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# REPORT ON A GEOTECHNICAL INVESTIGATION

at

## 41 HIGHGATE WESTHILL, HIGHGATE, LONDON N6

for

## PROMITE LIMITED

**CONSULTING ENGINEERS:**
**MESSRS MICHAEL BARCLAY PARTNERSHIP**

**Final Report No 99/4169/KJC** **July, 1999**

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FileRef A:C

## CONTENTS

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## FOREWORD

The following notes should be read in conjunction with the report. Any variations on the general procedures outlined below are indicated in the text.

***General***

The recommendations made and opinions expressed in the report are based on the strata conditions revealed by the fieldworks as indicated on the boring and trialpit records, together with an assessment of the data from insitu and laboratory tests. No responsibility can be accepted for conditions which have not been revealed by the fieldworks, for example, between borehole and/or trialpit positions. While the report may offer opinions on the possible configuration of strata, both between the excavations and below the maximum depth achieved by the investigation, these comments are for guidance only and no liability can be accepted for their accuracy.

***Boring Technique***

Unless otherwise stated, the light cable percussion technique of soft ground boring has been used. This method generally enables the maximum information to be obtained in respect of strata conditions, but a degree of mixing of some layered soils, for example, thin bands of coarse and fine granular soils, is inevitable. Specific attention is drawn to this occurrence where evidence of such a condition is available.

***Insitu Dynamic Penetration Tests***

The penetration resistances quoted on the boring records have been determined generally in accordance with the procedure given in BS1377:1990. The suffix '+' denotes that the result has been extrapolated from less than 0.3m penetration into undisturbed soil.

***Routine Sampling***

During the construction of boreholes, relatively undisturbed samples of predominantly cohesive soils are obtained in 100mm diameter open drive tube samplers, complying with the requirements of BS5930:1981. Large disturbed samples of granular soils, or of soils in which undisturbed sampling is impractical or inappropriate, are taken from boring tools and sealed in polythene bags. Small disturbed samples are taken at frequent intervals of depth and placed in sealed containers; similarly, where encountered in sufficient quantity, samples of groundwater are taken as indicated above.

***Groundwater***

The groundwater observations entered on boring and trialpit records are those noted at the time of the investigation. The normal rate of progress does not usually permit the recording of any equilibrium water level for any one water strike. Moreover, groundwater levels are prone to seasonal variation and to changes in local drainage conditions. The table on each boring record shows the groundwater level at the quoted borehole and casing depths usually at the start and finish of a day's work. The word 'none' indicates that groundwater was sealed off by the borehole casing, or that no water was observed in the borehole.

***Trialpits***

The method of construction employed to form the trialpits is entered on their records. In general, it is not possible to extend machine excavated trialpits to depths significantly below the water table, especially in predominantly granular soils. Except for manually excavated pits, and unless otherwise stated, the trialpits have not been provided with temporary side support during their construction, hence personnel have not entered them and examined insitu the strata so exposed.

***Laboratory Testing***

Unless stated in the text, all laboratory tests have been performed in accordance with the requirements detailed in BS1377:Part 9:1990, or other standards or specifications that may be appropriate.

# REPORT ON A GEOTECHNICAL INVESTIGATION

at

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for

## PROMITE LIMITED

## CONSULTING ENGINEERS:
## MESSRS MICHAEL BARCLAY PARTNERSHIP

| | |
|---|---|
| **Prepared by** | **K J Clark BSc Hons**<br>**Geotechnical Engineer** |
| **Reviewed by** | **C V Sweby CEng MICE**<br>**Technical Director** |

## I SYNOPSIS

This investigation has demonstrated that made ground overlies soils associated with the Bagshot Formation Sand of late Eocene age. The groundwater observations noted at the time of the fieldworks suggest that problems with respect to shallow depth excavations are unlikely.

It is considered that foundations located within the Bagshot Formation Sand can be designed to apply a maximum increase in load of 150kPa. Alternatively, consideration could be given to the use of a piled foundation system.

The results of laboratory testing suggest that no significant contamination of this site has occurred as a result of previous usage of the site.

## II INTRODUCTION

Promite Limited propose to convert the existing four storey mansion into a hotel and leisure facility. Consequently, a site investigation has been undertaken in order to ascertain the nature and engineering properties of the soils underlying this site, and to obtain data which will assist in the formulation of a safe and economical foundation solution.

The programme of this investigation included the construction of one borehole using light cable percussion boring techniques. In addition, six window sample probeholes and ten manually excavated trialpits were completed to identify the existing foundations. During this work, samples were taken for further examination and laboratory testing and a number of insitu standard penetration and hand shear vane tests were performed during construction of the borehole and probeholes.

## III FIELDWORKS

The borehole was constructed on the 21st and 22nd June, 1999, the window sample probeholes and trialpits subsequently being constructed during the period 29th and 30th June. The locations at which the work was completed are shown on the site plans, drawing nos 99/4169/11 and 99/4169/12. The salient details of these drawings were extracted from site layout plans supplied by the Consulting Engineer.

The depths and descriptions of the strata encountered in the borehole and window sample probeholes are given on their respective records in Appendix I to this report. These records note the depths at which samples were taken, the results of standard penetration and insitu hand shear vane tests and any groundwater observations noted at the time of the fieldworks. Upon completion of the shell and

auger borehole, a piezometric standpipe was installed in order to monitor the long-term groundwater profile at this site.

The foundation details as revealed in the trialpits constructed at basement level are presented as drawing nos 99/4169/1 to 99/4169/10 and are presented in Appendix II.

## IV GEOLOGY AND STRATA CONDITIONS

An examination of the 1: 50 000 Geological Survey Map of the area, together with the relevant Handbook of Regional Geology, suggests that the site is underlain by the Bagshot Sand formation of late Eocene age.

A study of the borehole and window sample probeholes indicates that made ground comprising topsoil over subsoil was noted at the investigatory locations and was proved to depths of between 0.1m and 0.4m. Further fill materials varying in composition from brown sandy clay with brick fragments to grey clayey sand with gravel and brick and ash were revealed beneath the surface cappings and were shown to extend to depths of between 0.7m and 2.1m.

Orange-brown/grey silty clay with occasional gravel was exposed upon penetration of the made ground at all the investigatory locations with the exception of window sample probehole no 6 where this cohesive soil was not encountered. The clay was proved to depths of between 1.5m and 4.8m.

Fine-grained soils varying in composition from orange-brown/grey very clayey sand to orange-brown/buff sand were noted upon penetration of the made ground in window sample probehole no 6 and the orange-brown/grey silty clay at the other locations. These soils were proved to the concluding depth of the window sample probeholes, the maximum depth achieved being 20m in borehole no 1. It is considered that the soils as described above are collectively associated with the Bagshot Sand.

b) Index Property

The liquid and plastic limit of selected samples of the soils occurring at this site have been determined. The results of this work indicate that the samples tested can generally be described as inorganic clays of intermediate plasticity and of medium shrinkage potential.

c) Particle Size Distribution

Samples of the soils occurring at this site have been subjected to sieve and sedimentation analysis in order to determine the soils particle size distribution. The results of this work are presented in the form of grading curves.

d) Triaxial Compression

The undrained shear strength characteristics of samples of the more cohesive soils encountered at this site have been determined by testing specimens in the triaxial compression apparatus. Under the conditions of this work, cohesions of 100kPa and 160kPa have been recorded which are representative of a stiff to very stiff condition insitu for a purely cohesive soil.

e) Chemical Analysis

Selected samples of the soils occurring at this site have been subjected to chemical analyses in order to determine their soluble sulphate content and pH values. Under the conditions of this work, low concentrations of soluble sulphate content have been recorded in association with near neutral pH values.

f) Contamination

A number of samples of the near surface soils have been analysed for the presence of contamination in accordance with ICRCL 59/83 Tables 3 and 4.

## VI DISCUSSION ON GROUND CONDITIONS

It is understood that it is proposed to turn the existing four storey mansion into a hotel and leisure facility. The works will include the construction of new four storey high lift and stair shafts, formation of new basement areas and the possible reduction in level of some existing areas of the basement floor. In addition, and a new four storey building will be inserted into the sloping ground at the western face of the house. The above works may result in a 30% increase in some existing foundation loads. At the time of preparation of this report, no precise information was available with regard to the structural loads generated by the four storey house.

It cannot be recommended that new foundations be located within the made ground revealed by this investigation. Soils of this origin are frequently present in a weak and variable condition, such that unacceptable settlement could occur, even under the action of light loading intensities. Where basements are not present all foundations should be located at a minimum depth of 1m below final ground level in order to ensure that problems with seasonal variation in soil moisture do not occur.

The works associated with extension of existing basement and construction of new basement areas will probably expose the stiff orange-brown silty clay which could form the foundation medium. Interpretation of the site and laboratory data indicates that strip or spread foundations placed within this soil can be designed to apply a maximum increase in load of 150kPa. Foundations operating at this loading will incorporate a factor of safety of 3 against general shear failure. Settlements are anticipated to be less than 20mm. However, there will be variation in magnitude of settlement in view of the proposal to underpin existing foundation walls and complete new works. In these circumstances, therefore, it may be prudent to incorporate joints in order to reduce the effect of differential settlement.

It cannot be recommended that groundfloor slabs be cast directly upon any made ground, otherwise unacceptable settlement is likely to occur. However, in view of the proposal to incorporate a basement it is evident that the floor slab will be cast directly upon the naturally occurring Bagshot Formation Sand soils and no problems are envisaged in this respect. With regard to the detached house, it may be prudent to adopt a suspended floor slab construction.

It is thought that satisfactory foundation solution can be formulated on the basis of the foregoing discussions. However, if the above recommendations are considered unsuitable, then an alternative foundation system will be required in order to transmit the structural loads to the more competent soils encountered at greater depth. Therefore, should further consideration be given to the use of a piled foundation system, then the advise of a suitably experienced piling contractor should be sought in order to arrive at a satisfactory solution to the problem. The information given in Appendices I and II of this report may be used in pile design.

## VII CONTAMINATION

The Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL), have produced Guidance Note 59/83 (Second Edition, July 1987) entitled, "Guidance on the Assessment and Redevelopment of Contaminated Land". This document proposes the concept of trigger concentrations for different contaminants, depending on the end usage of the site and whether plants are to be grown.

Values for threshold trigger concentrations have been suggested for the various contaminants, these being a function of proposed end use. Where the laboratory test results fall below the value for threshold trigger concentrations, there is demonstrably no contamination. It follows, therefore, that laboratory results which are consistently above the threshold values, imply that contamination is present. Some contaminants have been provided with an "action" level. Concentrations recorded above this level require remedial measures to be

undertaken as part of development. It should be noted that not every contaminant has an "action" level quoted. Should contamination values lie between the threshold and action concentrations, then an engineering assessment should be made as to the degree of remedial measures required.

A summary of Tables 3 and 4 of Guidance Note 59/83, presenting the threshold and action concentrations is presented in Appendix III to this report. The threshold concentrations are given below the individual contaminants on the test results sheets for an assumed end use of hard cover or recreational areas. It should be noted that the ICRCL 59/83 guidelines are the generally accepted criteria against which sites are assessed. It should be appreciated, however, that not all contaminants are covered by these guidelines. In these circumstances, it may be possible to consider the proposals made on a similar basis by the Dutch authorities, these being particularly useful with regard to other contaminants, for example, pesticides and aromatic compounds.

Consideration of the results of the laboratory analysis has not noted any test results above the threshold trigger concentrations proposed by ICRCL 59/83 in respect of landscaped areas. Therefore, the site can be regarded as being uncontaminated.

## VIII *EFFECT OF SULPHATES*

A Classification and Recommendations for Sulphates and Acid Resistance in Soils and Groundwaters is included with the results of the chemical analyses in Appendix II to this report. A comparison of the results obtained in the laboratory with this Classification indicates that the concentrations recorded lie within Class 1, where no special precautions are required in order to avoid the deterioration of buried concrete.

