CampbellReith
consulting engineers

77 Lawn Road
London, NW3 2XB

Basement Impact Assessment Audit

For

London Borough of Camden

Project Number: 12336-62

Revision: F1

August 2016

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Project Name	77 Lawn Road
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Contents

Appendix

1.0 NON-TECHNICAL SUMMARY

1.1. CampbellReith was instructed by London Borough of Camden, (LBC) to carry out an audit on the Basement Impact Assessment submitted as part of the Planning Submission documentation for 77 Lawn Road, London NW3 2XB (planning reference 2016/1737/P). The basement is considered to fall within Category B as defined by the Terms of Reference.

1.2. The Audit reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development in accordance with LBC's policies and technical procedures.

1.3. CampbellReith was able to access LBC's Planning Portal and gain access to the latest revision of submitted documentation and reviewed it against an agreed audit check list.

1.4. The proposed development is a new single storey basement across the full footprint of the existing two storey semi-detached house. Additional works include an extension to the side and rear of the property.

1.5. The BIA has been prepared by Momentum Structural Engineers with a supporting Site Investigation report prepared by Southern Testing. The authors' qualifications were initially not proven to meet the criteria outlined in CPG4, but in the revised submissions the authors' qualifications have been clarified and are accepted.

1.6. In the original submission, a desk study in accordance with the GSD Appendix G1 had not been presented. An appropriate desk study has now been submitted.

1.7. In the original submission, a conceptual site model, geotechnical parameters and retaining wall information were not presented. These have been included in the revised submissions, in line with the GSD Appendix G3.

1.8. The BIA indicates the site to be at very low risk of surface water flooding or impacting the wider surface water flow environment. Following review of the revised submissions, this is now accepted providing that the design advice submitted, incorporating attenuation SUDS, is followed.

1.9. It is accepted that the site is at very low risk from groundwater flooding and will not impact the wider hydrogeological environment. Perched water within the Made Ground has been identified and the Site Investigation report recommends long term monitoring to inform dewatering mitigation measures during construction and design criteria in the permanent case. Further monitoring data has been presented in the revised submissions.

1.10. The BIA identifies slopes in excess of 7° on site and states that the basement design will need to take account of the slope. Limited discussion on design and mitigation is presented. However, after review of the revised submissions, it is accepted that the retaining walls and foundations for the proposed basement will reduce lateral loads on the slope at the front of the property and therefore there should be no adverse slope stability impacts. During construction, monitoring of the slope should be included within the structural movement monitoring survey.

1.11. In the original submission, the BIA did not include a Ground Movement Assessment (GMA) or indicate land stability impacts caused by the proposed development. In the revised submissions, an appropriate GMA and damage impact assessments has been prepared for structures within the zone of influence, in line with CPG4 guidelines. Additional mitigation measures to further reduce those impacts, where practicable, should be agreed under the Party Wall Act.

1.12. In the original submission, the BIA did not contain sufficient design or structural information, and design drawings referenced to be within Appendix B were not presented. In the revised submissions, adequate outline structural and construction sequence information has been provided.

1.13. In the original submission, the BIA did not indicate survey and monitoring requirements to be implemented to monitor and control potential ground movement impacts during construction. In the revised submission, these have been discussed in outline. Monitoring methods, trigger levels, mitigation and contingency actions should be further detailed and linked to the predicted ground movements, and presented and agreed with the Engineer and Party Wall Surveyor.

1.14. Queries and matters requiring further information or clarification are discussed in Section 4 and summarised in Appendix 2. Following review of the revised BIA submissions, it is confirmed that the criteria contained in CPG4 and DP27 have been met.

2.0 INTRODUCTION

2.1. CampbellReith was instructed by London Borough of Camden (LBC) on 17 May 2016 to carry out a Category B Audit on the Basement Impact Assessment (BIA) submitted as part of the Planning Submission documentation for 77 Lawn Road, London NW3 2XB, Camden Reference 2016/1737/P.

2.2. The Audit was carried out in accordance with the Terms of Reference set by LBC. It reviewed the Basement Impact Assessment for potential impact on land stability and local ground and surface water conditions arising from basement development.

2.3. A BIA is required for all planning applications with basements in Camden in general accordance with policies and technical procedures contained within:

- Guidance for Subterranean Development (GSD). Issue 01. November 2010. Ove Arup & Partners.
- Camden Planning Guidance (CPG) 4: Basements and Lightwells.
- Camden Development Policy (DP) 27: Basements and Lightwells.
- Camden Development Policy (DP) 23: Water.

2.4. The BIA should demonstrate that schemes:

a) maintain the structural stability of the building and neighbouring properties;

b) avoid adversely affecting drainage and run off or causing other damage to the water environment; and,

c) avoid cumulative impacts upon structural stability or the water environment in the local area;

and evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology and land stability via the process described by the GSD and to make recommendations for the detailed design.

2.5. LBC's Audit Instruction described the planning proposal as: "Creation of basement to form additional living accommodation for existing dwelling and 1x self-contained 1-bed flat at lower ground floor level; creation of sunken garage to side with green roof above; alterations to driveway and erection of new boundary fencing; erection of part two storey and part single storey side and rear extension; alterations to fenestration; and associated works".

2.6. CampbellReith accessed LBC's Planning Portal on 23 August 2016 and gained access to the following relevant documents for audit purposes:

- Basement Impact Assessment (ref 2716) dated 10 March 2016 by Momentum Structural Engineers.
- Site Location Plan, Existing Plans and Elevations, Proposed Plans and Elevations (Rev P1 to P4, Planning) dated March to June 2016.
- Report to demonstrate Compliance with Code for Sustainable Homes SUR1 Surface Water Run-off dated March 2016 by Michael Ward.
- Site Investigation Report (ref J12507) dated March 2016 by Southern Testing Laboratories Ltd.
- Design and Access Statement dated March 2015. No author is identified.
- Comments and objections to the proposed development from local residents.

2.7. CampbellReith were provided with the following documents for audit purposes on 11 November 2016:

- Basement Impact Assessment (ref 2716, rev 01) dated 4 November 2016 by Momentum Structural Engineers.
- Site Investigation Report (ref J12507, rev 01) dated October 2016 by Southern Testing Laboratories Ltd.

3.0 BASEMENT IMPACT ASSESSMENT AUDIT CHECK LIST

Item	Yes/No/NA	Comment
Are BIA Author(s) credentials satisfactory?	Yes	
Is data required by Cl.233 of the GSD presented?	Yes	
Does the description of the proposed development include all aspects of temporary and permanent works which might impact upon geology, hydrogeology and hydrology?	Yes	
Are suitable plans/maps included?	Yes	
Do the plans/maps show the whole of the relevant area of study and do they show it in sufficient detail?	Yes	Desk Study information provided in revised submission.
Land Stability Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	In the revised submission, informed by Desk Study.
Hydrogeology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	
Hydrology Screening: Have appropriate data sources been consulted? Is justification provided for 'No' answers?	Yes	Desk Study information provided in revised submission.
Is a conceptual model presented?	Yes	Provided in revised submission.
Land Stability Scoping Provided? Is scoping consistent with screening outcome?	Yes	Desk study information, GMA and damage assessments provided in revised submission.

Item	Yes/No/NA	Comment
Hydrogeology Scoping Provided? Is scoping consistent with screening outcome?	Yes	
Hydrology Scoping Provided? Is scoping consistent with screening outcome?	Yes	Provided in revised submission. Outline attenuation SUDS proposals provided to limit discharge to 50% of current run-off rates.
Is factual ground investigation data provided?	Yes	Limited ground investigation has been undertaken.
Is monitoring data presented?	Yes	
Is the ground investigation informed by a desk study?	Yes	Provided in revised submission.
Has a site walkover been undertaken?	Yes	
Is the presence/absence of adjacent or nearby basements confirmed?	Yes	
Is a geotechnical interpretation presented?	Yes	Provided in revised submission.
Does the geotechnical interpretation include information on retaining wall design?	Yes	Provided in revised submission.
Are reports on other investigations required by screening and scoping presented?	N/A	
Are baseline conditions described, based on the GSD?	Yes	Provided in revised submission.
Do the base line conditions consider adjacent or nearby basements?	Yes	
Is an Impact Assessment provided?	Yes	
Are estimates of ground movement and structural impact presented?	Yes	Provided in revised submission.

Item	Yes/No/NA	Comment
Is the Impact Assessment appropriate to the matters identified by screen and scoping?	Yes	Updated in revised submission.
Has the need for mitigation been considered and are appropriate mitigation methods incorporated in the scheme?	Yes	Provided in revised submission. Additional detail to be agreed during Party Wall process.
Has the need for monitoring during construction been considered?	Yes	Provided in revised submission. Additional detail to be agreed during Party Wall process. This should be linked to the GMA and damage impact assessment.
Have the residual (after mitigation) impacts been clearly identified?	Yes	
Has the scheme demonstrated that the structural stability of the building and neighbouring properties and infrastructure will be maintained?	Yes	Provided in revised submission. Additional detail to be agreed during Party Wall process.
Has the scheme avoided adversely affecting drainage and run-off or causing other damage to the water environment?	Yes	Provided in revised submission.
Has the scheme avoided cumulative impacts upon structural stability or the water environment in the local area?	Yes	Provided in revised submission.
Does report state that damage to surrounding buildings will be no worse than Burland Category 2?	Yes	Provided in revised submission.
Are non-technical summaries provided?	Yes	

4.0 DISCUSSION

4.1. The BIA has been prepared by Momentum Structural Engineers with a supporting Site Investigation report prepared by Southern Testing. The authors' qualifications were initially not proven to meet the criteria outlined in CPG4, but in the revised submissions the authors' qualifications are accepted.

4.2. The proposed development is a new single storey basement across the full footprint of the existing two storey semi-detached house. Additional works include an extension to the side and rear of the property.

4.3. The ground conditions at the site are a shallow layer of Made Ground overlying London Clay. Perched water has been identified within the Made Ground. The proposed development will be founded within the London Clay. The rear of the site is relatively level, whilst at the front of the property the site slopes down to Lawn Road.

4.4. A desk study was presented that did not consider all the aspects recommended in the GSD Appendix G1, such as: making enquiries with relevant transport and utility companies to identify potential for underground infrastructure beneath the site; identifying current and historical wells, springs and water courses; identifying basements and listed buildings within the proposed development's zone of influence; or providing historical mapping. This has been updated in the revised submissions and is considered appropriate.

4.5. A site investigation has been presented which is limited in extent and does not follow guidelines within CPG4 or the GSD Section 7. The interpretative report was not in accordance with the GSD Appendix G3, but this has been updated in the revised submissions and is considered appropriate. The revised submissions include geotechnical parameters, a Conceptual Site Model and retaining wall design parameters, which were previously absent.

4.6. The BIA identifies slopes in excess of 7° on site and states that the basement design will need to take account of the slope. Limited discussion on mitigation is presented. However, after review of the revised submissions, it is accepted that the retaining walls and foundations for the proposed basement will reduce lateral loads on the slope at the front of the property and therefore there should be be no adverse slope stability impacts. During construction, monitoring of the slope should be included within the structural movement monitoring survey.

4.7. The BIA identifies that the impermeable area of the site will increase due to the proposed development and that peak run-off flows will also increase. An assessment of surface water flow and drainage design is presented. Following review of the revised submissions, and providing suitable attenuation SUDS is incorporated into the final design as proposed to limit

discharge flows to 50% of their current volume, there should be no significant impact to the wider hydrological environment.

4.8. Very limited structural information was presented, and the structural drawings were not included within the original BIA's Appendix B. The BIA stated that 'no adverse impacts are anticipated to the neighbouring structures' but insufficient information was presented to assess this. However, in the revised submissions, appropriate structural information has been provided In the revised submissions, an appropriate GMA and damage impact assessments has been prepared for structures within the zone of influence, in line with CPG4 guidelines. Additional mitigation measures to further reduce those impacts, where practicable, should be agreed under the Party Wall Act.

4.9. The revised BIA provides adequate structural information for both the temporary and permanent cases, including proposed construction sequencing and propping arrangements, and retaining wall design parameters.

4.10. Perched groundwater has been identified within the Made Ground and the BIA identifies that seepage along fissures or sandy partings within the London Clay is a possibility. Outline advice is provided to contractors, that longer term monitoring in advance of construction is recommended and that sump pumping is likely to be effective for low flow seepages during construction. The BIA states that waterproofing and permanent design elements, such as designing for potential hydrostatic uplift, should be informed by the recommended long term monitoring. Additional monitoring has been presented in the revised submission, and it is recommended that monitoring is ongoing, in accordance with the advice provided within the BIA.

4.11. The original BIA was substantially incomplete and referred to future assessments to provide design information, ground movement assessments and mitigation measures to reduce the impacts on the surrounding environment. In the revised submissions, the requested information has been provided in accordance with the guidance. Additional control actions, monitoring and mitigation measures to further reduce those potential stability impacts identified, should be agreed under the Party Wall Act.

