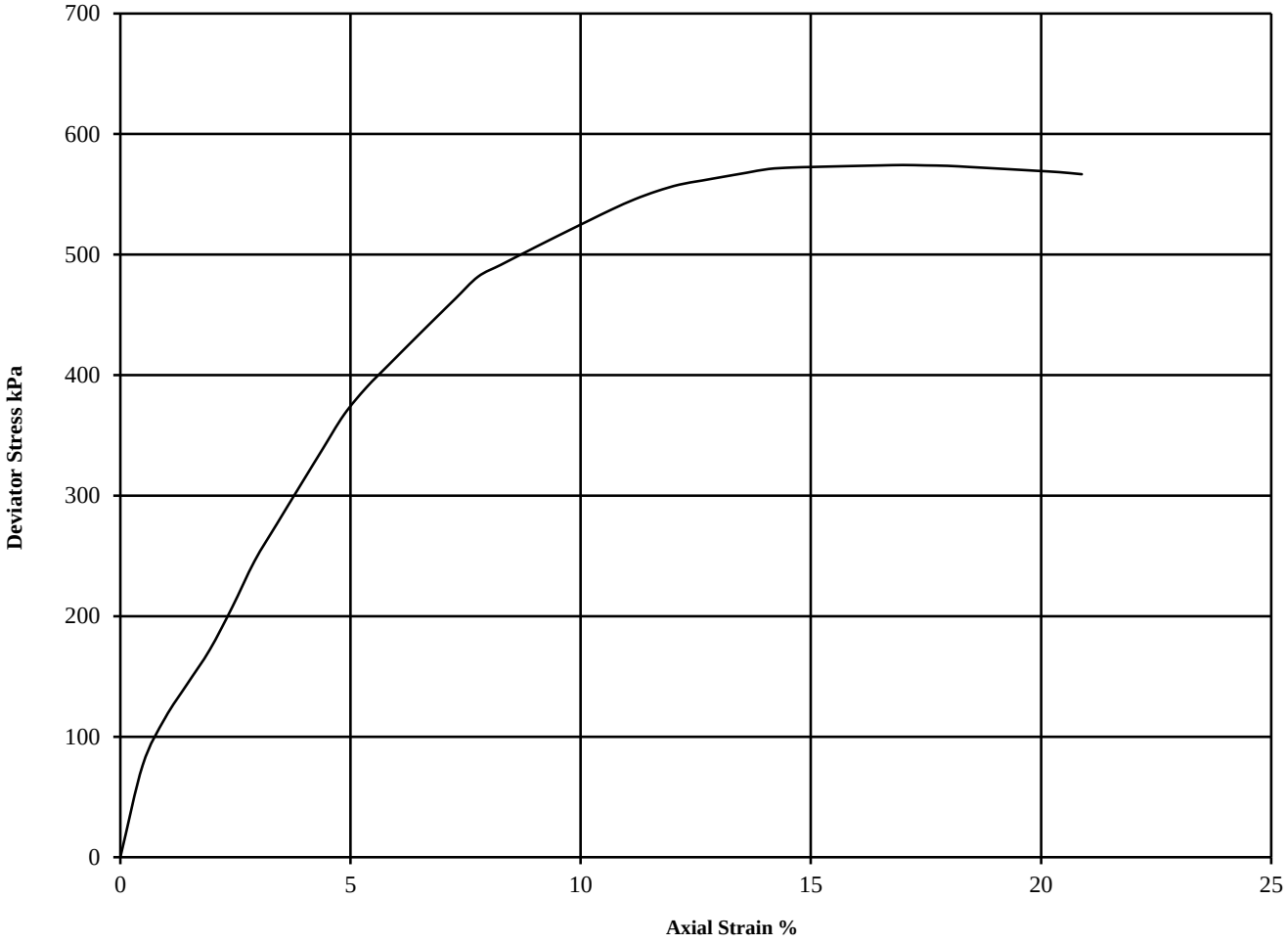
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	BKH	**Date** 28/11/16	**Contract No:** PSL16/5273
		Piccadilly Basin			**Client Ref:** 41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP01**	**Top Depth (m):**	**5.00**
Sample Number:	**15**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.34
1	18	2.13	1.81	100	574	287	17.0	Plastic	See summary of soil descriptions.

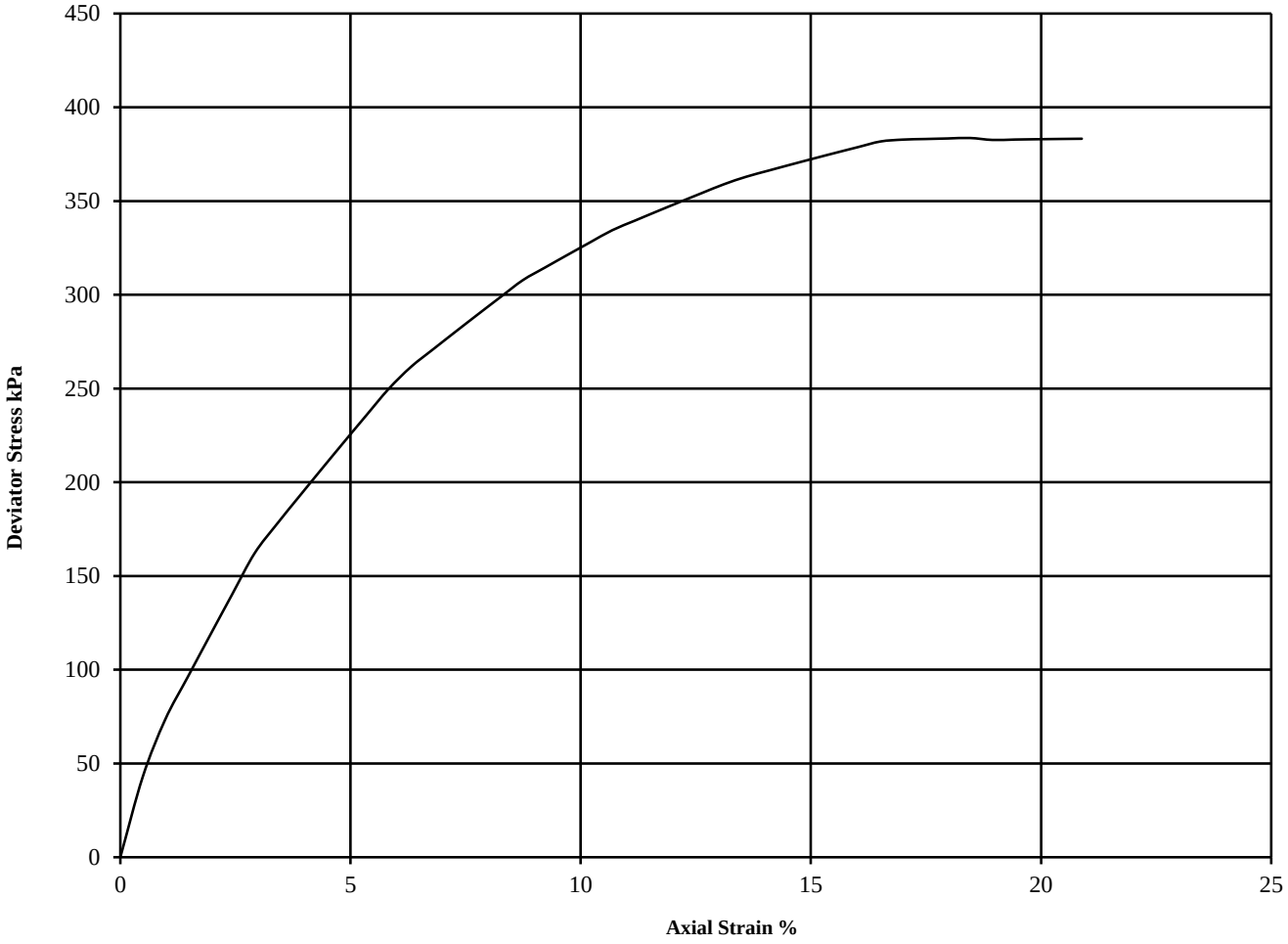
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin			**PSL16/5273**
					Client Ref:
					41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP01**	**Top Depth (m):**	**7.50**
Sample Number:	**19**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.34
1	14	2.17	1.91	150	384	192	18.5	Plastic	See summary of soil descriptions.

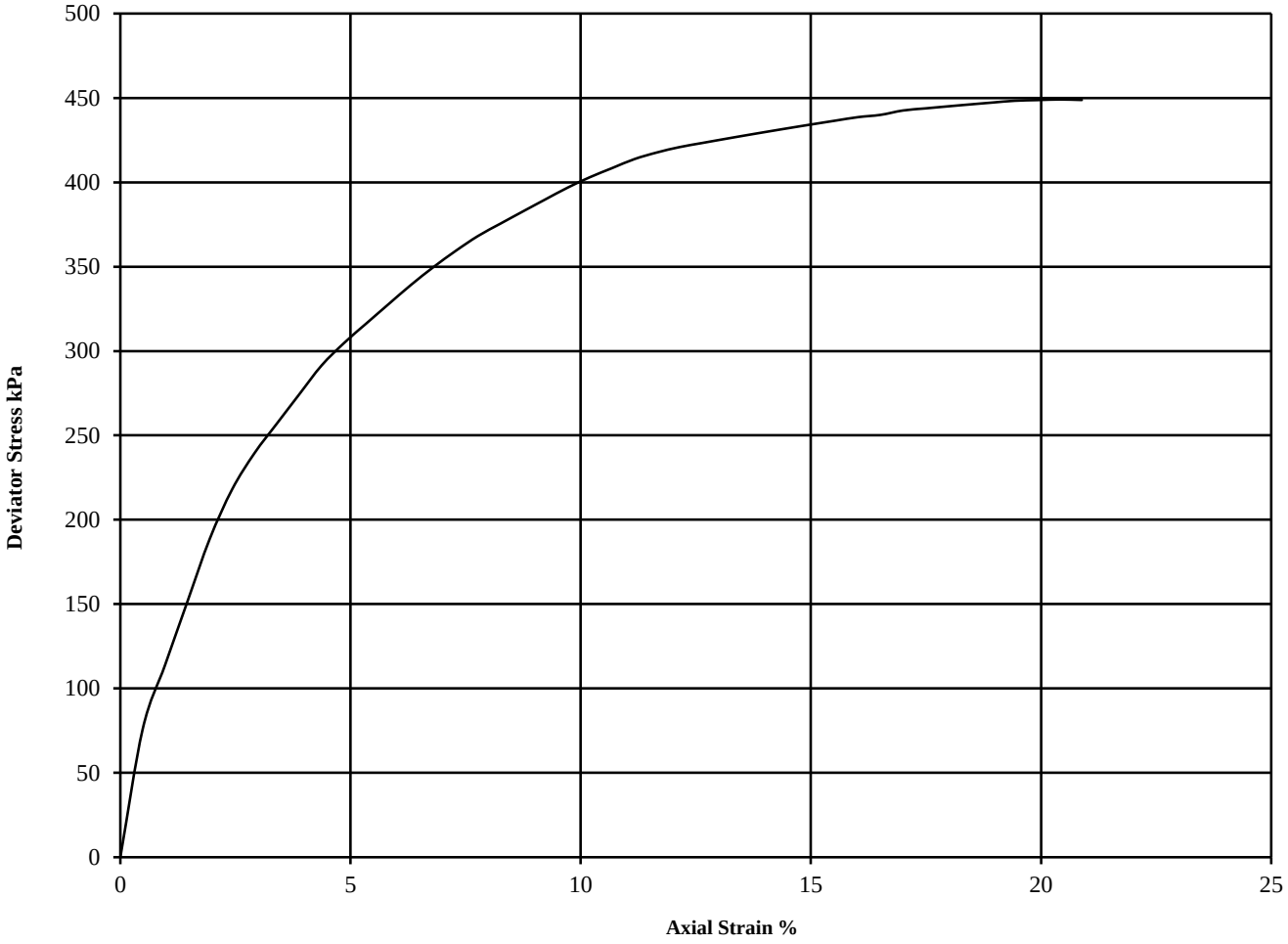
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin			**PSL16/5273**
					Client Ref:
					41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP02**	**Top Depth (m):**	**4.00**
Sample Number:	**8**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.33
1	18	2.12	1.80	80	449	225	20.4	Plastic	See summary of soil descriptions.

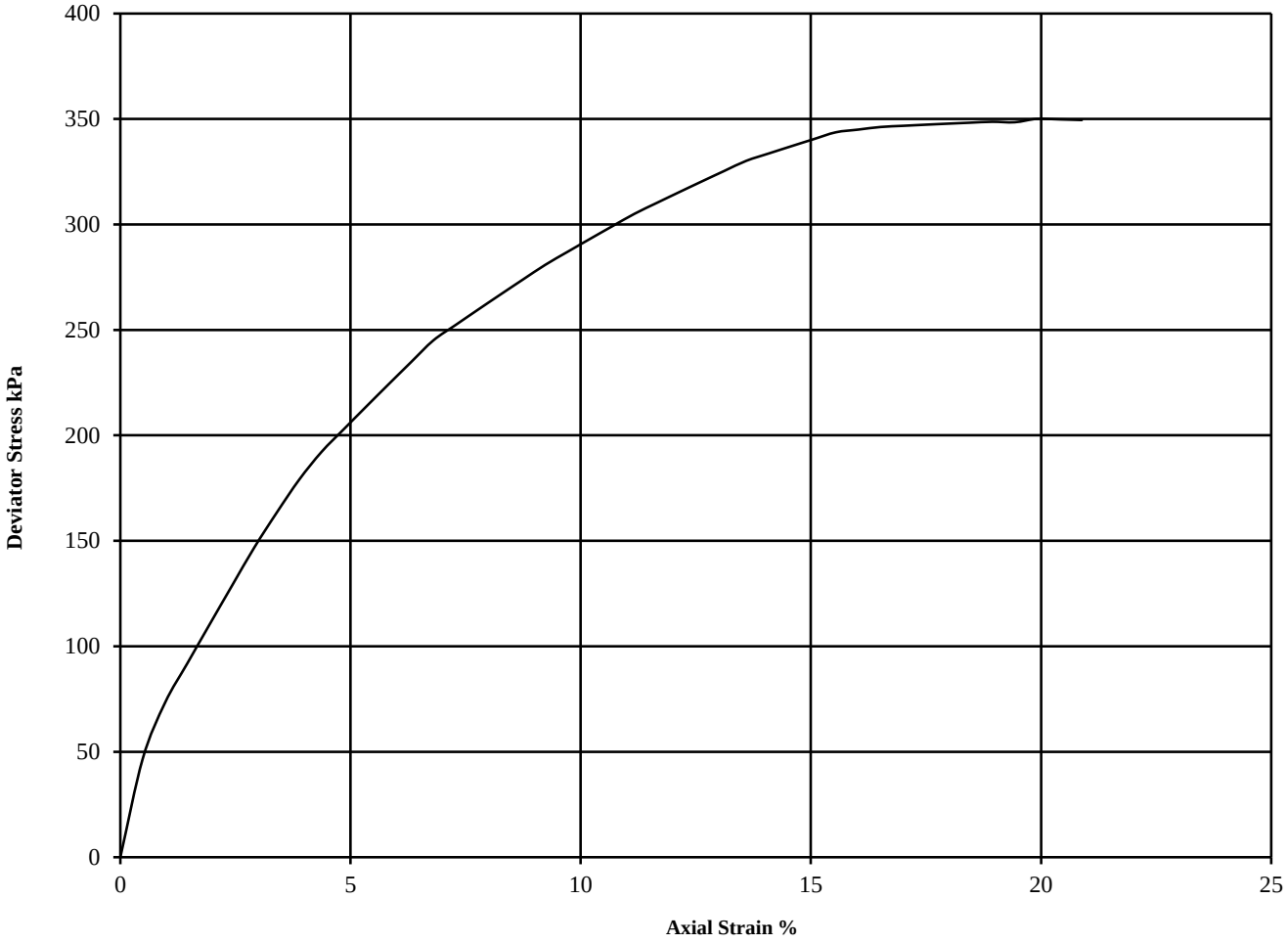
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	BHT	**Date** 28/11/16	**Contract No:** PSL16/5273
		Piccadilly Basin			**Client Ref:** 41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP02**	**Top Depth (m):**	**7.50**
Sample Number:	**14**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.33
1	14	2.19	1.92	150	350	175	19.9	Plastic	See summary of soil descriptions.

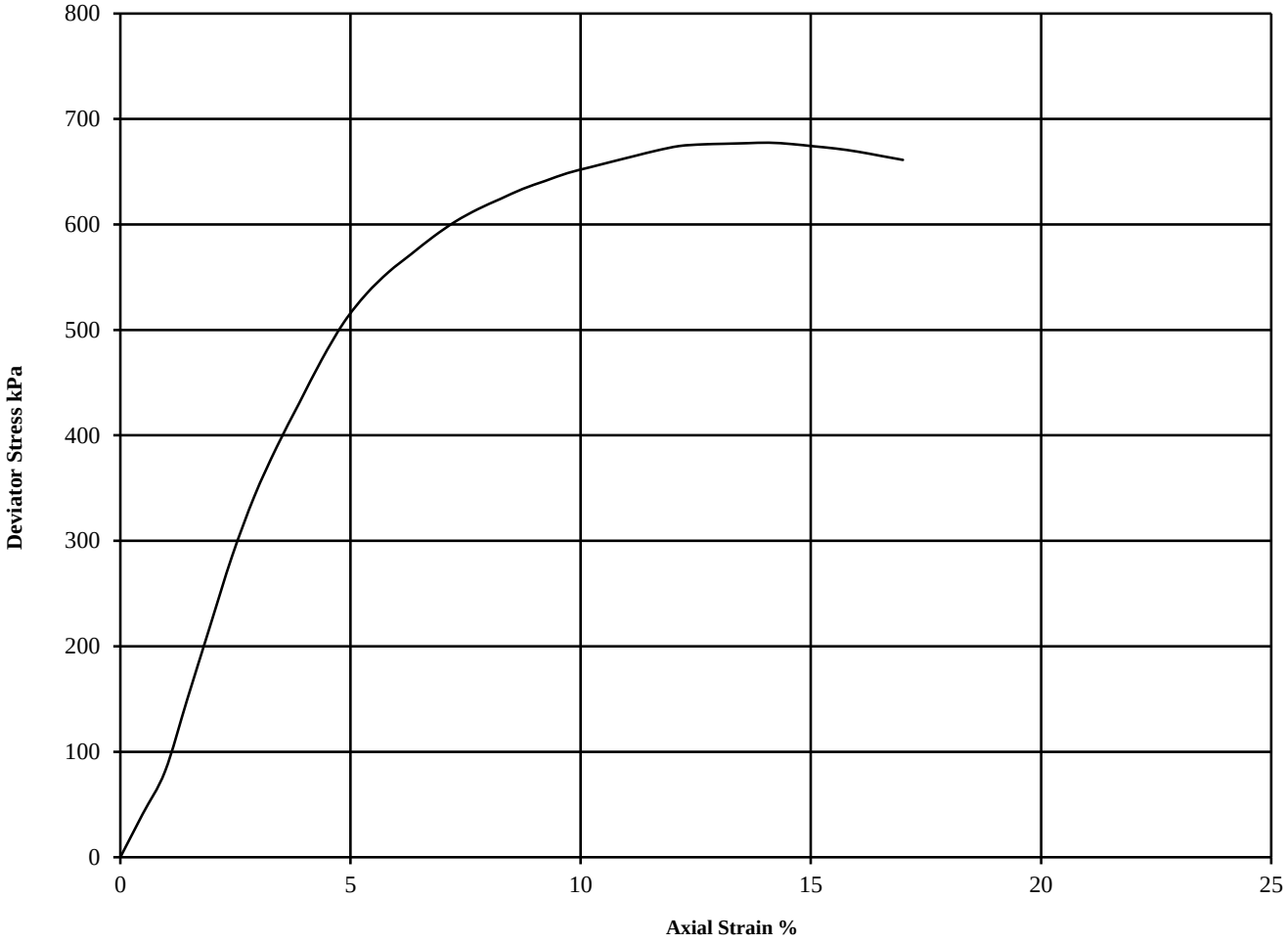
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin			**PSL16/5273**
					Client Ref:
					41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP02**	**Top Depth (m):**	**12.00**
Sample Number:	**20**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.35
1	11	2.19	1.97	240	678	339	14.1	Plastic	See summary of soil descriptions.