# APPENDIX I

## BORING AND TRIALPIT RECORDS

| | |
|---|---|
| **ALBURY S.I. LTD**<br>Petworth Road, Witley, Surrey GU8 5LH | Borehole No 1 |
| CONTRACT Highgate West Hill, Highgate | REPORT No 99/4169/KJC |
| Client Promite Ltd | Ground Level mOD |
| Site Address 41 Highgate West Hill, Highgate, London N6 | Boring Commenced 21/6/99<br>Boring Completed 22/6/99 |

Type and Diameter of Boring : Light cable percussion (shell and auger) : 150 mm diameter

| Water Strikes, m | Water Levels Recorded During Boring, m | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Date | | | | | | | |
| 2 | Hole Depth | | | | | | | |
| 3 | Casing Depth | | | | | | | |
| 4 | Water Level | | | | | | | |

Remarks
Standpipe installed to 6m depth

| Samples or Tests | | S P T | Scale 20mm - 1m | | Strata Descriptions |
|---|---|---|---|---|---|
| Type | Depth, m | N | Depth | Legend | |
| J | 0.20 | | 0.20 | | Made ground (topsoil/subsoil) |
| J | 0.50 | | | | Made ground (brown very silty clay with brick) |
| J | 0.80 | | 0.80 | | |
| D | 1.00-1.50 | 11 | | | Made ground (brown sand with brick fragments and gravel) |
| | | | 1.70 | | |
| J | 1.80 | | | | Stiff orange-brown very silty clay with traces of sand |
| U | 2.00-2.50 | | | | |
| J | 2.80 | | | | |
| J | 3.00-3.50 | 14 | | | |
| U | 4.00-4.50 | | 4.00 | | |
| J | 4.50 | | | | Very stiff orange-brown/buff very silty clay with seams of sand |
| | | | 4.80 | | |
| J | 5.00-5.50 | 25 | | | Medium dense light brown clayey sand with clay seams |
| J | 5.80 | | | | |
| J | 6.00-6.50 | 26 | | | |
| J | 7.00 | | | | |
| U | 7.50-8.00 | | | | |
| J | 8.50 | | 8.50 | | |
| | | | | | Light-grey/buff silty sand |

Sampling Code U Undisturbed D Large disturbed J Jar W Water (*) Non recovery of U Sample

| ALBURY S.I. LTD<br>Petworth Road, Witley, Surrey GU8 5LH | Continuation Sheet No 1 | Borehole No 1 |
|---|---|---|
| CONTRACT Highgate West Hill, Highgate | | REPORT No 99/4169/KJC |

| Samples or Tests | | S P T | Scale 20mm 1m | | Strata Descriptions |
|---|---|---|---|---|---|
| Type | Depth, m | N | Depth | Legend | |
| J | 9.00-9.50 | 40 | | | Light grey/buff silty sand (cont'd); becoming light/ dark brown silty and with seams of clay |
| J | 10.00 | | | | |
| J | 10.50-11.00 | 36 | | | |
| J | 12.00-12.50 | 20 | | | |
| J | 13.50-14.00 | 20 | | | |
| J | 14.70 | | | | |
| J | 15.00-15.50 | 21 | | | |
| J | 16.00 | | | | |
| J | 16.50-17.00 | 23 | | | |
| J | 17.50 | | | | |
| J | 18.00-18.50 | 26 | | | |
| J | 19.00 | | | | |
| J | 19.50-20.00 | 25 | | | |
| | | | 20.00 | | |

Sampling Code: U - Undisturbed D - Large disturbed J - Jar W - Water U*1 - Non recovery of U Sample

| *ALBURY S.I LTD* | | **Window Sampler No** 1 |
|---|---|---|
| **Contract** | Highgate West Hill | **Report No** 99/4169/KJC |
| **Client** | Promite Ltd | **Date** 29/6/99 |
| **Site Address** | Witanhurst, Highgate West Hill, Highgate N6 | **Ground Level mOD** |

Water Strikes none m  Water level after completion none m

Dimensions 80mm diameter

**Remarks**

| Sample type | Depth,m | Cohesion kPa | Depth,m | Legend | |
|---|---|---|---|---|---|
| J | 0.30 | | 0.40 | | Made ground (topsoil/subsoil) |
| J | 1.00 | 65 | 1.20 | | Made ground (brown sandy clay with brick fragments, root hairs) |
| J | 2.00 | 75 | 2.10 | | Made ground (grey/brown sandy clay with gravel, brick particles and root hairs) |
| J | 2.50 | 80 | | | Stiff orange/grey very sandy clay |
| J | 3.50 | 75 | 3.50 | | Orange-brown/grey very clayey sand |
| J | 4.50 | 60 | 5.00 | | |

a:11 Code: U-Undisturbed Sample D-Large Disturbed Sample J-Jar Sample W-Water Sample

| *ALBURY S.I LTD* | | **Window Sampler No 2** |
|---|---|---|
| **Contract** | Highgate West Hill | **Report No** 99/4169/KJC |
| **Client** | Promite Ltd | **Date** 29/6/99 |
| **Site Address** | Witanhurst, Highgate West Hill, Highgate N6 | **Ground Level mOD** |

Water Strikes none m  Water level after completion none m

Dimensions 80mm diameter

**Remarks**

| Sample type | Depth,m | Cohesion kPa | Depth,m | Legend | |
|---|---|---|---|---|---|
| | | | 0.30 | | Made ground (topsoil/subsoil) |
| | | | 0.70 | | Made ground (brown/grey very sandy clay with gravel and roots) |
| J | 1.00 | 75 | | | Stiff orange-brown/grey silty clay with gravel in upper levels and root hairs |
| | | | 1.50 | | Orange-brown/grey very clayey sand |
| J | 2.00 | 75 | | | |
| J | 3.00 | 140 | | | |
| J | 4.00 | 85 | 4.00 | | |

a:11 Code: U-Undisturbed Sample D-Large Disturbed Sample J-Jar Sample W-Water Sample

| *ALBURY S.I LTD* | | **Window Sampler No** 3 |
|---|---|---|
| **Contract** | Highgate West Hill | **Report No** 99/4169/KJC |
| **Client** | Promite Ltd | **Date** 29/6/99 |
| **Site Address** | Witanhurst, Highgate West Hill, Highgate N6 | **Ground Level mOD** |

Water Strikes none m  Water level after completion none m

Dimensions 80mm diameter

**Remarks**

| Sample type | Depth,m | Cohesion kPa | Depth,m | Legend | |
|---|---|---|---|---|---|
| | | | | | Made ground (topsoil/subsoil) |
| J | 0.40 | | 0.30 | | Made ground (brown/grey clayey sand with gravel and brick fragments) |
| J | 1.00 | | | | |
| | | | 1.20 | | |
| | 1.50 | 70 | | | Stiff orange-brown/grey very silty clay; becoming very sandy clay |
| J | 2.00 | 105 | | | |
| J | 3.00 | 95 | | | |
| | | | 3.50 | | Pale brown/buff sand |
| J | 4.00 | | 4.00 | | |

a:11 Code: U-Undisturbed Sample D-Large Disturbed Sample J-Jar Sample W-Water Sample

| *ALBURY S.I LTD* | | Window Sampler No 4 |
|---|---|---|
| Contract | Highgate West Hill | Report No 99/4169/KJC |
| Client | Promite Ltd | Date 29/6/99 |
| Site Address | Witanhurst, Highgate West Hill, Highgate N6 | Ground Level mOD |

Water Strikes none m  Water level after completion none m

Dimensions 80mm diameter

**Remarks**

| Sample type | Depth,m | Cohesion kPa | Depth,m | Legend | |
|---|---|---|---|---|---|
| | | | 0.10 | | Made ground (topsoil/subsoil) |
| J | 0.50 | | | | Made ground (grey/brown clayey sand with ash, brick fragments and gravel) |
| J | 1.00 | | 1.00 | | Made ground (brown very sandy clay; becoming grey very sandy clay) |
| J | 1.80 | 75 | 1.70 | | Stiff orange-brown/grey very sandy clay with roots in upper levels |
| | | | 2.50 | | Pale brown/grey very sandy clay |
| J | 3.00 | 65 | | | |
| | | | 3.50 | | Pale brown/grey clayey sand |
| J | 4.00 | 75 | 4.00 | | |

a:11 Code: U-Undisturbed Sample D-Large Disturbed Sample J-Jar Sample W-Water Sample

| *ALBURY S.I LTD* | | Window Sampler No 5 |
|---|---|---|
| **Contract** | Highgate West Hill | **Report No** 99/4169/KJC |
| **Client** | Promite Ltd | **Date** 30/6/99 |
| **Site Address** | Witanhurst, Highgate West Hill, Highgate N6 | **Ground Level mOD** |

Water Strikes none m  Water level after completion none m

Dimensions 80mm diameter

**Remarks**

| Sample type | Depth,m | Cohesion kPa | Depth,m | Legend | |
|---|---|---|---|---|---|
| | | | 0.10 | | Made ground (topsoil/subsoil)<br>Made ground (grey very sandy clay with gravel, ash and brick) |
| J | 1.00 | | 1.00 | | |
| | | | 1.50 | | Made ground (brown sand with gravel) |
| J | 2.00 | 130 | | | Stiff orange-brown/grey very silty clay |
| J | 3.00 | 115 | 3.00 | | Brown/grey clayey sand |
| J | 4.00 | 105 | | | |
| | | 95 | 5.00 | | |

a:11 Code: U-Undisturbed Sample D-Large Disturbed Sample J-Jar Sample W-Water Sample

| *ALBURY S.I LTD* | | **Window Sampler No** 6 |
|---|---|---|
| **Contract** | Highgate West Hill | **Report No** 99/4169/KJC |
| **Client** | Promite Ltd | **Date** 30/6/99 |
| **Site Address** | Witanhurst, Highgate West Hill, Highgate N6 | **Ground Level mOD** |

Water Strikes none m  Water level after completion none m

Dimensions 80mm diameter

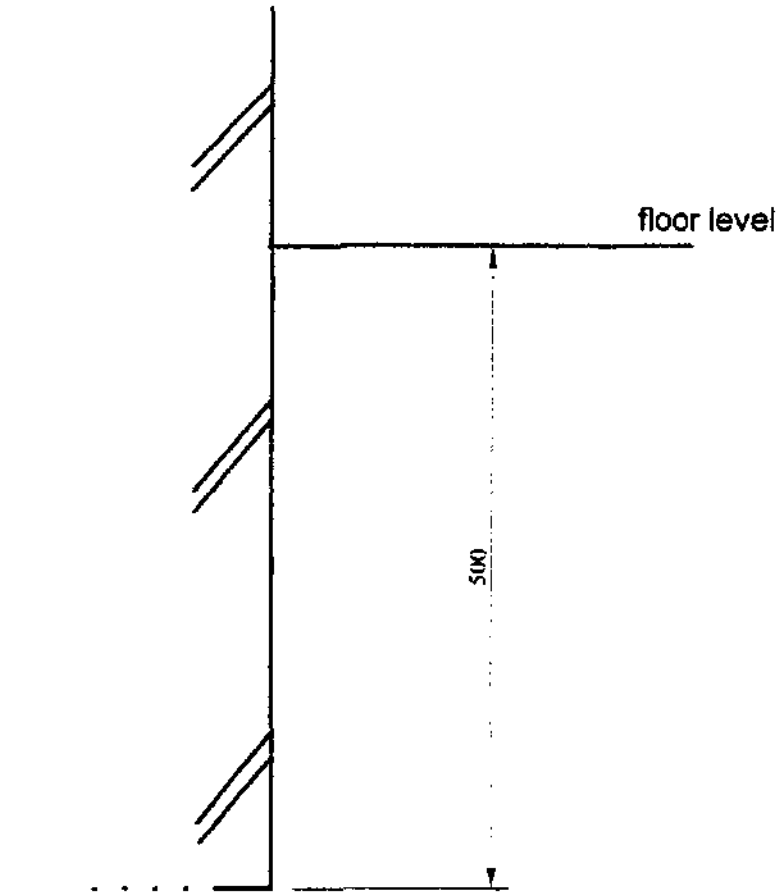
**Remarks**

| Sample type | Depth,m | Cohesion kPa | Depth,m | Legend | |
|---|---|---|---|---|---|
| | | | 0.10 | | Made ground (topsoil/subsoil)<br>Made ground (grey clayey sand with gravel, brick and ash) |
| J | 1.00 | | 0.90 | | Made ground (brown clayey sand with gravel) |
| J | 2.00 | | 2.00 | | Brown clayey sand with gravel |
| J | 3.00 | | 3.00 | | Orange-brown/buff sand |
| J | 4.00 | | 4.00 | | |

a:11 Code: U-Undisturbed Sample D-Large Disturbed Sample J-Jar Sample W-Water Sample