5.0 CONCLUSIONS

5.1. The BIA has been prepared by Momentum Structural Engineers with supporting Site Investigation report prepared by Southern Testing. The authors' qualifications were initially not proven to meet the criteria outlined in CPG4, but in the revised submissions the authors' qualifications are accepted.

5.2. In the original submission, a desk study in accordance with the GSD Appendix G1 had not been presented. An appropriate desk study has now been submitted.

5.3. In the original submission, a conceptual site model, geotechnical parameters and retaining wall information were not presented. These have been included in the revised submissions, in line with the GSD Appendix G3.

5.4. The BIA indicates the site to be at very low risk of surface water flooding or impacting the wider surface water flow environment, which is likely to be accepted pending review of a comprehensive desk study (as 5.2) including full appendices and providing that the design advice submitted as part of the site specific drainage assessment, incorporating attenuation SUDS, is followed.

5.5. It is accepted that the site is at very low risk from groundwater flooding and will not impact the wider hydrogeological environment.

5.6. Perched water within the Made Ground has been identified and the Site Investigation report recommends long term monitoring to inform dewatering mitigation measures during construction and design criteria in the permanent case. Further monitoring data has been presented in the revised submissions.

5.7. The BIA identifies slopes in excess of 7° on site and states that the basement design will need to take account of the slope. Limited discussion on design and mitigation is presented. However, after review of the revised submissions, it is accepted that the retaining walls and foundations for the proposed basement will reduce lateral loads on the slope at the front of the property and therefore there should be no adverse slope stability impacts. During construction, monitoring of the slope should be included within the structural movement monitoring survey.

5.8. In the original submission, the BIA did not include a Ground Movement Assessment (GMA) or indicate land stability impacts caused by the proposed development. In the revised submissions, an appropriate GMA and damage impact assessments has been prepared for structures within the zone of influence, in line with CPG4 guidelines. Additional mitigation measures to further reduce those impacts, where practicable, should be agreed under the Party Wall Act.

5.9. In the original submission, the BIA did not indicate survey and monitoring requirements to be implemented to monitor and control potential ground movement impacts during construction. In the revised submission, these have been discussed in outline. Monitoring methods, trigger levels, mitigation and contingency actions should be further detailed and linked to the predicted ground movements, and presented and agreed with the Engineer and Party Wall Surveyor.

5.10. In the original submission, the BIA did not contain sufficient design or structural information, and design drawings referenced to be within Appendix B were not presented. In the revised submissions, adequate outline structural and construction sequence information has been provided.

5.11. Queries and matters requiring further information or clarification are summarised in Appendix 2.

5.12. Following review of the revised BIA submissions, the criteria contained in CPG4 and DP27 have been met.

Appendix 1: Residents' Consultation Comments

Residents' Consultation Comments

Surname	Address	Date	Issue raised	Response
Summerfield	78 Lawn Road, NW3 2XB	21 April, 5 May, 9 May and 4 July 2016	Structural damage to adjoining building caused by construction.	4.5, 4.6
Luger	5, 19 Lawn Road, NW3 2XR	15 April 2016	Structural damage to adjoining buildings.	4.5, 4.6
Poole / Tomlinson	74 Lawn Road, NW3 2XB	10 May 2016	Structural damage to adjoining building caused by construction.	4.5, 4.6

Appendix 2: Audit Query Tracker

Audit Query Tracker

Query No	Subject	Query	Status/Response	Date closed out
1	BIA	A revised BIA submission should include evidence of review and approval by appropriately qualified professionals for the relevant sections e.g. CEng MICE, CGeol FGS.	Closed – provided in revised submissions	November 2016
2	Desk Study	A desk study in accordance with GSD Appendix G1 should be presented, to include full appendices. For example, it should include: enquiries with relevant transport and utility companies to identify potential for underground infrastructure beneath the site; identifying current and historical wells, springs and water courses; identifying basements and listed buildings within the proposed development's zone of influence; historical mapping; etc.	Closed – provided in revised submissions	November 2016
3	Land Stability	The BIA should present geotechnical interpretation in line with the GSD Appendix G3 e.g. a conceptual site model, geotechnical parameters, retaining wall design information, etc.	Closed – provided in revised submissions	November 2016
4	Groundwater	In line with the site investigation recommendations, long term groundwater monitoring should be undertaken.	Closed – provided in revised submissions	November 2016
5	Land Stability / Ground Movement Assessment	A GMA should be presented, to include a zone of influence, identified basements and listed buildings, damage impact assessments, methodology and calculations, etc.	Closed – provided in revised submissions. Suitable additional mitigation / propping should be proposed and agreed with the Engineer prior to construction in regards to Category 1 Damage Impacts.	November 2016

6	Land Stability / Slope Stability	Further assessment, design detail and mitigation advice should be presented in regards to the slopes on site.	Closed - the assessment states that the basement retaining wall and foundation reduce lateral loads on the slope and hence improve stability.	November 2016
7	Land Stability / Structural Information	Sufficient design detail and drawings should be prepared and presented, including temporary and permanent works, construction sequencing, propping arrangements, etc.	Closed – provided in revised submissions	November 2016
8	Land Stability / Monitoring and Survey	Survey and monitoring requirements to be implemented to monitor and control potential ground movement impacts during construction should be assessed and presented.	Outline discussion on monitoring is presented, but not in detail. Detailed monitoring proposals, trigger values and contingency actions should be prepared and agreed as part of the Party Wall process.	N/A

Appendix 3: Supplementary Supporting Documents

Southern Testing
Environmental & Geotechnical

ST Consult
Environmental & Geotechnical

Basement Impact Assessment Report
(Stages 3 & 4 Site Investigation Study & Impact Assessment)

Desk Studies | Risk Assessments | Site Investigations | Geotechnical | Contamination Investigations | Remediation Design and Validation

Site: 77 Lawn Road, London NW3 2XB

Client: Laura Bolohan

Report Date: October 2016

Project Reference: J12507 Rev 01

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SUMMARY

Following a planning submission for this site earlier this year which included a Basement Impact Assessment by Momentum structural engineers (ref: 2716.RPT dated March 2016) and supported by a Southern Testing ground investigation report (ref: J12507 dated March 2106), a Basement Impact Assessment audit was undertaken by Campbell Reith on behalf of Camden Council. This audit identified a number of areas where further work was required on the Basement Impact Assessment for it to be fully acceptable, this was laid out within the Campbell Reith BIA Audit dated August 2016 (ref: 12336-62/D1). Southern Testing was requested by Mr Richard Heath of Momentum Engineering to help address these issues.

This revised report therefore represents a supporting desk study document to Momentum's report in terms of Stages 1 & 2 (screening & scoping) as well as Stage 3 the site investigation and Stage 4 impact assessment in the form of ground movement analysis. Stage 4 site-specific groundwater impact modelling and assessment was not considered necessary for this site.

The site comprises half of a pair of two storey semi-detached houses. The existing property has no basement accommodation. It is proposed to construct a single storey basement extension, extending beyond the full footprint of the existing structure onsite. The formation level of the general basement will be around 4m below ground level.

Geological records indicate the site to be underlain by London Clay. A single phase of intrusive investigation was carried out.

The soils encountered confirmed the recorded geology with the addition of superficial made ground associated with the current buildings over London Clay at around 0.5 to 1.6m depth.

Standing water levels within the monitoring wells indicate relatively shallow groundwater. This has shown some variation during the monitoring period.

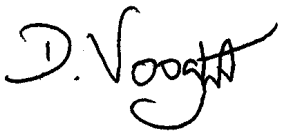
The sulphate content of the fill and natural soil was found to fall within Class DS-2. The ACEC classification for the site is AC-1s.

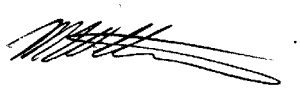
The basement construction and associated underpinning works should be achievable using conventional underpinning methods. Parameters for retaining wall design are given. The design of the new basement foundation system should take account the nature of the existing/adjacent foundations and their condition.

Ground movement analysis indicates negligible or very slight impacts on neighbouring properties.

The proposals at this site have been assessed as being likely to have negligible impact on groundwater levels and flow, so should have little effect on neighbouring properties.

The findings and opinions conveyed via this Site Investigation Report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Ltd believes are reliable. Nevertheless, Southern Testing Laboratories Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.





D. Vooght MSc (Countersigned)

M.W. Stevenson MICE CGeol (Countersigned)

Jon Race MSc CGeol (Signed)

For and on behalf of Southern Testing Laboratories Limited

STL: J12507 Rev 01
24 October 2016

TABLE OF CONTENTS

A INTRODUCTION

1 Introduction

Following a planning submission for this site earlier this year which included a Basement Impact Assessment by Momentum structural engineers (ref: 2716.RPT dated March 2016) and supported by a Southern Testing ground investigation report (ref: J12507 dated March 2106), a Basement Impact Assessment audit was undertaken by Campbell Reith on behalf of Camden Council. This audit identified a number of areas where further work was required on the Basement Impact Assessment for it to be fully acceptable, this was laid out within the Campbell Reith BIA Audit dated August 2016 (ref: 12336-62/D1).

Southern Testing was requested by Mr Richard Heath of Momentum Engineering to help address these issues. We have therefore updated our original ground investigation report to include a wider desk study, included some additional groundwater monitoring and a ground movement analysis for the proposed construction.

This revised report therefore represents within the Basement Impact Assessment process as defined in Camden planning guidance document CPG4 'Basements & Lightwells' – a supporting desk study document to Momentum's report in terms of Stages 1 & 2 (screening & scoping) as well as Stage 3 the site investigation and Stage 4 impact assessment in the form of ground movement analysis. Stage 4 site-specific groundwater impact modelling and assessment was not considered necessary for this site.

It is considered that the report has been produced in accordance with the requirements of the London Borough of Camden. Their requirements are set out within the Planning Guidance document CPG4 – Basements and Lightwells, the Development Policy DP27 – Basements and Lightwells and the LB Camden guidance document entitled "Camden geological, hydrogeological and hydrological study – Guidance for subterranean development".

2 Scope

This report presents our desk study and ground investigation findings along with our interpretation of these data.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Limited believes are reliable. Nevertheless, Southern Testing Laboratories Limited cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

This report was conducted and prepared for the sole internal use and reliance of Laura Bolohan and her appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorization of Southern Testing Laboratories Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The recommendations contained in this report may not be appropriate to alternative development schemes.

B STAGES 1 & 2 - SCOPING EXERCISE

These stages of the BIA were undertaken by Momentum structural engineers and reported within their report (ref: 2716.RPT dated March 2016). Their scoping assessment identified four items that will need to be investigated further to assess their potential impacts.

These are as follows:

- The proportion of paved/hard surfaced area will increase onsite. This will result in an increase to the peak flow into the existing main sewer. It is suggested that an attenuation tank be incorporated within the design to accommodate such increases in peak flow.

- The existing site includes slopes greater than 7 degrees. The site stability will need to be considered within the design and within the proposed methods of construction as potential impacts of basement construction can be a change in drainage and hence moisture content of slope soils and hence their stability, both onsite and within adjacent areas.

- The proposed basement may extend below the foundation level of the adjacent structure to the south and close to the neighbouring property to the north. This may result in structural damage to neighbouring properties. Careful design and management of the works both before and during construction will need to be undertaken to maintain the structural stability of the neighbouring properties.

- An existing house occupies the site. The presence of existing foundations and obstructions should be considered within the design.

The reader is referred to the following Stage 3 Ground Investigation of this Impact Assessment Report which considers some of the above issues.

C STAGE 3 – SITE INVESTIGATION & STUDY EXERCISE

D INTRODUCTION

3 Authority

Our authority for carrying out the original ground investigation works was contained in a completed Project Order Form dated 2nd February 2016 from Enric Torner of Torner Architects on behalf of the client Laura Bolohan. The authority for additional work and this revised and updated report was received from Xavier Menguy on 4th October 2016 on behalf of the client.

4 Location

The site is located 180m east of Belsize Park Underground station. The approximate National Grid Reference of the site is TQ 275 850 as shown on appended figure 1A.

5 Proposed Construction

It is proposed to construct a single storey basement extension, extending beyond the full footprint of the existing structure onsite, as illustrated within figures 2A & 2B in Appendix A.

For the purposes of the contamination risk assessment, the proposed development land use is classified as Residential with plant uptake (CLEA model[1]). The gas sensitivity of the site is rated as High (CIRIA C665[2]).

6 Object

This is a geotechnical investigation. However, limited contamination testing was undertaken, primarily for waste classification purposes and to assess potential risks to groundworkers who may come in contact during construction.

The object of the investigation was to assess foundation bearing conditions and other soil parameters relevant to the proposed development, and to assess the likely nature and extent of soil contamination on the site.

7 Scope

This report presents our exploratory hole logs and test results and our interpretation of these data.

A formal phase 1 desk study was outside of the scope of this investigation, however, a desk study appropriate for the BIA has been undertaken.

As with any site there may be differences in soil conditions between exploratory hole positions.