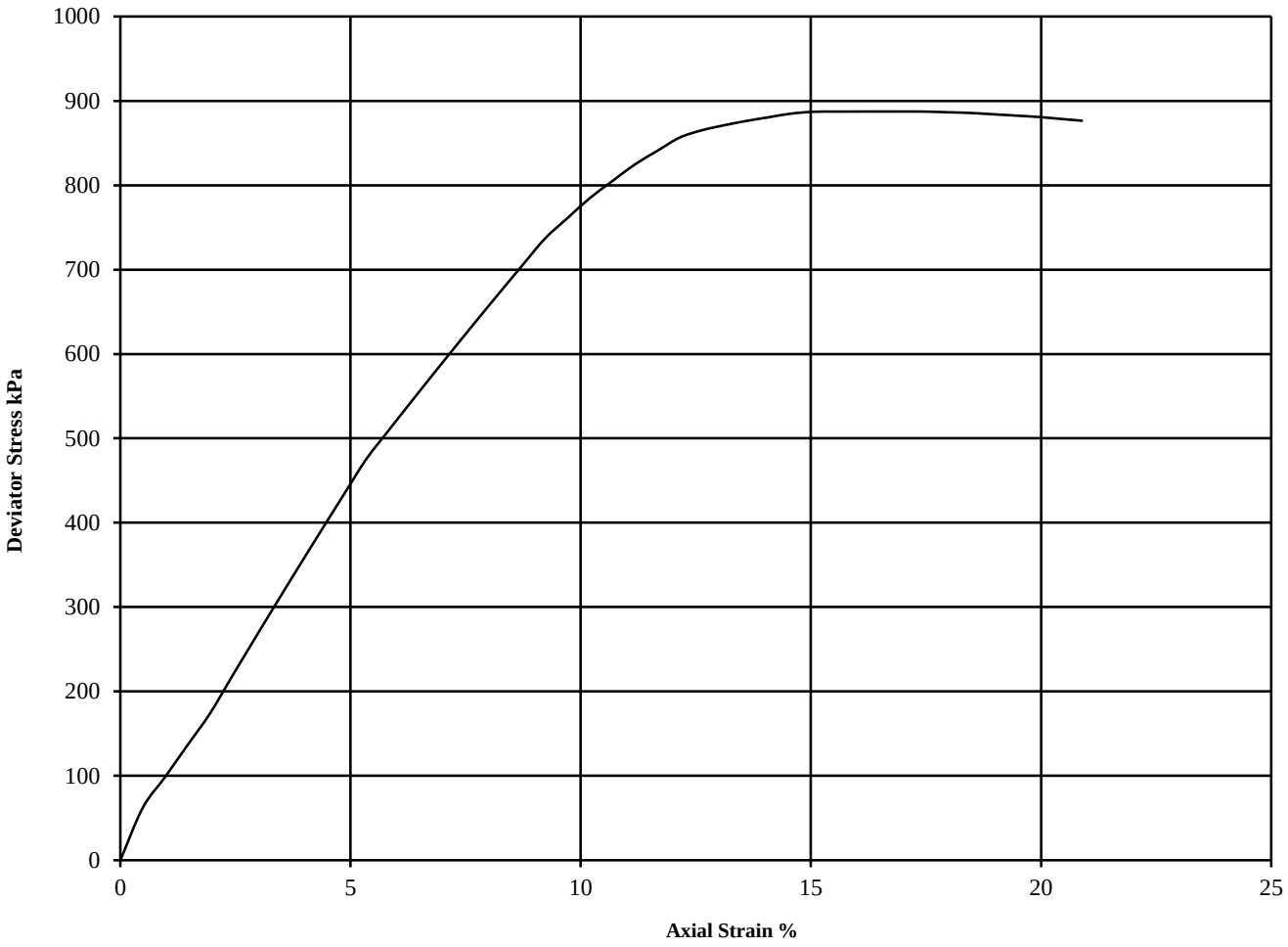
UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	BHH	**Date** 28/11/16	**Contract No:** PSL16/5273
		Piccadilly Basin			**Client Ref:** 41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number:	**CP02**	**Top Depth (m):**	**16.50**
Sample Number:	**28**	**Base Depth (m):**	
Sample Type	**U**		



Diameter (mm):		102.0	Height (mm):		210.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.34
1	10	2.17	1.98	330	887	444	16.5	Plastic	See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	EHT	**Date** 28/11/16	**Contract No:** PSL16/5273
		Piccadilly Basin			**Client Ref:** 41973

UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION

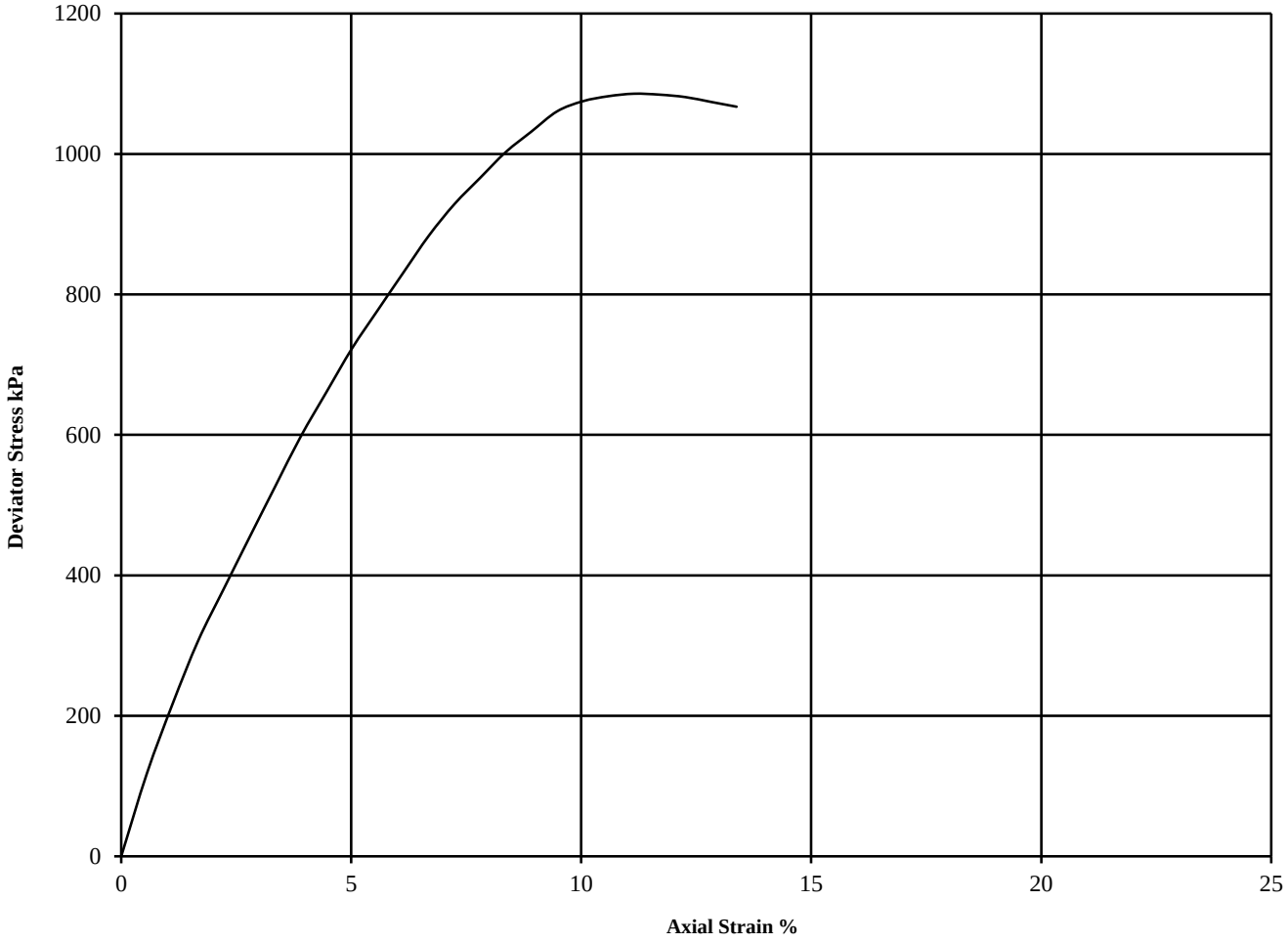
WITHOUT MEASUREMENT OF PORE PRESSURE

BS1377 : Part7 : 1990: Clause 8

Hole Number: CP03 **Top Depth (m):** 10.50

Sample Number: **Base Depth (m):**

Sample Type U



Diameter (mm):		102.0	Height (mm):		183.0	Test:	UU Single Stage		Remarks
Specimen	Moisture Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Cell Pressure (kPa) θ_3	Corr. Max. Deviator Stress (kPa) $(\theta_1-\theta_3)_f$	Shear Strength Cu (kPa) $^1/_2(\theta_1-\theta_3)_f$	Failure Strain (%)	Mode of Failure	Undisturbed Sample Sample taken from top of tube Rate of strain = 2 %/min Latex Membrane used 0.2 mm thick, Correction applied 0.35
1	8.7	2.27	2.08	220	1086	543	11.1	Plastic	See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date**	**28/11/16**	**Contract No:**
		Piccadilly Basin			**PSL16/5273**
					Client Ref:
					41973

ONE DIMENSIONAL CONSOLIDATION TEST

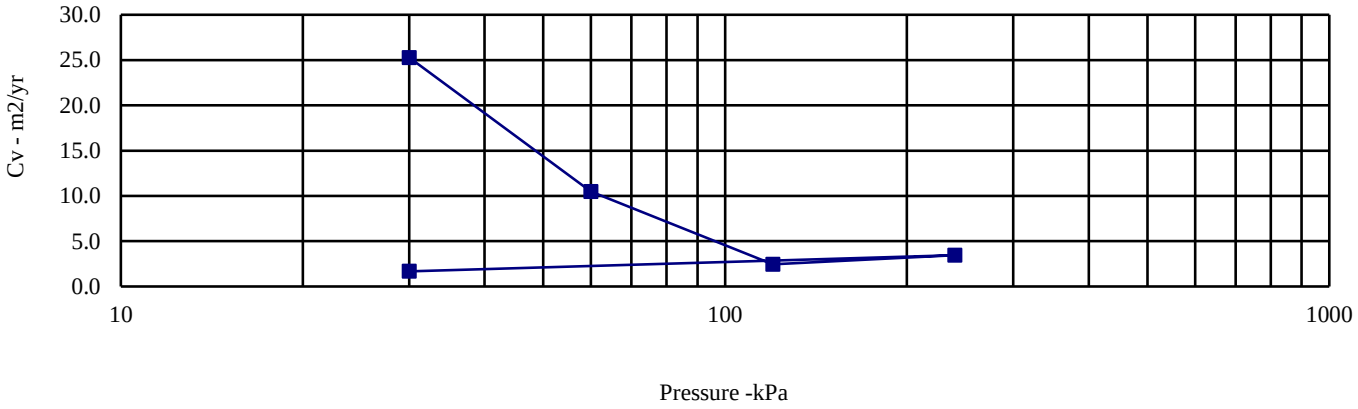
BS 1377: Part 5: 1990: Clause 3

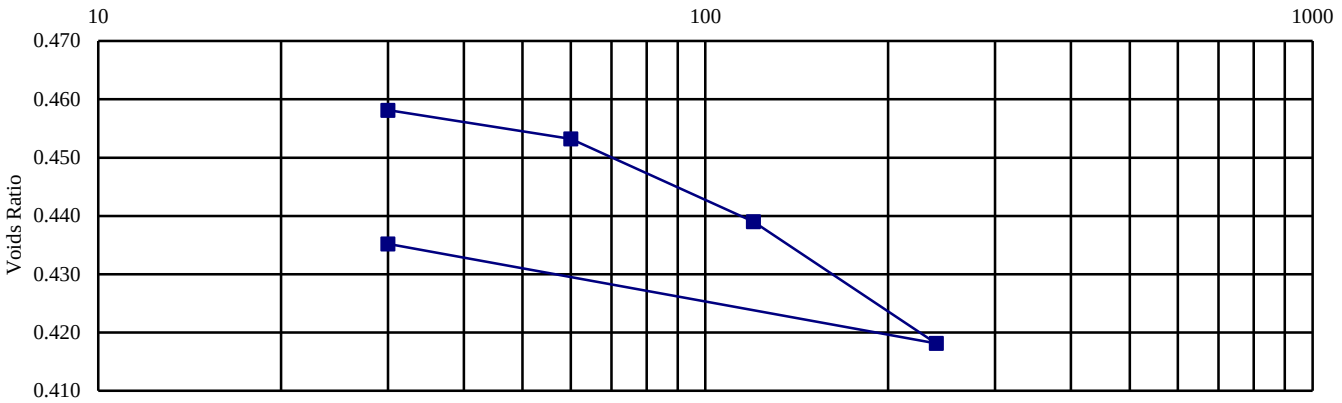
Hole Number: **CP01** **Top Depth (m):** **3.00**

Sample Number: **10** **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	17						
Bulk Density (Mg/m3):	2.12	0	30	0.132	25.285	Method used to	
Dry Density (Mg/m3):	1.81	30	60	0.113	10.485	determine CV:	T90
Voids Ratio:	0.464	60	120	0.163	2.458	Nominal temperature	
Degree of saturation:	97.0	120	240	0.121	3.444	during test ' C:	20
Height (mm):	19.914	240	30	0.057	1.670	Remarks:	
Diameter (mm)	75.02					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved		Date 28/11/16	Contract No: PSL16/5273
		Piccadilly Basin			Client Ref: 41973

ONE DIMENSIONAL CONSOLIDATION TEST

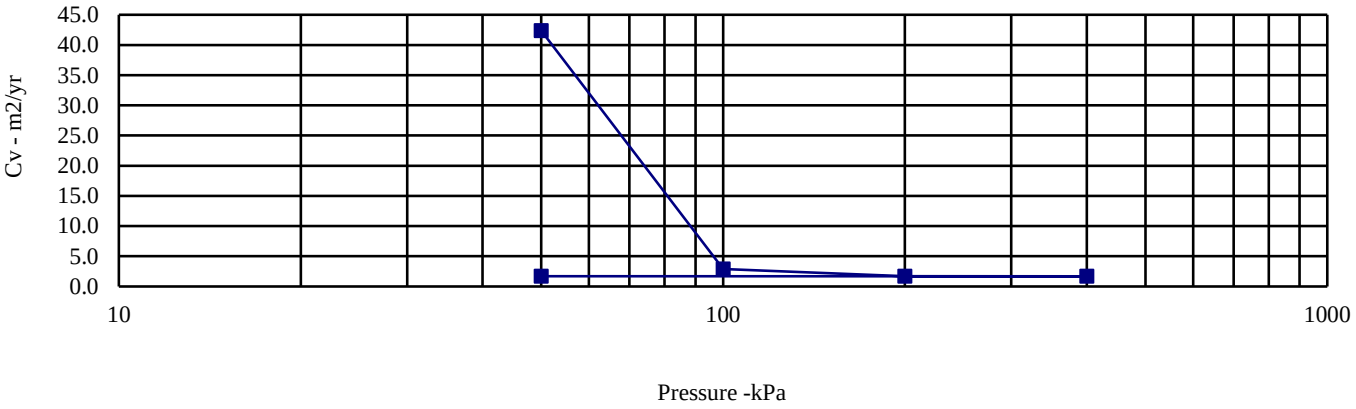
BS 1377: Part 5: 1990: Clause 3

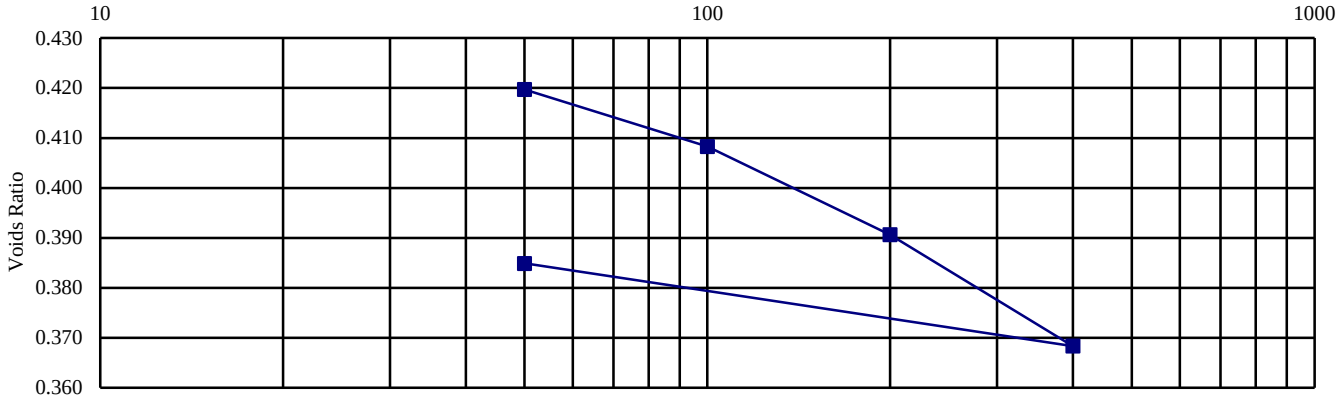
Hole Number: **CP01** **Top Depth (m):** **5.00**

Sample Number: **15** **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	18						
Bulk Density (Mg/m3):	2.12	0	50	0.736	42.377	Method used to	
Dry Density (Mg/m3):	1.80	50	100	0.161	2.913	determine CV:	T90
Voids Ratio:	0.474	100	200	0.125	1.698	Nominal temperature	
Degree of saturation:	99.7	200	400	0.080	1.686	during test ' C:	20
Height (mm):	20.29	400	50	0.035	1.713	Remarks:	
Diameter (mm)	75.038					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043 / PSL Professional Soils Laboratory	Checked / Approved		Date 28/11/16	Contract No: PSL16/5273
	Piccadilly Basin			Client Ref: 41973

ONE DIMENSIONAL CONSOLIDATION TEST

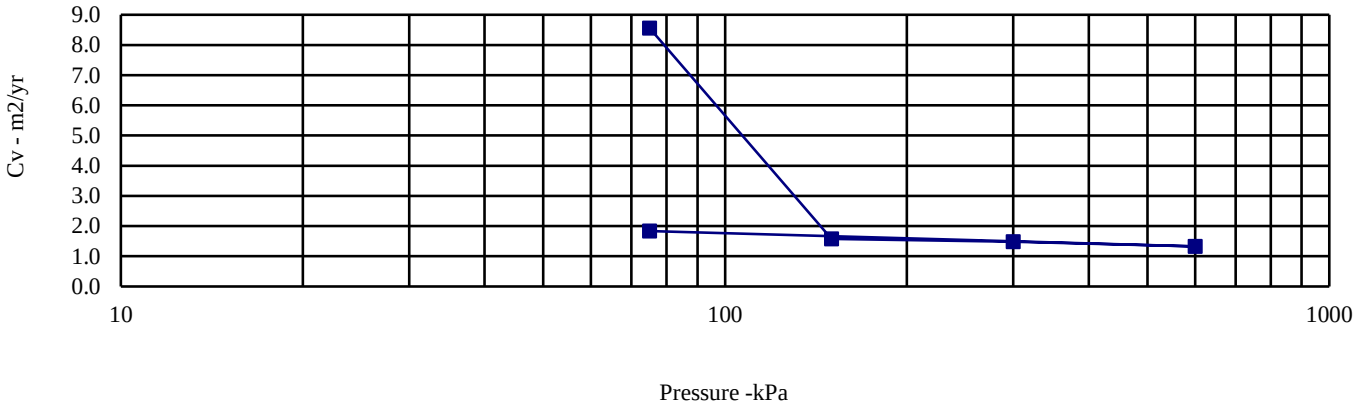
BS 1377: Part 5: 1990: Clause 3

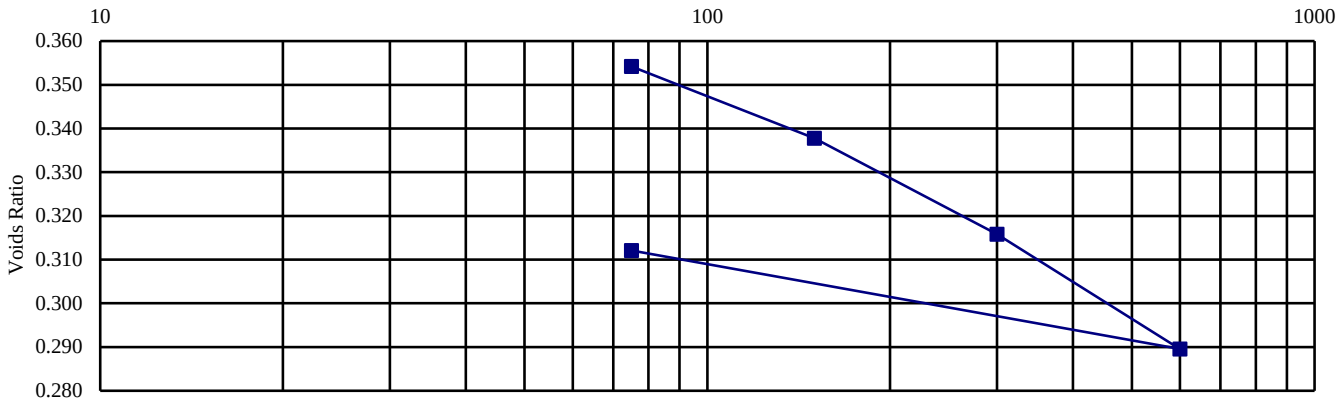
Hole Number: **CP01** **Top Depth (m):** **7.50**

Sample Number: **19** **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	14						
Bulk Density (Mg/m3):	2.18	0	75	0.328	8.558	Method used to	
Dry Density (Mg/m3):	1.91	75	150	0.162	1.572	determine CV:	T90
Voids Ratio:	0.388	150	300	0.109	1.478	Nominal temperature	
Degree of saturation:	98.3	300	600	0.067	1.328	during test ' C:	20
Height (mm):	19.938	600	75	0.033	1.832	Remarks:	
Diameter (mm)	75.053					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043 / PSL Professional Soils Laboratory	Checked / Approved	Date	28/11/16	Contract No: PSL16/5273
	Piccadilly Basin			Client Ref: 41973

ONE DIMENSIONAL CONSOLIDATION TEST

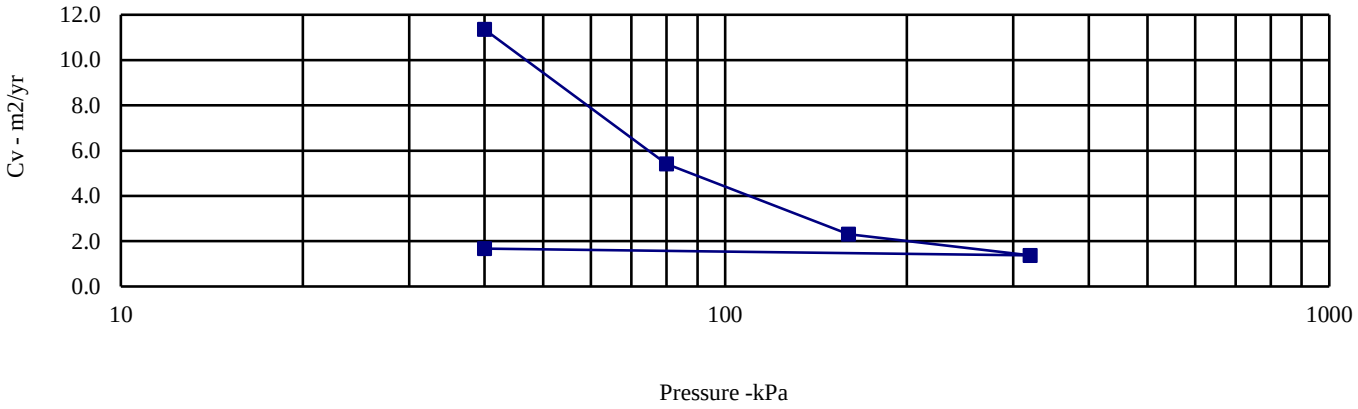
BS 1377: Part 5: 1990: Clause 3

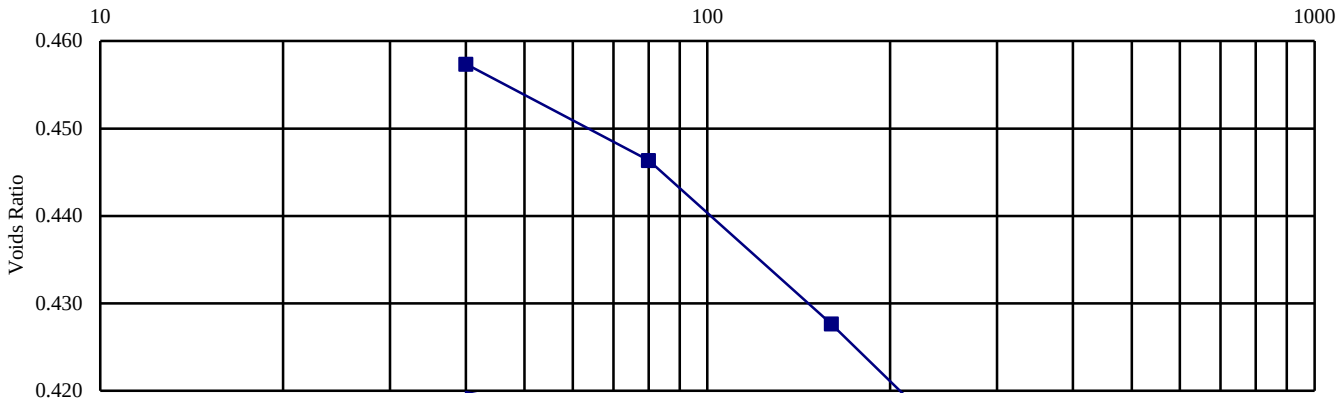
Hole Number: **CP02** **Top Depth (m):** **4.00**

Sample Number: **8** **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	18						
Bulk Density (Mg/m3):	2.12	0	40	0.206	11.351	Method used to	
Dry Density (Mg/m3):	1.80	40	80	0.189	5.419	determine CV:	T90
Voids Ratio:	0.469	80	160	0.162	2.308	Nominal temperature	
Degree of saturation:	100.6	160	320	0.089	1.374	during test ' C:	20
Height (mm):	20.128	320	40	0.032	1.676	Remarks:	
Diameter (mm)	75.04					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043 / PSL Professional Soils Laboratory	Checked / Approved	Date	28/11/16	Contract No: PSL16/5273
	Piccadilly Basin			Client Ref: 41973