# APPENDIX II

## FOUNDATION DETAILS




TRIALPIT No 1

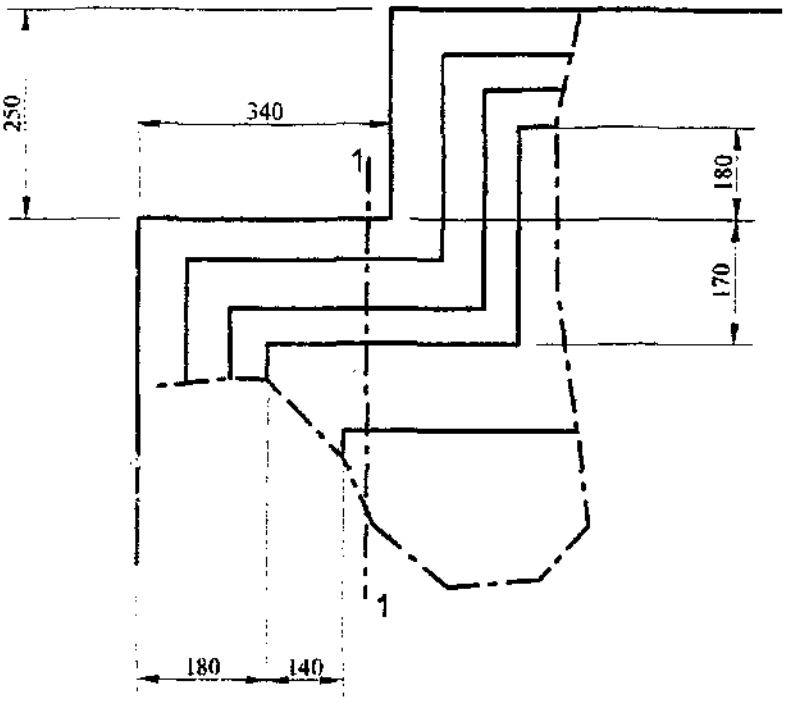
All dimensions are in millimetres

**ALBURY S.I. LTD**

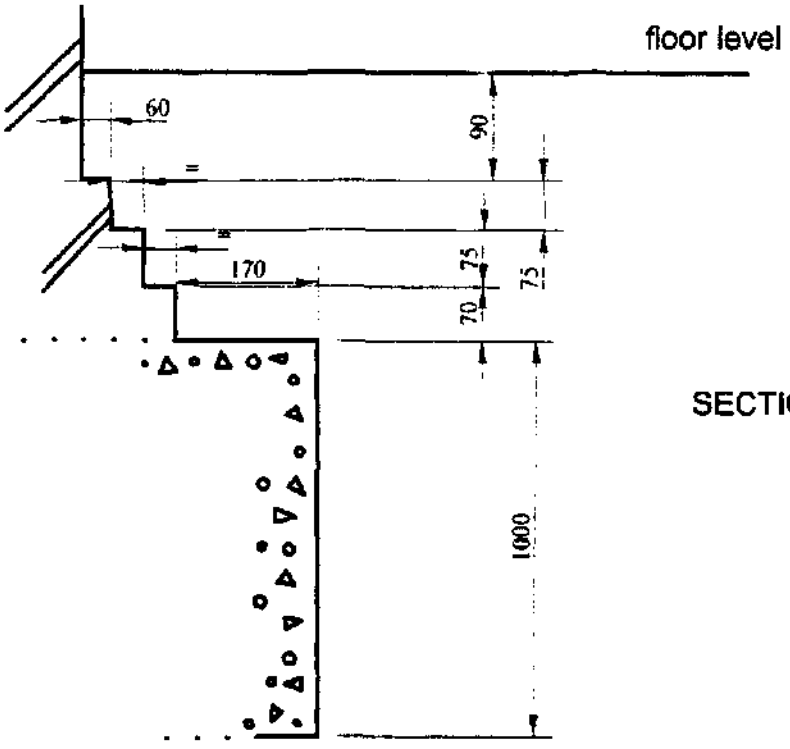
HIGHGATE WEST HILL, HIGHGATE

Scale: As shown

Drg No: 99/4169/1




PLAN




SECTION 1-1

Brown clayey sand Su = 145kPa

TRIALPIT No 2

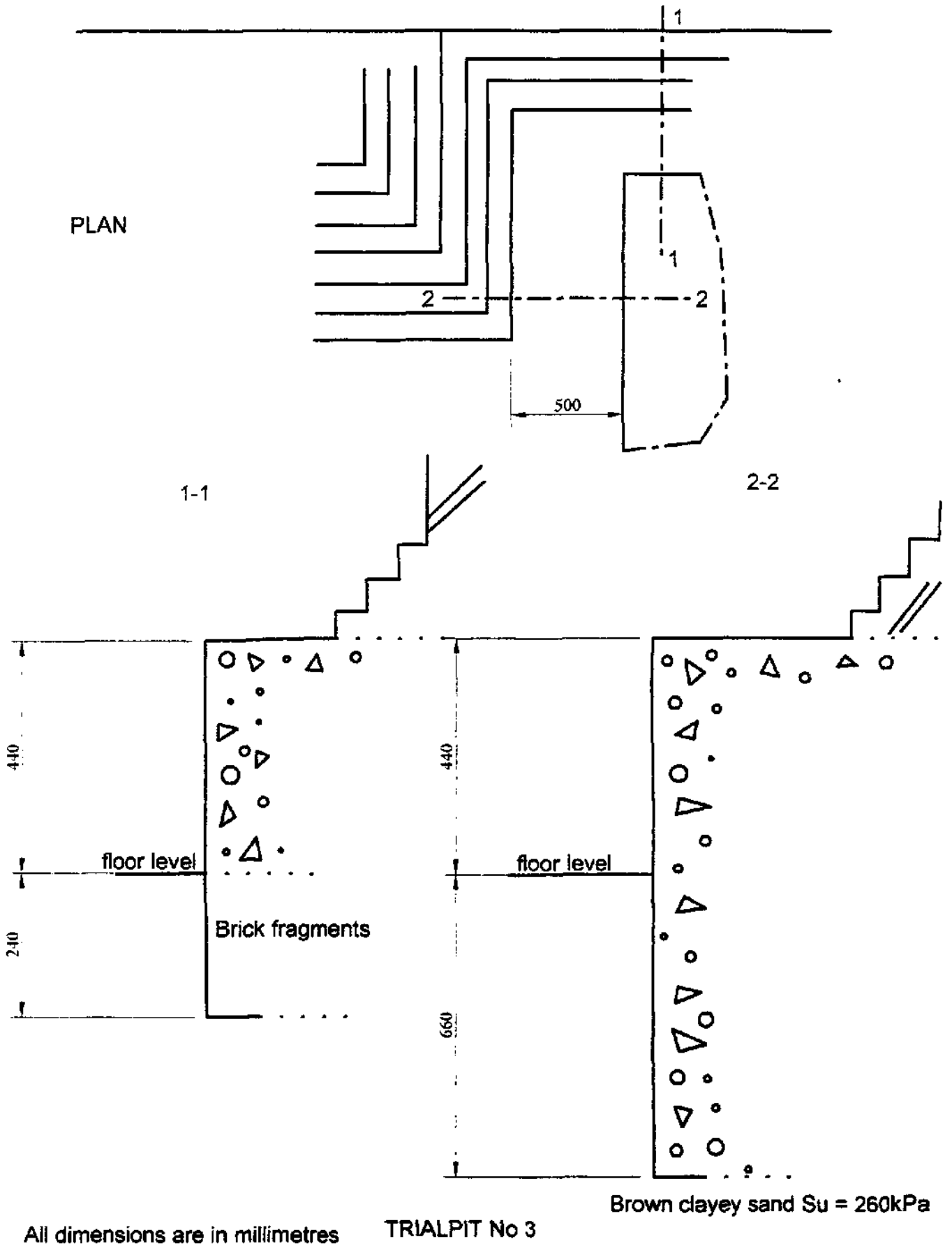
All dimensions are in millimetres

**ALBURY S.I. LTD**

HIGHGATE WEST HILL, HIGHGATE

Scale: As shown

Drg No: 99/4169/2




All dimensions are in millimetres

TRIALPIT No 3

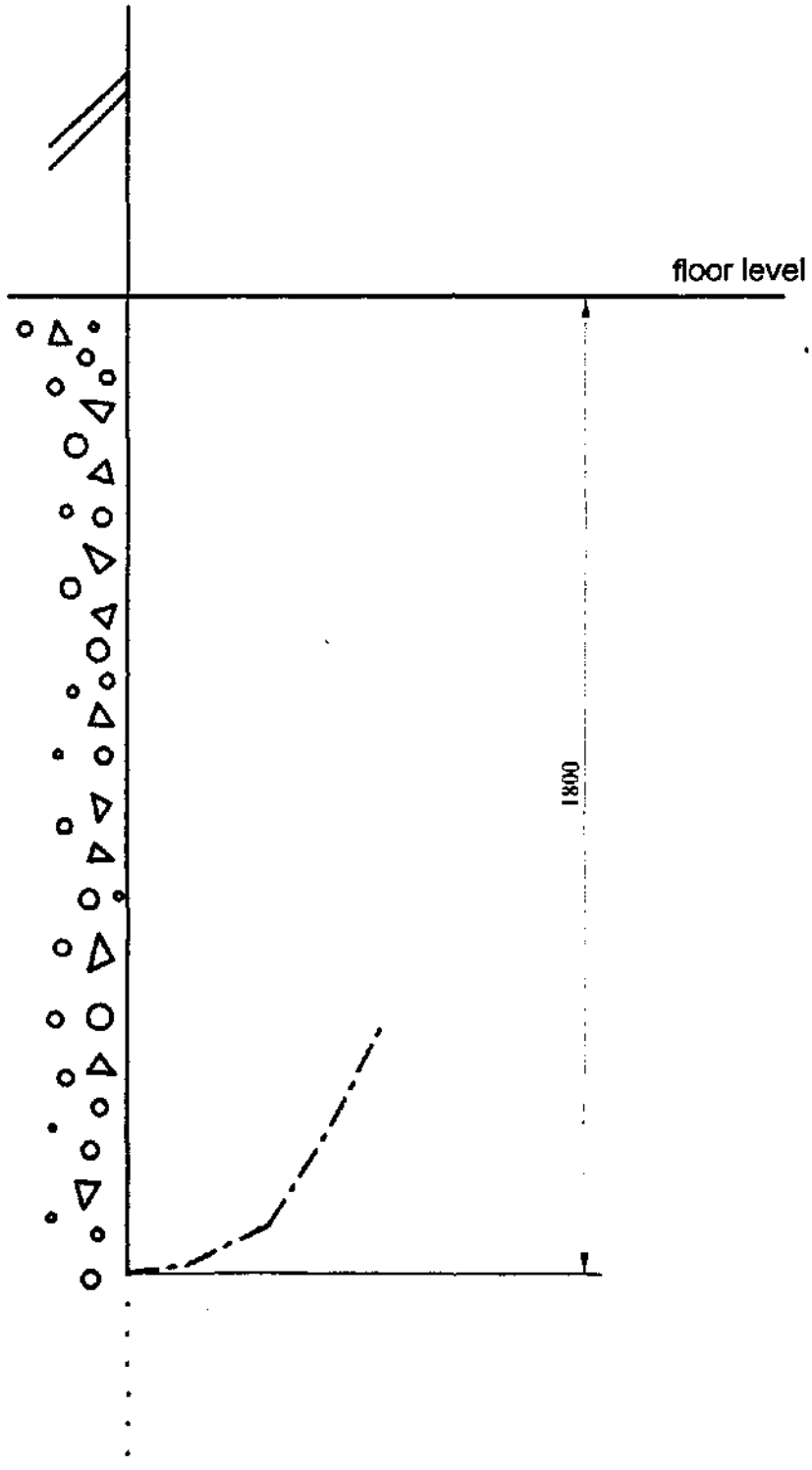