This report is not an engineering design and the figures and calculations contained in the report should be used by the Engineer, taking note that variations will apply, according to variations in design loading, in techniques used, and in site conditions. Our figures therefore should not supersede the Engineer's design.

The findings and opinions conveyed via this Site Investigation Report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Ltd believes are reliable. Nevertheless, Southern Testing Laboratories Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

The site investigation was conducted and this report has been prepared for the sole internal use and reliance of Laura Bolohan and the appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorization of Southern Testing Laboratories Ltd. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

The recommendations contained in this report may not be appropriate to alternative development schemes. The contamination screening values used are valid at the time of writing but may be subject to change and any such changes will have implications for the assessments based on them. Their validity should be confirmed at the time of site development.

[1] Environment Agency Publication SC050021/SR3 'Updated technical background to the CLEA Model' (2009).
[2] CIRIA C665 (2006) Assessing risks posed by hazardous ground gases to buildings.

E DESK STUDY & WALKOVER SURVEY

8 Desk Study

A formal desk study was outside of the scope of this investigation; however, a desk study suitable for the BIA to compliment that undertaken by Momentum structural engineers has been carried out. Reference has been made to the following information sources.

- Geological Maps
- Groundwater Vulnerability maps
- Historical Maps, freely available on the internet
- Environment Agency website
- Bomb Maps
- Camden Council online information
- BRE Radon Atlas[3]

8.1 Geology

The British Geological Survey Map of the area (No. 256 - North London) indicates that the site geology consists of London Clay.

London Clay

London Clay is a well-known stiff (high strength) blue-grey, fissured clay, which weathers to a brown colour near the surface. It contains thin layers of nodular calcareous mudstone - "claystone" - from place to place, and crystals of water clear calcium sulphate (selenite) are common.

8.2 Previous Ground Investigation data

There are a few historical borehole records dating from 1940-80's both to the northwest and southeast of this site. These indicate London Clay at shallow depth, but with some variable made ground deposits above. This generally supports the information on the published geological map.

8.3 Hydrology and Hydrogeology

Data from the Environment Agency and other information relating to controlled waters is summarised below.

Data		Remarks
Aquifer Designation	Superficial Deposits	There are no superficial deposits mapped onsite.
	Bedrock	The Bedrock (London Clay) mapped beneath the site is classified as Unproductive Strata - Rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.
Source Protection Zones		The site is not located within a Source Protection Zone.
Surface Water Features		A series of ponds/lakes are located approximately 1km to the north on Hampstead Heath.

[3] BR 211 (2007) 'Radon: guidance on protective measures for new buildings'

Data	Remarks
Fluvial Flood Risk	The "Risk of Flooding from Rivers" mapping on the Environment Agency website (February 2016) shows the site to be within an area of Very Low Risk. Very Low Risk means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%).
Surface Water Flood Risk	The "Risk of Flooding from Surface Water" mapping on the Environment Agency website (February 2016) shows the site to be within an area of Very Low Risk. Very Low Risk means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%).
Reservoir Flood Risk	On the basis of the Environment Agency mapping (February 2016), the site lies within an area not at risk from reservoir flooding.

8.4 Shallow Groundwater

No published groundwater information has been obtained that is relevant to this site itself, and there is only limited information for nearby sites. The data available indicates that there can be shallow perched groundwater within variable superficial made ground overlying the London Clay. No records of any nearby current or historical wells have been located.

Site-specific information on groundwater will need to be established.

8.5 Surface Water Features

From topography information no culvert, rivers and or other water bodies are known within the immediate vicinity of the site.

From information shown on Camden Council figure 11 relating to watercourses this site is located between the headwaters of the Tyburn and a tributary of the River Fleet. Within the 2016 revised edition of 'The Lost Rivers of London'; the site is shown around 300m south of a tributary of the River Fleet, and a similar distance northeast of the headwaters of the Tyburn. No surface water features are near this site and it is also outside the catchment of the Hampstead Heath ponds. This site or Lawn Road is not recorded as been subject to historical flooding as recorded within CPG4.

8.6 Historical Map Search

A review of Historical maps freely available on the internet was carried out. On the earliest mapping (1871-1873) until the 1954 mapping the subject site is shown to be undeveloped land, within the ground of Haverstock Lodge, which is directly to the south west of the site. Directly to the west of the site/on site is a small embankment/earthworks structure associated with landscaping within the grounds of Haverstock Lodge. Lawn Road is shown to be present in its present configuration from the earliest mapping onwards. The surrounding area appears to become increasingly developed throughout the course of the mapping, primarily with residential properties. Haverstock Lodge is not shown after 1915.

From the 1954 mapping onwards the site and surrounding area appears similar to its current configuration.

8.7 Bomb Map

The London County Council Bomb Damage Maps (1939-1945) are made up of 110 hand-coloured 1:2,500 Ordnance Survey base sheets, which were originally published in 1916 but updated by the London County Council to 1940. The colouring applied to the maps record a scale of damage to London's built environment during the war caused by aerial bombardment.

The published bomb map for the area (map No. 37), shows the site suffered general blast damage- not structural (shown in orange). The map also shows a building to north suffered damage beyond repair (shown in purple) and a series of buildings to the south east suffered total destruction (shown in black), please refer to Figure A in Appendix A.

The maps have been reviewed for information purposes only and should not be perceived as part of a formal UXO desk study or risk assessment as detailed in CIRIA C681 "Unexploded Ordnance (UXO) – A guide for the Construction Industry".

8.8 Radon Risk

With reference to BRE guidance: no radon protection is required on this site.

9 Basements

From a search of London Borough of Camden online planning applications over the last 20 years, it appears that the nearby property No. 81 Lawn Road was granted planning permission for a basement in 2007. Two other buildings backing on to this site (8 & 10 Downside Crescent) have also been granted planning permission for basement extensions. No other adjacent properties appear to have basements or have been granted permission for such.

10 Transport & Other Infrastructure

No tunnels are known to be present within the immediate vicinity of the site. Written returns from London Underground and Thames Water indicate that no infrastructure would be affected by works at this site. Known below ground infrastructure includes the London Underground Northern line as being within 100m of the site to the south and Thameslink tunnels within 200m to the north.

11 Walkover Survey

A walkover survey was carried out on 6th January 2016 at the time of the investigation.

11.1 General Description and Boundaries

The site comprises a two storey semi-detached residential structure. The site includes a sloping front garden area and drive leading to a side garage and a two tiered garden area at the rear.

No. 77 Lawn Road is a semi-detached property of masonry brick construction bounded on either side by similar properties believed to be of a similar age. The rear (west) of the site is bounded by similar two storey residential properties of Downside Crescent.

The topography of the site slopes down from the west towards Lawn road and the eastern site boundary. A 1m tall retaining wall is present along the eastern site boundary and the subject property (77 Lawn Road) is approximately 1.5m higher than Lawn Road.

A number of semi-mature to mature trees/shrubs including sycamore, cherry and eucalyptus were indentified both on site and in the surrounding area/adjacent garden areas.

The majority of the neighbouring properties appear to comprise residential dwellings. A number of properties on the opposite side of Lawn Road appear to have lower ground floors. Commercial properties are present to the west and south west of the site along Haverstock Hill.

F SITE INVESTIGATION

12 Method

The strategy adopted for the intrusive investigation comprised the following:

- 2 No 5.3-5.7m deep boreholes were drilled using hand held window sampler equipment (WS1 & WS2).
- Groundwater monitoring wells were installed within WS1 & WS2 for groundwater monitoring purposes.
- A series of 4 foundation inspection pits (TP1-4) were excavated by hand to establish existing foundation conditions.

Exploratory hole locations are shown in Figure 1 in Appendix B.

13 Weather Conditions

The fieldwork was carried out on 6th January 2016 at which time the weather was generally slightly overcast but dry.

The preceding month of December was neither wetter nor drier than average in the South East of England, with approximately 100% of the normal rainfall. November was slightly drier than average with approximately 90% of the normal, while October was drier than average with only approximately 65% of the normal rainfall.

14 Soils as Found

The soils encountered are described in detail in the attached exploratory hole logs (Appendix B), but in general comprised a covering of Made Ground over London Clay. A summary is given below.

Depth (m bgl)	Soil Type	Description
GL – 0.5/1.6	Made Ground	Firm, greyish brown to reddish brown, silty, sandy, gravelly, CLAY, with occasional to frequent roots and rootlets. Gravel comprises fine to medium, angular to sub-angular flint, brick, concrete and ash fragments (MADE GROUND).

Depth (m bgl)	Soil Type	Description
0.5/1.6 – 5.3/5.7+	London Clay	Firm to stiff, thinly laminated, yellowish brown to pale grey, CLAY, with occasional selenite crystals.

14.1 Visual and Olfactory Evidence of Contamination

No visual or olfactory evidence of significant contamination was noted during the investigation.

Made Ground was noted in a number of exploratory holes, which included some fragments of brick, concrete and ash. Such soils often contain elevated contaminant concentrations (e.g. heavy metals, Polyaromatic Hydrocarbons, asbestos etc.)

14.2 Existing Foundations

A series of 4 No. foundation inspection pits were excavated by hand to establish the existing foundation conditions. Drawn sections recording the foundation detail together with photographs are presented within Appendices B and E.

15 Groundwater Strikes

While siteworks were in progress no groundwater was encountered within the exploratory holes.

The site has been revisited on a number of occasions to carry out measurements of the standing water levels within the two standpipes installed in the window sample boreholes. The reader is referred to Section 18 for the results of these measurements.

G FIELD TESTING AND SAMPLING

The following in-situ test and sampling methods were employed. Descriptions are given in Appendix C together with the test results.

- Disturbed Samples
- Hand Penetrometer Tests

H GEOTECHNICAL LABORATORY TESTS

The following tests were carried out on selected samples. Test method references and results are given in Appendix D.

- Atterberg Limit Tests
- Moisture Content
- Soluble Sulphate and pH

I CONCEPTUAL GROUND MODEL

A conceptual site model has been derived for this site, which is illustrated in Figure 3 included in Appendix A. The neighbouring properties are shown, namely the attached No. 78 to the south and the adjacent No. 76 to the north. The distance between the subject property and No. 76 varies as they are not parallel buildings, reducing to a minimum of about 1.2m. The Highway is around 10m away from the proposed basement construction. Interpretation of the underlying geology and variations in measured groundwater levels are shown.

Analysis of ground movements in relation to the neighbouring properties is included within section M.

J DISCUSSION OF GEOTECHNICAL TEST RESULTS AND RECOMMENDATIONS

16 Soil Classification and Properties

Soil Type	Depth	Compressibility	VCP	Permeability	Frost Susceptible	CBR	Remarks
Made Ground	GL to 0.5/1.6m	N/A	N/A	Low but seepages from more permeable horizons are anticipated	Yes	N/A	Not suitable for foundations
London Clay	0.5/1.6m to 5.3/5.7m+	Medium	High	Very low/impermeable, but seepages from fissures can occur	No	Poor	

17 Swelling and Shrinkage

Shrinkable soils are subject to changes in volume as their moisture content is altered. Soil moisture contents vary from season to season and can be influence by a number of factors including the action of roots. The resulting swelling or shrinkage of the soils can cause subsidence or heave damage to foundations, the structures they support and services.

The designer should be aware that precautions regarding swelling and shrinkage are applicable. Chapter 4.2 of the NHBC Standards 2016 "Building Near Trees" provides a helpful guide with respect to minimum foundation depths and deepening precautions particularly within the zone of influence of trees.

Assessment of foundation depths should take into account not only those, trees, shrubs or hedgerows which have or are to be removed, but also those remaining or proposed which may be allowed to reach maturity.

Atterberg Limit tests were carried out on 6 No. samples of the natural London Clay soils, with plasticity indices in the range 46-54%; the samples tested were classified as being CV (clays of very high plasticity. All 6 No. samples are classified as being NHBC HIGH Volume Change Potential

(VCP). Therefore, on the basis of the testing undertaken to date a classification of NHBC **HIGH** VCP would be appropriate as an overall site classification.

Given the anticipated depth of the proposed basement construction (4.0m), no specific precautions are considered necessary with respect to further foundation deepening within the influence of trees. However, where shallower foundations are proposed foundation precautions and deepening in accordance with NHBC High Volume Change precautions will be required.

18 Groundwater Levels

Groundwater levels vary considerably from season to season and year to year, often rising close to the ground surface in wet or winter weather, and falling in periods of drought. Long-term monitoring from boreholes or standpipes is required to assess the ground water regime and this was not possible during the course of this site investigation.

While siteworks were in progress, no groundwater entries were noted within the Made Ground or underlying London Clay within the window sample holes.

The standing water levels from the groundwater monitoring visits to date are shown in the table below. From the limited records it is not entirely clear but it is believed that the standing water level may reflect a perched groundwater table within the Made Ground.