ONE DIMENSIONAL CONSOLIDATION TEST

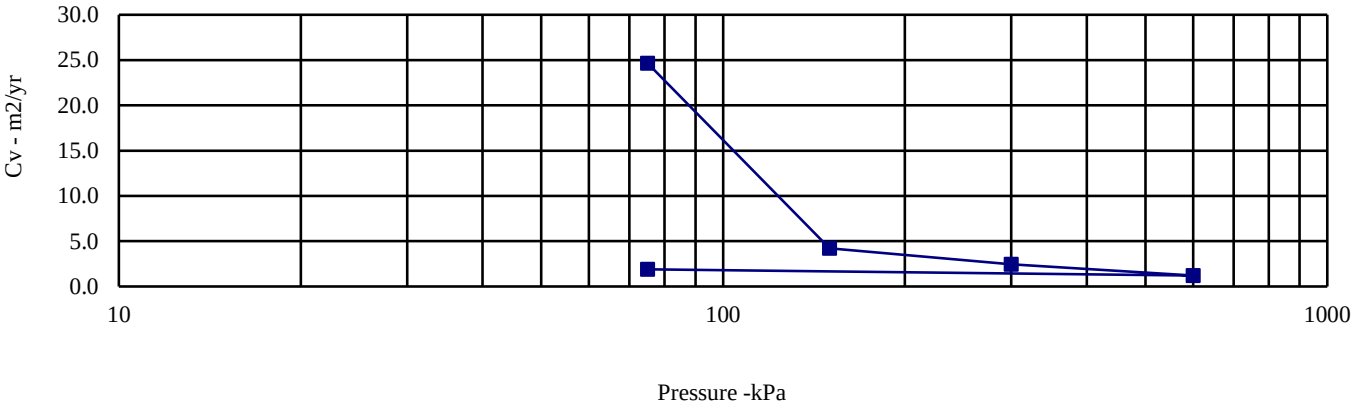
BS 1377: Part 5: 1990: Clause 3

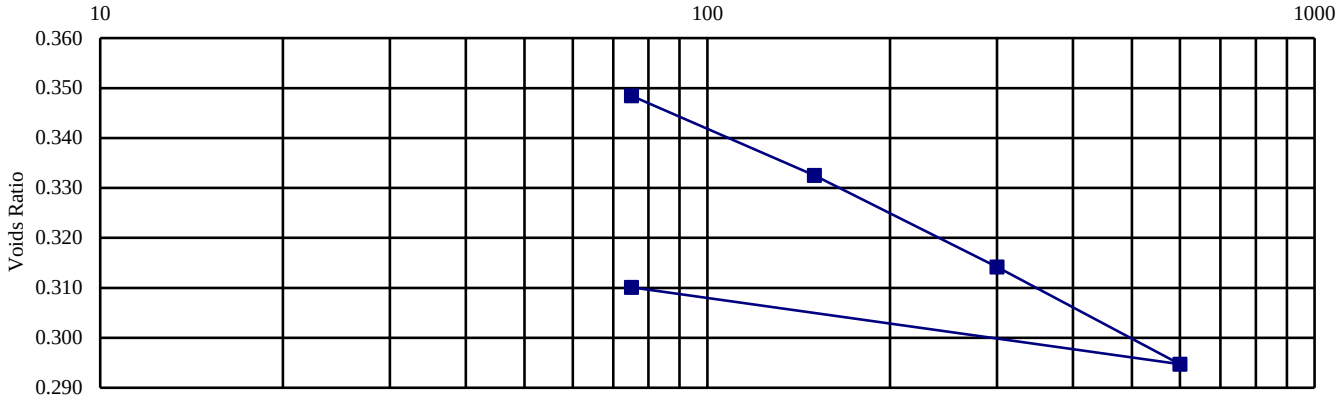
Hole Number: **CP02** **Top Depth (m):** **7.50**

Sample Number: **14** **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	14						
Bulk Density (Mg/m3):	2.21	0	75	0.230	24.651	Method used to	
Dry Density (Mg/m3):	1.93	75	150	0.157	4.212	determine CV:	T90
Voids Ratio:	0.372	150	300	0.092	2.437	Nominal temperature	
Degree of saturation:	103.2	300	600	0.049	1.209	during test ' C:	20
Height (mm):	20.078	600	75	0.023	1.890	Remarks:	
Diameter (mm)	75.128					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043 / PSL Professional Soils Laboratory	Checked / Approved	Date	28/11/16	Contract No: PSL16/5273
	Piccadilly Basin			Client Ref: 41973

ONE DIMENSIONAL CONSOLIDATION TEST

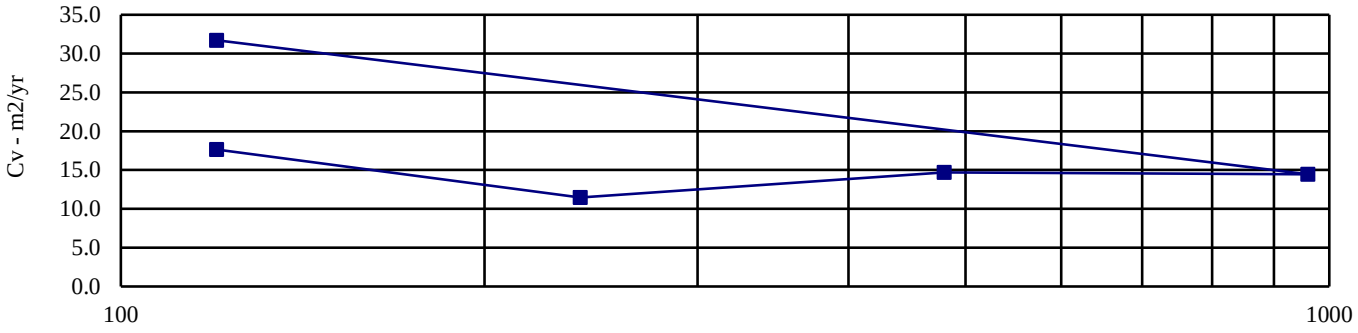
BS 1377: Part 5: 1990: Clause 3

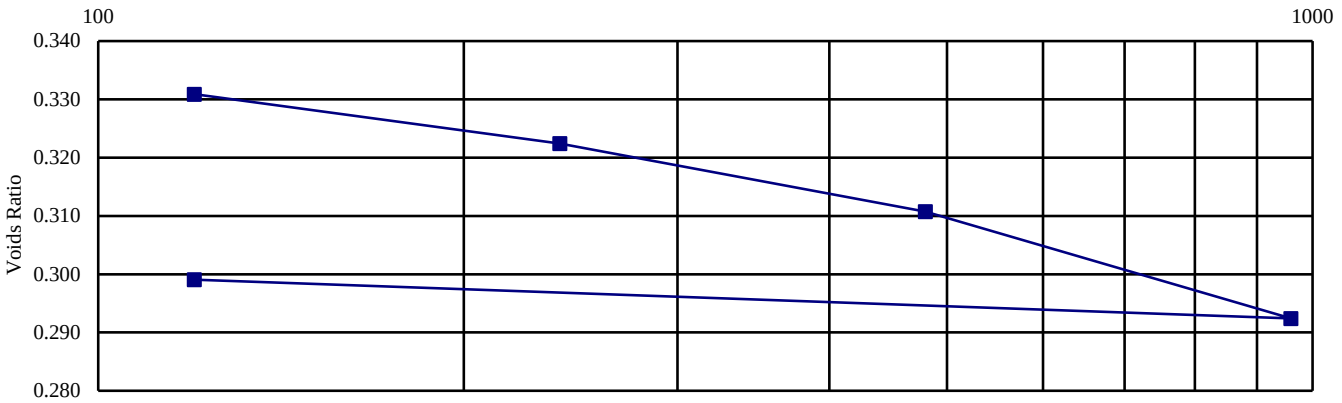
Hole Number: **CP02** **Top Depth (m):** **12.00**

Sample Number: **20** **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	11						
Bulk Density (Mg/m3):	2.17	0	120	0.137	17.644	Method used to	
Dry Density (Mg/m3):	1.96	120	240	0.053	11.464	determine CV:	T90
Voids Ratio:	0.353	240	480	0.037	14.688	Nominal temperature	
Degree of saturation:	80.7	480	960	0.029	14.458	during test ' C:	20
Height (mm):	19.8	960	120	0.006	31.721	Remarks:	
Diameter (mm)	75.028					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043 / PSL Professional Soils Laboratory	Checked / Approved	[illegible]	Date	28/11/16	Contract No: PSL16/5273
	Piccadilly Basin				Client Ref: 41973

ONE DIMENSIONAL CONSOLIDATION TEST

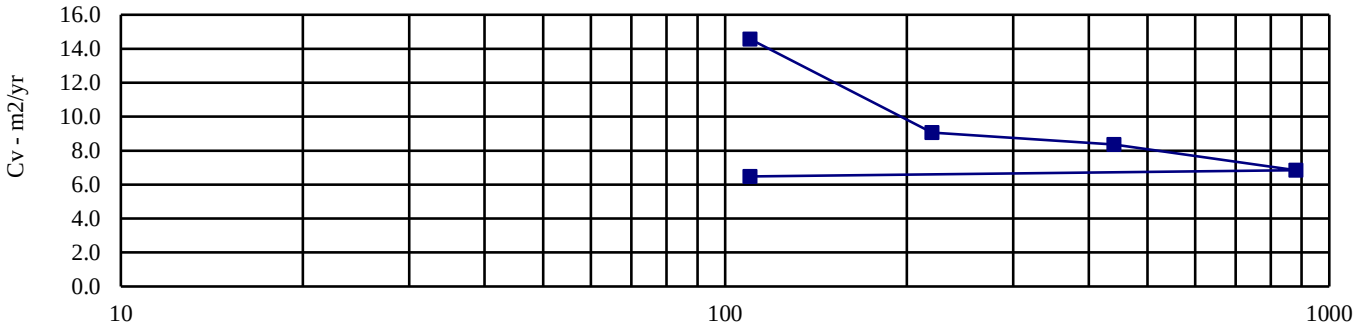
BS 1377: Part 5: 1990: Clause 3

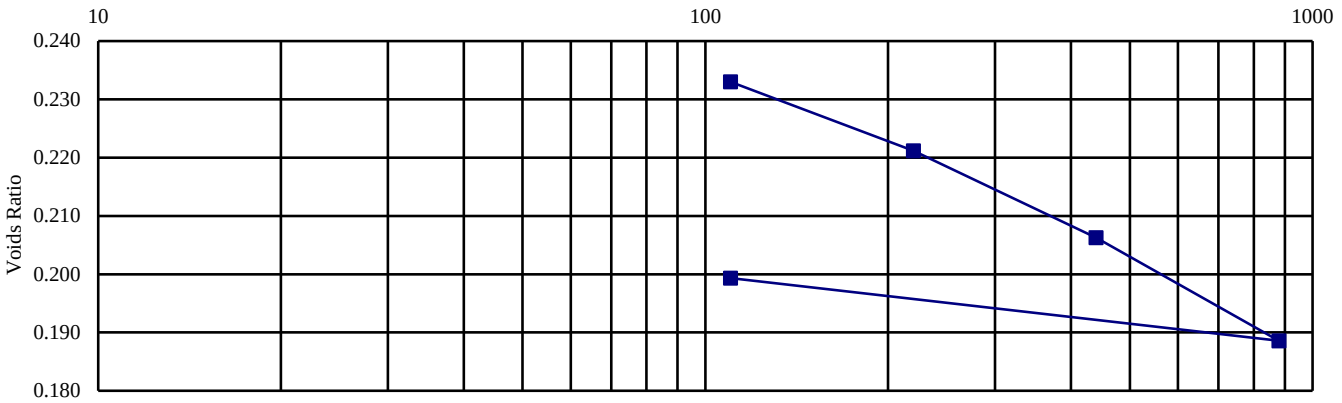
Hole Number: **CP03** **Top Depth (m):** **10.50**

Sample Number: **Base Depth (m) :**

Sample Type: **U**

Initial Conditions		Pressure Range kPa		Mv m2/MN	Cv m2/yr	Specimen location within tube:	Top
Moisture Content (%):	8.8						
Bulk Density (Mg/m3):	2.26	0	110	0.315	14.567	Method used to	
Dry Density (Mg/m3):	2.07	110	220	0.087	9.055	determine CV:	T90
Voids Ratio:	0.277	220	440	0.055	8.363	Nominal temperature	
Degree of saturation:	84.4	440	880	0.033	6.854	during test ' C:	20
Height (mm):	19.986	880	110	0.012	6.481	Remarks:	
Diameter (mm)	75.083					See summary of soils description.	
Particle Density (Mg/m3): Assumed	2.65						





UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved	Date 28/11/16	Contract No: PSL16/5273
		Piccadilly Basin		Client Ref: 41973

SUMMARY OF LABORATORY HAND VANES

(BS1377 : PART 9 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content %	Peak Shear Strength kPa	Residual Shear Strength kPa	Remarks
CP02	32	U	19.50		22	>140		
CP03		U	24.00		12	>140		

UKAS TESTING 4043

PSL Professional Soils Laboratory

Checked / Approved		28/11/16	Contract No:
Piccadilly Basin			PSL16/5273
			Client Ref:
			41973

Derwentside Environmental Testing Services

Certificate of Analysis

Certificate Number 16-83839

18-Nov-16

Client Professional Soils Laboratory Ltd
5/7 Hexthorpe Road
Hexthorpe
DN4 0AR

Our Reference	16-83839
Client Reference	PSL16/5273
Order No	(not supplied)
Contract Title	41973 Picadilly Basin
Description	7 Soil samples.
Date Received	14-Nov-16
Date Started	14-Nov-16
Date Completed	18-Nov-16
Test Procedures	Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Rob Brown
Business Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 16-83839
Client Ref PSL16/5273
Contract Title 41973 Picadilly Basin

			Lab No	1083372	1083373	1083374	1083375	1083376	1083377	1083378
			Sample ID	CP01	CP01	CP02	CP02	CP02	CP03	CP03
			Depth	3.00	7.50	7.50	12.00	19.50	10.50	24.00
			Other ID							
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	n/s	n/s	n/s	n/s	n/s	n/s	n/s
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Inorganics										
pH	DETSC 2008#			8.6	8.7	8.8	8.8	8.8	8.6	8.4
Chloride Aqueous Extract	DETSC 2055	1	mg/l	14	12		2.6		6.7	
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	82	58	29	26	25	63	67

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 16-83839
Client Ref PSL16/5273
Contract 41973 Picadilly Basin

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1083372	CP01 3.00 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1083373	CP01 7.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1083374	CP02 7.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1083375	CP02 12.00 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1083376	CP02 19.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1083377	CP03 10.50 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	
1083378	CP03 24.00 SOIL		PT 500ml	Sample date not supplied, Anions 2:1 (365 days), pH + Conductivity (7 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

LABORATORY REPORT

4043

Contract Number: PSL16/5564

Report Date: 07 December 2016

Client's Reference: 41973

Client Name: Ian Farmer Associates
4 Faraday Close
Washington
Tyne & Wear
NE38 9QJ

For the attention of: Tim Downes

Contract Title: Piccadilly Basin

Date Received: 24/11/2016
Date Commenced: 24/11/2016
Date Completed: 7/12/2016

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
D Lambe (Senior Technician)	S Royle (Senior Technician)	A Fry (Senior Technician)

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SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

Borehole Number	Depth (m)	Sample Ref	Test Type	Orientation	Dimensions (mm)		Area	D_e^2	D_e	Failure Load (P)		I_s	Corr Fac	I_{s50}	Failure Type	Remarks
				Par / Perp	W	D	(mm2)		(mm)	(Mpa)	(kN)	(MPa)	F	(MPa)		
RT01	27.00	1	A	Par	85	45	3825	4870.14	69.79	-	1.21	0.248	1.162	0.29	Valid	
RT01	27.00	1	A	Par	85	35	2975	3787.89	61.55	-	0.86	0.227	1.098	0.25	Valid	
RT01	29.10	3	A	Par	85	37	3145	4004.34	63.28	-	0.83	0.207	1.112	0.23	Valid	
RT01	29.10	3	A	Par	85	30	2550	3246.76	56.98	-	1.02	0.314	1.061	0.33	Valid	
RT02	28.60	1	A	Par	85	50	4250	5411.27	73.56	-	0.50	0.092	1.190	0.11	Valid	
RT02	28.60	1	A	Par	85	45	3825	4870.14	69.79	-	0.39	0.080	1.162	0.09	Valid	
RT02	29.70	2	A	Par	85	40	3400	4329.01	65.80	-	0.59	0.136	1.131	0.15	Valid	
RT02	29.70	2	A	Par	85	42	3570	4545.47	67.42	-	0.66	0.145	1.144	0.17	Valid	
CP02	25.75	1	A	Par	85	59	5015	6385.30	79.91	-	0.55	0.086	1.235	0.11	Valid	
CP02	25.75	1	A	Par	85	46	3910	4978.37	70.56	-	0.61	0.123	1.168	0.14	Valid	
CP02	26.35	2	A	Par	85	43	3655	4653.69	68.22	-	0.57	0.122	1.150	0.14	Valid	
CP02	26.35	2	A	Par	85	38	3230	4112.56	64.13	-	0.61	0.148	1.119	0.17	Valid	

Note All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular

UKAS TESTING 4043	PSL Professional Soils Laboratory	Checked / Approved	Date 07/12/16	Contract No: PSL16/5564
		Piccadilly Basin		Client Ref: 41973

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

Borehole Number	Depth (m)	Sample Ref	Test Type	Orientation	Dimensions (mm)		D_e^2	D_e	Failure Load		I_s	Corr Fac	I_{s50}	Failure Type	Remarks
				Par / Perp	L	D		(mm)	(Mpa)	(kN)	(MPa)	F	(MPa)		
RT01	27.00	1	D	Perp		85	7225	85.00	-	0.88	0.122	1.270	0.15	Valid	
RT01	27.00	1	D	Perp		85	7225	85.00	-	0.66	0.091	1.270	0.12	Valid	
RT01	29.10	3	D	Perp		85	7225	85.00	-	0.42	0.058	1.270	0.07	Valid	
RT01	29.10	3	D	Perp		85	7225	85.00	-	0.70	0.097	1.270	0.12	Valid	
RT02	28.60	1	D	Perp		85	7225	85.00	-	0.25	0.035	1.270	0.04	Valid	
RT02	28.60	1	D	Perp		85	7225	85.00	-	0.21	0.029	1.270	0.04	Valid	
RT02	29.70	2	D	Perp		85	7225	85.00	-	0.41	0.057	1.270	0.07	Valid	
RT02	29.70	2	D	Perp		85	7225	85.00	-	0.52	0.072	1.270	0.09	Valid	
CP02	25.75	1	D	Perp		85	7225	85.00	-	0.47	0.065	1.270	0.08	Valid	
CP02	25.75	1	D	Perp		85	7225	85.00	-	0.58	0.080	1.270	0.10	Valid	
CP02	26.35	2	D	Perp		85	7225	85.00	-	0.47	0.065	1.270	0.08	Valid	
CP02	26.35	2	D	Perp		85	7225	85.00	-	0.49	0.068	1.270	0.09	Valid	

Note All testing carried out on samples at as received water content Par = parallel, Perp = perpendicular

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date** 07/12/16	**Contract No:** PSL16/5564
		Piccadilly Basin		**Client Ref:** 41973

DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

Hole Number	Sample Number	Sample Type	Top Depth (m)	Base Depth (m)	Sample Diameter (mm)	Sample Length (mm)	Height Ratio	Initial Mass (g)	Bulk Density (Mg/m)	Moisture Content (%)	Dry Density (Mg/m)	Load Failure (kN)	UCS (MPa)	Failure Mode	Date Tested	Remarks
RT01	2	C	28.05	28.30	85	200	2.4	2527	2.23	14	1.95	56.1	9.9	Brittle	07/12/16	
RT02	3	C	30.70	30.95	85	201	2.4	2537	2.22	15	1.93	51.0	9.0	Brittle	07/12/16	
CP02	3	C	26.60	26.90	85	200	2.4	2486	2.19	13	1.94	34.9	6.1	Brittle	07/12/16	

PSL Professional Soils Laboratory	Checked / Approved	AP	Date	07/12/16	Contract No:
	Piccadilly Basin				PSL16/5564
					Client Ref:
					41973

Appendix D Chemical Tests

SCIENTIFIC ANALYSIS LABORATORIES
DELIVERING SCIENCE

Scientific Analysis Laboratories is a limited company registered in England and Wales (No 2514788) whose address is at Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 611478-1

Date of Report: 14-Nov-2016

Customer: Ian Farmer Associates
14-15 Rufford Court
Hardwick Grange
Warrington
Cheshire
WA1 4RF

Customer Contact: Mr Tim Downes

Customer Job Reference: 41793
Customer Purchase Order: 41655
Customer Site Reference: Piccadilly Basin
Date Job Received at SAL: 27-Oct-2016
Date Analysis Started: 02-Nov-2016
Date Analysis Completed: 14-Nov-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Stefan Kondziela
Project Manager

Issued by :
Stefan Kondziela
Project Manager

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
MCERTS Preparation

SAL Reference	**611478 001**	**611478 002**	**611478 003**	**611478 004**	**611478 005**
Customer Sample Reference	**WS03**	**WS05**	**WS08**	**WS08**	**WS10**
Bottom Depth	**0.3**	**0.5**	**1.0**	**2.6**	**0.9**
Date Sampled	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**	**26-OCT-2016**
Type	**Clay**	**Sandy Soil**	**Sandy Soil**	**Clay**	**Clay**

Determinand	Method	Test Sample	LOD	Units					
Moisture @105C	T162	AR	0.1	%	**15**	**9.7**	**7.8**	**15**	**21**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1	<0.1

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
MCERTS Preparation

SAL Reference	**611478 006**	**611478 007**	**611478 008**	**611478 009**
Customer Sample Reference	**WS11**	**WS13**	**BH01**	**BH01**
Bottom Depth	**0.6**	**1.0**	**0.2**	**2.0**
Date Sampled	**26-OCT-2016**	**26-OCT-2016**	**24-OCT-2016**	**24-OCT-2016**
Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units				
Moisture @105C	T162	AR	0.1	%	**8.5**	**15**	**7.4**	**6.7**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1	<0.1

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
Miscellaneous

SAL Reference	**611478 001**	**611478 002**	**611478 003**	**611478 004**	**611478 005**
Customer Sample Reference	**WS03**	**WS05**	**WS08**	**WS08**	**WS10**
Bottom Depth	**0.3**	**0.5**	**1.0**	**2.6**	**0.9**
Date Sampled	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**	**26-OCT-2016**
Type	**Clay**	**Sandy Soil**	**Sandy Soil**	**Clay**	**Clay**

Determinand	Method	Test Sample	LOD	Units					
Asbestos ID	T27	AR			N.D.	Chrysotile Detected	N.D.	N.D.	N.D.
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	**10**	**10**	**8.8**	**9.0**	**9.4**
Chloride (2:1)	T686	AR	0.5	mg/l	**5.1**	**3.9**	**21**	**15**	**7.1**
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1
Cyanide(free)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
pH	T7	AR			**7.8**	**9.3**	**8.9**	**8.7**	**8.4**
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1	<1
Soil Organic Matter	T287	M40	0.1	%	**3.1**	**5.1**	**6.5**	**1.6**	**2.7**
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	**0.02**	**0.01**	<0.01	**0.01**	**0.11**
SO4(Total)	T6	A40	0.01	%	**0.04**	**0.14**	**0.09**	**0.03**	**0.09**
Sulphide	T4	AR	10	mg/kg	<10	<10	<10	<10	<10