**ALBURY S.I. LTD**

HIGHGATE WEST HILL, HIGHGATE

Scale: As shown

Drg No: 99/4169/3

TRIALPIT No 4




All dimensions are in millimetres

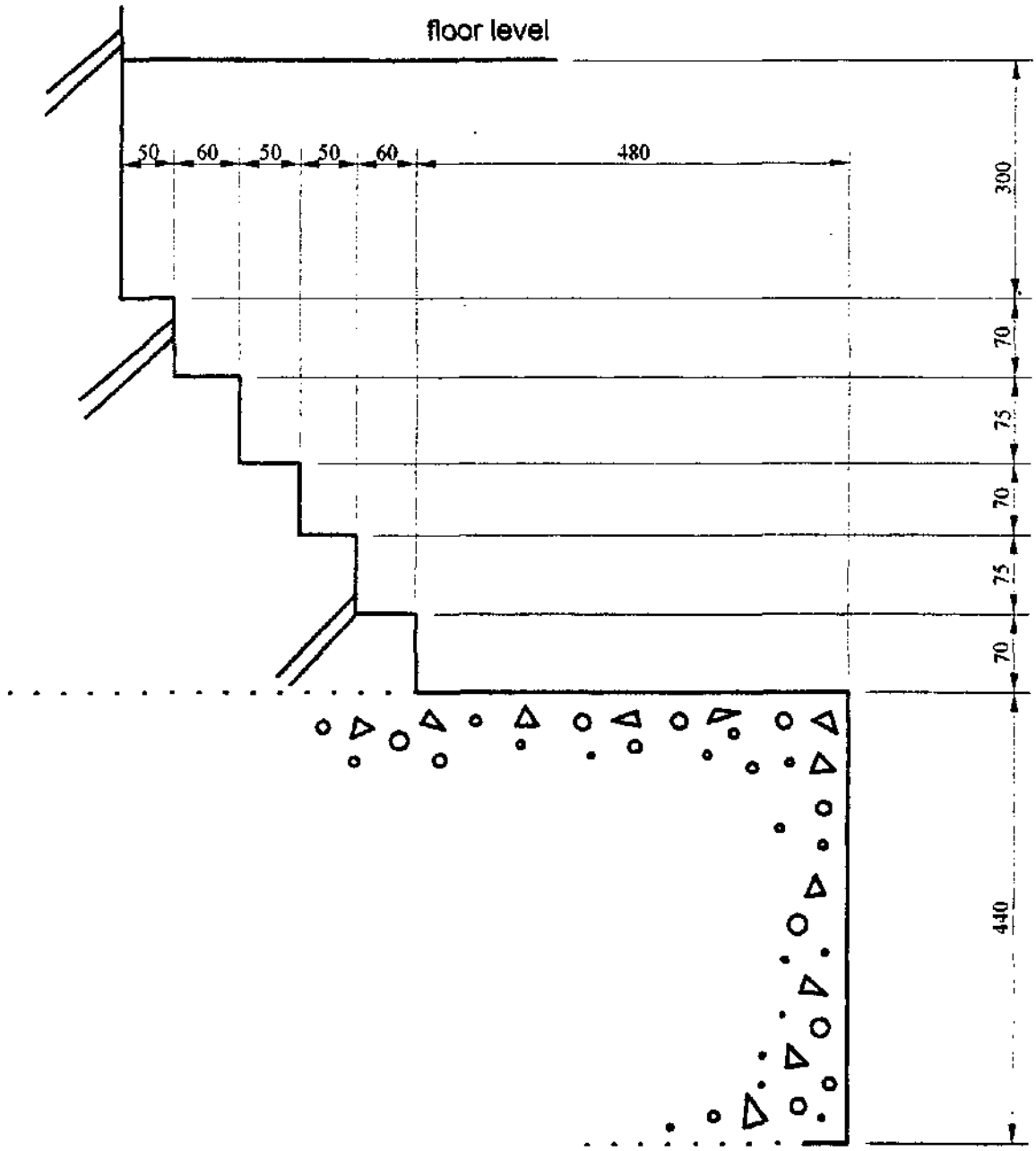
**ALBURY S.I. LTD**

HIGHGATE WEST HILL, HIGHGATE

Scale: As shown

Drg No: 99/4169/4

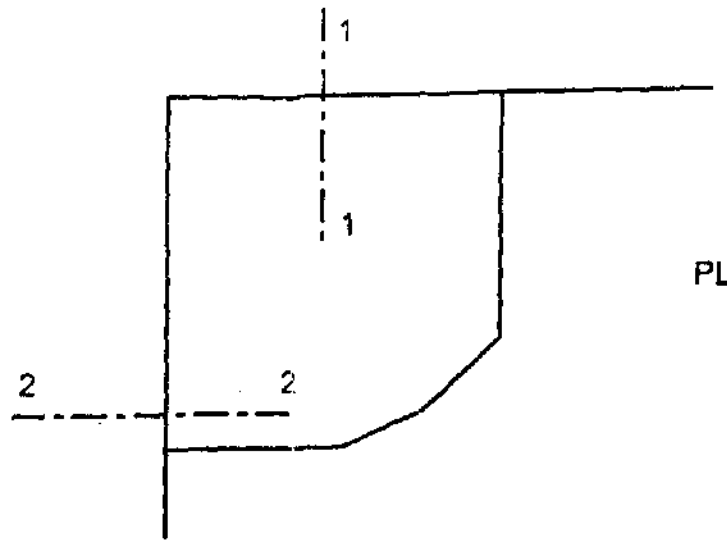
TRIALPIT No 5




All dimensions are in millimetres

**ALBURY S.I. LTD**

| | |
|---|---|
| HIGHGATE WEST HILL, HIGHGATE | Scale: As shown |
| | Drg No: 99/4169/5 |

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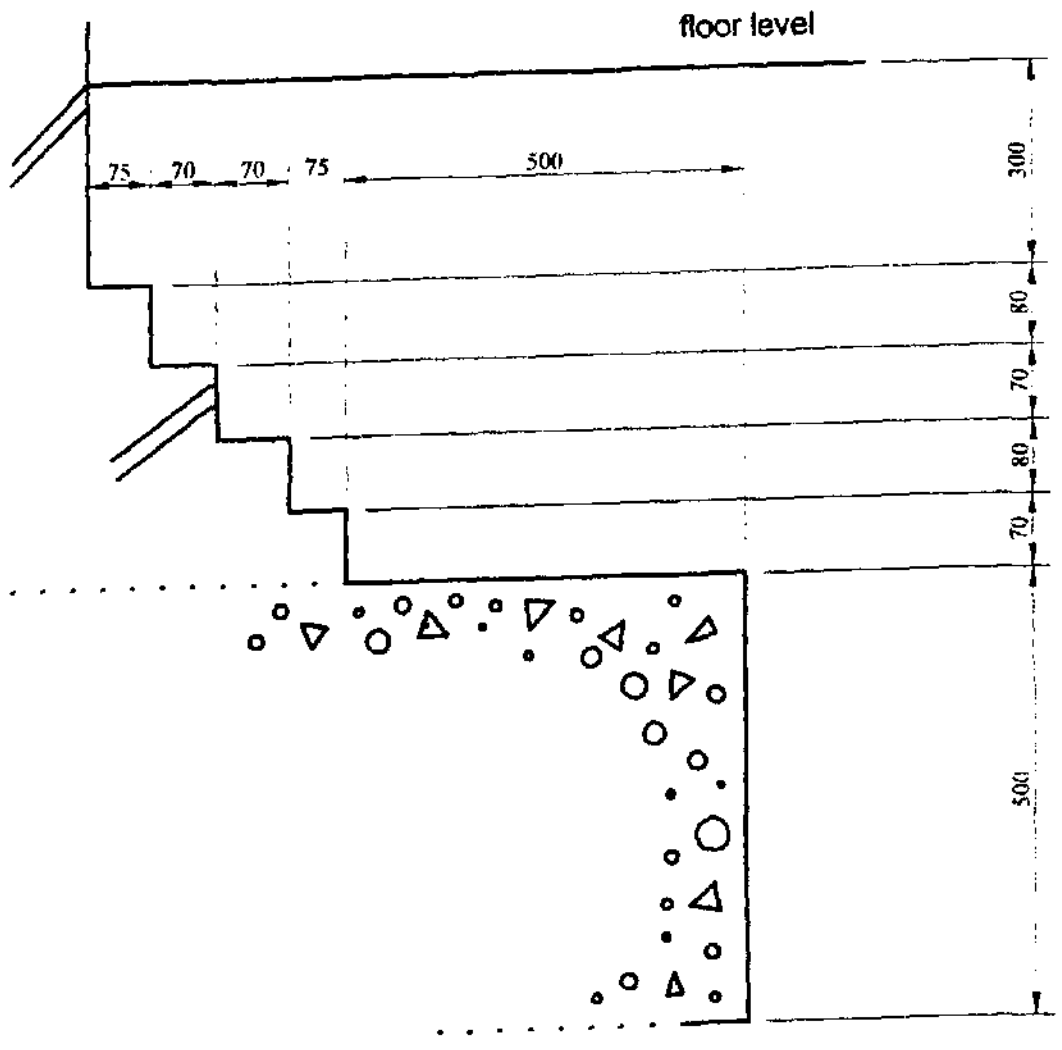
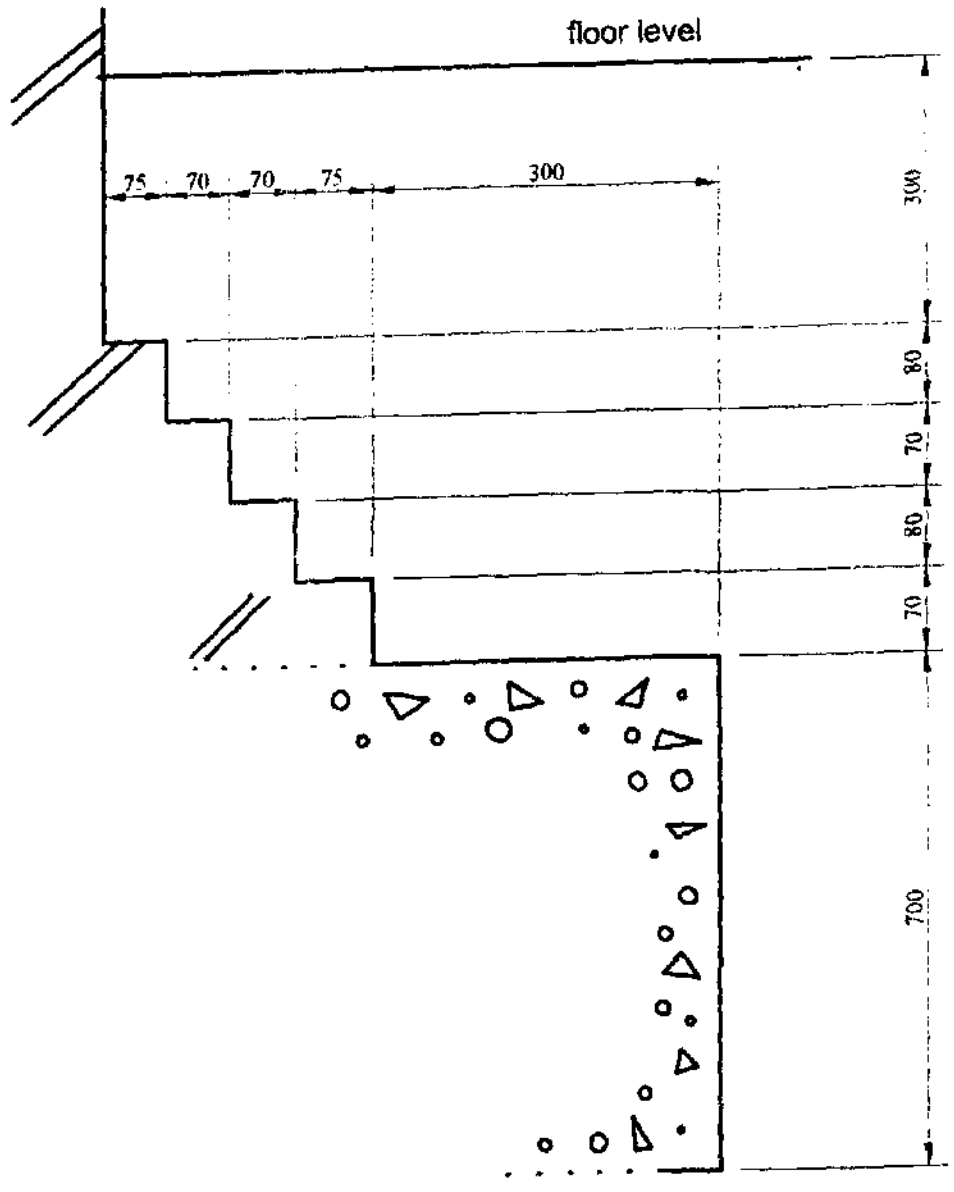