Hole ID	Date	Standing water level (m bgl)
WS1	06/01/2016 (during siteworks)	Dry
	22/01/2016	0.31
	09/02/2016	0.92
	04/10/2016	2.00
	14/10/2016	2.04
WS2	06/01/2016 (during siteworks)	Dry
	22/01/2016	0.95
	09/02/2016	0.97
	04/10/2016	2.09
	14/10/2016	2.15

The relatively short and narrow nature of the site along with the existing structures makes locating a series of groundwater monitoring point problematic to provide information on the hydraulic gradient across the site.

On the basis of the observations made while siteworks were in progress and the measurements to date, groundwater ingress is not expected to be a significant problem in terms of dewatering issues etc during construction. Allowances for some dewatering, however, should be made from perched sources e.g. within the made ground, in the form of intermittent pumping from strategically placed collector sumps, which may results in a very slight local lowering of groundwater.

For the longer term condition, seepage entries from fissure flow within the clays and any perched water from within the overlying Made Ground should be allowed for in the design of the basement area e.g. provision of waterproofing measures, and also for hydrostatic uplift of the basement floor slab.

Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-9} m/s and 1x 10^{-14} m/s, with an even lower vertical permeability. Accordingly, the groundwater flow rate is anticipated to be extremely low to negligible.

Any groundwater flows that take place will likely follow the local/regional topography which in this instance comprises local falls predominantly to the north/east. Given the very low/impermeable nature of the underlying clay materials, there is negligible risk of the proposed basement walls causing a "damming effect" or mounding of water on the upstream faces.

Given the above observations/comments, it is concluded that the proposed construction of the basement will not result in any specific issues relating to the hydrogeology and hydrology of the site. In terms of the potential cumulative effects on the groundwater environment in the local area, i.e. the effects of the proposed basement construction, and should other future basements be granted beneath adjacent properties, the combination of the overall regional and local topographic falls of the area (hence negligible to low hydraulic gradients), and the very low/impermeable nature of the underlying London Clay, there is negligible risk of the proposed basement walls causing a "damming effect" or mounding of water on the upstream faces or resulting in increases in groundwater levels within the area.

19 Sulphates and Acidity

The measured pH of the made ground and natural soils ranged between 7.0 and 8.0.

The soluble sulphate levels recorded within the made ground ranged between 20-590mg/l and within the underlying natural soils soluble sulphate concentrations ranged between 20-979mg/l.

On the basis of the above measurements, we would recommend that BRE Class DS-2 precautions are adopted for the subsurface concrete, together with an ACEC Class of AC-1s.

20 Bearing Capacity

We understand that it is proposed to construct the basement, possibly using conventional underpinning methods.

Where it is necessary to construct spread foundations or bases to retaining walls/underpinned sections as part of the proposed works, all foundations should clearly penetrate any made ground and be formed on the underlying natural Clay materials. For basement foundations formed on these materials, an allowable bearing capacity of 125kPa may be adopted.

21 Basement Construction

We would anticipate that the proposed basement will be constructed using a form of conventional underpinning methods. Based on the findings of the boreholes (WS1 & WS2) and the soil types encountered, the following soil parameters are suggested for design of basement retaining walls:

Soil Type	Bulk density γ_b (kN/m^3)	Undrained Shear Strength (Temporary Condition)	Long Term "Drained" Condition	
			c' (kN/m^2)	!^{o}
Made Ground	19	N/A	0	25
London Clay	20	C_u=70kPa	0	25

Given the slight difference in level across the site, the new basement walls will need to be designed to support the slope using the parameters above. Any temporary works for the construction will also need to be carefully considered in terms of marinating the stability of the site.

Due to the stress relief following the removal of existing soils to form the basement structure, both immediate (undrained) and long term (drained) heave displacements can be expected to occur in the underlying London Clay.

The immediate (undrained) heave displacements will occurs as excavation of the basement takes place and before the construction of basement elements e.g. slabs etc. Accordingly, only the long term (drained) heave displacements will need to be catered for in design, to overcome the problem of uplift pressures forming. This is normally overcome by installing appropriate void forming materials beneath the basements elements.

Analysis of the predicted ground movements are included within section M of this report.

For the analysis of heave movements, the following stiffness parameters after Burland and Kalra (1986)[4] are suggested for the London Clay:

Undrained Young's Modulus (E_u) = (10+5.2z) (MN/m^2)

Undrained Poisson Ratio (ν_u) =0.5

Drained Young's Modulus (E_d) = (7.5+3.9z) (MN/m^2)

Drained Poisson Ratio (ν_d) =0.2

Where z (m) is taken from the surface of the London Clay

All works will be carried out in accordance with the Structural Engineers design. In terms of the method of basement construction it is envisaged that conventional underpinning methods will be adopted. Appropriate propping methods and working practices will be carried out to ensure that movements associated with the works are kept within acceptable limits.

[4] Burland J.B. and Kalra J.C. (1986) Queen Elizabeth Conference Centre: geotechnical aspects, Proc. Inst. Civ. Engnrs, Part 1,80,1479-1503

The extent and nature of the propping/works will be evaluated during the detailed design phase of the works in order to allow discussions (should they be required) with the party wall surveyor. Throughout the construction phase the party wall on the southern side of the building and the building in the north will be monitored for both movement and vibration to make sure these are within acceptable limits.

Such necessary information will be provided within a Construction Method Statement.

22 Excavations and Trenching

Statutory lateral earth support will be required in all excavations where men must work. Instability of the sides of any excavations carried out must be expected. Accordingly, measures should be taken at all times to ensure that excavations undertaken during underpinning operations are adequately supported.

Given the presence of the existing/adjacent foundations, close attention in design of temporary and permanent propping is required of the underpinning works at all times to prevent settlement or excessive lateral yielding of the excavation/foundations.

Providing good levels of construction are employed and close attention is taken to temporary/permanent propping measures as noted above, it is unlikely that the proposed construction will result in any specific issues relating to land stability issues, however monitoring of the adjacent properties are likely to be required while the works are in progress.

Allowances should be made for breaking out subsurface obstructions, e.g. old footings, drain runs etc. associated with the existing development on the site.

K LAND QUALITY

23 Analytical Framework

There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

The CLEA model[5] provides a methodology for quantitative assessment of the long term risks posed to human health by exposure to contaminated soils. Toxicological data is used to calculate a Soil Guideline Value (SGV) for an individual contaminant, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

In the absence of any published SGVs for certain substances, Southern Testing have derived or adopted Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH[6] S4UL's and CL:AIRE[7] generic assessment criteria. In addition, in March 2014, DEFRA[8] published the results of a research programme to develop screening

[5] Environment Agency Publication SC050021/SR3 'Updated technical background to the CLEA Model' (2009).
[6] The LQM/CIEH S4ULs for Human Health Risk Assessment. (2014).
[7] The EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment (2009).
[8] SP1010 Development of Category 4 Screening Levels foe Assessment of Land Affected by Contamination. DEFRA, 2014.

values to assist decision making under Part 2A of the Environmental Protection Act. Category 4 screening levels were published for 6 substances, with reference to human health risk only. This guidance includes revisions of the CLEA exposure parameters, presenting parameters for public open space land use scenarios, and also of the toxicological approach. The screening levels represent a low risk scenario, based on a 'Low Level of Toxicological Concern' rather than the 'Minimal Risk' of CLEA, and the analytical results of this investigation may be considered relative to these levels.

The values used are valid at the time of writing but may be subject to change and any such changes will have implications for the assessments based upon them. Their validity should be confirmed at the time of site development.

Site-specific assessments are undertaken wherever possible and/or applicable.

CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

24 Site Investigation – Soil

24.1 Sampling Regime

The number of sample locations was limited and was targeted to provide general coverage. Access was partly restricted by the presence of existing buildings and buried services.

24.2 Testing

The potential for contamination by Made Ground was identified by observations made on site. No visual or olfactory evidence of hydrocarbon contamination was noted on site and as such no testing for such has been undertaken.

Therefore, the following tests were selected.

Test Suite	Number of Samples	Soil Tested
STL Key Contaminant Suite	3 1	Made Ground Natural Soil (CLAY)
Asbestos Identification	3	Made Ground

The test results are presented in full in Appendix F. A summary and discussion of the significance of the results and identified contamination sources is given below.

24.3 Test Results and Identified Contamination Sources

24.3.1 General Contaminants

The results of the key contaminant tests have been analysed in accordance with the CLEA methodology. The samples have been grouped into 2 populations comprising Made Ground and natural CLAY. For each parameter in each population the sample mean is calculated and compared to a Tier 1 screening value. If the sample mean exceeds the screening value, the soil may be regarded as contaminated and further assessment may be required. If neither the sample mean nor any single value exceeds the screening value, the soil may be regarded as not

contaminated, though further confirmatory assessment may be required. Where any single parameter value exceeds the screening value but the sample mean does not, further statistical analysis may be applied to that parameter if the available data is suitable. Such analysis would include an assessment of the Normality of the distribution of the data, consideration of the presence of outliers, and the calculation of a UCL estimate of the mean.

Summary data is presented in the tables below and the laboratory analysis is included in Appendix F. The screening values and source notes are presented in Table 1 "Tier 1 Screening Values" at the front of Appendix F.

Soil Type: Made Ground

Contaminants	Units	No of Samples Tested	Range	Sample Mean	Residential with Homegrown Produce Consumption Tier 1 Screening Value
Arsenic (As)	mg/kg	3	14-17	16.3	37
Cadmium (Cd)	mg/kg	3	<0.1-0.3	0.17	11
Total Chromium (Cr)	mg/kg	3	24-53	34.7	910
Hexavalent Chromium (CrVI)	mg/kg	3	<1	<1	6
Lead (Pb)	mg/kg	3	21-**460**	**213.7**	200
Mercury (Hg)	mg/kg	3	<1.0-1.8	1.27	7.6-11
Selenium (Se)	mg/kg	3	<3	<3	250
Nickel (Ni)	mg/kg	3	15-60	30.7	130
Copper (Cu)	mg/kg	3	28-57	39.7	2400
Zinc (Zn)	mg/kg	3	62-230	123.7	3700
Phenol	mg/kg	3	<1	<1	120-380
Benzo[a]pyrene	mg/kg	3	<0.1-0.1	0.1	1.7-2.4
Naphthalene	mg/kg	3	<0.1	<0.1	2.3-13
Total Cyanide (CN)	mg/kg	3	<1	<1	/
Acidity (pH value)	Units	3	7.0-8.0	7.57	/
Soil Organic Matter	%	3	0.3-4.7	3.03	/

A total of three samples of Made Ground taken from across the site were sent for testing. With the exception of a single elevated Lead result, all the results fall below the corresponding Tier 1 assessment criterion for Residential with Plant Uptake.

Elevated concentrations of Lead (460mg/kg in TP4 @0.3m) was reported in one of the three samples analysed, compared with a screening value of 200mg/kg. In our experience high concentrations of Lead are fairly typical of Made Ground in London and is not considered significant in terms of the development proposals and the likely risk to the site works (assuming good, basic, health and safety measures are adopted) and the end users. Furthermore given that the site is underlain by London Clay, there is no aquifer risk.

Soil Type: Natural Soils

Contaminants	Units	No of Samples Tested	Result	Residential with Homegrown Produce Consumption Tier 1 Screening Value
Arsenic (As)	mg/kg	1	19	37
Cadmium (Cd)	mg/kg	1	<0.1	11
Total Chromium (Cr)	mg/kg	1	49	910
Hexavalent Chromium (CrVI)	mg/kg	1	<1	6
Lead (Pb)	mg/kg	1	17	200
Mercury (Hg)	mg/kg	1	<1.0	7.6-11
Selenium (Se)	mg/kg	1	<3	250
Nickel (Ni)	mg/kg	1	61	130
Copper (Cu)	mg/kg	1	26	2400
Zinc (Zn)	mg/kg	1	70	3700
Phenol	mg/kg	1	<1	120-380
Benzo[a]pyrene	mg/kg	1	<0.1	1.7-2.4
Naphthalene	mg/kg	1	<0.1	2.3-13
Total Cyanide (CN)	mg/kg	1	<1	/
Acidity (pH value)	Units	1	7.8	/
Soil Organic Matter	%	1	0.3	/

One sample of natural soil, from WS2 @ 2.0m was submitted for testing. The results all fall below the Tier 1 screening value for Residential with Plant Uptake.

24.3.2 Asbestos

During the course of the investigation from visual assessment the garage roof of No. 77 Lawn Road was suspected to contain asbestos cement. No asbestos containing materials were detected in the soil samples analysed and none were observed in the exploratory holes. Although, it should be noted that the exploratory holes are of small diameter/the investigation was constrained by site usage and the samples obtained may not reflect the full composition of the soils on the site. Therefore, there is always the potential for pockets of asbestos or for asbestos containing materials to be present, which have not been detected in the sampling.

It is also our experience that asbestos containing materials are quite often encountered in buried pockets and beneath slabs (sometimes adhering to the concrete) on older sites.

25 Waste Classification

Preliminary Waste Acceptance Criteria (WAC) testing has been undertaken on one sample of Made Ground and one sample of the underlying natural clay.