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
Miscellaneous

					SAL Reference	**611478 006**	**611478 007**	**611478 008**	**611478 009**
					Customer Sample Reference	**WS11**	**WS13**	**BH01**	**BH01**
					Bottom Depth	**0.6**	**1.0**	**0.2**	**2.0**
					Date Sampled	**26-OCT-2016**	**26-OCT-2016**	**24-OCT-2016**	**24-OCT-2016**
					Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Asbestos ID	T27	AR			N.D.	N.D.	N.D.	N.D.
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	**8.4**	**13**	**9.0**	**9.7**
Chloride (2:1)	T686	AR	0.5	mg/l	**1.5**	**3.0**	**3.7**	**3.0**
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1
Cyanide(free)	T546	AR	1	mg/kg	<1	<1	<1	<1
pH	T7	AR			**9.0**	**8.4**	**8.6**	**8.6**
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1	<1
Soil Organic Matter	T287	M40	0.1	%	**6.6**	**1.5**	**4.2**	**5.2**
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	**0.08**	**0.06**	**0.03**	**0.01**
SO4(Total)	T6	A40	0.01	%	**0.22**	**0.22**	**0.16**	**0.15**
Sulphide	T4	AR	10	mg/kg	<10	<10	<10	<10

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
Heavy Metals(9)

					SAL Reference	**611478 001**	**611478 002**	**611478 003**	**611478 004**	**611478 005**
					Customer Sample Reference	**WS03**	**WS05**	**WS08**	**WS08**	**WS10**
					Bottom Depth	**0.3**	**0.5**	**1.0**	**2.6**	**0.9**
					Date Sampled	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**	**26-OCT-2016**
					Type	**Clay**	**Sandy Soil**	**Sandy Soil**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**						
Arsenic	T6	M40	2	mg/kg	**9**	**11**	**13**	**9**	**10**
Cadmium	T6	M40	1	mg/kg	<1	**1**	<1	<1	<1
Chromium	T6	M40	1	mg/kg	**27**	**20**	**15**	**34**	**29**
Copper	T6	M40	1	mg/kg	**35**	**58**	**63**	**26**	**27**
Lead	T6	M40	1	mg/kg	**50**	**150**	**360**	**22**	**30**
Mercury	T6	M40	1	mg/kg	<1	<1	**2**	<1	<1
Nickel	T6	M40	1	mg/kg	**31**	**14**	**17**	**37**	**40**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**67**	**200**	**140**	**65**	**66**

SCIENTIFIC ANALYSIS LABORATORIES

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
Heavy Metals(9)

SAL Reference					611478 006	611478 007	611478 008	611478 009
Customer Sample Reference					WS11	WS13	BH01	BH01
Bottom Depth					0.6	1.0	0.2	2.0
Date Sampled					26-OCT-2016	26-OCT-2016	24-OCT-2016	24-OCT-2016
Type					Sandy Soil	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	**Method**	**Test Sample**	**LOD**	**Units**				
Arsenic	T6	M40	2	mg/kg	**40**	**18**	**10**	**9**
Cadmium	T6	M40	1	mg/kg	<1	**2**	**1**	<1
Chromium	T6	M40	1	mg/kg	**19**	**25**	**18**	**16**
Copper	T6	M40	1	mg/kg	**120**	**110**	**44**	**44**
Lead	T6	M40	1	mg/kg	**1400**	**730**	**170**	**110**
Mercury	T6	M40	1	mg/kg	<1	<1	<1	<1
Nickel	T6	M40	1	mg/kg	**27**	**23**	**15**	**13**
Selenium	T6	M40	3	mg/kg	<3	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**190**	**330**	**210**	**190**

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

SAL Reference					611478 001	611478 002	611478 003	611478 004	611478 005
Customer Sample Reference					WS03	WS05	WS08	WS08	WS10
Bottom Depth					0.3	0.5	1.0	2.6	0.9
Date Sampled					27-OCT-2016	27-OCT-2016	27-OCT-2016	27-OCT-2016	26-OCT-2016
Type					Clay	Sandy Soil	Sandy Soil	Clay	Clay
Determinand	**Method**	**Test Sample**	**LOD**	**Units**					
Naphthalene	T207	M105	0.1	mg/kg	<0.1	<0.1	**2.3**	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	**0.6**	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	<0.1	**0.2**	**1.7**	<0.1	<0.1
Fluorene	T207	M105	0.1	mg/kg	<0.1	**0.2**	**2.3**	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	<0.1	**1.9**	**12**	<0.1	<0.1
Anthracene	T207	M105	0.1	mg/kg	<0.1	**0.5**	**3.0**	<0.1	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	<0.1	**2.9**	**10**	<0.1	<0.1
Pyrene	T207	M105	0.1	mg/kg	<0.1	**2.6**	**10**	<0.1	<0.1
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	<0.1	**1.7**	**7.4**	<0.1	<0.1
Chrysene	T207	M105	0.1	mg/kg	<0.1	**1.2**	**5.9**	<0.1	<0.1
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	<0.1	**1.8**	**8.2**	<0.1	<0.1
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	<0.1	**0.6**	**2.6**	<0.1	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	<0.1	**1.4**	**6.6**	<0.1	<0.1
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	<0.1	**0.8**	**3.2**	<0.1	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	<0.1	**0.2**	**0.9**	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	<0.1	**0.8**	**3.6**	<0.1	<0.1
PAH(total)	T207	M105	0.1	mg/kg	<0.1	**17**	**80**	<0.1	<0.1

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

SAL Reference	**611478 006**	**611478 007**	**611478 008**	**611478 009**
Customer Sample Reference	**WS11**	**WS13**	**BH01**	**BH01**
Bottom Depth	**0.6**	**1.0**	**0.2**	**2.0**
Date Sampled	**26-OCT-2016**	**26-OCT-2016**	**24-OCT-2016**	**24-OCT-2016**
Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units				
Naphthalene	T207	M105	0.1	mg/kg	**0.2**	**0.8**	<0.1	<0.1
Acenaphthylene	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T207	M105	0.1	mg/kg	**0.6**	**0.4**	**0.1**	<0.1
Fluorene	T207	M105	0.1	mg/kg	**0.4**	**0.5**	<0.1	<0.1
Phenanthrene	T207	M105	0.1	mg/kg	**3.5**	**3.6**	**1.0**	**0.2**
Anthracene	T207	M105	0.1	mg/kg	**0.9**	**0.8**	**0.3**	<0.1
Fluoranthene	T207	M105	0.1	mg/kg	**4.6**	**3.7**	**1.5**	**0.3**
Pyrene	T207	M105	0.1	mg/kg	**4.3**	**3.7**	**1.3**	**0.3**
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	**2.8**	**2.2**	**0.8**	**0.2**
Chrysene	T207	M105	0.1	mg/kg	**2.4**	**1.9**	**0.6**	**0.2**
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	**2.7**	**2.1**	**0.9**	**0.2**
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	**1.1**	**0.8**	**0.3**	<0.1
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	**2.3**	**1.9**	**0.6**	**0.2**
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	**1.1**	**0.9**	**0.3**	<0.1
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	**0.3**	**0.2**	<0.1	<0.1
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	**1.3**	**1.0**	**0.4**	<0.1
PAH(total)	T207	M105	0.1	mg/kg	**29**	**25**	**8.1**	**1.5**

SAL Reference: 611478
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
TPH (CWG) with MTBE, BTEX

SAL Reference	**611478 001**	**611478 003**
Customer Sample Reference	**WS03**	**WS08**
Bottom Depth	**0.3**	**1.0**
Date Sampled	**27-OCT-2016**	**27-OCT-2016**
Type	**Clay**	**Sandy Soil**

Determinand	Method	Test Sample	LOD	Units		
Benzene	T209	M40	0.010	mg/kg	(13) <0.010	(13) <0.010
Toluene	T209	M40	0.010	mg/kg	<0.010	<0.010
EthylBenzene	T209	M40	0.010	mg/kg	<0.010	<0.010
M/P Xylene	T209	M40	0.010	mg/kg	<0.010	<0.010
O Xylene	T209	M40	0.010	mg/kg	<0.010	<0.010
Methyl tert-Butyl Ether	T209	M40	0.010	mg/kg	<0.010	<0.010
TPH (C5-C6 aliphatic)	T209	M40	0.100	mg/kg	<0.100	<0.100
TPH (C6-C8 aliphatic)	T209	M40	0.10	mg/kg	<0.10	<0.10
TPH (C8-C10 aliphatic)	T209	M40	0.10	mg/kg	<0.10	<0.10
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	(13) <1	(13) <1
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	(13) <1	**(13) 5**
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	(13) <1	**(13) 8**
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	**(13) 2**	**(13) 17**
TPH (C6-C7 aromatic)	T209	M40	0.10	mg/kg	<0.10	<0.10
TPH (C7-C8 aromatic)	T209	M40	0.10	mg/kg	<0.10	<0.10
TPH (C8-C10 aromatic)	T209	M40	0.10	mg/kg	<0.10	<0.10
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	(13) <2	**(13) 5**
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	(13) <1	**(13) 37**
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	(13) <1	**(13) 160**
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	(13) <1	**(13) 220**

Index to symbols used in 611478-1

Value	Description
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
AR	As Received
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
A40	Assisted dried < 40C
N.D.	Not Detected
13	Results have been blank corrected.
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T287	Calc TOC/0.58
T2	Grav
T207	GC/MS (MCERTS)
T686	Discrete Analyser
T909	GCxGC
T546	Colorimetry (CF)
T6	ICP/OES
T162	Grav (1 Dec) (105 C)
T209	GC/MS (Head Space)(MCERTS)
T7	Probe
T4	Colorimetry
T27	PLM

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Asbestos ID	T27	AR			SU	001-009
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	N	001-009
Chloride (2:1)	T686	AR	0.5	mg/l	N	001-009
Chromium VI	T6	AR	1	mg/kg	N	001-009
Cyanide(free)	T546	AR	1	mg/kg	M	001-009
pH	T7	AR			M	001-009
Phenols(Mono)	T546	AR	1	mg/kg	M	001-009
Soil Organic Matter	T287	M40	0.1	%	N	001-009
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-009
SO4(Total)	T6	A40	0.01	%	N	001-009
Sulphide	T4	AR	10	mg/kg	N	001-009
Arsenic	T6	M40	2	mg/kg	M	001-009
Cadmium	T6	M40	1	mg/kg	M	001-009
Chromium	T6	M40	1	mg/kg	M	001-009
Copper	T6	M40	1	mg/kg	M	001-009
Lead	T6	M40	1	mg/kg	M	001-009
Mercury	T6	M40	1	mg/kg	M	001-009
Nickel	T6	M40	1	mg/kg	M	001-009
Selenium	T6	M40	3	mg/kg	M	001-009
Zinc	T6	M40	1	mg/kg	M	001-009
Moisture @105C	T162	AR	0.1	%	N	001-009
Retained on 10mm sieve	T2	M40	0.1	%	N	001-009
Naphthalene	T207	M105	0.1	mg/kg	M	001-009
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-009
Acenaphthene	T207	M105	0.1	mg/kg	M	001-009
Fluorene	T207	M105	0.1	mg/kg	M	001-009
Phenanthrene	T207	M105	0.1	mg/kg	M	001-009
Anthracene	T207	M105	0.1	mg/kg	U	001-009
Fluoranthene	T207	M105	0.1	mg/kg	M	001-009

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Pyrene	T207	M105	0.1	mg/kg	M	001-009
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-009
Chrysene	T207	M105	0.1	mg/kg	M	001-009
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-009
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-009
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-009
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-009
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-009
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-009
PAH(total)	T207	M105	0.1	mg/kg	U	001-009
Benzene	T209	M40	0.010	mg/kg	M	001,003
Toluene	T209	M40	0.010	mg/kg	M	001,003
EthylBenzene	T209	M40	0.010	mg/kg	M	001,003
M/P Xylene	T209	M40	0.010	mg/kg	M	001,003
O Xylene	T209	M40	0.010	mg/kg	M	001,003
Methyl tert-Butyl Ether	T209	M40	0.010	mg/kg	M	001,003
TPH (C5-C6 aliphatic)	T209	M40	0.100	mg/kg	N	001,003
TPH (C6-C8 aliphatic)	T209	M40	0.10	mg/kg	N	001,003
TPH (C8-C10 aliphatic)	T209	M40	0.10	mg/kg	N	001,003
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	M	001,003
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	M	001,003
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	M	001,003
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	M	001,003
TPH (C6-C7 aromatic)	T209	M40	0.10	mg/kg	N	001,003
TPH (C7-C8 aromatic)	T209	M40	0.10	mg/kg	N	001,003
TPH (C8-C10 aromatic)	T209	M40	0.10	mg/kg	N	001,003
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	M	001,003
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	M	001,003
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	M	001,003
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	M	001,003

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Certificate of Analysis

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Report Number: Supplemental to 613320-1

Date of Report: 16-Nov-2016

Customer: Ian Farmer Associates
14-15 Rufford Court
Hardwick Grange
Warrington
Cheshire
WA1 4RF

Customer Contact: Mr Tim Downes

Customer Job Reference: 41973
Customer Site Reference: Piccadilly Basin, Manchester
Date Job Received at SAL: 27-Oct-2016
Date Analysis Started: 10-Nov-2016
Date Analysis Completed: 14-Nov-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked and authorised by :
Stefan Kondziela
Project Manager

Issued by :
Stefan Kondziela
Project Manager

SAL Reference: 613320
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Soil Analysed as Soil
MCERTS Preparation

				SAL Reference	**613320 001**	**613320 002**	**613320 003**
				Customer Sample Reference	**WS06**	**WS07A**	**WS09**
				Bottom Depth	**0.5**	**0.8**	**0.8**
				Date Sampled	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Moisture @105C	T162	AR	0.1	%	**14**	**8.0**	**8.4**
Retained on 10mm sieve	T2	M40	0.1	%	<0.1	<0.1	<0.1

SAL Reference: 613320
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Soil Analysed as Soil
Miscellaneous

				SAL Reference	**613320 001**	**613320 002**	**613320 003**
				Customer Sample Reference	**WS06**	**WS07A**	**WS09**
				Bottom Depth	**0.5**	**0.8**	**0.8**
				Date Sampled	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Asbestos ID	T27	AR			N.D.	N.D.	N.D.
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	**9.8**	**7.3**	**9.4**
Chloride (2:1)	T686	AR	0.5	mg/l	**7.4**	**7.4**	**5.3**
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1
Cyanide(free)	T546	AR	1	mg/kg	<1	<1	<1
pH	T7	AR			**8.4**	**9.0**	**8.4**
Phenol	T207	M105	0.1	mg/kg	<0.1	<0.1	<0.1
Phenols(Mono)	T546	AR	1	mg/kg	<1	<1	<1
Soil Organic Matter	T287	M40	0.1	%	**12**	**5.0**	**9.1**
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	**0.15**	**0.04**	**0.03**
SO4(Total)	T6	A40	0.01	%	**0.35**	**0.32**	**0.13**
Sulphide	T4	AR	10	mg/kg	<10	<10	**11**

SAL Reference: 613320
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Soil Analysed as Soil
Heavy Metals(9)

				SAL Reference	**613320 001**	**613320 002**	**613320 003**
				Customer Sample Reference	**WS06**	**WS07A**	**WS09**
				Bottom Depth	**0.5**	**0.8**	**0.8**
				Date Sampled	**27-OCT-2016**	**27-OCT-2016**	**27-OCT-2016**
				Type	**Sandy Soil**	**Sandy Soil**	**Sandy Soil**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Arsenic	T6	M40	2	mg/kg	**27**	**11**	**14**
Cadmium	T6	M40	1	mg/kg	**1**	<1	<1
Chromium	T6	M40	1	mg/kg	**26**	**17**	**14**
Copper	T6	M40	1	mg/kg	**140**	**39**	**130**
Lead	T6	M40	1	mg/kg	**470**	**210**	**250**
Mercury	T6	M40	1	mg/kg	<1	<1	**1**
Nickel	T6	M40	1	mg/kg	**33**	**14**	**15**
Selenium	T6	M40	3	mg/kg	<3	<3	<3
Zinc	T6	M40	1	mg/kg	**520**	**180**	**99**

SAL Reference: 613320
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Soil Analysed as Soil
PAH US EPA 16 (B and K split)

	SAL Reference	613320 001	613320 002	613320 003
	Customer Sample Reference	WS06	WS07A	WS09
	Bottom Depth	0.5	0.8	0.8
	Date Sampled	27-OCT-2016	27-OCT-2016	27-OCT-2016
	Type	Sandy Soil	Sandy Soil	Sandy Soil
Determinand	Method / Test Sample / LOD / Units			
Naphthalene	T207 / M105 / 0.1 / mg/kg	**1.4**	**0.2**	**120**
Acenaphthylene	T207 / M105 / 0.1 / mg/kg	**0.2**	<0.1	**11**
Acenaphthene	T207 / M105 / 0.1 / mg/kg	**0.5**	**0.2**	**32**
Fluorene	T207 / M105 / 0.1 / mg/kg	**0.9**	**0.1**	**57**
Phenanthrene	T207 / M105 / 0.1 / mg/kg	**5.0**	**1.4**	**260**
Anthracene	T207 / M105 / 0.1 / mg/kg	**1.3**	**0.3**	**63**
Fluoranthene	T207 / M105 / 0.1 / mg/kg	**4.8**	**1.4**	**190**
Pyrene	T207 / M105 / 0.1 / mg/kg	**4.7**	**1.2**	**190**
Benzo(a)Anthracene	T207 / M105 / 0.1 / mg/kg	**2.1**	**0.6**	**90**
Chrysene	T207 / M105 / 0.1 / mg/kg	**2.5**	**0.6**	**97**
Benzo(b)fluoranthene	T207 / M105 / 0.1 / mg/kg	**2.3**	**0.6**	**85**
Benzo(k)fluoranthene	T207 / M105 / 0.1 / mg/kg	**1.0**	**0.2**	**32**
Benzo(a)Pyrene	T207 / M105 / 0.1 / mg/kg	**2.0**	**0.5**	**79**
Indeno(123-cd)Pyrene	T207 / M105 / 0.1 / mg/kg	**0.9**	**0.3**	**32**
Dibenzo(ah)Anthracene	T207 / M105 / 0.1 / mg/kg	**0.3**	<0.1	**9.8**
Benzo(ghi)Perylene	T207 / M105 / 0.1 / mg/kg	**1.1**	**0.3**	**39**
PAH(total)	T207 / M105 / 0.1 / mg/kg	**31**	**7.8**	**1400**

SAL Reference: 613320
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Soil Analysed as Soil
TPH (CWG) with MTBE, BTEX

	SAL Reference	613320 001	613320 003
	Customer Sample Reference	WS06	WS09
	Bottom Depth	0.5	0.8
	Date Sampled	27-OCT-2016	27-OCT-2016
	Type	Sandy Soil	Sandy Soil
Determinand	Method / Test Sample / LOD / Units		
Benzene	T209 / M105 / 0.010 / mg/kg	(13) <0.010	(13) **0.011**
Toluene	T209 / M105 / 0.010 / mg/kg	<0.010	**0.079**
EthylBenzene	T209 / M105 / 0.010 / mg/kg	<0.010	**0.073**
M/P Xylene	T209 / M105 / 0.010 / mg/kg	<0.010	**0.50**
O Xylene	T209 / M105 / 0.010 / mg/kg	<0.010	**0.37**
Methyl tert-Butyl Ether	T209 / M105 / 0.010 / mg/kg	<0.010	<0.010
TPH (C5-C6 aliphatic)	T209 / M105 / 0.100 / mg/kg	<0.100	<0.100
TPH (C6-C8 aliphatic)	T209 / M105 / 0.10 / mg/kg	<0.10	<0.10
TPH (C8-C10 aliphatic)	T209 / M105 / 0.10 / mg/kg	<0.10	<0.10
TPH (C10-C12 aliphatic)	T909 / M105 / 1 / mg/kg	(13) **1**	(13,9) <10
TPH (C12-C16 aliphatic)	T909 / M105 / 1 / mg/kg	(13) **6**	(13) **59**
TPH (C16-C21 aliphatic)	T909 / M105 / 1 / mg/kg	(13) **12**	(13) **140**
TPH (C21-C35 aliphatic)	T909 / M105 / 2 / mg/kg	(13) **28**	(13) **130**
TPH (C6-C7 aromatic)	T209 / M105 / 0.10 / mg/kg	<0.10	<0.10
TPH (C7-C8 aromatic)	T209 / M105 / 0.10 / mg/kg	<0.10	<0.10
TPH (C8-C10 aromatic)	T209 / M105 / 0.10 / mg/kg	<0.10	**2.2**
TPH (C10-C12 aromatic)	T909 / M105 / 2 / mg/kg	(13) **3**	(13) **90**
TPH (C12-C16 aromatic)	T909 / M105 / 1 / mg/kg	(13) **36**	(13) **600**
TPH (C16-C21 aromatic)	T909 / M105 / 1 / mg/kg	(13) **110**	(13) **1800**
TPH (C21-C35 aromatic)	T909 / M105 / 1 / mg/kg	(13) **150**	(13) **2400**

Index to symbols used in Supplemental to 613320-1

Value	Description
AR	As Received
M105	Analysis conducted on an "as received" aliquot. Results are reported on a dry weight basis where moisture content was determined by assisted drying of sample at 105C
A40	Assisted dried < 40C
M40	Analysis conducted on sample assisted dried at no more than 40C. Results are reported on a dry weight basis.
N.D.	Not Detected
13	Results have been blank corrected.
9	LOD raised due to dilution of sample
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Supplemental report to include depths previously missed: WS06 - 0.5m, WS07B - 0.8m and WS09 - 0.8m.
Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T287	Calc TOC/0.58
T162	Grav (1 Dec) (105 C)
T4	Colorimetry
T207	GC/MS (MCERTS)
T209	GC/MS (Head Space)(MCERTS)
T6	ICP/OES
T909	GCxGC
T2	Grav
T27	PLM
T686	Discrete Analyser
T7	Probe
T546	Colorimetry (CF)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Asbestos ID	T27	AR			SU	001-003
Ammoniacal nitrogen	T4	AR	0.5	mg/kg	N	001-003
Chloride (2:1)	T686	AR	0.5	mg/l	N	001-003
Chromium VI	T6	AR	1	mg/kg	N	001-003
Cyanide(free)	T546	AR	1	mg/kg	M	001-003
pH	T7	AR			M	001-003
Phenol	T207	M105	0.1	mg/kg	M	001-003
Phenols(Mono)	T546	AR	1	mg/kg	M	001-003
Soil Organic Matter	T287	M40	0.1	%	N	001-003
(Water Soluble) SO4 expressed as SO4	T242	AR	0.01	g/l	N	001-003
SO4(Total)	T6	A40	0.01	%	N	001-003
Sulphide	T4	AR	10	mg/kg	N	001-003
Arsenic	T6	M40	2	mg/kg	M	001-003
Cadmium	T6	M40	1	mg/kg	M	001-003
Chromium	T6	M40	1	mg/kg	M	001-003
Copper	T6	M40	1	mg/kg	M	001-003
Lead	T6	M40	1	mg/kg	M	001-003
Mercury	T6	M40	1	mg/kg	M	001-003
Nickel	T6	M40	1	mg/kg	M	001-003
Selenium	T6	M40	3	mg/kg	M	001-003
Zinc	T6	M40	1	mg/kg	M	001-003
Moisture @105C	T162	AR	0.1	%	N	001-003
Retained on 10mm sieve	T2	M40	0.1	%	N	001-003
Naphthalene	T207	M105	0.1	mg/kg	M	001-003
Acenaphthylene	T207	M105	0.1	mg/kg	U	001-003
Acenaphthene	T207	M105	0.1	mg/kg	M	001-003
Fluorene	T207	M105	0.1	mg/kg	M	001-003