1-1



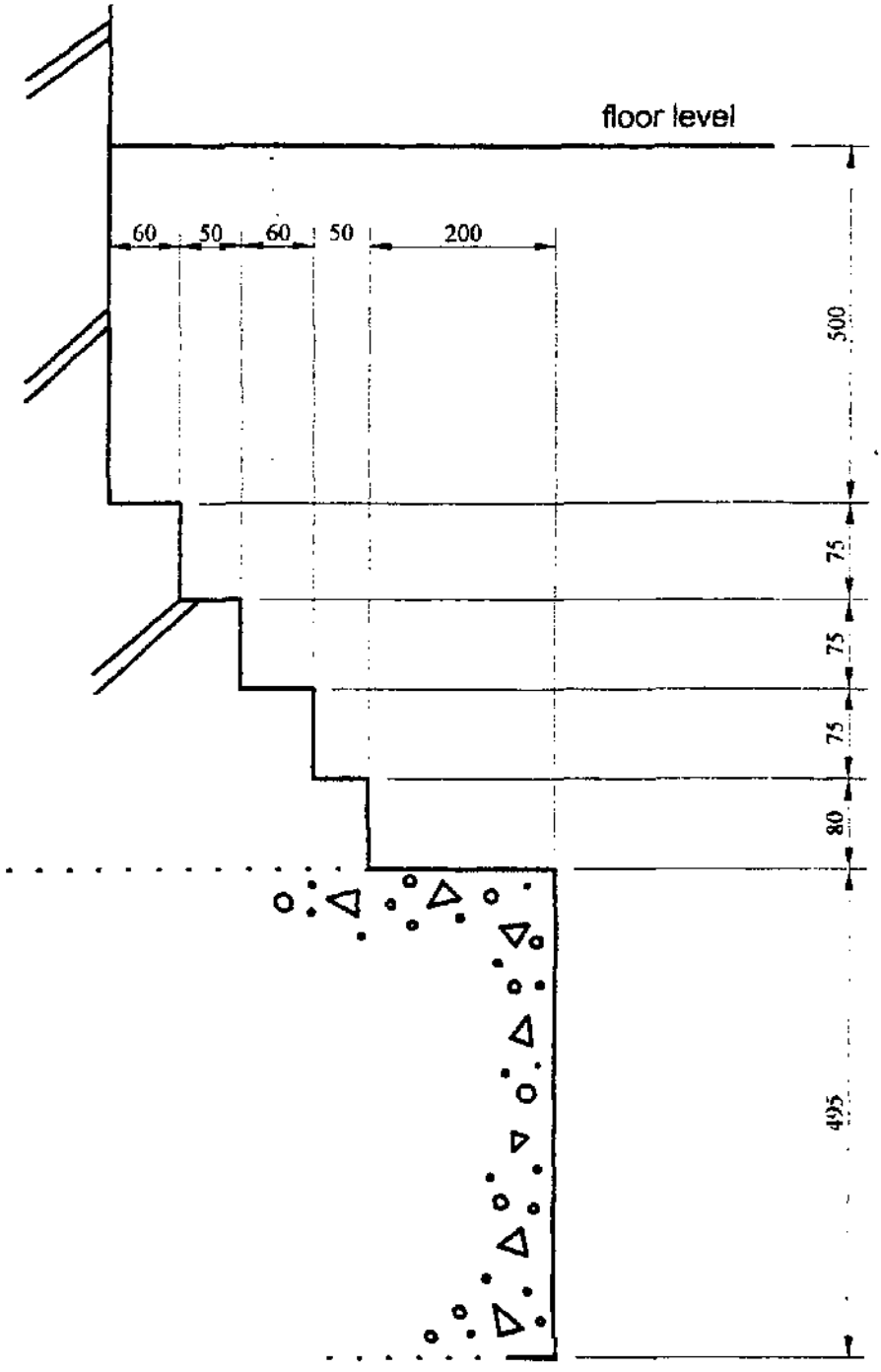

2-2

All dimensions are in millimetres

Brown clayey sand Su = 150kPa

| | | |
|---|---|---|
| **ALBURY S.I. LTD** | Contract: HIGHGATE WEST HILL, HIGHGATE | Scale: As shown |
| | | Org No: 99/4169/6 |

TRIALPIT No 7




Brown clayey sand Su = 130kPa

All dimensions are in millimetres

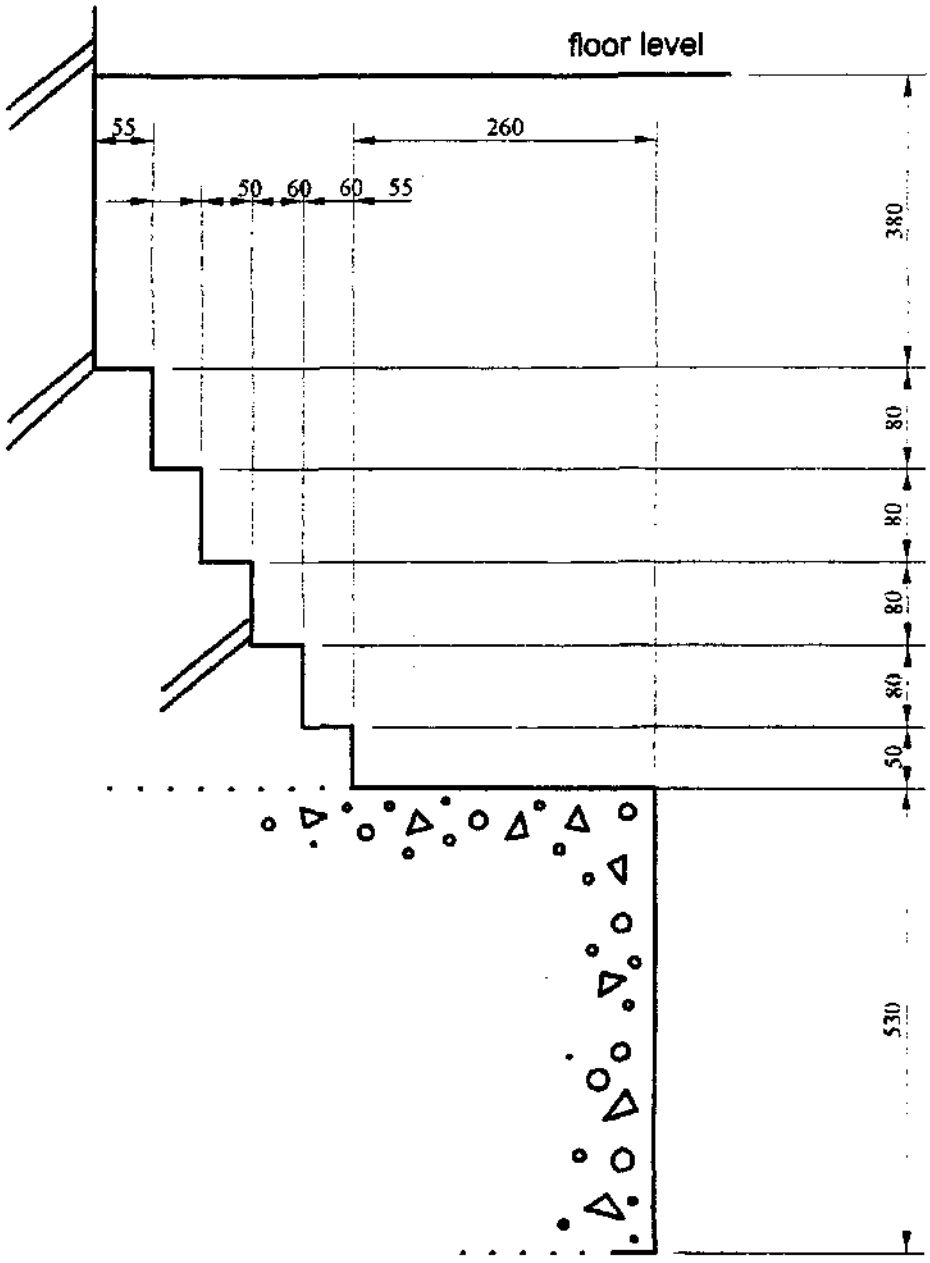
**ALBURY S.I. LTD**

HIGHGATE WEST HILL, HIGHGATE

Scale: As shown

Drg No: 99/4169/7

TRIALPIT No 8



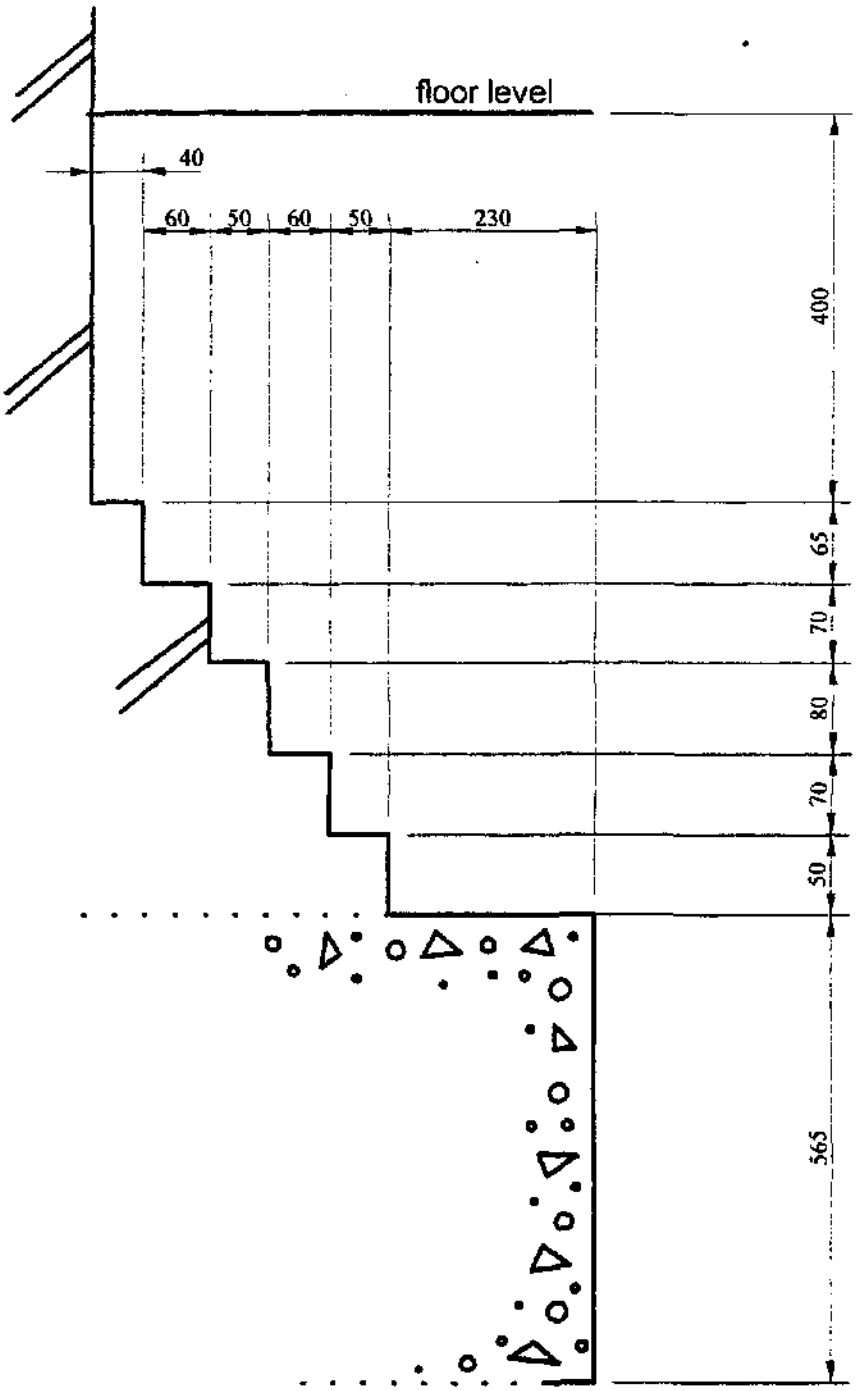

Brown clayey sand Su = 150kPa

All dimensions are in millimetres

**ALBURY S.I. LTD**

| | |
|---|---|
| HIGHGATE WEST HILL, HIGHGATE | Scale: As shown |
| | Drg No: 99/4169/8 |