The WAC testing and other chemical analysis appended will provide initial information to assist in classifying any soils to be removed from site to landfill as part of the ground works.

We would advise that care is taken during excavation to ensure that the differing soil types/ wastes are segregated during excavation in order to minimise waste disposal costs. Different guidelines and charges will apply to different waste classifications.

The developer, as waste producer, will ultimately be responsible for the material removed from site. The contents of this report should be forwarded to tip operators for their own assessment, to confirm classification of the soils for off-site disposal, and whether they can accept the material.

Should any more significant contamination be encountered during the ground works, then this may alter the waste classification.

26 Discussion and Conclusions

At the time of writing it is unclear whether the approved planning will be subject to contaminated land planning conditions.

On the basis of the observations made during the investigation and the results of the contamination testing to date, the risk to the site users and ground works is considered to be low, given that good, health and safety and site practices are adopted (in the case of the site workers).

Notwithstanding the above, elevated Lead has been reported within TP4 @0.3mbgl. High concentrations of Lead are fairly typical of Made Ground in London. It is believed that the source of the lead may be associated with the construction of the existing property.

It is anticipated that the Made Ground soils in area of trial hole TP4 will either be removed from site as part of the foundation/basement constructions, or some material may possibly remain beneath the proposed structure and so pose a low level of risk to future site occupants.

On the basis of these results it appears that good general site practice, such as appropriate PPE and basic hygiene measures, will be sufficient to mitigate any minor risk to the ground workers. As with the waste management facility, these results should be provided to the ground works for their own appraisal.

During the investigation it was also noted the garage roof, contained asbestos cement. If it is proposed to remove this building allowance should be made for carrying out an asbestos survey prior to its demolition. A careful watch should be maintained during demolition/ground works so that any suspect materials can be spotted and analyses as necessary.

As with any site, areas of contamination not identified during site investigation works may come to light in the course of redevelopment. Accordingly, a **discovery strategy** must be in place during the redevelopment to ensure that any hitherto unknown contamination is identified and dealt with in an appropriate manner. Depending on the nature of any such contamination, it may prove necessary to reassess the remedial strategy for the site.

27 General Guidance

Allowance should be made for experienced verification of any remedial works.

It may be that specific local requirements apply to this site, of which we are not aware at this time.

In general terms, the workforce and general public should be protected from contact with contaminated material. There is a range of relevant documents published by the Health and Safety Executive, and organisations such as CIRIA, and the BRE.

It should be noted that organic contaminants present in the soils could affect plastic underground service pipes (such as the types used by water and gas supply companies). Guidance should be sought from the relevant companies regarding any proposed plant in the affected area.

Many water supply companies now require higher specification pipe on contaminated sites, even following remediation.

L STAGE 4 – IMPACT ASSESSMENT

M GROUND MOVEMENT ANALYSIS

28 Impact of the Proposed Basement in terms of Ground Movement

Following an audit carried out by Campbell Reith of the original Basement Impact Assessment for the above site it was requested that a Ground Movement Analysis (GMA) should be carried out. The required information from the GMA was to establish the vertical and horizontal movements in relation to their impact on the neighbouring properties (No's 76 and 78 Lawn Road).

28.1 Modelling of movements due to vertical stress changes

We understand that beneath the existing footprint of the building it is proposed to construct the basement by using conventional underpinning methods and hit and miss techniques. In areas without existing structure over, it is proposed to use sheet piled retaining walls to resist the lateral loads in the temporary condition and then to use concrete retaining walls to support the loads in the permanent condition. For the purpose of our analysis we have assumed that all the underpinning works, sheet piled walls and concrete retaining walls will be fully propped for both the temporary and permanent conditions. We have also assumed that the sheet piles will be installed using suitable low disturbance techniques e.g. hydraulically jacked "silent" sheet piling methods.

Allowing for thickness of the slab, etc, the formation level of the proposed basement will be about 4m below existing site levels.

The vertical movements associated with the proposed construction are normally modelled as producing a short-term response followed by a longer term (drained) response. The excavation and construction of the proposed basement will result in changes in vertical soil loading, thus giving rise to short and long term displacements occurring within the underlying soils. Assuming that there is no delay in excavation and construction of the basement etc, the longer term drained displacements will be governed by the net stress changes caused by the combination of the basement excavation and the net difference at formation level between the existing and new basement foundation loadings.

The predicted ground response was modelled using the OASYS program PDISP. This program assumes a linear elastic behaviour of the soil and a flexible structure. In reality, the finite stiffness of the structure(s) will tend to redistribute or smooth out the movements, when compared to those predicted by PDISP. The vertical movement calculations therefore represent free field movements unaffected by the stiffness of the structure(s) and are likely to be conservative (i.e. the distortions of the structure would be less than those obtained from the predicted movements).

For PDISP modelling purposes London Clay was assumed to extend from 1.0m below existing ground surface to depth. The rigid base for the analysis was taken as 40m BGL. The soil parameters used are presented in Section 21 of this report. Site ground level was taken as an arbitrary value of 0.0mOD; the rigid base for the analysis was taken as -40mOD.

28.2 Vertical Movements from Excavation and Existing/Proposed Construction Loadings

In terms of the proposed construction pressures associated with the underpinning and proposed foundation loadings these were taken as acting at a formation level of -4.0mOD. In addition to unload pressures associated with the excavation of soils to form the basement, the Structural Engineer also provided existing and proposed loadings for estimating net changes in vertical loadings due to foundation loadings (refer Appendix G: Figures 1 and 2). For the purpose of estimating the unload pressure associated with the 4.0m deep basement excavation, an unload pressure of 80kPa has been adopted.

A short-term (undrained) analysis was undertaken to determine the movements likely to arise as a result of the combination of the unloading due to excavation of the basement and the net difference between the existing foundations loadings (acting at their existing levels) and proposed construction loadings. This indicated a maximum undrained heave of about 12mm occurring within the central area of the basement (see Figure U1 included in Appendix G).

For the purpose of illustrating the likely displacements occurring beneath the neighbouring properties No's 76 and 78 Priory Road, displacement lines (see Figure U1) were extended from the basement excavation walls across both properties. It should be noted however that the movements occurring outside of the basement area will be influenced by other movements associated with the installation and excavation in front of the basement walls which will be considered in later sections of this report.

In the case of the neighbouring property (No 76), an undrained heave movement of approximately 3.5mm is indicated at the closest wall (approximately 1.2m from the proposed basement) reducing to about zero at its furthest side assumed to be some 12.8m from the wall (Figure LU1). In our final analysis of damage category, the building was assumed to be 9.6m high.

In the case of the attached property (No 78), an undrained heave movement of approximately 6.8mm is indicated at the party wall thereby reducing to about 0.6mm at its furthest side assumed to be some 8.3m from the wall (Figure LU2). In our final analysis of damage category, the height of No 78 was assumed to be 9.6m high.

The movements of the ground following construction were also analysed for the total long-term (drained) case. The analysis was again undertaken for the combination of the unloading due to excavation of the basement and the net difference between the existing and proposed construction loadings. The PDISP assessment indicates peak long-term drained heave movements of between 18-20mm occurring within the central zones of the basement area (Figure V1).

Referring to displacement line plot (Figure LV1), a predicted long-term drained heave movement of approximately 6.2mm is indicated at the closest wall of No 76 to the basement thereby reducing to about 0.8mm on the furthest side of the property.

In the case of the neighbouring property No 78 (Figure LV2), a predicted long-term drained heave movement of approximately 10.8mm is indicated at the party wall thereby reducing to about 1.6mm at its furthest side.

It should be noted that in practice, the above vertical movements that develop from vertical changes in loading of the soil do not occur in isolation from other ground movements associated with basement excavation and construction (as discussed below).

28.3 Movements due to basement excavation and underpin construction

In addition to the changes in vertical stress caused by excavation and the net changes in vertical loadings due to construction loadings the installation of the new walls and then the removal of soil from in front of the walls will also generate both horizontal and vertical movement in the ground.

Ground movements resulting from underpinning is not well documented, and there is no specific method of assessing their magnitude. However when underpinning is carried out in a well controlled manner, movements are typically small.

To provide some basis of estimating likely movements and damage resulting from excavating the basement in front of the underpinning, and in the absence of underpinning-specific guidance, the underpinned sections of the new basement have been treated as piles. It has been assumed that the movements resulting from excavation in front of the underpins also incorporate the movements resulting from the construction of the underpins, since, unlike for the piles, the construction process requires an excavation prior to the pins being formed. As noted previously we have assumed that the sheet piles will be installed using suitable low disturbance techniques e.g. hydraulically jacked "silent" sheet piling methods.

Assessment of the ground movements resulting from excavation to form the basement has been undertaken with reference to CIRIA guide C580 "Embedded retaining walls – guidance for economic design". This provides guidance on the horizontal and vertical movements of the soil adjacent to an embedded retaining wall as a result of pile installation and of excavation in front of the wall based on numerous case histories, for the cases of a high stiffness (propped) retaining wall and a low stiffness (cantilevered) retaining wall.

In this case a high stiffness wall condition has been assumed for both the underpinned and sheet piled wall sections.

Estimates of movements using CIRIA guide C580, are based on empirical data. Since such data is likely collected during and soon after construction, it is assumed to include any short term heave element. However, long-term ground movements from changes in vertical stress would likely not have occurred when the measurements of ground movement were made.

The methodology within C580 indicates that the excavation to create the basement will, for a high support stiffness wall, produce horizontal movements of 0.15% of the excavation depth at the wall, with movements extending to four times the depth of the excavation, while peak vertical

movements will be 0.07% of the excavation depth, with such movements becoming zero at 3.5 times the depth of the excavation. Horizontal movements will decrease in a generally linear fashion with distance from the wall, whereas vertical movements peak at about half the excavation depth from the wall, with movements at the wall being about 0.04% of the excavation depth.

Referring to the displacement line plot (Figure CL1), the horizontal movement of the closest wall of No 76 to the basement in towards the basement excavation is predicted to be about 5.6mm with horizontal movements reducing to approximately 1.3mm on the furthest side of No 76. The predicted vertical settlement of the closest wall of No 76 is about 2.5mm with vertical movements increasing to about 3mm thereby reducing to approximately 0.25mm on the furthest side of the property.

Referring to the displacement line plot (Figure CL2), the horizontal movement of the party wall to No 78 in towards the basement excavation is predicted to be about 6.0mm with horizontal movements reducing to approximately 3mm on the furthest side of No 78. The predicted vertical settlement of the party wall to No 78 is about 1.6mm with vertical movements increasing to about 3.0mm thereby reducing to about 1.2mm on the furthest side of the property.

28.4 Long-Term Movements

The movements derived from the CIRIA guidance are based on the empirical data within C580. As such, it is assumed that they include any short term element of ground movement due to vertical stress changes. However, it is unlikely that the C580 data includes the long-term movements resulting from vertical stress changes. Total ground movements resulting from the proposed development are therefore taken as the sum of the predicted ground movements using C580, plus the difference in estimated PDISP movements between short and long-term conditions. Therefore in addition to previous analysis for the short term construction movements further analysis for the long-term condition was carried out and these are shown in Figures LT1 (No 76 Lawn Road) and LT2 (No 78 Lawn Road). It should be noted that the horizontal movements as predicted above will remain the same.

Referring to the displacement line plot (Figure LT1), as before the horizontal movement of the closest wall of No 76 in towards the basement excavation is predicted 5.6mm with horizontal movements reducing to approximately 1.3mm on the furthest side of No 76. The predicted long-term vertical movement of the closest wall of No 76 to the basement is about 2.2mm heave with vertical movements then tending to a maximum settlement of 1.2mm thereby reducing to near zero on the furthest side of the property.

Referring to the displacement line plot (Figure LT2), as before the horizontal movement of the party wall to No 78 in towards the basement excavation is predicted to be about 6.0mm with horizontal movements reducing to approximately 3mm on the furthest side of No 78. The predicted vertical movement at the party wall to No 78 is about 2.4mm heave with vertical movements then tending to a maximum settlement of 1.2mm thereby reducing to about 0.3mm settlement on the furthest side of the property.

28.5 Ground Movements and Damage Category

The calculated ground movements have been used to assess potential "damage categories" that may apply to the neighbouring properties due to the proposed basement construction. The methodology proposed by Burland and Wroth and later supplemented by Boscardin and Cording has been adopted as described in *Ciria* Special Publication 200 and *Ciria* C580.

The general damage categories are summarised in the table below:

Category	Description
0 (Negligible)	Negligible – hairline cracks
1 (Very slight)	Fine cracks that can easily be treated during normal decoration (crack width <1mm)
2 (Slight)	Cracks easily filled, redecoration probably required. Some repointing may be required externally (crack width <5mm).
3 (Moderate)	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. Repointing of external brickwork and possibly a small amount of brickwork to be replaced (crack width 5 to 15mm or a number of cracks > 3mm).
4 (Severe)	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows (crack width 15mm to 25mm but also depends on number of cracks).
5 (Very Severe)	This requires a major repair involving partial or complete re-building (crack width usually >25mm but depends on number of cracks).