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Phenanthrene	T207	M105	0.1	mg/kg	M	001-003
Anthracene	T207	M105	0.1	mg/kg	U	001-003
Fluoranthene	T207	M105	0.1	mg/kg	M	001-003
Pyrene	T207	M105	0.1	mg/kg	M	001-003
Benzo(a)Anthracene	T207	M105	0.1	mg/kg	M	001-003
Chrysene	T207	M105	0.1	mg/kg	M	001-003
Benzo(b)fluoranthene	T207	M105	0.1	mg/kg	M	001-003
Benzo(k)fluoranthene	T207	M105	0.1	mg/kg	M	001-003
Benzo(a)Pyrene	T207	M105	0.1	mg/kg	M	001-003
Indeno(123-cd)Pyrene	T207	M105	0.1	mg/kg	M	001-003
Dibenzo(ah)Anthracene	T207	M105	0.1	mg/kg	M	001-003
Benzo(ghi)Perylene	T207	M105	0.1	mg/kg	M	001-003
PAH(total)	T207	M105	0.1	mg/kg	U	001-003
Benzene	T209	M105	0.010	mg/kg	M	001,003
Toluene	T209	M105	0.010	mg/kg	M	001,003
EthylBenzene	T209	M105	0.010	mg/kg	M	001,003
M/P Xylene	T209	M105	0.010	mg/kg	M	001,003
O Xylene	T209	M105	0.010	mg/kg	M	001,003
Methyl tert-Butyl Ether	T209	M105	0.010	mg/kg	M	001,003
TPH (C5-C6 aliphatic)	T209	M105	0.100	mg/kg	N	001,003
TPH (C6-C8 aliphatic)	T209	M105	0.10	mg/kg	N	001,003
TPH (C8-C10 aliphatic)	T209	M105	0.10	mg/kg	N	001,003
TPH (C10-C12 aliphatic)	T909	M105	1	mg/kg	M	001,003
TPH (C12-C16 aliphatic)	T909	M105	1	mg/kg	M	001,003
TPH (C16-C21 aliphatic)	T909	M105	1	mg/kg	M	001,003
TPH (C21-C35 aliphatic)	T909	M105	2	mg/kg	M	001,003
TPH (C6-C7 aromatic)	T209	M105	0.10	mg/kg	N	001,003
TPH (C7-C8 aromatic)	T209	M105	0.10	mg/kg	N	001,003
TPH (C8-C10 aromatic)	T209	M105	0.10	mg/kg	N	001,003
TPH (C10-C12 aromatic)	T909	M105	2	mg/kg	M	001,003
TPH (C12-C16 aromatic)	T909	M105	1	mg/kg	M	001,003
TPH (C16-C21 aromatic)	T909	M105	1	mg/kg	M	001,003
TPH (C21-C35 aromatic)	T909	M105	1	mg/kg	M	001,003

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
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Report Number: 614965-1

Date of Report: 21-Nov-2016

Customer: Ian Farmer Associates
14-15 Rufford Court
Hardwick Grange
Warrington
Cheshire
WA1 4RF

Customer Contact: Mr Tim Downes

Customer Job Reference: 41793
Customer Purchase Order: 41655
Customer Site Reference: Piccadilly Basin
Date Job Received at SAL: 28-Oct-2016
Date Analysis Started: 17-Nov-2016
Date Analysis Completed: 21-Nov-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

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Tests covered by this certificate were conducted in accordance with SAL SOPs

All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

Report checked and authorised by :
Stefan Kondziela
Project Manager

Issued by :
Stefan Kondziela
Project Manager



SAL Reference: 614965
Project Site: Piccadilly Basin
Customer Reference: 41793

Soil Analysed as Soil
Miscellaneous

SAL Reference	**614965 001**
Customer Sample Reference	**WS05 (611478/002)**
Date Sampled	**27-OCT-2016**

Determinand	Method	Test Sample	LOD	Units	
Asbestos Quantification	T27	AR	0.001	%	Chrysotile Fibres Detected **0.002**

Index to symbols used in 614965-1

Value	Description
AR	As Received
S	Analysis was subcontracted
U	Analysis is UKAS accredited

Notes

Asbestos was subcontracted to REC Asbestos.

Method Index

Value	Description
T27	PLM

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Asbestos Quantification	T27	AR	0.001	%	SU	001

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Report Number: 616951-2

Date of Report: 09-Dec-2016

Customer: Ian Farmer Associates
14-15 Rufford Court
Hardwick Grange
Warrington
Cheshire
WA1 4RF

Customer Contact: Mr Tim Downes

Customer Job Reference: 41973
Customer Purchase Order: 41840
Customer Site Reference: Piccadilly Basin
Date Job Received at SAL: 23-Nov-2016
Date Analysis Started: 25-Nov-2016
Date Analysis Completed: 09-Dec-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

Report checked and authorised by :
Stefan Kondziela
Project Manager

Issued by :
Stefan Kondziela
Project Manager

SAL Reference: 616951
Project Site: Piccadilly Basin
Customer Reference: 41973

Water Analysed as Water
Miscellaneous

	SAL Reference	616951 001	616951 002	616951 003	616951 004
	Customer Sample Reference	WS03	WS13	CP02	BH02
	Date Sampled	23-NOV-2016	23-NOV-2016	23-NOV-2016	23-NOV-2016
Determinand	**Method** / **Test Sample** / **LOD** / **Units**				
Cyanide(free)	T4 / AR / 50 / µg/l	<50	<50	<50	<50
pH	T7 / AR / /	**7.4**	**7.4**	**7.4**	**7.4**
Phenol	T149 / AR / 0.5 / µg/l	(9) <1.0	<0.5	<0.5	(9) <1.0
Sulphate	T686 / F / 500 / µg/l	**40000**	**830000**	**260000**	**270000**

SAL Reference: 616951
Project Site: Piccadilly Basin
Customer Reference: 41973

Water Analysed as Water
Heavy Metals(9) total

	SAL Reference	616951 001	616951 002	616951 003	616951 004
	Customer Sample Reference	WS03	WS13	CP02	BH02
	Date Sampled	23-NOV-2016	23-NOV-2016	23-NOV-2016	23-NOV-2016
Determinand	**Method** / **Test Sample** / **LOD** / **Units**				
As (Total)	T301 / Total / 0.2 / µg/l	**33**	**19**	**25**	**28**
Cd (Total)	T301 / Total / 0.02 / µg/l	**4.7**	**1.5**	**2.4**	**0.55**
Cr (Total)	T301 / Total / 1 / µg/l	**92**	**29**	**35**	**40**
Cu (Total)	T301 / Total / 0.5 / µg/l	**230**	**56**	**120**	**83**
Pb (Total)	T301 / Total / 0.3 / µg/l	**1500**	**220**	**350**	**89**
Hg (Total)	T301 / Total / 0.05 / µg/l	**0.15**	**0.12**	**0.11**	**0.10**
Ni (Total)	T301 / Total / 1 / µg/l	**59**	**54**	**69**	**39**
Se (Total)	T301 / Total / 0.5 / µg/l	**4.5**	**12**	**5.0**	**3.2**
Zn (Total)	T301 / Total / 2 / µg/l	**420**	**140**	**160**	**96**

SAL Reference: 616951
Project Site: Piccadilly Basin
Customer Reference: 41973

Water Analysed as Water
PAH US EPA 16 (B and K split)

	SAL Reference	616951 001	616951 002	616951 003	616951 004
	Customer Sample Reference	WS03	WS13	CP02	BH02
	Date Sampled	23-NOV-2016	23-NOV-2016	23-NOV-2016	23-NOV-2016
Determinand	**Method** / **Test Sample** / **LOD** / **Units**				
Naphthalene	T149 / AR / 0.01 / µg/l	(13) **0.06**	(13) <0.01	(13) <0.01	(9,13) <0.02
Acenaphthylene	T149 / AR / 0.01 / µg/l	**0.07**	<0.01	<0.01	**0.02**
Acenaphthene	T149 / AR / 0.01 / µg/l	**0.35**	**0.01**	**0.03**	**0.03**
Fluorene	T149 / AR / 0.01 / µg/l	**0.22**	**0.01**	**0.01**	**0.03**
Phenanthrene	T149 / AR / 0.01 / µg/l	**0.77**	**0.01**	**0.02**	**0.05**
Anthracene	T149 / AR / 0.01 / µg/l	**0.26**	**0.02**	**0.01**	**0.02**
Fluoranthene	T149 / AR / 0.01 / µg/l	**1.3**	**0.01**	**0.03**	**0.03**
Pyrene	T149 / AR / 0.01 / µg/l	**1.2**	**0.01**	**0.03**	**0.05**
Benzo(a)Anthracene	T149 / AR / 0.01 / µg/l	**0.47**	**0.01**	**0.01**	**0.02**
Chrysene	T149 / AR / 0.01 / µg/l	**0.47**	<0.01	**0.01**	**0.02**
Benzo(b)fluoranthene	T149 / AR / 0.01 / µg/l	**0.54**	**0.01**	**0.01**	**0.02**
Benzo(k)fluoranthene	T149 / AR / 0.01 / µg/l	**0.22**	<0.01	**0.01**	**0.02**
Benzo(a)Pyrene	T149 / AR / 0.01 / µg/l	(13) **0.45**	(13) <0.01	(13) <0.01	(9,13) <0.02
Indeno(123-cd)Pyrene	T149 / AR / 0.01 / µg/l	(13) **0.27**	(13) <0.01	(13) <0.01	(13,9) <0.02
Dibenzo(ah)Anthracene	T149 / AR / 0.01 / µg/l	**0.11**	<0.01	<0.01	**0.02**
Benzo(ghi)Perylene	T149 / AR / 0.01 / µg/l	(13) **0.33**	(13) <0.01	(13) <0.01	(13) **0.02**
PAH(total)	T149 / AR / 0.01 / µg/l	**7.0**	**0.09**	**0.17**	**0.35**

SAL Reference: 616951
Project Site: Piccadilly Basin
Customer Reference: 41973

Water Analysed as Water
TPH (CWG) with MTBE, BTEX

	SAL Reference	616951 001	616951 002	616951 003	616951 004
	Customer Sample Reference	WS03	WS13	CP02	BH02
	Date Sampled	23-NOV-2016	23-NOV-2016	23-NOV-2016	23-NOV-2016
Determinand	**Method** / **Test Sample** / **LOD** / **Units**				
Benzene	T54 AR 1 µg/l	(13) <1	(13) <1	(13) <1	(13) <1
Toluene	T54 AR 1 µg/l	<1	<1	<1	<1
EthylBenzene	T54 AR 1 µg/l	<1	<1	<1	<1
M/P Xylene	T54 AR 1 µg/l	<1	<1	<1	<1
O Xylene	T54 AR 1 µg/l	<1	<1	<1	<1
Methyl tert-Butyl Ether	T54 AR 1 µg/l	<1	<1	<1	<1
TPH (C5-C6 aliphatic)	T215 AR 10 µg/l	<10	<10	<10	<10
TPH (C6-C8 aliphatic)	T215 AR 10 µg/l	<10	<10	<10	<10
TPH (C8-C10 aliphatic)	T215 AR 10 µg/l	<10	<10	<10	<10
TPH (C10-C12 aliphatic)	T910 AR 10 µg/l	(13,100) <30	(13,100) <30	(13,100) <20	(100,13) <20
TPH (C12-C16 aliphatic)	T910 AR 10 µg/l	(13,100) <30	(13,100) <30	(100,13) <20	(100,13) <20
TPH (C16-C21 aliphatic)	T910 AR 10 µg/l	(13,100) <30	(13,100) <30	(100,13) <20	(100,13) <20
TPH (C21-C35 aliphatic)	T910 AR 10 µg/l	(100,13) <30	(100,13) <30	(13,100) <20	(100,13) <20
TPH (C6-C7 aromatic)	T215 AR 10 µg/l	<10	<10	<10	<10
TPH (C7-C8 aromatic)	T215 AR 10 µg/l	<10	<10	<10	<10
TPH (C8-C10 aromatic)	T215 AR 10 µg/l	<10	<10	<10	<10
TPH (C10-C12 aromatic)	T910 AR 10 µg/l	(13,100) <30	(13,100) <30	(13,100) <20	(100,13) <20
TPH (C12-C16 aromatic)	T910 AR 10 µg/l	(100,13) <30	(100,13) <30	(13,100) <20	(13,100) <20
TPH (C16-C21 aromatic)	T910 AR 10 µg/l	(100,13) <30	(13,100) <30	(13,100) <20	(100,13) <20
TPH (C21-C35 aromatic)	T910 AR 10 µg/l	(13,100) <30	(100,13) <30	(100,13) <20	(13,100) <20

Index to symbols used in 616951-2

Value	Description
F	Filtered
AR	As Received
Total	Total
100	LOD determined by sample aliquot used for analysis
13	Results have been blank corrected.
9	LOD raised due to dilution of sample
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T910	GCxGC (LV)
T301	ICP/MS (Total)
T4	Colorimetry
T7	Probe
T149	GC/MS (SIR)
T215	GC/MS (Headspace)(LV)
T686	Discrete Analyser
T54	GC/MS (Headspace)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Cyanide(free)	T4	AR	50	µg/l	U	001-004
pH	T7	AR			U	001-004
Phenol	T149	AR	0.5	µg/l	U	001-004
Sulphate	T686	F	500	µg/l	U	001-004
As (Total)	T301	Total	0.2	µg/l	U	001-004
Cd (Total)	T301	Total	0.02	µg/l	U	001-004
Cr (Total)	T301	Total	1	µg/l	U	001-004

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Cu (Total)	T301	Total	0.5	µg/l	U	001-004
Pb (Total)	T301	Total	0.3	µg/l	U	001-004
Hg (Total)	T301	Total	0.05	µg/l	U	001-004
Ni (Total)	T301	Total	1	µg/l	U	001-004
Se (Total)	T301	Total	0.5	µg/l	U	001-004
Zn (Total)	T301	Total	2	µg/l	U	001-004
Naphthalene	T149	AR	0.01	µg/l	U	001-004
Acenaphthylene	T149	AR	0.01	µg/l	U	001-004
Acenaphthene	T149	AR	0.01	µg/l	U	001-004
Fluorene	T149	AR	0.01	µg/l	U	001-004
Phenanthrene	T149	AR	0.01	µg/l	U	001-004
Anthracene	T149	AR	0.01	µg/l	U	001-004
Fluoranthene	T149	AR	0.01	µg/l	U	001-004
Pyrene	T149	AR	0.01	µg/l	U	001-004
Benzo(a)Anthracene	T149	AR	0.01	µg/l	U	001-004
Chrysene	T149	AR	0.01	µg/l	U	001-004
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	U	001-004
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	U	001-004
Benzo(a)Pyrene	T149	AR	0.01	µg/l	U	001-004
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	U	001-004
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	U	001-004
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	U	001-004
PAH(total)	T149	AR	0.01	µg/l	U	001-004
Benzene	T54	AR	1	µg/l	U	001-004
Toluene	T54	AR	1	µg/l	U	001-004
EthylBenzene	T54	AR	1	µg/l	U	001-004
M/P Xylene	T54	AR	1	µg/l	U	001-004
O Xylene	T54	AR	1	µg/l	U	001-004
Methyl tert-Butyl Ether	T54	AR	1	µg/l	U	001-004
TPH (C5-C6 aliphatic)	T215	AR	10	µg/l	N	001-004
TPH (C6-C8 aliphatic)	T215	AR	10	µg/l	N	001-004
TPH (C8-C10 aliphatic)	T215	AR	10	µg/l	N	001-004
TPH (C10-C12 aliphatic)	T910	AR	10	µg/l	N	001-004
TPH (C12-C16 aliphatic)	T910	AR	10	µg/l	N	001-004
TPH (C16-C21 aliphatic)	T910	AR	10	µg/l	N	001-004
TPH (C21-C35 aliphatic)	T910	AR	10	µg/l	N	001-004
TPH (C6-C7 aromatic)	T215	AR	10	µg/l	N	001-004
TPH (C7-C8 aromatic)	T215	AR	10	µg/l	N	001-004
TPH (C8-C10 aromatic)	T215	AR	10	µg/l	N	001-004
TPH (C10-C12 aromatic)	T910	AR	10	µg/l	N	001-004
TPH (C12-C16 aromatic)	T910	AR	10	µg/l	N	001-004
TPH (C16-C21 aromatic)	T910	AR	10	µg/l	N	001-004
TPH (C21-C35 aromatic)	T910	AR	10	µg/l	N	001-004

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Report Number: 618574-1

Date of Report: 14-Dec-2016

Customer: Ian Farmer Associates
14-15 Rufford Court
Hardwick Grange
Warrington
Cheshire
WA1 4RF

Customer Contact: Mr Tim Downes

Customer Job Reference: 41973
Customer Purchase Order: 41886
Customer Site Reference: Piccadilly Basin, Manchester
Date Job Received at SAL: 30-Nov-2016
Date Analysis Started: 02-Dec-2016
Date Analysis Completed: 13-Dec-2016

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
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Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual

UKAS TESTING
1549

Report checked and authorised by :
Stefan Kondziela
Project Manager

Issued by :
Stefan Kondziela
Project Manager

SAL Reference: 618574
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Water Analysed as Water
Miscellaneous

				SAL Reference	**618574 001**	**618574 002**	**618574 003**
				Customer Sample Reference	**WS03**	**RT02**	**CP02**
				Date Sampled	**30-NOV-2016**	**30-NOV-2016**	**30-NOV-2016**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Cyanide(free)	T4	AR	50	µg/l	<50	<50	<50
pH	T7	AR			**7.2**	**6.9**	**7.1**
Phenol	T149	AR	0.5	µg/l	<0.5	**0.8**	**0.6**
Sulphate	T686	F	500	µg/l	**19000**	**620000**	**130000**

SAL Reference: 618574
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Water Analysed as Water
Heavy Metals(9) total

				SAL Reference	**618574 001**	**618574 002**	**618574 003**
				Customer Sample Reference	**WS03**	**RT02**	**CP02**
				Date Sampled	**30-NOV-2016**	**30-NOV-2016**	**30-NOV-2016**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
As (Total)	T301	Total	0.2	µg/l	**43**	**11**	**22**
Cd (Total)	T301	Total	0.02	µg/l	**5.2**	**0.49**	**1.9**
Cr (Total)	T301	Total	1	µg/l	**100**	**62**	**29**
Cu (Total)	T301	Total	0.5	µg/l	**280**	**21**	**110**
Pb (Total)	T301	Total	0.3	µg/l	**2000**	**20**	**330**
Hg (Total)	T301	Total	0.05	µg/l	**0.66**	**0.11**	**0.26**
Ni (Total)	T301	Total	1	µg/l	**57**	**22**	**57**
Se (Total)	T301	Total	0.5	µg/l	**6.6**	**0.9**	**5.1**
Zn (Total)	T301	Total	2	µg/l	**390**	**120**	**120**

SAL Reference: 618574
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Water Analysed as Water
PAH US EPA 16 (B and K split)

				SAL Reference	**618574 001**	**618574 002**	**618574 003**
				Customer Sample Reference	**WS03**	**RT02**	**CP02**
				Date Sampled	**30-NOV-2016**	**30-NOV-2016**	**30-NOV-2016**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**			
Naphthalene	T149	AR	0.01	µg/l	**(13) 0.04**	**(13) 0.61**	**(13) 0.44**
Acenaphthylene	T149	AR	0.01	µg/l	**0.02**	<0.01	<0.01
Acenaphthene	T149	AR	0.01	µg/l	**0.10**	<0.01	**0.03**
Fluorene	T149	AR	0.01	µg/l	**0.06**	**0.01**	**0.02**
Phenanthrene	T149	AR	0.01	µg/l	**(13) 0.15**	(13) <0.01	**(13) 0.01**
Anthracene	T149	AR	0.01	µg/l	**0.08**	<0.01	**0.01**
Fluoranthene	T149	AR	0.01	µg/l	**0.40**	<0.01	**0.02**
Pyrene	T149	AR	0.01	µg/l	**0.49**	<0.01	**0.02**
Benzo(a)Anthracene	T149	AR	0.01	µg/l	**(13) 0.14**	(13) <0.01	**(13) 0.01**
Chrysene	T149	AR	0.01	µg/l	**0.14**	<0.01	**0.01**
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	**0.11**	<0.01	**0.01**
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	**0.04**	<0.01	<0.01
Benzo(a)Pyrene	T149	AR	0.01	µg/l	**0.10**	<0.01	<0.01
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	**0.05**	<0.01	<0.01
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	**0.02**	<0.01	<0.01
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	**0.06**	<0.01	**0.01**
PAH(total)	T149	AR	0.01	µg/l	**(13) 2.0**	**(13) 0.62**	**(13) 0.59**

SAL Reference: 618574
Project Site: Piccadilly Basin, Manchester
Customer Reference: 41973

Water Analysed as Water
TPH (CWG) with MTBE, BTEX

SAL Reference	**618574 001**	**618574 002**	**618574 003**
Customer Sample Reference	**WS03**	**RT02**	**CP02**
Date Sampled	**30-NOV-2016**	**30-NOV-2016**	**30-NOV-2016**

Determinand	Method	Test Sample	LOD	Units			
Benzene	T54	AR	1	µg/l	(13) <1	(13) <1	(13) <1
Toluene	T54	AR	1	µg/l	<1	<1	<1
EthylBenzene	T54	AR	1	µg/l	<1	<1	<1
M/P Xylene	T54	AR	1	µg/l	<1	<1	<1
O Xylene	T54	AR	1	µg/l	<1	<1	<1
Methyl tert-Butyl Ether	T54	AR	1	µg/l	<1	<1	<1
TPH (C5-C6 aliphatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C6-C8 aliphatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C8-C10 aliphatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C10-C12 aliphatic)	T910	AR	10	µg/l	(100,13) <100	(13) <10	(13) <10
TPH (C12-C16 aliphatic)	T910	AR	10	µg/l	(13,100) <100	(13) <10	(13) <10
TPH (C16-C21 aliphatic)	T910	AR	10	µg/l	(100,13) <100	(13) <10	(13) <10
TPH (C21-C35 aliphatic)	T910	AR	10	µg/l	(13,100) <100	(13) <10	**(13) 67**
TPH (C6-C7 aromatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C7-C8 aromatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C8-C10 aromatic)	T215	AR	10	µg/l	<10	<10	<10
TPH (C10-C12 aromatic)	T910	AR	10	µg/l	(100,13) <100	(13) <10	(13) <10
TPH (C12-C16 aromatic)	T910	AR	10	µg/l	**(13) 400**	(13) <10	**(13) 13**
TPH (C16-C21 aromatic)	T910	AR	10	µg/l	**(13) 1200**	(13) <10	**(13) 10**
TPH (C21-C35 aromatic)	T910	AR	10	µg/l	**(13) 1200**	(13) <10	(13) <10