TRIALPIT No 9




Brown clayey sand Su = 130kPa

All dimensions are in millimetres

**ALBURY S.I. LTD**

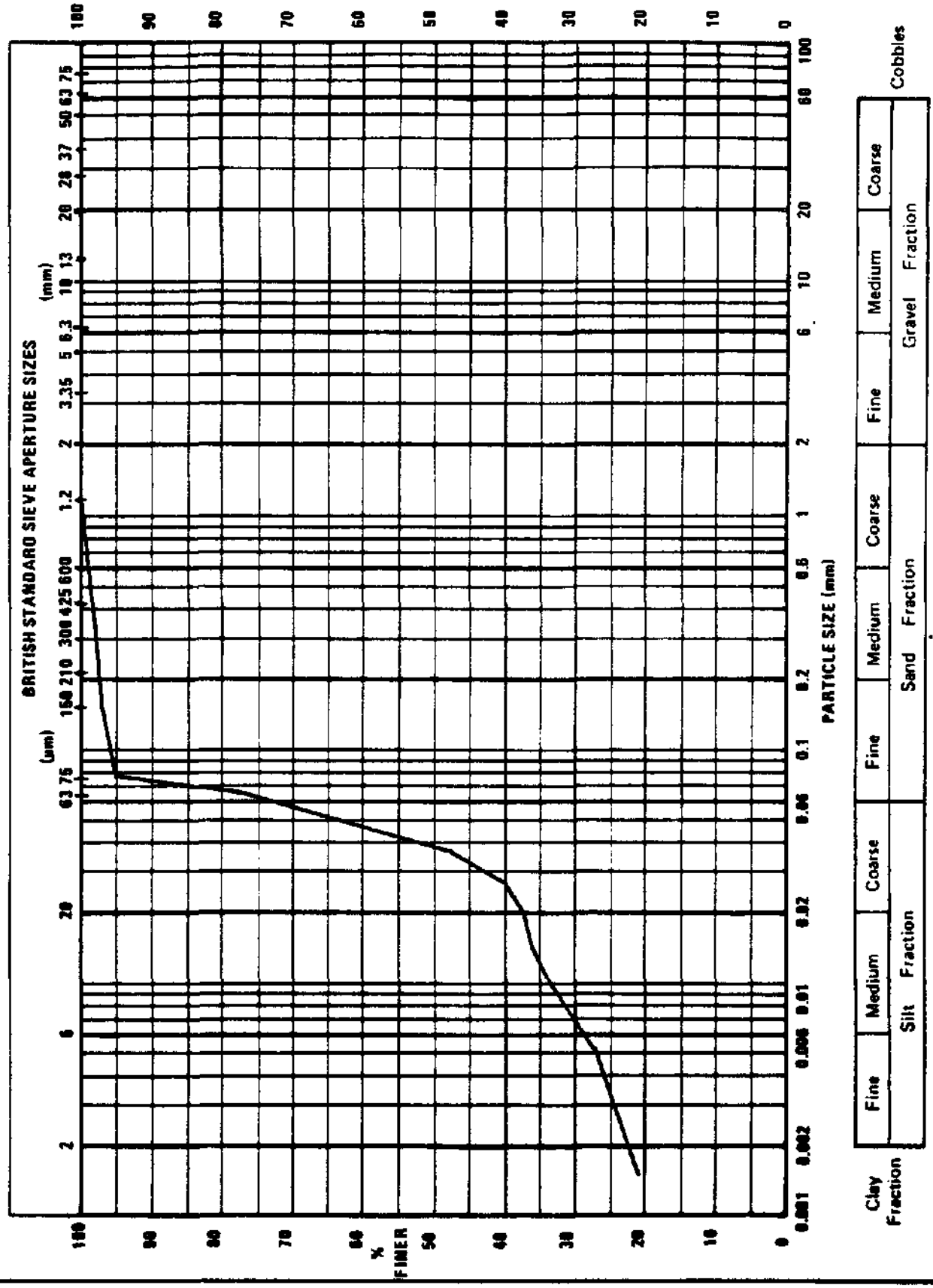
HIGHGATE WEST HILL, HIGHGATE

Scale: As shown

Drg No: 99/4169/9

## PARTICLE SIZE DISTRIBUTION - GRADING CURVE

Contract: Highgate West Hill
Report No: 99/4169/KJC




Borehole No: 1
Sample No:
Depth of Sample, m: 2.00-2.50

Visual Description: Orange-brown very silty clay

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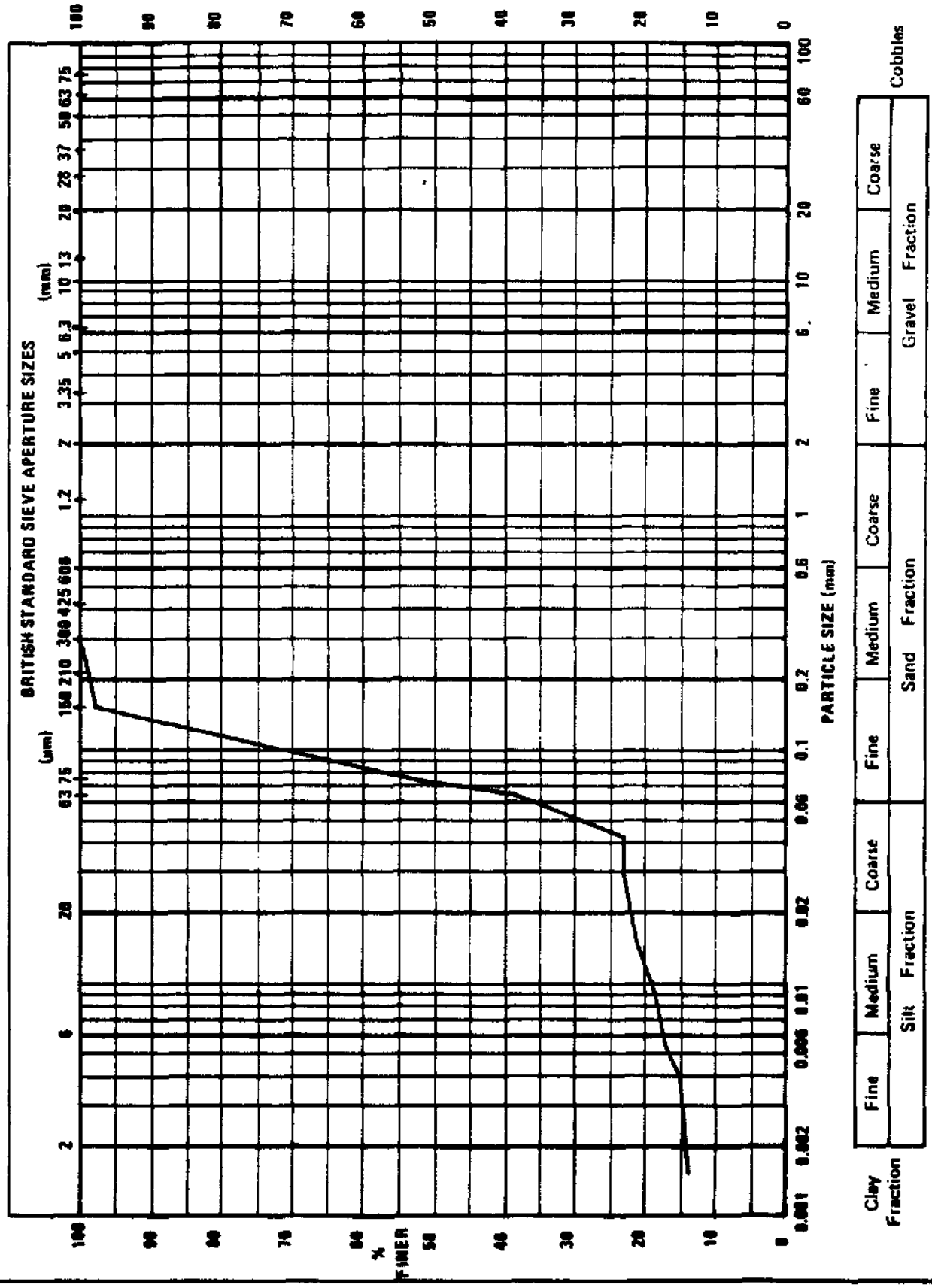
**PARTICLE SIZE DISTRIBUTION - GRADING CURVE**

Contract: Highgate West Hill
Report No: 99/4169/KJC




Borehole No: 1 Sample No: Depth of Sample, m: 6.00-6.50

Visual Description: Brown clayey sand

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# *ALBURY S.I. LTD*

Sheet no 1 of 1

## TEST RESULTS SHEET

Contract: Highgate West Hill, Highgate

Report No: 99/4169/KJC

| Borehole no | Depth of Sample m | Description of Sample | INDEX PROPERTIES | | | | TRIAXIAL COMPRESSION | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Liquid Limit % | Plastic Limit % | Plasticity Index % | Soil Classification | Code | Lateral Pressure kPa | Compression Strength kPa | Cohesion kPa | Angle of Friction (degrees) | Bulk Density kg/m$_3$ | Water Content (% dry wt) |
| 1 | 1.80 | Orange-brown very silty clay | 50 | 21 | 29 | CI/CH | | | | | | | 21.2 |
| | 2.00-2.50* | Orange-brown very silty clay | 39 | 21 | 18 | CI | 38U | 150<br>300<br>450 | 155<br>210<br>245 | 100 | 0 | 2005<br>1995<br>1985 | 23.9<br>23.4<br>23.3 |
| | 3.00-3.50 | Orange-brown very silty clay | 42 | 20 | 22 | CI | | | | | | | 22.5 |
| | 4.00-4.50 | Orange-brown very silty clay | | | | | 38U | 150<br>300<br>450 | 320<br>335<br>295 | 160 | 0 | 2020<br>2005<br>1970 | 17.3<br>19.2<br>17.9 |
| WS 1 | 2.50 | Orange-brown/grey very sandy clay | 48 | 19 | 29 | CI | | | | | | | 25.5 |
| WS 2 | 2.00 | Orange-brown/grey very sandy clay | 42 | 20 | 22 | CI | | | | | | | 19.9 |
| WS 3 | 2.00 | Orange-brown/grey very sandy clay | 45 | 19 | 26 | CI | | | | | | | 23.7 |
| WS 4 | 1.80 | Orange-brown/grey very sandy clay | 45 | 19 | 26 | CI | | | | | | | 23.2 |
| WS 5 | 2.00 | Orange-brown/grey very sandy clay | 49 | 20 | 29 | CI | | | | | | | 22.4 |
| WS 6 | 2.00 | Brown clayey sand with gravel | 29 | 17 | 12 | CL | | | | | | | 14.2 |

**TRIAXIAL COMPRESSION TEST CODE:**

**U-Undrained** **CD-Consolidated** **CU-Consolidated Undrained** **P-Pore water pressure measurement**

**M-Multistage** **F-Functional** **R-Remoulded** **LV-Laboratory Vane Test**

**38-38mm dia specimen** **100-100mm dia specimen**

**REMARKS**

* clay fraction = 23%

# RESULTS OF CHEMICAL ANALYSES

*Determinations of Sulphate content and pH value*

**Contract:** Highgate West Hill, Highgate **Report No:** 99/4169/KJC

| Borehole no | Depth of sample, m | Sample type | Concentrations of sulphates expressed as $SO_3$ | | | pH value |
|---|---|---|---|---|---|---|
| | | | In soil | | In ground-water *g/l* | |
| | | | Total $SO_3$ (%) | 2:1 water:soil extract *g/l* | | |
| 1 | 1.00-1.50 | Made ground | | <0.2 | | 7.5 |
| | 3.00-3.50 | Clay | | <0.2 | | 7.3 |
| | 6.00-6.50 | Sand | | <0.2 | | 7.2 |
| WS 1 | 1.00 | Made ground | | <0.2 | | 7.3 |
| WS 3 | 0.40 | Made ground | | <0.2 | | 7.2 |
| WS 4 | 0.50 | Made ground | | <0.2 | | 6.6 |
| WS 6 | 1.00 | Made ground | | <0.2 | | 6.6 |

**Table 1**

Requirements for well compacted cast insitu concrete 140mm to 450mm in thickness exposed on all vertical faces to a permeable sulphate soil or fill. Aggregates to BS882 or BS1047. *For other exposures or types of concrete see Tables 1a and 1b. For acid conditions see Table 2.*

| Class | Concentrations of sulphate and magnesium | | | | | Cement type *see Table 1c* | Minimum cement content - kg/m³ *Notes 1 and 2* | Maximum free water/cement ratio *Note 1* |
|---|---|---|---|---|---|---|---|---|
| | In soil or fill | | | In groundwater - g/l | | | | |
| | By acid extraction % $SO_4$ | By 2:1 water/soil extract - g/l | | | | | | |
| | | $SO_4$ | Mg | $SO_4$ | Mg | | | |
| 1 | <0.24 | <1.2 | | <0.4 | | A - L | *Note 3* | 0.65 |
| 2 | If >0.24 classify on basis of 2:1 extract | 1.2-2.3 | | 0.4-1.4 | | A - G | 330 | 0.50 |
| | | | | | | H | 280 | 0.55 |
| | | | | | | I - L | 300 | 0.55 |
| 3 | | 2.3-3.7 | | 1.4-3.0 | | H | 320 | 0.50 |
| | | | | | | I - L | 340 | 0.50 |
| 4 | | 3.7-6.7 | <1.2 | 3.0-6.0 | <1.0 | H | 360 | 0.45 |
| | | | | | | I - L | 380 | 0.45 |
| | | 3.7-6.7 | >1.2 | 3.0-6.0 | >1.0 | H | 360 | 0.45 |
| 5 | | >6.7 | <1.2 | >6.0 | <1.0 | As for Class 4 plus surface protection - *see CP 102* | | |
| | | >6.7 | >1.2 | >6.0 | >1.0 | | | |

Note 1 Cement content includes pfa and slag.

Note 2 Cement contents relate to 20mm nominal maximum size aggregate. In order to maintain the cement content of the mortar fraction at similar values, the minimum cement contents given should be increased by 40 kg/m³ for 10mm nominal maximum size aggregate and may be decreased by 30 kg/m³ for 40mm nominal maximum size aggregate as described in Table 8 of BS 5328:Part 1.