28.5.1 Damage Category for No 76 Lawn Road

Using the Oasys Program XDISP, the "damage categories" are presented in the outputs from the program for the combination of predicted horizontal and vertical strains relating to the short-term and long-term conditions. Output A relates to the short term condition and Output B for the long-term condition. In the case of No 76 Lawn Road, a damage category of category 0 (negligible) is predicted for the short term condition and category 1 (very slight) for the long-term condition.

28.5.2 Damage Category for No 78 Lawn Road

Again using the Oasys Program XDISP, the "damage categories" are presented in the outputs from the program for the combination of predicted horizontal and vertical strains relating to the short-term and long-term conditions (see Outputs A and B). In the case of No 78 Lawn Road, a damage category of 1 (very slight) is predicted for both the short term and long-term conditions.

28.6 Conclusion

The above categories of damage assume good quality working practice during basement construction and that a "robust" level propping is employed.

Finally a formal monitoring system should be employed during construction in order to observe and monitor ground movements, especially in critical areas such as with the neighbouring properties. Monitoring data should be checked against predefined trigger limits to give early indications if any deviating ground movements are occurring.

APPENDIX A

Figures

Site: 77 Lawn Road, London NW3	STL: J12507	Fig No: 1A
Date: 18 October 2016	Site Location Plan	

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

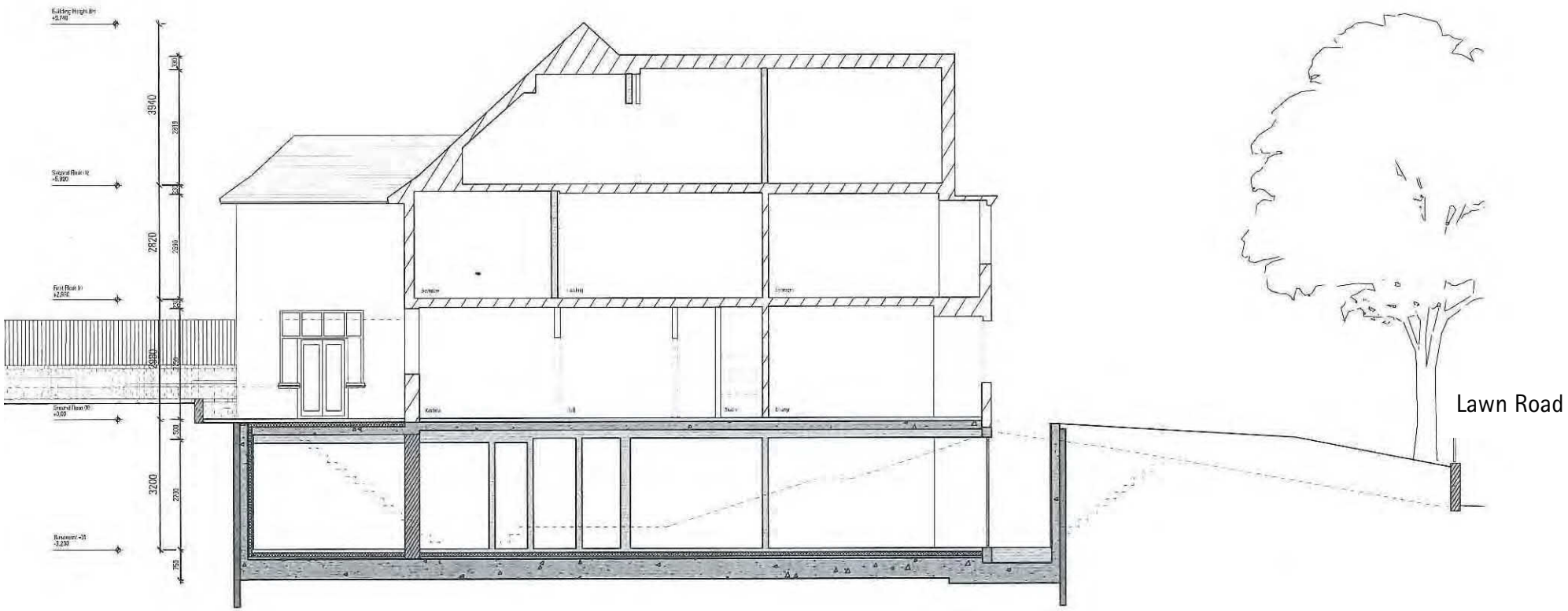
ST Consult

Site: 77 Lawn Road, London NW3	STL: J12507	Fig No: 2A
Date: 20 October 2016	Proposed street elevation with outline of basement.	

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

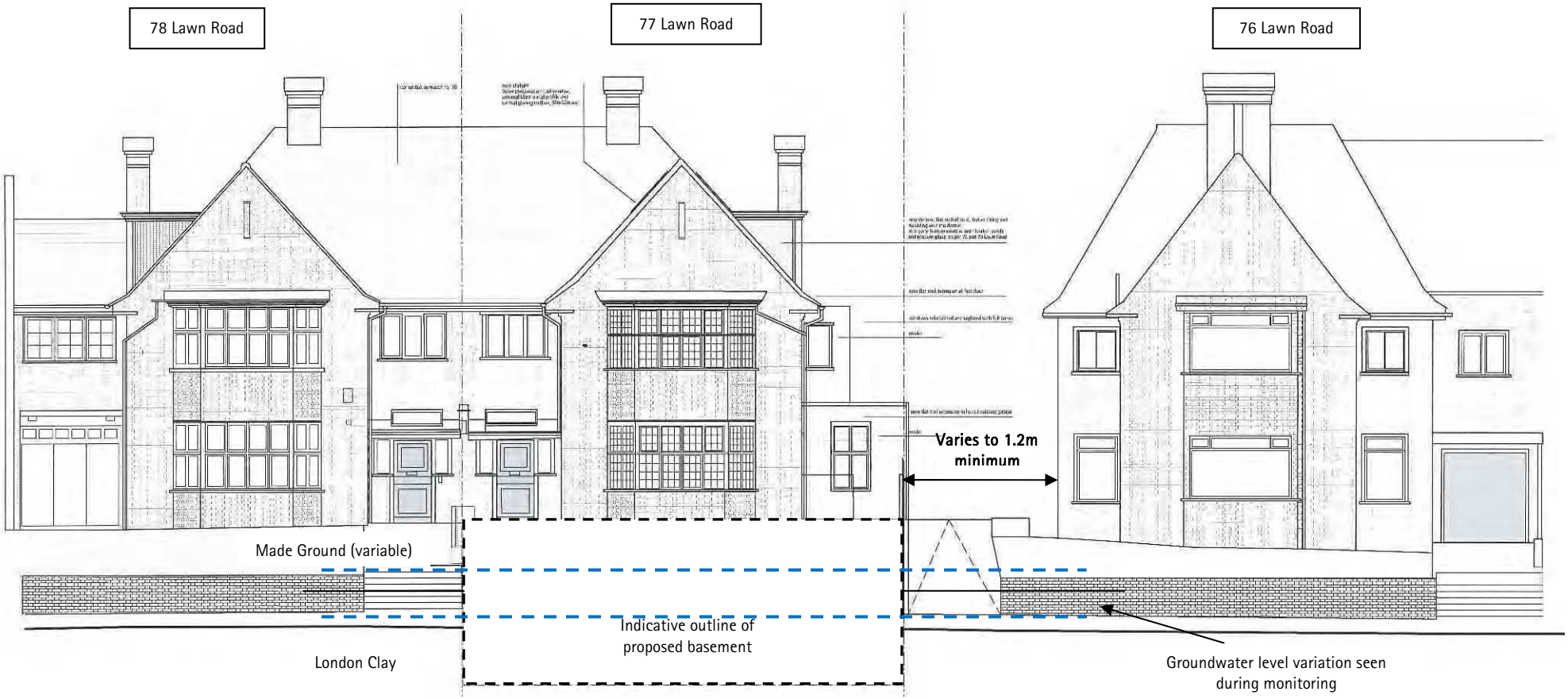


Site: 77 Lawn Road, London NW3	STL: J12507	Fig No: 2B
Date: 20 October 2016	Proposed section (front to rear)	

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult



Site: 77 Lawn Road, London NW3	STL: J12507	Fig No: 3
Date: 20 October 2016	Conceptual Ground Model	

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

Colour Key References
(for guidance only)

Black
Total destruction

Purple
Damaged beyond repair

Dark Red
Seriously damaged; doubtful if repairable

Light Red
Seriously damaged, but repairable at cost

Orange
General blast damage – not structural

Yellow
Blast damage, minor in nature

Light Blue
Clearance areas

Light Green
Clearance areas

V1 flying bomb

V2 long range rocket

Site: 77 Lawn Road, London NW3	STL: J12507	Fig No: A
Date: 01 March 2016	Bomb Map	

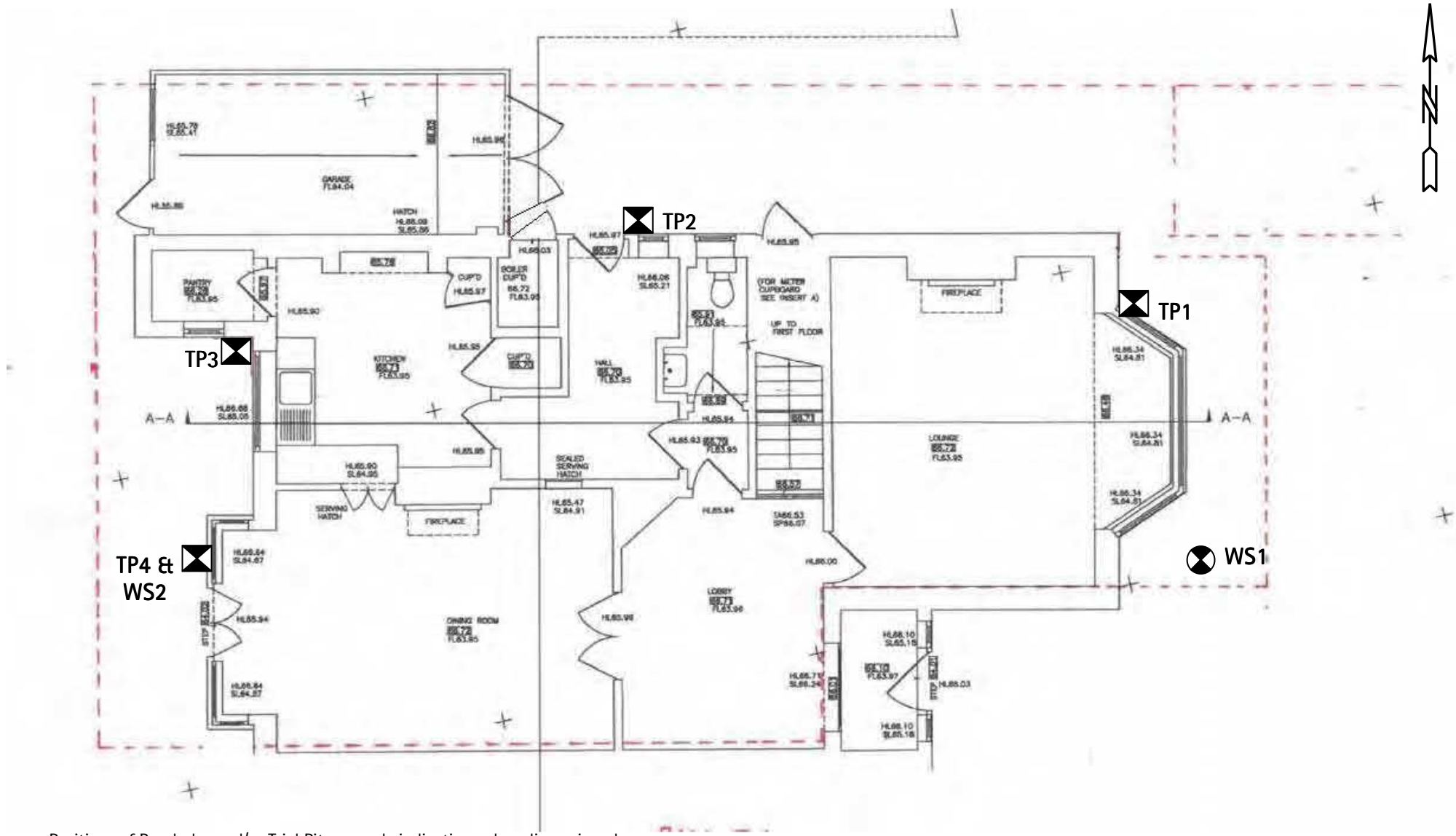
Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

APPENDIX B

Site Plans and Exploratory Hole Logs



NB: Positions of Boreholes and/or Trial Pits are only indicative unless dimensioned

Site: 77 Lawn Road, London NW3	STL: J12507	Fig No: 1
Date: 6th January 2016	1. Site plan showing approximate exploratory hole locations.	