Index to symbols used in 618574-1

Value	Description
F	Filtered
AR	As Received
Total	Total
100	LOD determined by sample aliquot used for analysis
13	Results have been blank corrected.
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T215	GC/MS (Headspace)(LV)
T7	Probe
T54	GC/MS (Headspace)
T686	Discrete Analyser
T4	Colorimetry
T149	GC/MS (SIR)
T301	ICP/MS (Total)
T910	GCxGC (LV)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Cyanide(free)	T4	AR	50	µg/l	U	001-003
pH	T7	AR			U	001-003
Phenol	T149	AR	0.5	µg/l	U	001-003
Sulphate	T686	F	500	µg/l	U	001-003
As (Total)	T301	Total	0.2	µg/l	U	001-003
Cd (Total)	T301	Total	0.02	µg/l	U	001-003
Cr (Total)	T301	Total	1	µg/l	U	001-003
Cu (Total)	T301	Total	0.5	µg/l	U	001-003

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Pb (Total)	T301	Total	0.3	µg/l	U	001-003
Hg (Total)	T301	Total	0.05	µg/l	U	001-003
Ni (Total)	T301	Total	1	µg/l	U	001-003
Se (Total)	T301	Total	0.5	µg/l	U	001-003
Zn (Total)	T301	Total	2	µg/l	U	001-003
Naphthalene	T149	AR	0.01	µg/l	U	001-003
Acenaphthylene	T149	AR	0.01	µg/l	U	001-003
Acenaphthene	T149	AR	0.01	µg/l	U	001-003
Fluorene	T149	AR	0.01	µg/l	U	001-003
Phenanthrene	T149	AR	0.01	µg/l	U	001-003
Anthracene	T149	AR	0.01	µg/l	U	001-003
Fluoranthene	T149	AR	0.01	µg/l	U	001-003
Pyrene	T149	AR	0.01	µg/l	U	001-003
Benzo(a)Anthracene	T149	AR	0.01	µg/l	U	001-003
Chrysene	T149	AR	0.01	µg/l	U	001-003
Benzo(b)fluoranthene	T149	AR	0.01	µg/l	U	001-003
Benzo(k)fluoranthene	T149	AR	0.01	µg/l	U	001-003
Benzo(a)Pyrene	T149	AR	0.01	µg/l	U	001-003
Indeno(123-cd)Pyrene	T149	AR	0.01	µg/l	U	001-003
Dibenzo(ah)Anthracene	T149	AR	0.01	µg/l	U	001-003
Benzo(ghi)Perylene	T149	AR	0.01	µg/l	U	001-003
PAH(total)	T149	AR	0.01	µg/l	U	001-003
Benzene	T54	AR	1	µg/l	U	001-003
Toluene	T54	AR	1	µg/l	U	001-003
EthylBenzene	T54	AR	1	µg/l	U	001-003
M/P Xylene	T54	AR	1	µg/l	U	001-003
O Xylene	T54	AR	1	µg/l	U	001-003
Methyl tert-Butyl Ether	T54	AR	1	µg/l	U	001-003
TPH (C5-C6 aliphatic)	T215	AR	10	µg/l	N	001-003
TPH (C6-C8 aliphatic)	T215	AR	10	µg/l	N	001-003
TPH (C8-C10 aliphatic)	T215	AR	10	µg/l	N	001-003
TPH (C10-C12 aliphatic)	T910	AR	10	µg/l	N	001-003
TPH (C12-C16 aliphatic)	T910	AR	10	µg/l	N	001-003
TPH (C16-C21 aliphatic)	T910	AR	10	µg/l	N	001-003
TPH (C21-C35 aliphatic)	T910	AR	10	µg/l	N	001-003
TPH (C6-C7 aromatic)	T215	AR	10	µg/l	N	001-003
TPH (C7-C8 aromatic)	T215	AR	10	µg/l	N	001-003
TPH (C8-C10 aromatic)	T215	AR	10	µg/l	N	001-003
TPH (C10-C12 aromatic)	T910	AR	10	µg/l	N	001-003
TPH (C12-C16 aromatic)	T910	AR	10	µg/l	N	001-003
TPH (C16-C21 aromatic)	T910	AR	10	µg/l	N	001-003
TPH (C21-C35 aromatic)	T910	AR	10	µg/l	N	001-003

SCIENTIFIC ANALYSIS LABORATORIES

Appendix E Design Considerations

GEOTECHNICAL DESIGN CONSIDERATIONS

Assessment of Granular Soil Condition

SPT 'N' values reported on the borehole logs are as measured in the field with no corrections applied.

However for general design in sands the 'N' values should be normalised to 60% by the following equation:

N60 = Er/60.N where:

- N is the blow count, and
- Er is the energy ratio of the specific test equipment.

Further corrections for rod length and overburden pressure in sands may be applied in accordance with BS EN ISO 22476-3, ref 9.6.

Assessment of Cohesive Soil Condition

In accordance with BS EN ISO 22475-1, ref. 9.8, and BS5930, ref.9.4, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref.9.5.

Laboratory strength and consolidation testing should only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 9.5. This is due to possible disturbance during sampling, giving a weaker strength in testing.

Therefore laboratory test values for cu and mv obtained from thick walled U100 samples should only be used as guidance and not used as absolute values for the shear strength and compressibility properties of the clay and only used to provide guidance to descriptive strength on the borehole records.

Work undertaken by Stroud, ref. 9.14 determined a relationship between SPT 'N' values, plasticity undrained shear strength and compressibility of many over-consolidated clays. Further work by Stroud and Butler, ref.9.15, in which data was analysed from sites covering a wide range of glacial deposits, confirmed there to be a correlation between the 'N' value plasticity undrained shear strength and compressibility.

The relationship was of the form: $Cu = f1 \times N$ and $mv = 1/(f2 \times N)$.

Where cu = Un-drained shear strength.

mv = Coefficient of compressibility f1 and f2 = Factors.

It was determined by Stroud that f1 varied between 4kPa for material of high plasticity and 6kPa for material of low plasticity. Similarly f2 varied between 400kPa and 600kPa.

GUIDELINES FOR THE DESIGN OF PILES FIRST APPROXIMATION OF WORKING LOAD

Piling Parameters – General

The ultimate carrying capacity, Qu, of a particular pile is taken as the sum of the ultimate shaft friction resistance, Qs, and the ultimate end bearing resistance, Qb. This may be expressed as follows:

- Qu = Qs + Qb.
- = f.As + q.Ab.
- Where f = unit shaft resistance.
- As = embedded surface area of pile q = unit end bearing resistance.
- Ab = effective cross-sectional area of pile base.

COHESIVE SOILS

Shaft Resistance

The ultimate shaft resistance, f, for piles in both compression or tension in cohesive soils is determined by applying a factor to the undrained shear strength, Cs, which exists in the soils along the embedded length of the pile, and is given by:-

- f = Cs.
- Where is an adhesion factor, which for straight-shafted bored piles may be taken as 0.45 to 0.60. Ultimate unit shaft friction should not exceed 100kN/m².

End Bearing

For piles terminating in cohesive soils, the ultimate unit end bearing resistance q, is given by:

q = Nc.Cb.

- Where Cb is the undrained shear strength at the base of the pile and Nc is a bearing capacity factor The value of Nc for a cohesive material is variable, depending on the depth of the penetration of the pile into the bearing stratum. Generally, Nc could be taken to have a value of 9, except in the case of large diameter short piles where a lesser value should be used.

COHESIONLESS SOILS

Shaft Resistance

For piles driven in cohesionless soils the ultimate unit shaft resistance, f, may be calculated using the following method, which gives:

- F = 0.5 ' (D+d) Ks tan
- Where ' = average effective unit weight of soil surrounding the pile.
- D = depth to the pile toe or to the base of the granular stratum whichever is the lesser.
- d = depth to the top of the granular stratum.
- δ = angle of friction between pile and soil.

(see below)

a) Ks = a coefficient (see below)

TABLE OF VALUES FOR Ks AND δ

Pile Type	δ	Ks		
		Relative Density		Tension Piles
		Low	High	
Steel	20°	0.5	1.5	0.5
Concrete	0.75φ	1.0	2.0	0.5

The value of φ may be interpreted from standard penetration tests.

For bored and cast-in-place piles, δ = 22° and Ks = 1 should be used to allow for loosening of the soil during boring.

It has been found that the ultimate unit shaft resistance does not exceed 100kN/m² and therefore this value should not be exceeded in design.

End Bearing
The unit ultimate end bearing resistance (q) of piles in cohesionless soils may be calculated as follows:

q = '.D.Nq

where ' = average effective unit weight of soil surrounding the pile

D = depth to pile toe

Nq = bearing capacity factor

Values for Nq, where piles penetrate the bearing stratum by more than five diameters, may be taken from work carried out by Berezantsev, ref.9.23. In addition, the ultimate unit base resistance should not exceed a value of 11,000kN/m². For bored and cast-in-place piles the value of Nq used should correspond to loose soil conditions.

FACTORS OF SAFETY

Cohesive and Non-cohesive Soils
For cohesive and non-cohesive soils a factor of safety of 3 may be used to obtain the allowable or safe carrying capacity of piles from the ultimate carrying capacity.

Appendix F Contamination Assessment

GENERAL NOTES ON CONTAMINATION ASSESSMENT

STATUTORY FRAMEWORK AND DEFINITIONS

The statutory de4finition of contaminated land is defined in the Environmental Protection Act 1990, ref 9.24, as:

'Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, or under the land, that:

- Significant harm is being caused or there is a significant possibility of such harm being caused; or
- Pollution of controlled waters is being, or is likely to be, caused'

The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CRLs), a proposed series of 12 documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document, CLR 11, ref 9.43 was published in 2004. In 2008CLR reports 7 to 10 were withdrawn by DEFRA and the Environment Agency and updated version of CRL 9 and 10 were produced in the form of Science Reports SR2, ref. 9.37 and SR3, ref. 9.27.

In establishing whether a site fulfils the statutory definition of 'contaminated land' it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- Is resulting in significant harm being caused to the receptor in the pollutant linkage.
- Presents a significant possibility of significant harm being caused to that receptor.
- Is resulting in the pollution of the controlled waters which constitute the receptor, or
- Is likely to result in such pollution.

A '*pollutant linkage*' may be defined as the link between a contaminant '*source*' and a '*receptor*' by means of a '*pathway*'.

ASSESSMENT METHODOLOGY

The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

Stages 1 and 2 develop a '*conceptual model*' based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref. 9.45. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref.9.26. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. CLR 8, ref. 9.38, together with specific DoE 'Industry Profiles' provides guidance on the nature of contaminants relating to specific industrial processes. Although CLR 8 has been withdrawn, no replacement guidance has been published that lists the contaminants likely to be present on contaminated sites and as such the guidance relating to this issue of CLR 8 is considered to still be relevant.

If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref. 9.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

All site works should be in general accordance with the British Standards, BS 5930:2015, ref. 9.4, ISO 1997, ref. 9.5 and BS 10175:2011, ref. 9.3.

The generic contamination risk assessment screens the results of the chemical analysis against generic guidance values which are dependent on the proposed end-use of the development.

The end-use may be defined as one of the following ref. 9.35:

- Residential with home grown produce – domestic low rise and low density housing with gardens where vegetable may be grown for home consumption.
- Residential without home grown produce – domestic low density and low density housing where no gardens are present.
- Allotments – specific areas where vegetables are grown for home consumption.

Public open space in close proximity to residential housing – includes the predominantly grassed area adjacent to high density housing and the central green area around which houses are developed. This land-use includes the smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soil with planting.

Public open space in use as general parkland – provided for recreational use and may be used for family visits and picnics, children's play area, sports grounds and dig walking.
Commercial – industrial premises where there is limited exposure to soil.

Exposure pathways for each type of end-use are given below:

Standard Land Use	Oral Routes			Dermal Routes	Inhalation Routes				
	Direct soil & dust ingestion	Consumption of home grown produce	Soil attached to home grown produce	Indoor	Outdoor	Indoor dust	Outdoor dust	Indoor vapour	Outdoor vapour
Residential with home grown produce	✓	✓	✓	✓	✓	✓	✓	✓	✓
Residential without home grown produce	✓	×	×	✓	✓	✓	✓	✓	✓
Allotments	✓	✓	✓	×	✓	×	✓	✓	✓
Public open space – adjacent to dwellings	✓	×	×	✓	✓	✓	✓	×	✓
Public open space – parkland	✓	×	×	×	✓	×	✓	×	✓
Commercial	✓	×	×	✓	×	✓	×	✓×	×

In the first instance, soils will be compared to Suitable 4 Use Levels (S4ULs) published by LQM ref. 9.29. Screening levels for lead are taken from guidance published by DEFRA as no S4UL has been derived, ref. 9.35. Where no S4UL or C4SL is available, the assessment criteria (AC) may be generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.07, ref. 9.31. Toxicological and physico- chemical/fate and transport data used to generate the AC will be derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs.

(DEFRA) documents:

2. Other documents produced by UK Government or state organisations.
3. European institution documents.
4. International organisation documents.
5. Foreign government institutions.

Where appropriate, input data has been drawn from the relevant SGV where available, or existing toxicological reports published by the Environment Agency which have not yet been withdrawn/replaced. Fate and transport data has been derived in the first instance from Environment Agency (2008), ref 9.46.

Individual concentrations are compared to the selected screening levels to identify concentrations of contaminants that are above the selected screening criteria. If appropriate, a statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 9.32.

Initially the distribution of the data set is tested using the Shapiro-Wilk normality test to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.

Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

The potential receptors include:

- Humans – current site occupants, construction workers, future site users and neighbouring site users.
- Controlled Waters – surface water and groundwater resources.
- Plants – current and future site vegetation.
- Building materials.

The potential hazards to be considered in relation to contamination are:

a) Ingestion and inhalation.

b) Uptake of contaminants via cultivated vegetables.

c) Dermal contact.

d) Phytotoxicity (the prevention or inhibition of plant growth).

e) Contamination of water resources.

f) Chemical attack on building materials and services.

g) Fire and explosion.

Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

GENERIC GUIDANCE VALUES USED WITHIN CONTAMINATION RISK ASSESSMENT

Commercial End Use

Commercial	Determinant	Guidance Value (mg/kg) 1% SOM	Guidance Value (mg/kg) 2.5% SOM	Guidance Value (mg/kg) 6% SOM	Primary Data Source
PAH	Acenaphthene	85000	97000	100000	LQM/CIEH S4UL
	Acenaphthylene	84000	97000	100000	LQM/CIEH S4UL
	Anthracene	520000	540000	540000	LQM/CIEH S4UL
	Benzo(a)anthracene	170	170	180	LQM/CIEH S4UL
	Benzo(a)pyrene	35	35	36	LQM/CIEH S4UL
	Benzo(b)fluoranthene	44	44	45	LQM/CIEH S4UL
	Benzo(ghi)perylene	3900	4000	400	LQM/CIEH S4UL
	Benzo(k)fluoranthene	1200	1200	1200	LQM/CIEH S4UL
	Chrysene	350	350	350	LQM/CIEH S4UL
	Dibenzo(ah)anthracen	3.5	3.6	3.6	LQM/CIEH S4UL
	Fluoranthene	23000	23000	23000	LQM/CIEH S4UL
	Fluorene	63000	68000	71000	LQM/CIEH S4UL
	Indeno(123-cd)pyrene	500	510	510	LQM/CIEH S4UL
	Naphthalene	190	460	1100	LQM/CIEH S4UL
	Phenanthrene	22000	22000	2300	LQM/CIEH S4UL
	Pyrene	54000	54000	54000	LQM/CIEH S4UL
Other Organics	Phenol	760	1500	3200	LQM/CIEH S4UL
Metals	Arsenic	640	640	640	LQM/CIEH S4UL
	Beryllium	12	12	12	LQM/CIEH S4UL
	Boron	240000	240000	240000	LQM/CIEH S4UL
	Cadmium	190	190	190	LQM/CIEH S4UL
	Chromium (III)	8600	8600	8600	LQM/CIEH S4UL
	Chromium (VI)	49	49	49	LQM/CIEH S4UL
	Copper	68000	68000	68000	LQM/CIEH S4UL
	Lead	2330	2330	2330	EA C4SL
	Mercury	58	58	58	LQM/CIEH S4UL
	Nickel	980	980	980	LQM/CIEH S4UL
	Selenium	12000	12000	12000	LQM/CIEH S4UL
	Vanadium	9000	9000	9000	LQM/CIEH S4UL
	Zinc	730000	730000	730000	LQM/CIEH S4UL

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC

Generic Assessment Criteria for Petroleum Hydrocarbons

Commercial	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	2.5% SOM	6% SOM	
Aliphatic				
EC 5-6	3200 (304)	5900 (558)	12000 (1150)	LQM/CIEH S4UL
EC >6-8	7800 (144)	17000 (322)	40000 (736)	LQM/CIEH S4UL
EC >8-10	2000 (78)	4800 (190)	11000 (451)	LQM/CIEH S4UL
EC >10-12	9700 (48)	23000 (118)	47000 (283)	LQM/CIEH S4UL
EC >12-16	59000 (24)	82000 (59)	90000 (142)	LQM/CIEH S4UL
EC >16-35	1600000	1700000	1800000	LQM/CIEH S4UL
EC >35-44	1600000	1700000	1800000	LQM/CIEH S4UL
Aromatic				
EC 5-7 (benzene)	26000 (1220)	46000 (2260)	86000 (4710)	LQM/CIEH S4UL
EC >7-8 (toluene)	56000 (869)	110000 (1920)	180000 (4360)	LQM/CIEH S4UL
EC >8-10	3500 (613)	8100 (1500)	17000 (3580)	LQM/CIEH S4UL
EC >10-12	16000 (364)	28000 (899)	34000 (2150)	LQM/CIEH S4UL
EC >12-16	36000 (169)	37000	38000	LQM/CIEH S4UL
EC >16-21	28000	28000	28000	LQM/CIEH S4UL
EC >21-35	28000	8000	28000	LQM/CIEH S4UL
EC >35-44	28000	28000	28000	LQM/CIEH S4UL
Aliphatic and Aromatic				
EC >44-70	28000	28000	28000	LQM/CIEH S4UL
BTEX				
Benzene	27	47	90	LQM/CIEH S4UL
Toluene	56000	110000	180000	LQM/CIEH S4UL
Ethylbenzene	5700	13000	27000	LQM/CIEH S4UL
m/p Xylenes	5900	14000	30000	LQM/CIEH S4UL
o Xylene	17000	24000	33000	LQM/CIEH S4UL

SOM = Soil Organic Matter
Values in brackets indicate the vapour saturation limit where this is exceeded by the GAC or SGV

Guidance Values Used For Assessment of Risk to Controlled Waters

Contaminant	Units	EQS Freshwater1	EQS Saltwater1	Water Supply5
Alachlor	ug/l	0.7	0.7	
Abamectin	ug/l	0.03	0.01	
Acrylamide	ug/l			0.1
Aluminium	ug/l	103	25	200
Ammonia (unionised)	ug/l	15	212	
Ammonium (as NH4)	mg/l			0.5
Anthracene	ug/l	0.4	0.4	
Antimony	ug/l			5
Arsenic	ug/l	502	252	10
Atrazine	ug/l	2	2	
Azamethiphos	ug/l	0.05	0.05	
Barium	ug/l			1000
Benzene	ug/l	50	50	1
Benzyl-butyl-phthalate	ug/l	7.52	0.752	
Boron	mg/l	2	7	1
Brominated Diphenylether	ug/l	0.00052	0.00052	
Bromine	ug/l	5	10	
Bromoxynil	ug/l	1000	1000	
Cadmium	ug/l	0.453	0.22	5
Calcium	mg/l			250
Carbon Tetrachloride	ug/l	122	122	
Carbendazin	ug/l	0.152	-	
C10-C13 Chloroalkanes	ug/l	1.4	1.4	
Chlorenvinphos	ug/l	0.3	0.3	
Chlorpyrifos (Chlorpyrifos-ether)	ug/l	0.1	0.1	
Chlorothalonil	ug/l	0.0352	-	
Cyclodiene Pesticides (aldrin, Dieldrin, Endrin,Isodrin)	ug/l	2	2	
Chloride	mg/l	250	-	400
Chlorpropham	ug/l	40	40	
Chlortoluron	ug/l	20	-	
Chromium III	ug/l	4.72	-	50
Chromium VI	ug/l	3.42	0.62	
Cobalt	ug/l	100	100	
Copper	ug/l	12	3.762	2
Coumaphos	ug/l	0.1	0.1	
Cyanide (hydrogen cyanide)	ug/l	12	12	50
Cypermethrin	ug/l	0.12	0.12	
Cyfluthrin	ug/l	0.001	0.001	
1,2-Dichloroethane	ug/l			3
2,4-Dichlorophenoxyacetic acid (2,4-D)	ug/l	0.32	0.32	
2,4-Dichlorophenol	ug/l	4.22	0.0422	
3,4-Dichloroaniline	ug/l	0.22	0.22	
DDT (total)	ug/l	0.0252	0.0252	
Diazinon	ug/l	0.012	0.012	
Dibutylphthalate (DBP)	ug/l	40	40	
Dichlorobenzenes (all isomers)	ug/l	200	200	
para, para-DDT	ug/l	0.012	0.012	
Diethylphthalate (DEP)	ug/l	1000	1000	
Dimethylphthalate (DMP)	ug/l	4000	4000	
Dioctylphthalate (DOP)	ug/l	40	40	
Dimethoate	ug/l	0.482	0.482	
Diflubenzuron	ug/l	0.015	0.1	
Doromectin	ug/l	0.01	0.01	
Diuron	ug/l	1.8	1.8	
Endosulfan	ug/l	0.01	0.004	
Epichlorohydrin	ug/l			0.1
EDTA	ug/l	4000	4000	
Ethylbenzene	ug/l	200	200	
Fenchlorphos	ug/l	0.1	0.1	
Flucofuron	ug/l	1	1	
Fluoride	mg/l	34	15	1.5
Fluoranthene	ug/l	1	1	
Formaldehyde	ug/l	50	-	