Note 3 The minimum value required in BS 8110:1985 and BS 5328:Part 1:1990 is 275 kg/m³ for unreinforced structural concrete in contact with non-aggressive soil. A minimum cement content of 300 kg/m³ (BS 8110) and maximum free water/cement ratio of 0.60 is required for reinforced concrete. A minimum cement content of 200 kg/m³ and maximum free water/cement ratio of 0.80 is permissible for C20 grade concrete when using unreinforced strip foundations and trench fill for low-rise buildings in Class 1.

**Table 1a** Modifications to Table 1 for other types of exposure to sulphates

| Exposure | General Recommendations |
|---|---|
| **Floors** On fill or hardcore containing sulphate in: | |
| Class 1 | Provide membrane between the fill or hardcore and the floor finish. |
| Class 2 | Provide membrane between the fill or hardcore and any concrete. |
| Classes 3, 4 and 5 | Not recommended for use as a base for concrete floors. |
| **Static Groundwater** Table 1 refers to permeable soils (ie > $10^{-5}$ m/s in Fig 6 of BS 8004) which give rise to mobile groundwater and would include exposure to free water. In less permeable soils, the amount of water movement will depend on the topography on the site and a judgement or a site measurement must be made to decide whether the groundwater is static or mobile. | For nominally dry sites or in soils with permeability less than $10^{-5}$ m/s (eg unfissured clay) where it is decided that the groundwater is essentially *static*, the classification in Table 1 for Classes 2, 3 and 4 may be *reduced* by one class. |
| **Basement embankment or retaining walls** | If a hydrostatic head greater than five times the thickness of the concrete is created by the groundwater, the classification in Table 1 should be increased by one class. This requirement can be waived if a barrier to prevent moisture transfer through the wall is provided or if, after completion of normal curing, the concrete face that is to be exposed to sulphate has been exposed to air but protected from rain for several weeks. |

**Table 1b** Modifications to Table 1 for other types of concrete

| Concrete type | General Recommendations |
|---|---|
| Poorly compacted concrete designed for full compaction | Not acceptable for sulphate resistance |
| Cast insitu concrete over 450mm thick. Precast ground beams, wall units or piles with smooth surfaces which, after normal curing, have been exposed to air but protected from rain for several weeks. | For Classes 2, 3 and 4 the requirements for type of cement, cement content and water/cement ratio given in Table 1 may be *reduced* by one class if other durability and structural considerations permit. |
| Cast insitu concrete (other than ground floor slabs) less than 140mm thick or having many edges and corners. | *Increase* classification in Table 1 by one class. |
| Precast concrete blocks | Blocks should comply with BS 6073 and with BS 5628: Part 3 relating to use below ground for Classes 2 and 3 of Table 1. As an alternative to compliance with the minimum cement content and water/cement ratio given in Table 1 for Classes 1 to 3, autoclaved blocks (including aerated blocks - *Aircrete* - with a minimum density of 600 kg/m$^3$) or pressed blocks with more than 50% of their least cross-sectional area carbonated* may be used. |
| Concrete bricks | Compliance with BS 6073 and with Table 1. |
| Concrete pipes | Classification with respect to type of cement may be *reduced* by one class for pipes complying with Parts 100 and 120 of BS 5911. Cement contents and water/cement ratios in Table 1 are not relevant. |
| Porous concrete pipes | Compliance with BS 1194. Porous concrete pipes are not suitable for use in Class 3, 4 or 5 soils. |

* Estimated by breaking block and applying phenolphthalein - *see BRE Information Paper 6/81*

**Table 1c** Types of Cement

| Code | Type or combination | Code | Type or Combination |
|---|---|---|---|
| A | Portland cement to BS 12 | H | Sulphate-resisting Portland cement to BS 4027 |
| B | Portland blastfurnace cements to BS 146 | I | High-slag blastfurnace cement to BS 4246 containing not less than 74% slag by mass of nucleus |
| C | High slag blastfurnace cement to BS 4246 | J | Combination of Portland cements to BS 12 and blastfurnace slag to BS 6699 containing not less than 70% slag and not more than 90% slag by mass of slag plus cement |
| D | Combination of Portland cements to BS 12 and blastfurnace slag to BS 6699 | K | Portland pfa cements to BS 6588 containing not less than 26% pfa by mass of nucleus |
| E | Portland pfa cements to BS 6588 | L | Combinations of Portland cements to BS 12 and pfa to BS 3892: Part 1 containing not less than 25% pfa and not more than 40% pfa by mass of pfa plus cement |
| F | Combinations of Portland cement to BS 12 and pfa to BS 3892: Part 1 | | |
| G | Pozzolanic pfa-cement to BS 6610: 1991 | | |

In Codes I and J, slag with alumina ($Al_2O_3$) content over 14% should be used only with Portland cement having low to moderate $C_3A$ content (typically less than 10%)

**Water table and mobility of groundwater**

A 'dry' site, for which a standing water table is hard to identify in any season, is unlikely to give rise to any significant chemical attack on concrete placed in it. Where water is found, its movement may be vertical or horizontal depending on seasonal variations in rainfall and on the geology of the site and its environs. A low sulphate or acid content in the soil does not eliminate the possibility of attack since groundwater may flow from adjacent areas, particularly if the soil has been disturbed, eg by laying pipes. However, in undisturbed and unfissured clay soils, the movement will be very slow. The principal requirement in assessing the likely degree of chemical attack, particularly in the case of acid attack, is to establish whether the water adjacent to the concrete is essentially static or mobile. A subjective assessment can often be made taking into account observations of the rate of percolation into excavations, the type of strata and local topography. Accumulations of free water or water in highly permeable material should be regarded as mobile - See Table 1a.

**Table 2** Requirements for concrete exposed to attack from acids of pH > 2.5

| Use | Concrete in contact with: | pH | Mobility water *(Table 1a)* M = Mobile S = Static | Aggressive $CO_2$ *(Table 3)* H = High L = Low | Change in classification with respect to minimum cement content and maximum water/cement ratio for the type of cement recommended on the basis of sulphate in Tables 1, 1a and 1b *When advancing classes for cements A - G into Classes 3 - 5, choose the higher cement content option* |
|---|---|---|---|---|---|
| Foundations including poured cast insitu piles. *For piles made by special techniques using low water/cement ratio slightly less stringent requirements may be applicable* | Natural ground | >5.5 | S or M | - | No change |
| | | 3.5 to 5.5 | S | - | No change |
| | | | M | - | Advance by one class |
| | | <3.5 | S | - | Advance by one class |
| | | | M | - | Advance by one class |
| | Ground containing waste or made up ground | >5.5 | S | - | No change |
| | | | M | - | Advance by one class |
| | | 4.5 to 5.5 | S | - | Advance by one class |
| | | | M | - | Advance by two classes |
| | | <4.5 | S | - | Advance by one class |
| | | | M | - | Advance by three classes |

## CLASSIFICATION OF SITES AND RECOMMENDATIONS FOR CONCRETE

Classification of a site on the basis of groundwater samples is preferred. The acid extraction of the sulphate in a soil or fill will reveal the total potential reservoir of sulphate but will not reflect its solubility. The use of a 2:1 water:soil extract takes relative solubility into account. Higher values for sulphate concentration are given in column 3 of Table 1 than in the equivalent groundwater classification, in recognition of the difficulties of obtaining representative samples and of achieving a comparable extraction rate to that indicated by analysis of groundwater samples.

Having classified the site on the basis of the sulphate level (Table 1), type of exposure (Table 1a) and type of concrete (Table 1b), the further recommendations for concrete in acidic conditions are given in Table 2. The pH of the soil extract or groundwater should be determined by the method given in Clause 9 of BS 1377:Part 3.

Some suitable methods for the analysis of groundwaters for sulphates are given in BS 1377:Part 3 and in BRE Current Paper 2/79 which also gives methods for the determination of magnesium.

**The above are extracts from BRE Digest 363: June 1991, Sulphate and Acid Resistant Concrete in the Ground**

## RESULTS OF CONTAMINATION ANALYSIS

*ICRCL 59/83 (Second Edition) Table 3*

**Contract:** Highgate West Hill, Highgate **Report No:** 99/4169/KJC

| Location | Depth m | Sample Description | Arsenic mg/kg | Cadmium mg/kg | Chromium (Hexavelent) mg/kg | Chromium (Total) mg/kg | Lead mg/kg | Mercury mg/kg | Selenium mg/kg | Boron (Water Soluble) mg/kg | Copper mg/kg | Nickel mg/kg | Zinc mg/kg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH 1 | 0.50 | Made ground | <1 | <1 | | 10 | 38 | <1 | <1 | <1 | 8 | 2 | 19 |
| WS 5 | 1.00 | Made ground | <1 | <1 | | 23 | 348 | <1 | <1 | <1 | 53 | 6 | 76 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Threshold Trigger Concentrations for open space | | | 40 | 15 | | 1000 | 2000 | 20 | 6 | 3 | 130 | 70 | 300 |

## RESULTS OF CONTAMINATION ANALYSIS

*ICRCL 59/83 (Second Edition) Table 4*

**Contract:** Highgate West Hill, Highgate **Report No:** 99/4169/KJC

| Location | Depth m | Sample Description | PAH mg/kg | Phenols mg/kg | Cyanide (Total) mg/kg | Cyanide (Free) mg/kg | Cyanide (Complex) | Thiocyanate mg/kg | Sulphate (Total) mg/kg | Sulphide mg/kg | Sulphur mg/kg | Acidity (ph) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH 1 | 0.50 | Made ground | <20 | <0.5 | <1-0 | <10 | <10 | | 100 | <10 | 100 | 7.7 |
| WS 5 | 1.00 | Made ground | 472 | <0.5 | <10 | <10 | <10 | | 500 | <10 | 300 | 8.2 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Threshold Trigger Concentrations for open space | | | 1000 | 5 | | 25 | 250 | | 2000 | 250 | 5000 | <5 |

## EVALUATION OF CONTAMINATION

The Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL), have produced Guidance Note 59/83 (Second Edition, July 1987) entitled, "Guidance on the Assessment and Redevelopment of Contaminated Land". This document proposes the concept of trigger concentrations for different contaminants, depending on the end usage of the site and whether plants are to be grown.

Values for threshold trigger concentrations have been suggested for the various contaminants, these being a function of proposed end use. Where the laboratory test results fall below the value for threshold trigger concentrations, there is demonstrably no contamination. It follows, therefore, that laboratory results which are consistently above the threshold values, imply that contamination is present. Some contaminants have been provided with an "action" level. Concentrations recorded above this level require remedial measures to be undertaken as part of development. It should be noted that not every contaminant has an "action" level quoted. Should contamination values lie between the threshold and action concentrations, then an engineering assessment should be made as to the degree of remedial measures required.

A summary of Tables 3 and 4 of Guidance Note 59/83, presenting the threshold and action concentrations is presented with this précis. The threshold concentrations are given below the individual contaminants on the test results sheets. It should be noted that the ICRCL 59/83 guidelines are the generally accepted criteria against which sites are assessed. It should be appreciated, however, that not all contaminants are covered by these guidelines. In these circumstances, it may be possible to consider the proposals made on a similar basis by the Dutch authorities, these being particularly useful with regard to other contaminants, for example, pesticides and aromatic compounds.

References


| | | |
|---|---|---|
| ICRCL Guidance Note | 17/78 (Dec 1990) | "Notes on the development and after use of landfill sites" |
| | 18/79 (Apr 1986) | "Notes on the redevelopment of gasworks sites" |
| | 23/79 (Nov 1983) | "Notes on the redevelopment of sewage works and farms" |
| | 42/80 (Oct 1983) | "Notes on the redevelopment of scrap yards and similar sites" |
| | 59/83 (Jul 1987) | "Guidance on the assessment and redevelopment of contaminated land" |
| | 61/84 (Jul 1986) | "Notes on the fire hazards of contaminated land" |
| | 64/85 (Oct 1990) | "Asbestos on contaminated sites" |
| | 70/90 (Feb 1990) | "Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing" |

## ICRCL 59/83 (Second Edition) TABLE 3
## TENTATIVE 'TRIGGER CONCENTRATIONS' FOR SELECTED INORGANIC CONTAMINANTS

**Conditions**

1. This table is invalid if reproduced without the conditions and footnotes.
2. All values are for concentrations determined on "spot" samples based on an adequate site investigation carried out prior to development. They do not apply to analysis of averaged, bulked or composited samples, nor to sites which have already been developed. All proposed values are tentative.
3. The lower values in Group A are similar to the limits for metal content of sewage sludge applied to agricultural land. The values in Group B are those above which phytoxicity is possible.
4. If all sample values are below the threshold concentrations, then the site may be regarded as uncontaminated as far as the hazards from these contaminants are concerned, and development may proceed. Above these concentrations, remedial action may be needed, especially if the contamination is still continuing. Above the action concentration, remedial action will be required or the form of development changed.

| Contaminants | Proposed Uses | Trigger Concentrations mg/kg air-dried soil<br>Threshold | Action |
|---|---|---|---|
| **Group A:** | ***Contaminants which may possess hazards to health*** | | |
| Arsenic | Domestic gardens, allotments | 10 | * |
| | parks, playing fields, open space | 40 | * |
| Cadmium | Domestic gardens, allotments | 3 | * |
| | parks, playing fields, open space | 15 | * |
| Chromium | Domestic gardens, allotments | 25 | * |
| (hexavelant)[1] | parks, playing fields, open space | | |
| Chromium (total) | Domestic gardens, allotments | 600 | * |
| | parks, playing fields, open space | 1000 | * |
| Lead | Domestic gardens, allotments | 500 | * |
| | parks, playing fields, open space | 2000 | * |
| Mercury | Domestic gardens, allotments | 1 | * |
| | parks, playing fields, open space | 20 | * |
| Selenium | Domestic gardens, allotments | 3 | * |
| | parks, playing fields, open space | 6 | * |
| **Group B:** | ***Contaminants which are phytotoxic but not normally hazards to health*** | | |
| Boron (water soluble)[3] | Any uses where plants are to be grown[2,6] | 3 | * |
| Copper[4,5] | Any uses where plants are to be grown[2,6] | 130 | * |
| Nickel[4,5] | Any uses where plants are to be grown[2,6] | 70 | * |
| Zinc[4,5] | Any uses where plants are to be grown | 300 | * |

**NOTES**

* Action concentrations will be specified in the next edition of ICRCL 59/83.