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

Key to Exploratory Hole Logs

General

All soil & rock descriptions in general accordance with BS5930:1999+A2:2010, BS EN ISO 14688 & BS EN ISO 14689
The Geology Code only entered where positive identification of the sampled strata has been made

Sampling

ES	Environmental Sample (taken in appropriate sampling container)
D	Disturbed Sample
B	Bulk Sample
LB	Large Bulk for Earthworks testing
C	Core Sample
U	Undisturbed Sample (number of blows indicated in results column)
SPTLS	SPT Liner Sampler
P	Piston Sample
W	Water Sample

Insitu Tests

SPT	Standard Penetration Test in accordance with BS EN ISO 22476-3:2005+A1:2011
SPT (C)	Cone Penetration Test in accordance with BS EN ISO 22476-3:2005+A1:2011
PT	Penetration Test - STL documented equivalent SPT N Value
PPT	Perth Penetration Test - STL in house documented method (N Value)
UCS (⊥)	Unconfined Compressive Strength measure by hand penetrometer (kN/m^2)
IVN	Hand Vane (kPa)
PID	Photo Ionisation Detector Results (ppm)
MEXE	Mexecone CBR Result

Drilling Records

Depth to standing water level	▼
Depth to water strike	▽
TCR	Total Core Recovery (%)
SCR	Solid Core Recovery (%)
RQD	Rock Quality Index (%)
FI	Fracture Index

Backfill Symbols

Arisings

Concrete

Blacktop

Bentonite Seal

Gravel Filter

Sand Filter

Pipe Symbols

Plain Pipe

Slotted Pipe

Filter Tip

Principal Soil Types

Topsoil

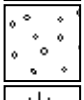
Made Ground

Clay

Silt

Sand

Gravel



Peat

Principal Rock Types

Mudstone/Claystone

Siltstone

Sandstone

Limestone

Chalk

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	WS1
06/01/2016	J12507	WS	Sheet 1 of 1

Project Name:	77 Lawn Road	Remarks:	Co-ordinates:	Level:	Logger:
					SM
Location:	London NW3	1. Borehole dry upon completion.			
Client:	Mr Eric Torner	2. Refusal at 5.7m (bgl) on stiff clay.			

Backfill	Water Strikes	Samples and Insitu Testing: Depth (m bgl)	Type	Results	Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		0.20	ES			(0.30)		0.30	Dark greyish brown, sandy, gravelly, CLAY, with frequent roots and rootlets. Gravel comprises fine to medium, angular to sub-angular flint, chalk, brick and concrete (MADE GROUND).
		1.00	ES			(1.30)			Pale greyish brown, silty, gravelly, CLAY, with occasional roots, rootlets and fragments of fine brick. Gravel comprises fine to medium, flint (MADE GROUND).
		1.50	D						
		1.50	ES					1.60	Firm, pale yellowish brown mottled grey, CLAY.
		2.00	D						
		2.00	HP	UCS(kPa)=130					
		2.50	HP	UCS(kPa)=170		(1.90)			
		3.00	D						
		3.00	HP	UCS(kPa)=230					
		3.40	HP	UCS(kPa)=270					
		3.50	D					3.50	Firm to stiff, thinly laminated, pale grey, CLAY, with occasional selenite crystals.
		4.00	D						
		4.00	HP	UCS(kPa)=280					
		4.50	D						
		4.50	HP	UCS(kPa)=250		(2.20)			
		5.00	D						
		5.00	HP	UCS(kPa)=270					
		5.50	D						
		5.50	HP	UCS(kPa)=400				5.70	End of borehole at 5.70m

Hole Details		Casing Details		Water Strike (m bgl)				Readings (m bgl)			Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth	Casing	Sealed	Rose to:	Time (min)	Remarks	From	To	Time	Remarks

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Start - End Date	Project ID:	Hole Type:	WS2
06/01/2016	J12507	WS	Sheet 1 of 1

Project Name:	77 Lawn Road	Remarks:	Co-ordinates:	Level:	Logger:
					SM
Location:	London NW3	1. Borehole undertaken through base of TP4.			
Client:	Mr Eric Torner	2. Borehole dry upon completion.			
		3. Refusal at 5.3m (bgl) on stiff clay.			

Backfill	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.05)		0.05	Paving Slab.
						(0.09)		0.14	CONCRETE.
						(0.36)		0.50	Firm, dark greyish brown to reddish brown, sandy, CLAY, with occasional fragments of brick, ash and rootlets (MADE GROUND).
		0.70	HP	UCS(kPa)=90		(0.50)		1.00	Firm, yellowish brown, CLAY.
		1.50	D						Firm to stiff, pale brown, CLAY.
		1.50	HP	UCS(kPa)=110					
		2.00	D						
		2.00	ES						
		2.00	HP	UCS(kPa)=130					
		2.50	D						
		2.50	HP	UCS(kPa)=180					
		3.00	D						
		3.00	HP	UCS(kPa)=230		(4.30)			
		3.50	D						
		3.50	HP	UCS(kPa)=210					
		4.00	D						
		4.00	HP	UCS(kPa)=260					
		4.50	D						
		4.50	HP	UCS(kPa)=300					
		5.00	D						
		5.00	HP	UCS(kPa)=330					*[5.0-5.3m Occasional selenite crystals.]*
		5.30	D					5.30	End of borehole at 5.30m
		5.30	HP	UCS(kPa)=350					

Hole Details		Casing Details		Water Strike (m bgl)				Readings (m bgl)			Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth	Casing	Sealed	Rose to:	Time (min)	Remarks	From	To	Time	Remarks

Southern Testing ST Consult

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Start - End Date:	Project ID:	Machine Type:	TP1
06/01/2016	J12507	Hand Dug	Sheet 1 of 1

Project Name:	77 Lawn Road	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
					SM
Location:	London NW3	1. Trial pit dry upon completion.			
Client:	Mr Eric Torner				

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
0.5	ES			(0.95)		0.95	Greyish brown to brown, clayey, slightly gravelly SAND, with occasional roots, rootlets and fragments of ash. Gravel comprises fine to medium, flint, brick and concrete (MADE GROUND).
							Pit terminated at 0.95m.

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.60		
Length:	0.65		
Depth:	0.95		

Southern Testing ST Consult	Start - End Date:	Project ID:	Machine Type:	TP2
www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020	06/01/2016	J12507	Hand Dug	Sheet 1 of 1

Project Name:	77 Lawn Road	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
					SM
Location:	London NW3	1. Trial pit dry upon completion.			
Client:	Mr Eric Torner				

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.20)			CONCRETE.
						0.20	
0.4 0.4	D ES			(0.40)			Pale brown gravelly, clayey, SILT, with occasional rootlets. Gravel comprises fine to medium, sub-angular to rounded, flint.
						0.60	Pit terminated at 0.60m.

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.35		
Length:	0.60		
Depth:	0.60		

Southern Testing ST Consult	Start - End Date:	Project ID:	Machine Type:	TP3
www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020	06/01/2016	J12507	Hand Dug	Sheet 1 of 1

Project Name:	77 Lawn Road	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
					SM
Location:	London NW3	1. Trial pit dry upon completion.			
Client:	Mr Eric Torner				

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.05)		0.05	Paving slab.
0.2	ES			(0.25)			Dark grey to black, clayey, gravelly SAND, with occasional fragments of glass, ash, patches of reworked clay, roots and rootlets. Gravel comprises fine to medium, flint and brick (MADE GROUND).
				(0.30)		0.30	Firm, dark greyish brown to reddish brown, sandy CLAY, with occasional fragments of brick, ash and rootlets (MADE GROUND).
				(0.20)		0.60	Firm, pale yellowish brown, CLAY, with occasional roots and rootlets.
0.8	D					0.80	Pit terminated at 0.80m.
0.8	HP	UCS(kPa)=140					

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.42		
Length:	0.73		
Depth:	0.80		

Southern Testing ST Consult

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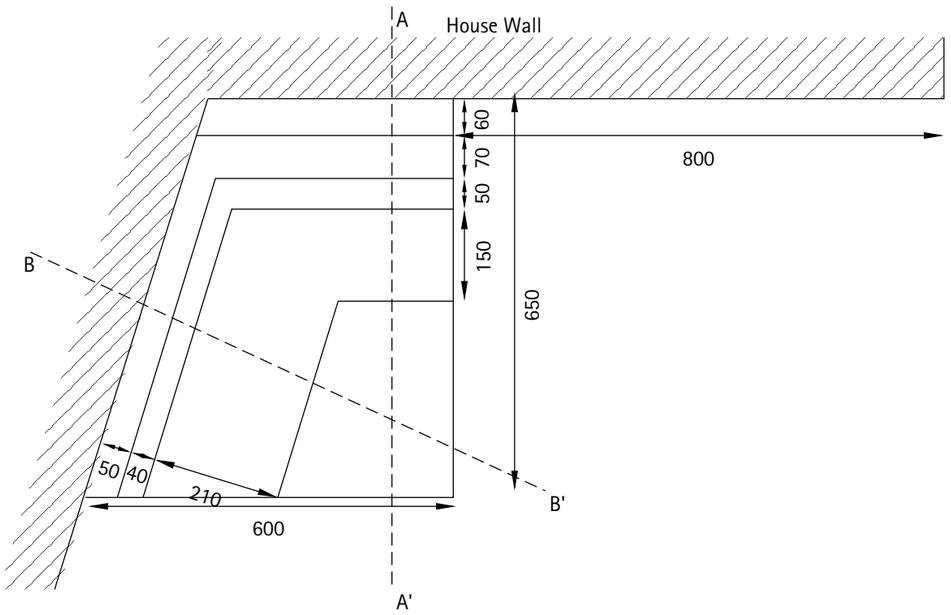
Start - End Date:	Project ID:	Machine Type:	TP4
06/01/2016	J12507	Hand Dug	Sheet 1 of 1

Project Name:	77 Lawn Road	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
					SM
Location:	London NW3	1. Trial pit dry upon completion.			
Client:	Mr Eric Torner				

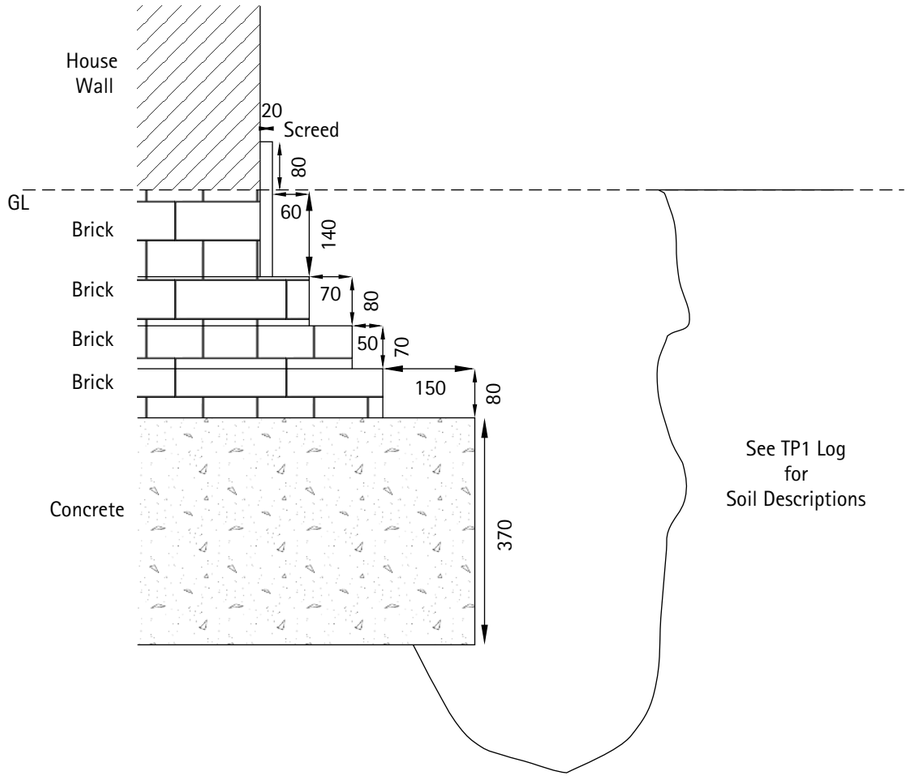
Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.05)		0.05	Paving slab.
				(0.09)			CONCRETE
						0.14	Firm, dark greyish brown to reddish brown, sandy, CLAY, with occasional fragments of brick, ash and rootlets (MADE GROUND).
0.3	ES			(0.36)			
						0.50	Firm, yellowish brown, CLAY.
0.7	D			(0.30)			
0.7	HP	UCS(kPa)=90				0.80	Pit terminated at 0.80m.