Contaminant	Units	EQS Freshwater1	EQS Saltwater1	Water Supply5
Glyphosate	ug/l	1962	1962	
Hexachlorobenzene	ug/l	0.05	0.05	
Hexachlorobutadiene	ug/l	0.6	0.6	
Hexachlorocyclohexane (lindane)	ug/l	0.04	0.02	
Hydrogen Sulphide	ug/l	1	10	
Ioxynil	ug/l	100	100	
Iron	ug/l	10002	10002	200
Isoproturon	ug/l	1	1	
Ivermectin	ug/l	0.001	0.001	
Kjeldahl Nitrogen (as N)	mg/l			1
Lead	ug/l	7.22	7.22	10
Linuron	ug/l	0.52	0.52	
Malachite Green	ug/l	100	100	
Magnesium	mg/l			50
Manganese	ug/l	1232	-	50
Mecoprop	ug/l	182	182	
Methiocarb	ug/l	0.012	-	
Mancozeb	ug/l	20	20	
Maneb	ug/l	30	30	
MCPA	ug/l	1203	800	
Methylphenols	ug/l	300	300	
Mevinphos	ug/l	0.02	-	
Monochlorophenols	ug/l	250	250	
Mercury	ug/l	0.07	0.07	1
Naphthalene	ug/l	2.42	1.22	
Nickel	ug/l	202	202	20
NTA	ug/l	10000	30000	
Nitrate (as N)	mg/l			50
Nitrite (as NO2)	mg/l			0.5
Nonylphenol (4-nonylphenol)	ug/l	2	2	
Oils/hydrocarbons	ug/l			10
Pendimethylin	ug/l	0.32	-	
Permethrin	ug/l	0.0012	0.00022	
Polycyclic Aromatic Hydrocarbons (PAH)	ug/l			0.1
- Benzo(a)pyrene	ug/l	0.1	0.1	0.01
- Benzo(b)fluoranthene	ug/l	Σ=0.032	Σ=0.032	
- Benzo(k)fluoranthene	ug/l			
- Benzo(ghi)perylene	ug/l	Σ=0.0022	Σ=0.002	
- Indeno(123-cd)perylene	ug/l			
Pentachlorobenzene	ug/l	0.0072	0.00072	
Pentachlorophenol	ug/l	1	1	
Pesticides (individual)	ug/l			0.1
- Aldrin	ug/l			0.03
- Dieldrin	ug/l			0.03
- Heptachlor	ug/l			0.03
- Heptachlor epoxide	ug/l			0.03
Pesticides (total)	ug/l			0.5
Phenol	ug/l	7.72	7.72	0.5
PCSDs	ug/l	0.05	0.05	
Pirimicarb	ug/l	5	5	
Pendimethalin	ug/l	6	6	
Primaphos-methyl	ug/l	0.05	0.05	
Prochloraz	ug/l	40	40	
Propetamphos	ug/l	0.1	0.1	
Propyzamide	ug/l	1000	1000	
Phosphorous	ug/l			2200
Potassium	mg/l			12
Selenium	ug/l			10
Silver	ug/l	0.1	1	10
Simizine	ug/l	4	4	
Styrene	ug/l	500	500	
Sulcofuron	ug/l	25	25	
Sulphate	mg/l	400	-	250
Surfactants (as lauryl sulphate)	ug/l			200
Tecnazene	ug/l	10	10	
Tetrachloromethane (PCM)	ug/l	2.52	2.52	3

Contaminant	Units	EQS Freshwater1	EQS Saltwater1	Water Supply5
Tetrachloroethylene (PCE)	ug/l	102	102	10
Tetrachloroethane	ug/l	1402	-	
Trichloroethylene (TCE)	ug/l	102	102	10
Thiabendazole	ug/l	50	50	
Tin (inorganic)	ug/l	252	102	
Trihalomethanes	ug/l			100
Trichlorobenzenes	ug/l	0.42	0.42	
Toluene	ug/l	742	742	
Tributyl phosphate	ug/l	500	500	
Tributyltin	ug/l	0.0015	0.0015	
Trifluralin	ug/l	0.032	0.032	
Vanadium	ug/l	204	100	
Vinyl chloride	ug/l			0.5
Zinc	ug/l	11.92	7.92	5000

1 MAC – Maximum Allowed Concentration
2 AA – Average Annualised
3 Dependant on pH
4 Dependant on water hardness
5 For sample taken at consumers' taps

Appendix G Gas Generation

GENERAL NOTES ON GAS GENERATION

GENERAL

In the past, a series of guidance documents were published by CIRIA, ref. 9.47, providing advice on hazards associated with methane. This earlier guidance was consolidated in CIRIA Document C659 to provide a risk based approach to gas contaminated land. This was subsequently re-issued as CIRIA Document C665, ref 9.48. In 2007, British Standard, BS8485, ref 9.49, dealing with ground gas was published. It is recommended that guidance in C665 and BS8485 is adopted to provide a consistent approach in dealing with ground gas contamination, the principal details being as follows.

This guidance is based on a similar approach to that for dealing with contaminated soil. The presence of hazardous gases could be deemed to be the 'source' in a 'pollutant linkage' that could lead to the conclusion that significant harm is or could be caused to people, buildings or the environment. In such circumstances the land could be deemed 'contaminated', ref. 9.24.

Should a potential source of gas be identified in the conceptual model, a gas risk assessment should be carried out, sufficient to demonstrate to the local authority that the proposals mitigate any hazards associated with ground gas. The authority enforces compliance with Approved Document Part C of the Building Regulations, ref. 9.50.

APPROACH

A flow chart detailing the approach to assessing a site is given in CIRIA document C665, Figure 1.1. This may be summarised as follows:

- Carry out Phase 1 desk study, including initial conceptual model.
- Assess site, potential presence of gas / potential unacceptable risk/identify further action, if necessary.
- Monitor gas concentrations.
- Assessment of Risk.
- Recommendations/remediation.
- Validation.

POLLUTANT LINKAGE ASSESSMENT

A pollutant linkage assessment is presented in Appendix 3 of the Phase 1 Desk Study Report.

Using the risk model in the desk study, the pollutant linkage can be identified and a preliminary estimate of risk undertaken. If there is no relevant pollutant linkage identified there is no risk. If there is a very low risk, it is likely that no further assessment is required. If further assessment is necessary, then gas monitoring is required

SITE MONITORING

For sites with low generation potential, giving consistently low concentrations of soil gas under the worst-case conditions, a limited programme of monitoring would be appropriate. Where high or variable concentrations are anticipated or recorded, an extended programme of monitoring would be appropriate. The following guideline has been proposed, ref. 9.52.

Table A7.1

Sensitivity of development		Generation potential of source				
		Very low	**Low**	**Moderate**	**High**	**Very high**
	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with gardens)	6/3*	9/6	12/6	24/12	24/24

Notes:

1. First number is minimum number of readings and second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.
2. At least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions (see Boyle and Witherington, 2006).
3. The frequency and period stated are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required (e.g. any such variation subject to site specific justification). * The NHBC guidance is also recommending these periods/frequency of monitoring (Boyle and Witherington, 2006).
4. Historical data can be used as part of the data set.
5. Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.
6. Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long- term monitoring may not be appropriate or required.

Before taking any readings, zero the instrument, record atmospheric pressure and temperature.

Gas flow should be recorded, giving the range of pressures, ensuring positive or negative flow is recorded.

Record gas levels, recording peak and steady. Where steady state not obtained within 3 minutes, record change in concentration, where concentrations are decreasing, always record peak value. For very high concentrations, record for longer period of up to 10 minutes.

ASSESSMENT OF RISK AND RECOMMENDATIONS

The main method of characterising a site is the method described by Wilson and Card, ref. 9.53 and is termed Situation A. This can be used for all types of development except conventional low-rise housing with suspended ground floor and ventilated underfloor void.

Low rise housing, Situation B, was developed by Boyle and Witherington, ref. 9.54 and was developed for the NHBC for classifying gassing sites for houses with suspended ground floor slab with ventilated void.

Although the Code of Practice, ref 9.49, assesses the characteristic gas situation as CIRIA recommend for Situation A, see Table A7.2 below, their solution for gas protection systems is different, see section A7.10.

SITUATION A - ASSESSMENT

This system proposed by Wilson and Card, ref. 9.53 was originally developed in CIRIA Report 149, ref. 9.47.

The method uses both gas concentrations and borehole flow rate for methane and carbon dioxide to define a Characteristic Situation for a site.

Gas Screening Value (litre/hr) = borehole flow rate (litre/hr) x gas concentration (%). The GSV is determined for methane and carbon dioxide and the worst case adopted. The Characteristic Situation can then be determined from the table below. The GSV can be exceeded if the conceptual model indicates it is safe to do so, and other factors may lead to a change in the Characteristic Situation.

Table A7.2

Characteristic Situation	Risk Classification	Gas screening value (CH4 or CO2(1/hr)1	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane <1% and/or carbon dioxide <5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" Made Ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to Characteristic Situation 3	Natural soil, high peat/organic content. "Typical" Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mine working – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table A7.1

Source of gas and generation potential/performance must be identified.

If there is no detectable flow use the limit of detection of the instrument.

SITUATION A – SOLUTION

The Characteristic Situation can be used to define the scope of gas protective measures required.

The CIRIA approach uses the characteristic situation to define the level of gas protection as follows:

Table A7.3

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
	Number of levels of protection	Typical scope of protective measures	Number of levels of protection	Typical scope of protective measures
1	None	No special precautions	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended non-suspended or raft) with at least 1200g DPM and underfloor venting b) Beam and block or pre- cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM b) Beam and block or pre cast concrete slab and minimum 2000g DPM/reinforced gas membrane c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use All joints and penetrations sealed
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
4	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in ground venting layer.	2 to 3	All types of floor slab as above. All joints and penetration sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers.	3 to 4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub- space with monitoring facility. In ground venting wells or barriers.
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design.	4 to 5	Reinforced concrete cast in- situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub- space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.

Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414, ref. 9.51.

In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.

Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs.

Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for characteristic situations 3 and 4.

Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block and beam floor is used it should be well detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m3 and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membrane).

The gas-resistant membrane can also act as the damp-proof membrane.

SITUATION B -ASSESSMENT

The NHBC has developed a characterisation system that is similar to Situation A but is specific to low-rise housing development with a clear ventilated underfloor void. The gas emission rates are compared to generic 'Traffic Lights'.

The Traffic Lights include a Typical Maximum Concentration that is used for initial screening purposes. Where the Typical Maximum Concentration is exceeded the risk-based Gas Screening Value, GSV, should be adopted. The GSVs are determined for the 'model' low rise development and where they differ from this model, the GSV should be reassessed, ref. 9.48.

The calculations should be made for both methane and carbon dioxide, and the worst case adopted.

The GSV is only a guideline.

Table A7.4

Traffic Light	Methane		Carbon Dioxide	
	Typical maximum concentration[2] (% v/v)	Gas screening value (GSV)3 (litres per hour)	Typical maximum concentration[2] (% v/v)	Gas screening value (GSV)1,2 (litres per hour)
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.13
Red				

1 Generic GSVs are based on guidance contained within latest revision of Department of the Environment and the Welsh Office (2004 edition) "The Building Regulations: Approved Document C" and used a sub-floor void of 150mm thickness.

2 The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgement will be required, based on a thorough understanding of the gas-regime identified at the site where monitoring in the worst temporal conditions has occurred.

3 The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

SITUATION B – SOLUTION

On the basis of this Traffic Light classification the following protection should be applied to low- rise housing.

Table A7.5

Traffic Light Classification	Protection measures required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. A specialist contractor should always fit membranes. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

CODE OF PRACTICE – SOLUTIONS

The Characteristic Gas Situation is determine in a similar manner to that recommended by CIRIA, see Table A7.2 above.

Having selected the Characteristic Gas Situation, the appropriate gas protection could be selected for the building. The tables below give a guide as to the relative performance of the various designs and systems.

A guidance value for the required gas protection, in the range 0 to 7 should be obtained from Table A7.6 below. Then, a combination of ventilation and/or barrier system should be chosen from Table A7.7 to meet that requirement.

Table A7.6

Characteristic gas situation, CS	NHBC traffic light	Required gas protection			
		Non-managed property, e.g. private housing	Public building A)	Commercial buildings	Industrial buildings B)
1	Green	0	0	0	0
2	Amber 1	3	3	2	1C)
3	Amber 2	4	3	2	2
4	Red	6D)	5D) 6E)	4 5 7	3 4 6

NOTE: Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

A) Public buildings include, for example, managed apartments, schools and hospitals.

B) Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.

C) Maximum methane concentration 20% otherwise consider an increase to CS3.

D) Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

E) Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any protection scheme.

Having determined the appropriate guidance value from Table A7.6, an element or combination of elements from a), b), c) or d) in Table A7.7, should be chosen to achieve the required level of protection.

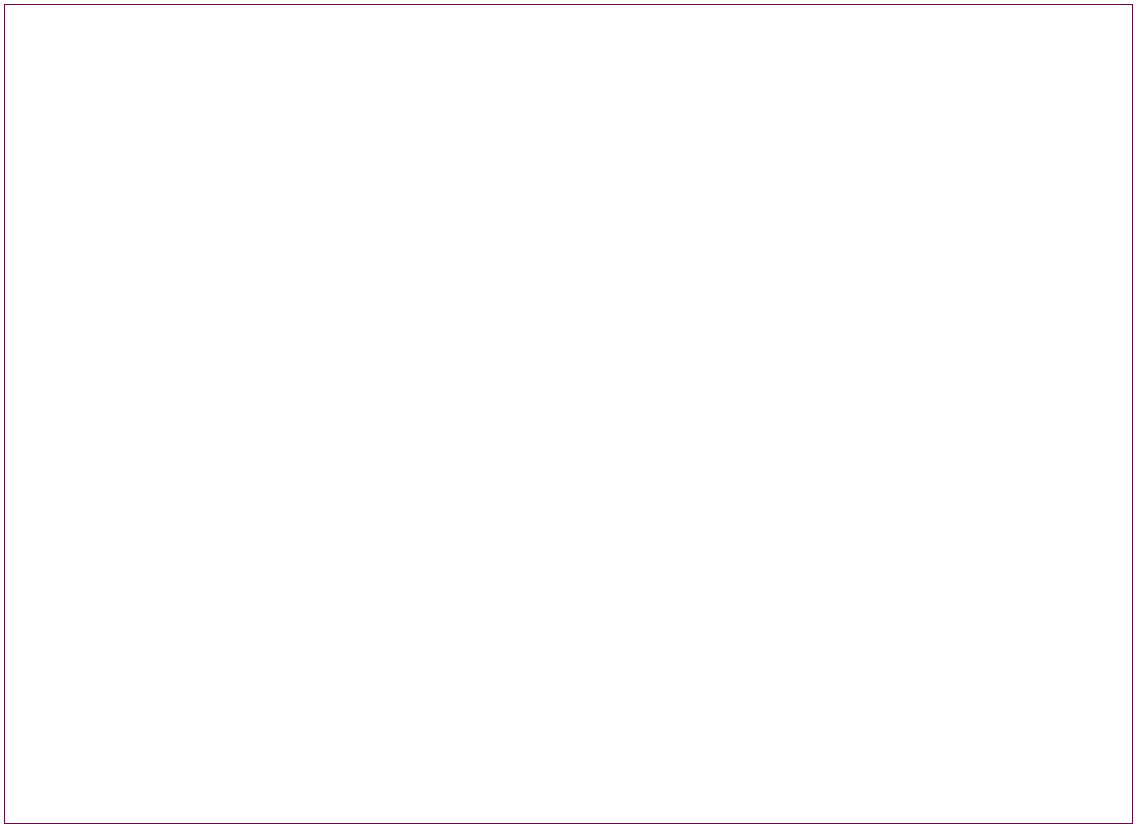
Table A7.7

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)A)	Very good performance	2.5	Ventilation performance in accordance with Annex A, ref. 9.49
	Good performance	1	If passive ventilation is poor this is generally unacceptable and some form of active system will be required
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)A)		2.5	There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: extraction and positive pressurization.
Ventilated car park (basement or undercroft)		4	Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IstructE guidance.
b) Barriers			
Floor slabs Block and beam floor slab		0	It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breached in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.
Reinforced concrete ground bearing floor slab.		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab.		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints.		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation), C).		0.5	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints
Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current good practice under independent inspection (CQA)B), C).		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation.		2	

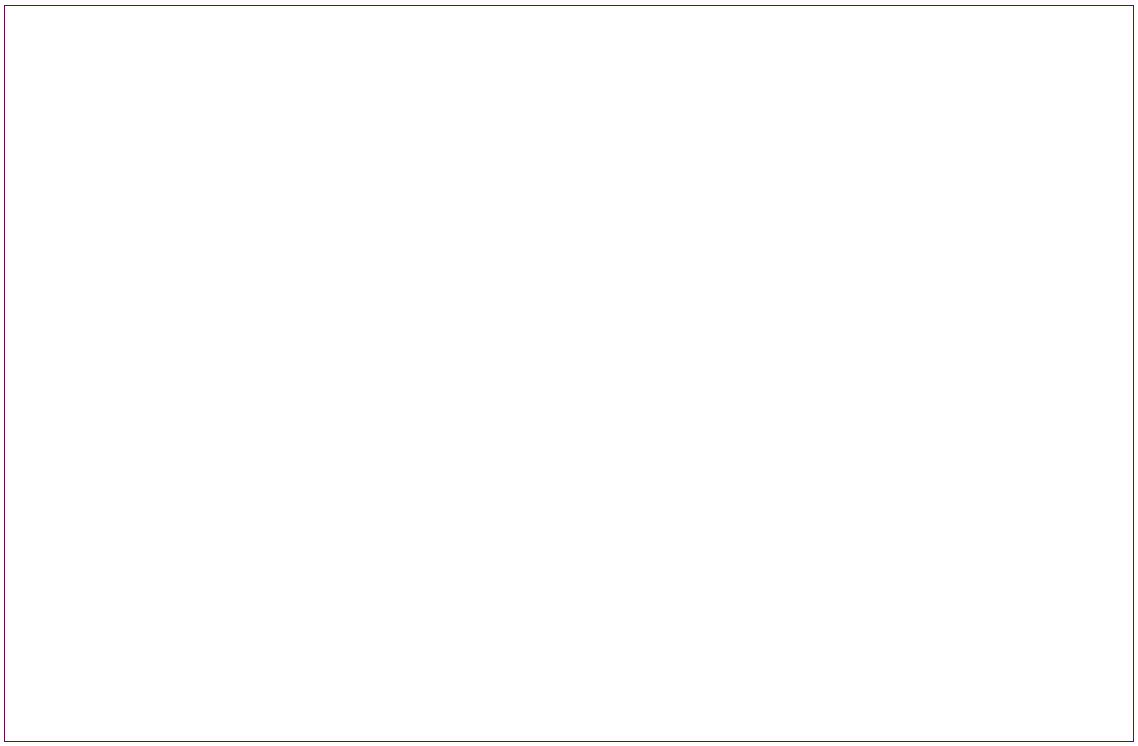
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.
Permanent monitoring and alarm system [A])	Installed in the underfloor venting/dilution system.	2	
	Installed in the building.	1	
e) Pathway intervention			
Pathway intervention		-	This can consist of site protection measures for off-site or on-site sources (see Annex A, ref. 9.49)

NOTE: In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection.

Appendix H Photographs of Rock Core



Photograph 1



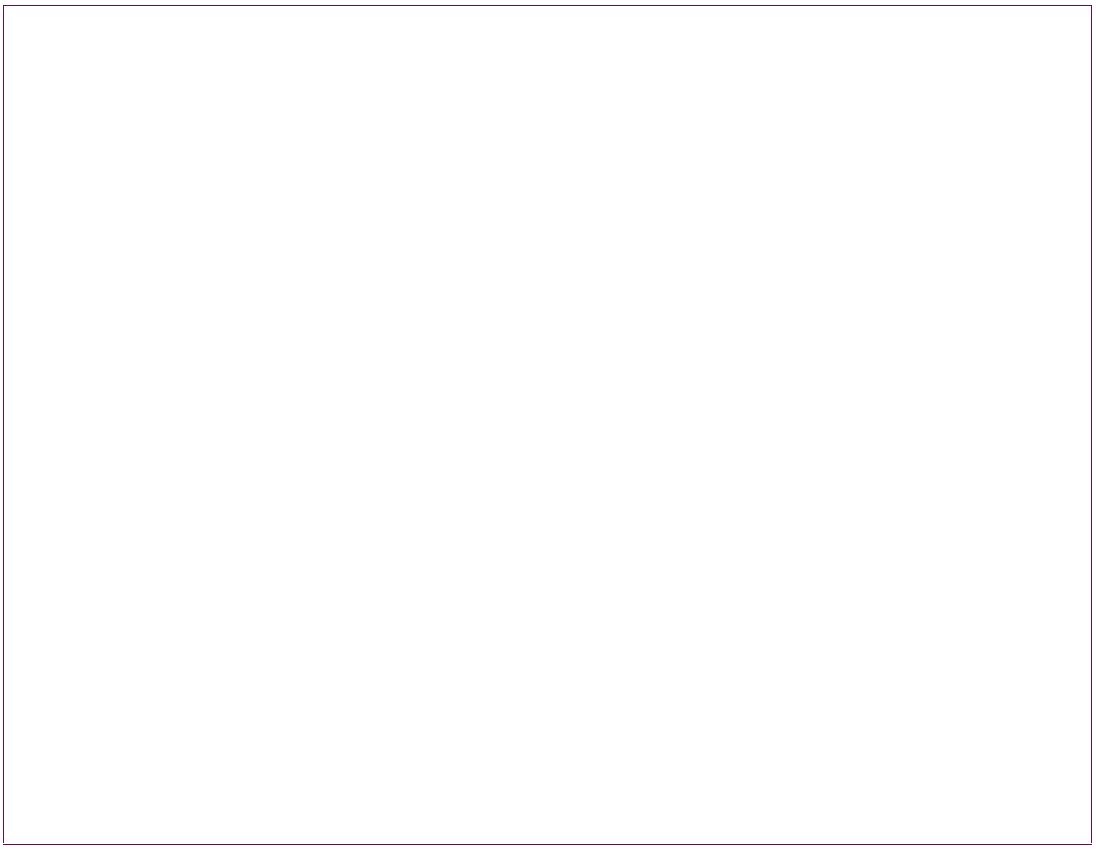
Photograph 2



Photograph 3



Photograph 4



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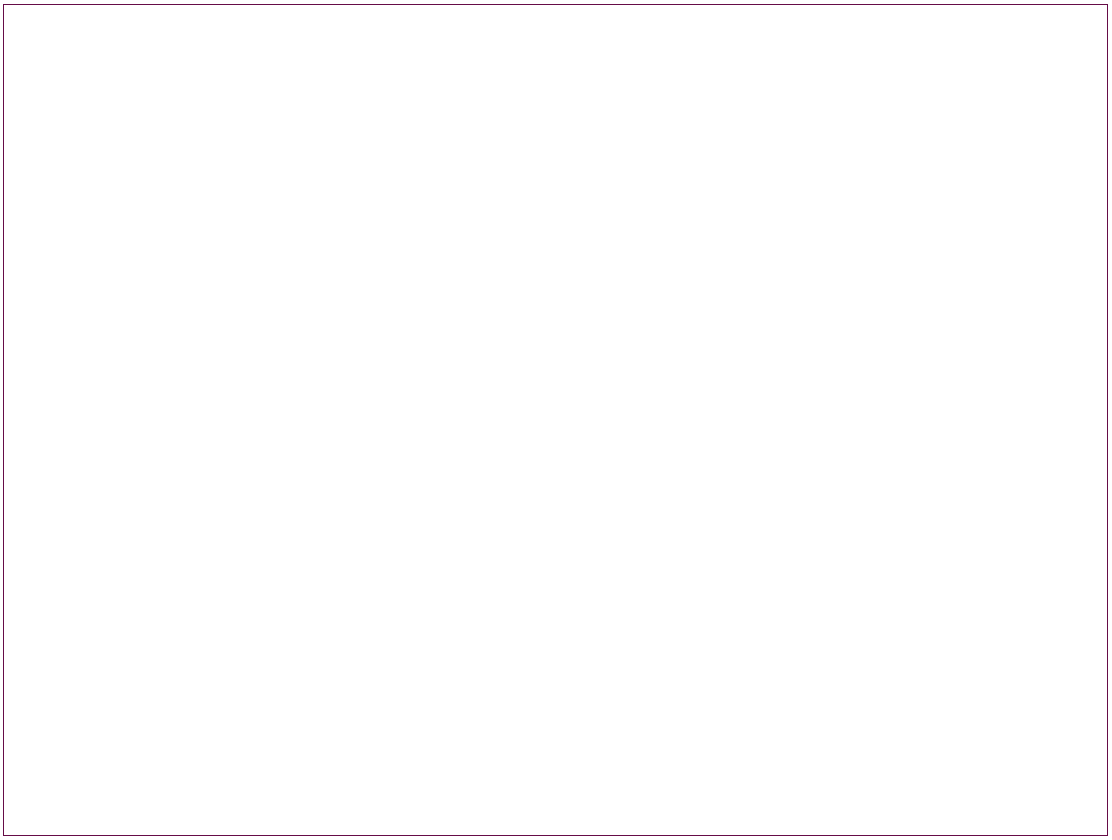