1. Soluble hexavelant chromium extracted by 0.1M HCL at 37°, solution adjusted to pH 1.0 if alkaline substances present.
2. The soil's pH value is assumed to be about 6.5 and should be maintained at this value. If the pH falls, the toxic effects and the uptake of these elements will be increased.
3. Determined by standard ADAS method (soluble in hot water).
4. Total concentration (extractable by $HNO_3/HClO_4$).
5. The phytotoxic effects of copper, nickel and zinc may be addictive. The trigger values given here are those applicable to the 'worst-case': phytotoxic effects may occur at these concentrations in acid. sandy soils. In neutral or alkaline soils, phytotoxic effects are unlikely at these concentrations.
6. Grass is more resistant to phytotoxic effects than are most other plants, and its growth may not be adversely affected at these concentrations.

## ICRCL 59/83 (Second Edition) TABLE 4:
## TENTATIVE 'TRIGGER CONCENTRATIONS' FOR CONTAMINANTS ASSOCIATED WITH FORMER COAL CARBONIZATION SITES

**Conditions**

1. This table is invalid if reproduced without the conditions and footnotes.
2. All values are for concentrations determined on "spot" samples based on an adequate site investigation carried out prior to development. They do not apply to analysis of averaged, bulked or composited samples, nor to sites which have already been developed.
3. Many of these values are preliminary and will require regular updating. They should not be applied without reference to the current edition of the report "Problems arising from the Development of Gas Works and similar sites".
4. If all sample values are below the threshold concentrations, then the site may be regarded as uncontaminated as far as the hazards from these contaminants are concerned, and development may proceed. Above these concentrations, remedial action may be needed, especially if the contamination is still continuing. Above the action concentrations, remedial action will be required of the form of development changed.

| Contaminants | Proposed Uses | Trigger Concentrations mg/kg air-dried soil Threshold | Action |
|---|---|---|---|
| Polyaromatic Hydrocarbons[1,2] | Domestic gardens, allotments, play areas | 50 | 500 |
| | Landscaped areas, buildings, hard cover | 1000 | 10000 |
| Phenols | Domestic gardens allotments | 5 | 200 |
| | Landscaped areas, buildings, hard cover | 5 | 1000 |
| Free Cyanide | Domestic gardens allotments, landscaped areas | 25 | 500 |
| | Buildings, hard cover | 100 | 500 |
| Complex Cyanides | Domestic gardens, allotments | 250 | 1000 |
| | Landscaped areas, buildings, hard cover | 250 | NL |
| Thiocyanate[2] | All proposed uses | 50 | NL |
| Sulphate | Domestic gardens | 2000 | 10000 |
| | Buildings[3] | 2000[3] | 50000[3] |
| | Hard cover | 2000 | NL |
| Sulphide | All proposed areas | 250 | 1000 |
| Sulphur | All proposed uses | 5000 | 20000 |
| Acidity (pH less than) | Domestic gardens, allotments, landscaped areas | pH5 | pH3 |
| | Buildings, hard cover | NL | NL |

**NOTES**

NL No limit set as the contaminant does not pose a particular hazard for this use.

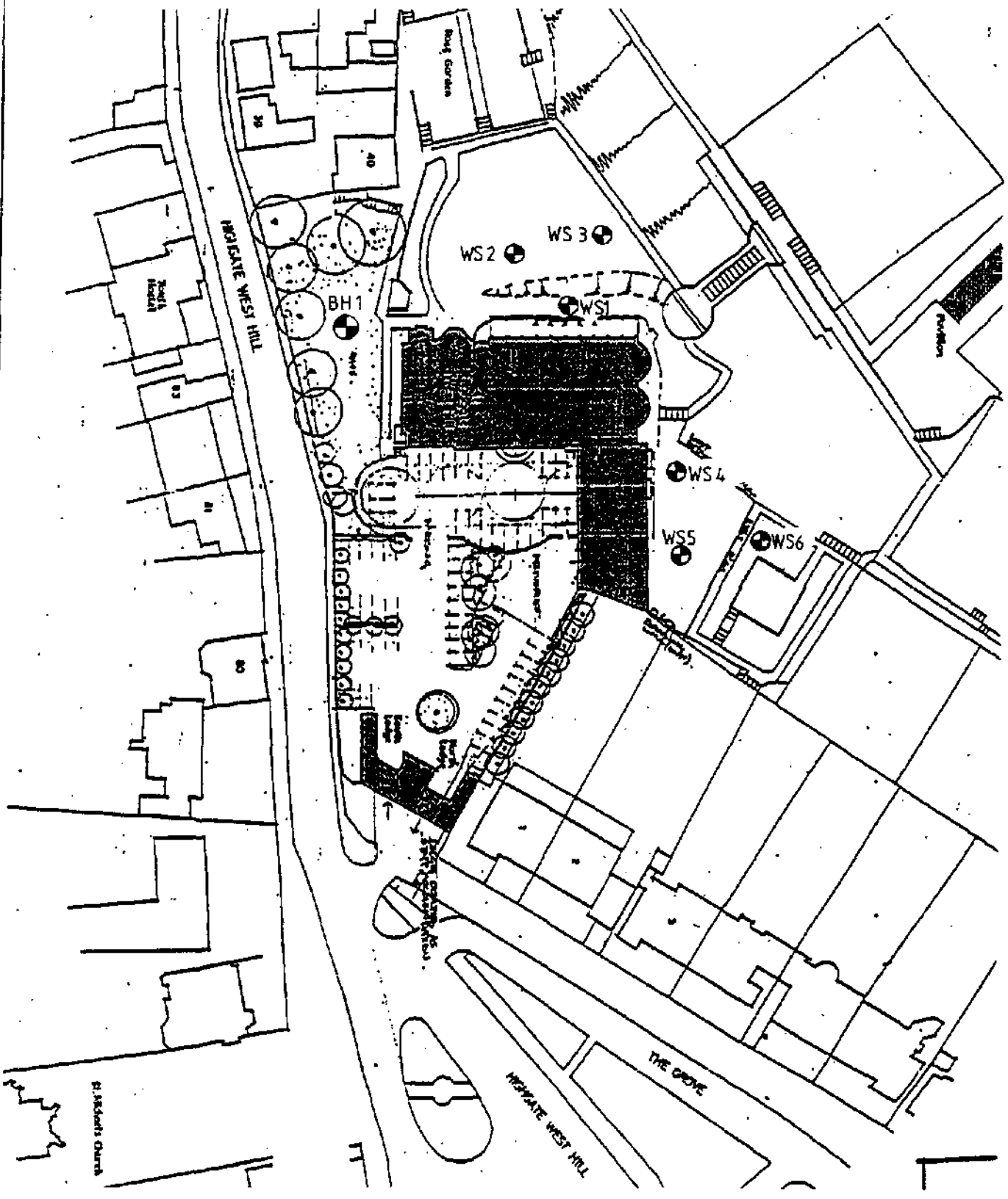
1. Used here as a marker for coal tar, for analytical reasons. See "Problems Arising from the Redevelopment of Gas Works and Similar Sites" Annex A1.

2. See "Problems Arising from the Redevelopment of Gas Works and Similar Sites" for details of analytical methods.

3. See also BRE Digest 250: Concrete in sulphate-bearing soils and groundwater.

# APPENDIX IV

## SITE PLAN

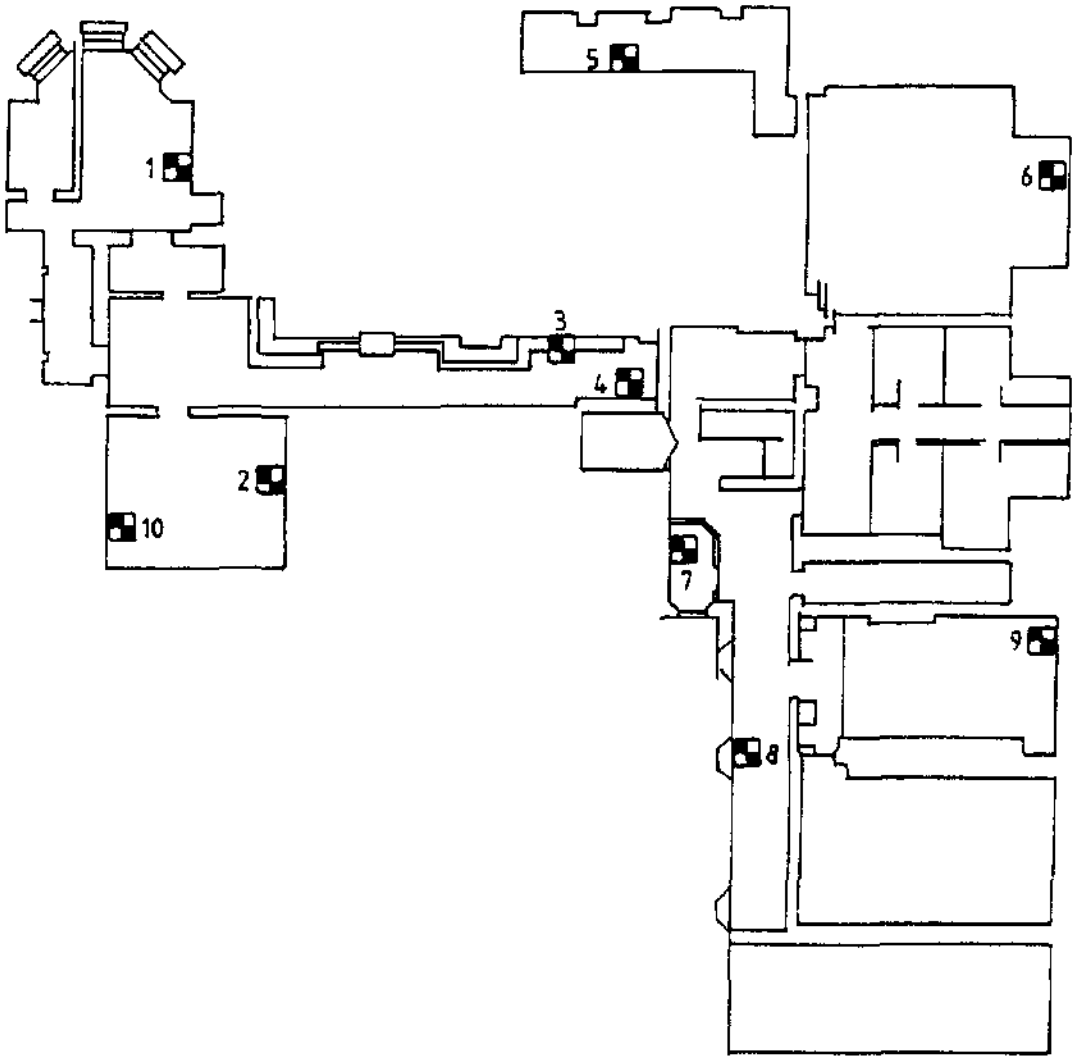



# ALBURY S.I. LTD

HIGHGATE WEST HILL , HIGHGATE

Scale : —

Drg No : 99/4169/11




TRIALPIT LOCATIONS
PLAN AT BASEMENT LEVEL

ALBURY S.I. LTD

HIGHGATE WEST HILL , HIGHGATE

Scale
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99/4169/12