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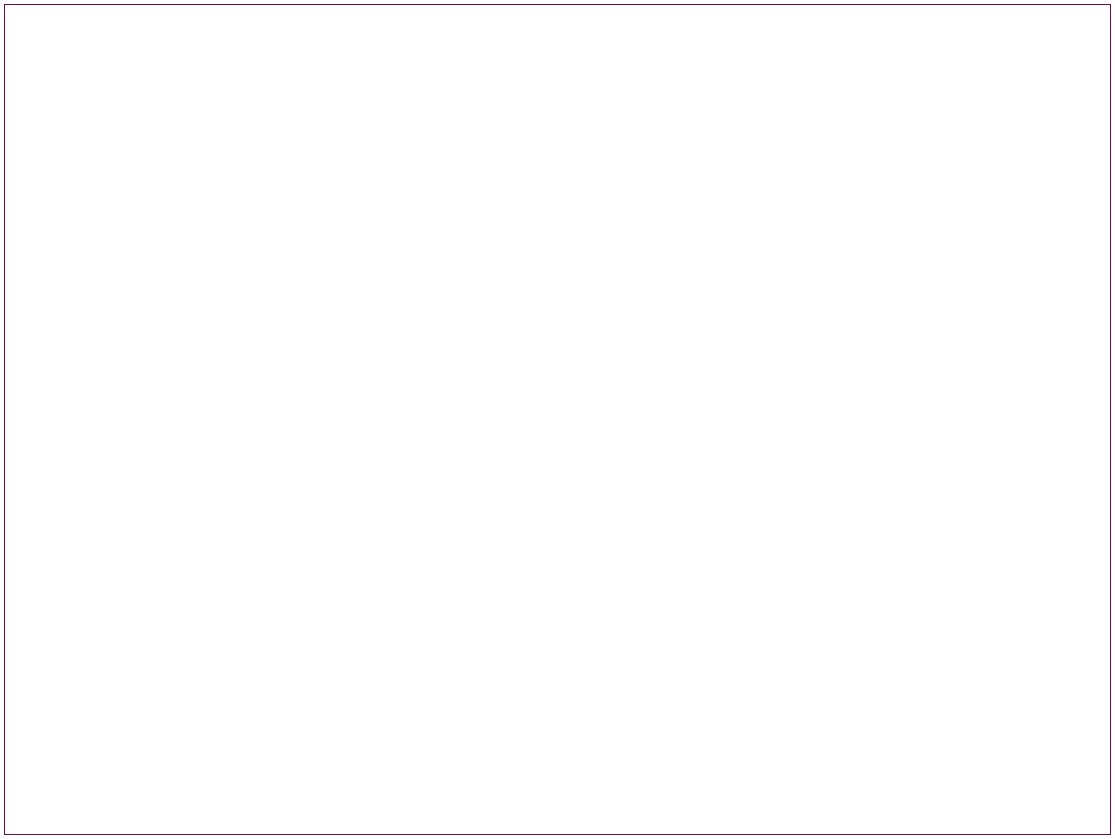

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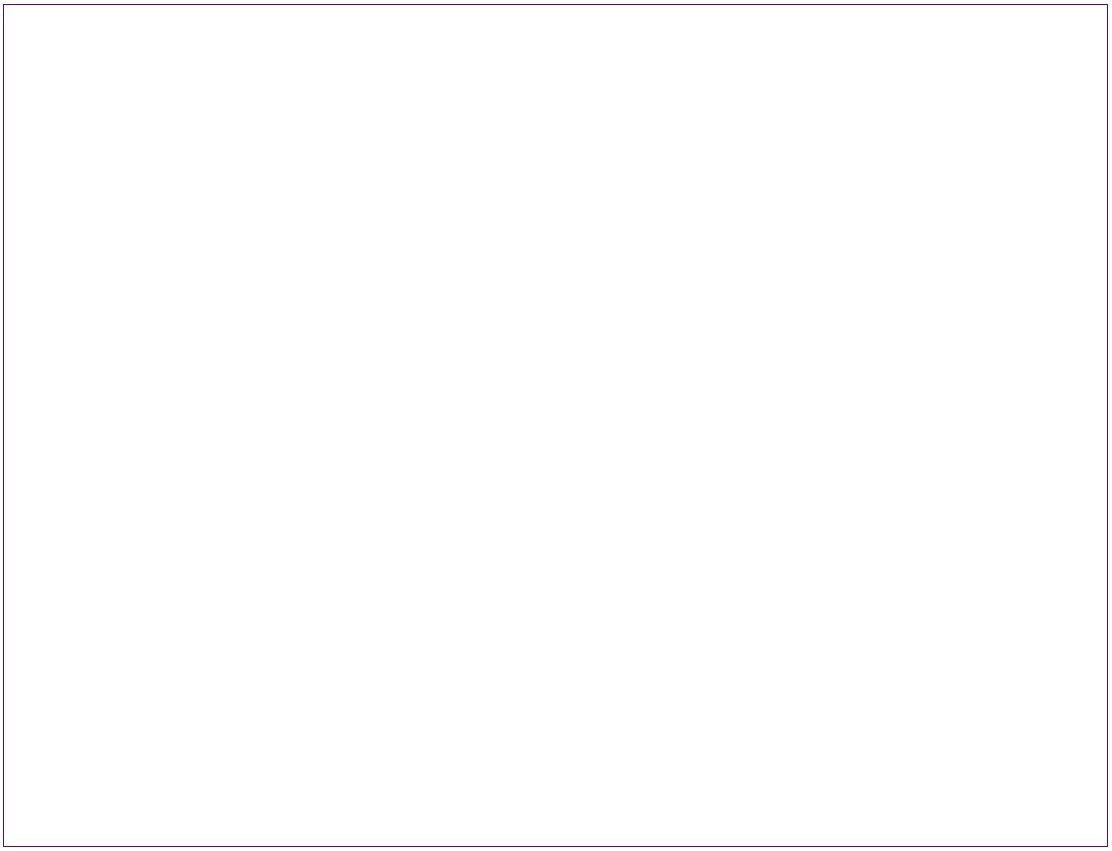

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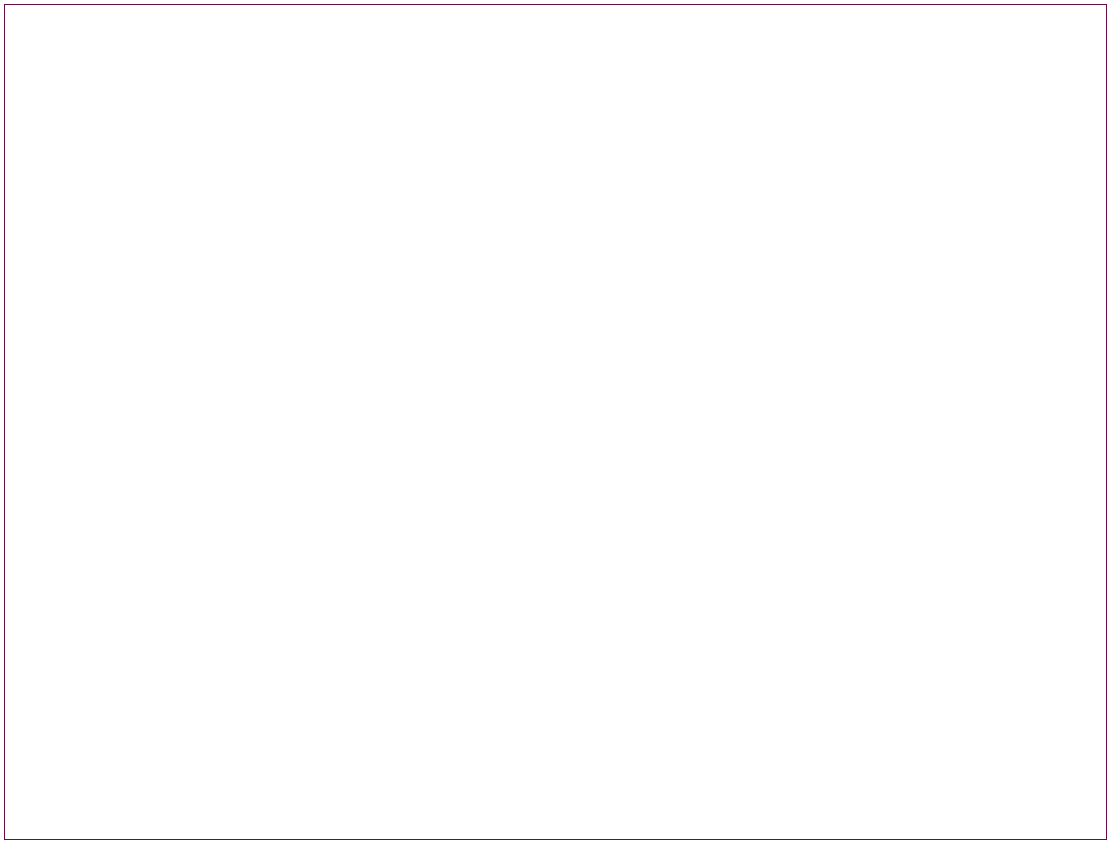

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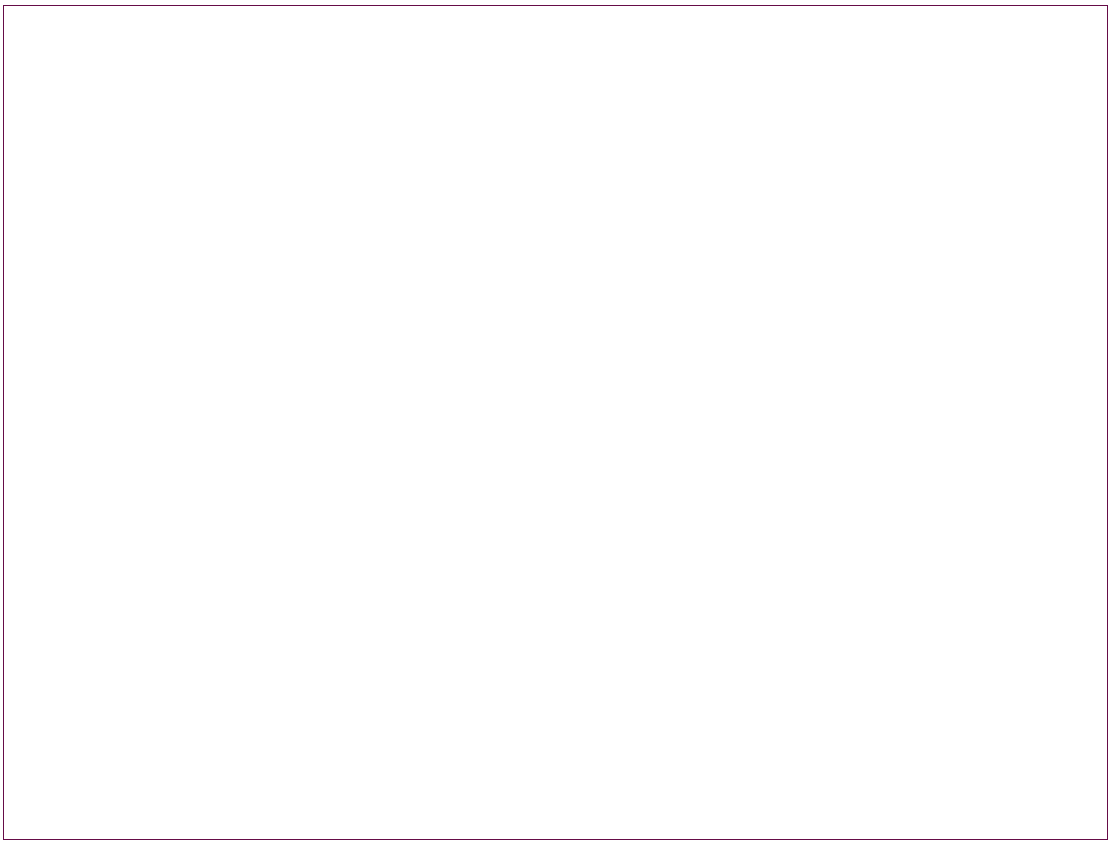

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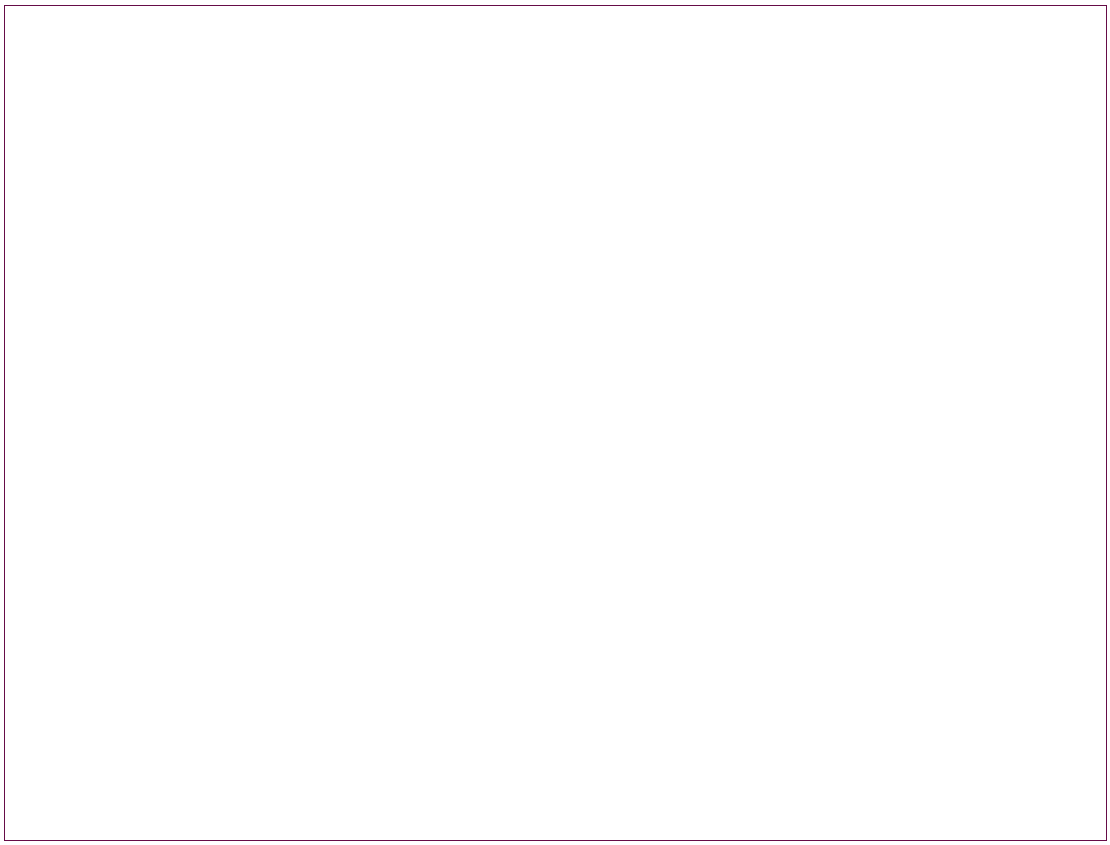

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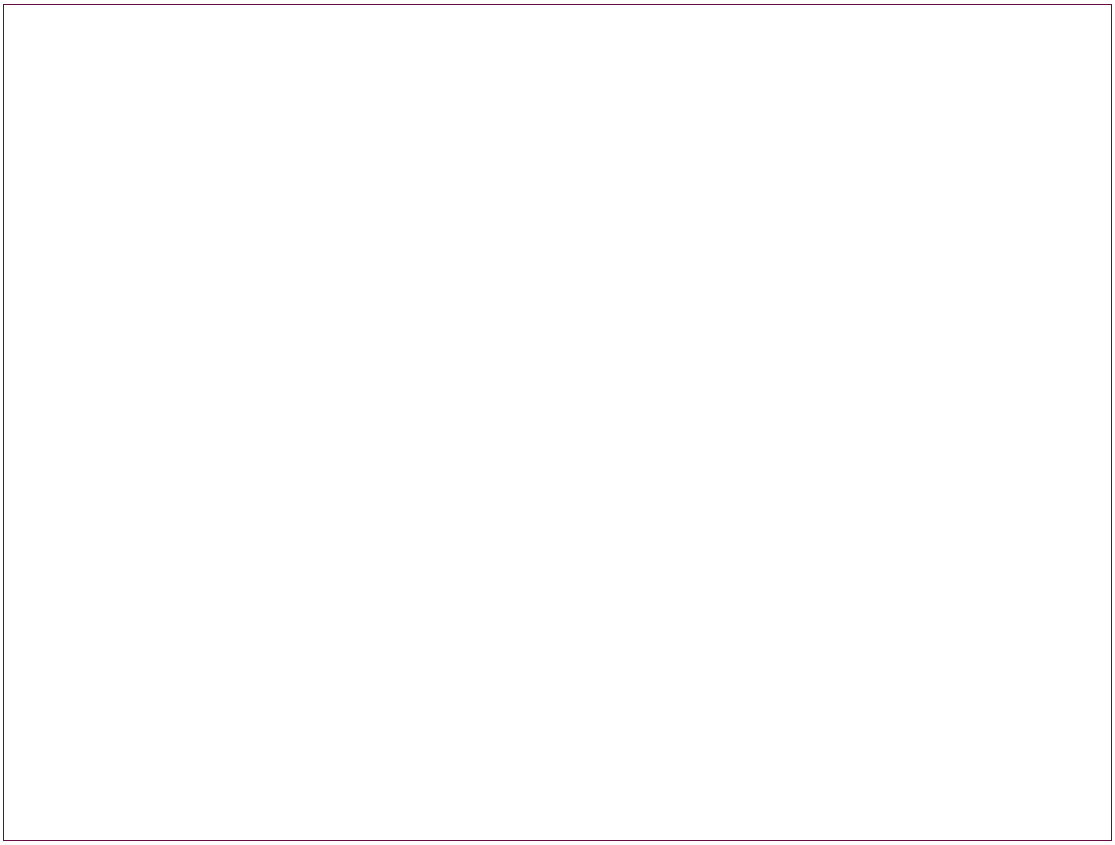

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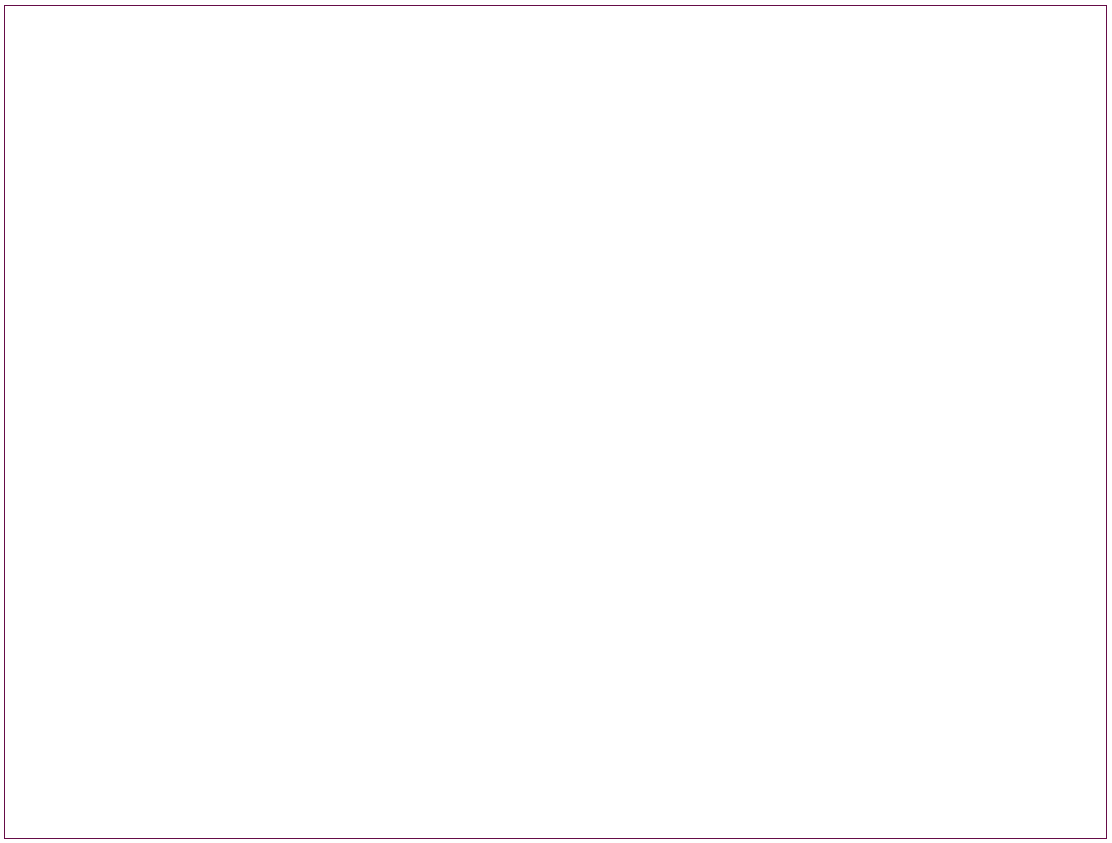

Photograph 13

Appendix I Notes on Limitations

General

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b) this document to any third party with whom an agreement has not been executed.

Phase I Desk Study Reports

The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the site and meetings and discussions with relevant authorities and other interested parties. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only to the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, JPG (Leeds) Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed; actual risks can only be assessed following a physical investigation of the site.

Phase II Geo-Environmental Investigations

The investigation of the site has been carried out to provide sufficient information concerning the type and degree of contamination, geotechnical characteristics and ground and groundwater conditions to allow a reasonable assessment of the environmental risks together with engineering and development implications. The objectives of the investigation have been limited to establishing the risks associated with potential human targets, building materials, the environment (including adjacent land), and to surface and groundwater.

The amount of exploratory work and chemical testing undertaken has necessarily been restricted by the short timescale available, and the locations of exploratory holes have been restricted to the areas unoccupied by the building(s) on the site and by buried services. A more comprehensive investigation may be required if the site is to be redeveloped as, in addition to risk assessment, a number of important engineering and environmental issues may need to be resolved.

For these reasons if costs have been included in relation to site remediation these must be considered as tentative only and must, in any event, be confirmed by a qualified quantity surveyor.

The exploratory holes undertaken, which investigate only a small volume of the ground in relation to the size of the site, can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions apparent at the site of each of the exploratory holes. There may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that groundwater levels will vary owing to seasonal, tidal and weather related effects.

The number of sampling points and the methods of sampling and testing do not preclude the existence of localised "hotspots" of contamination where concentrations may be significantly higher than those actually encountered.

The risk assessment and opinions provided, inter alia, take in to consideration currently available guidance values relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.

The scope of the investigation was selected on the basis of the specific development proposed by the Client and may be inappropriate to another form of development or scheme.

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