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.00		
Length:	0.00		
Depth:	0.00		

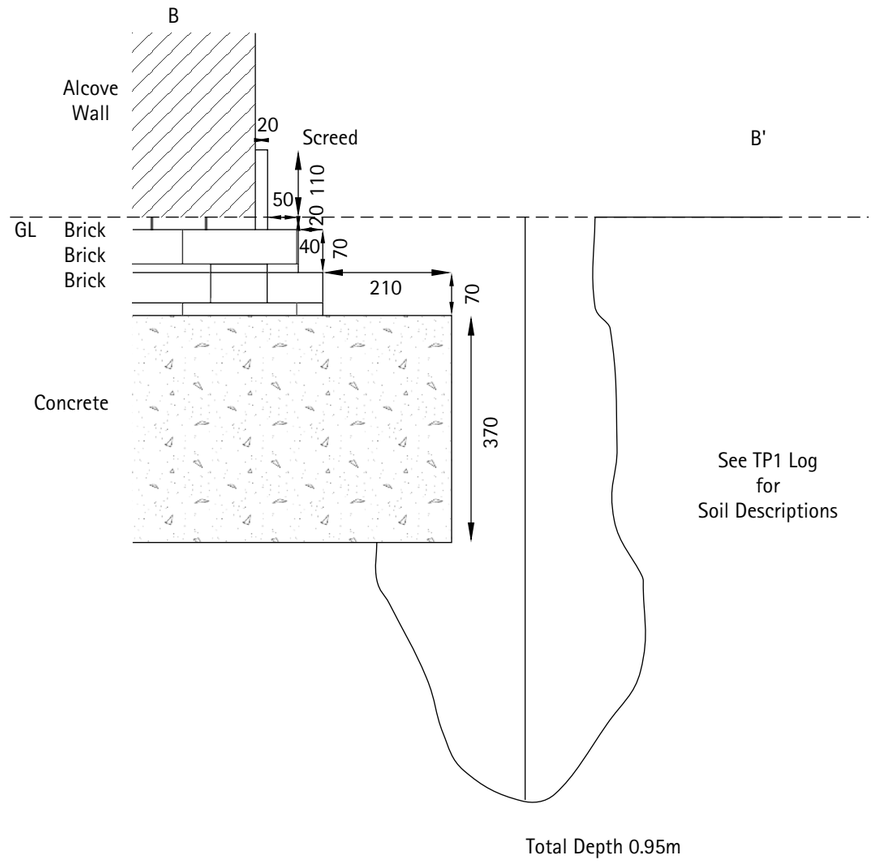
TP1 Plan View:



TP1 Section A to A'



TP1 Section B to B'



Notes

1. All dimensions in mm unless stated otherwise.

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Environmental & Geotechnical

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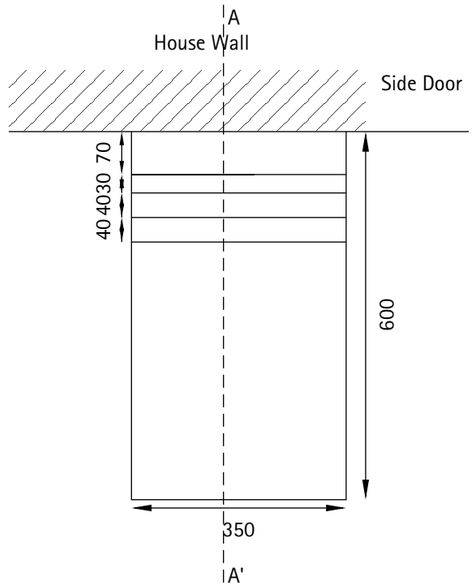
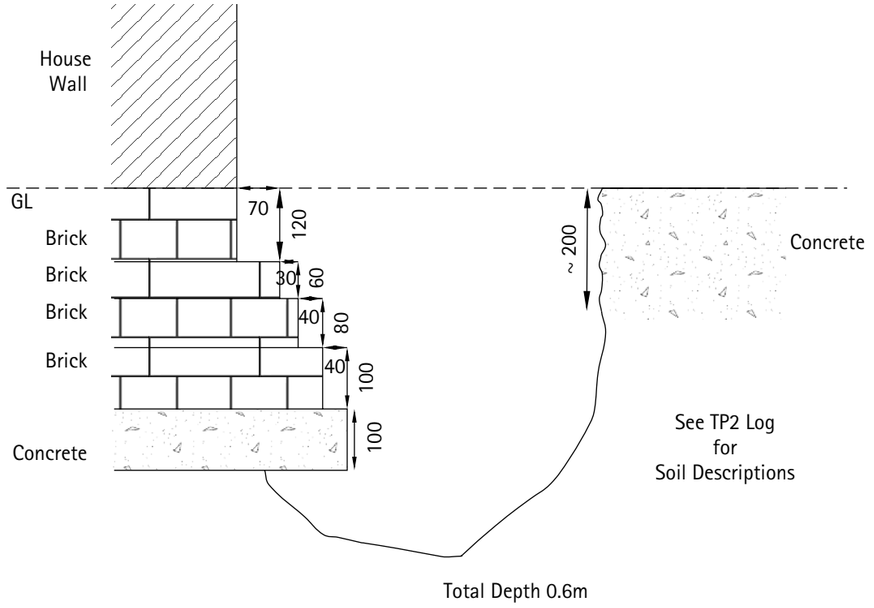
Client: Mr Eric Torner	
Job Title: 77 Lawn Road, London NW3	
Description: Trial Pit Sections	
Drawing No: TP1	
Scale: 1:100	Paper Size: A3
Drawn by: SM	Checked by: DV
Date: 06/01/2015	

TP2 Plan View:



TP2 Section A to A'



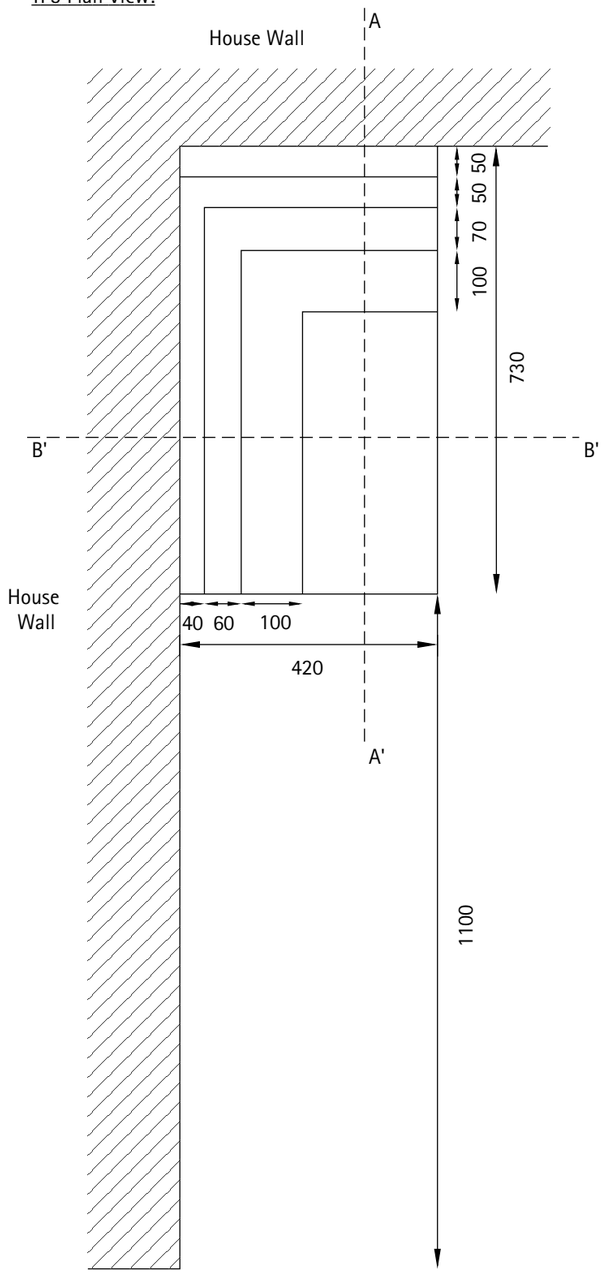
Notes

1. All dimensions in mm unless stated otherwise.

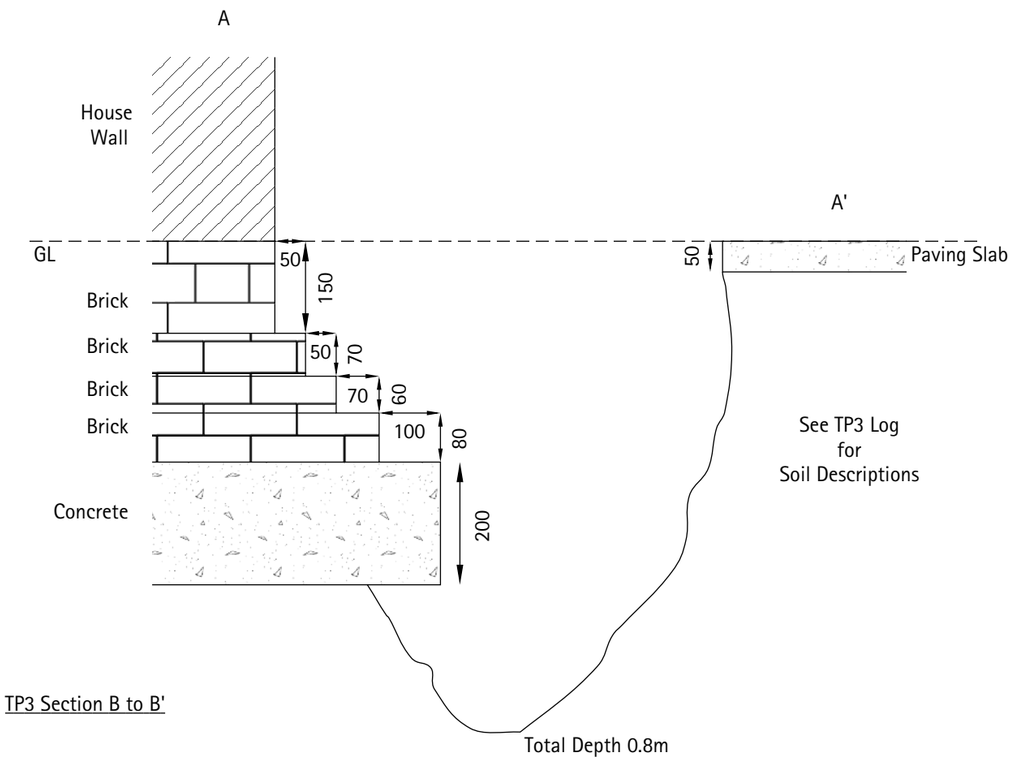
Southern Testing
Environmental & Geotechnical
Keeble House, Stuart Way, East Grinstead, West Sussex. RH19 4QA
Tel: 01342 333100 Fax: 01342 410321
www.southerntesting.co.uk

Client: Mr Eric Torner	
Job Title: 77 Lawn Road, London NW3	
Description: Trial Pit Sections	
Drawing No: TP2	
Scale: 1:100	Paper Size: A3
Drawn by: SM	Checked by: DV
Date: 06/01/2015	

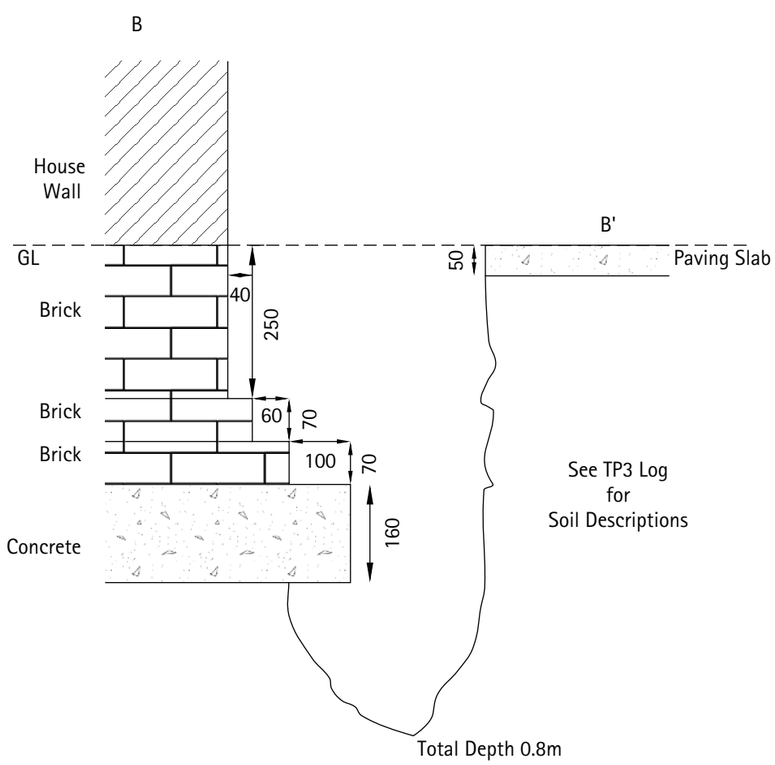
TP3 Plan View:



TP3 Section A to A'



TP3 Section B to B'



Notes

1. All dimensions in mm unless stated otherwise.

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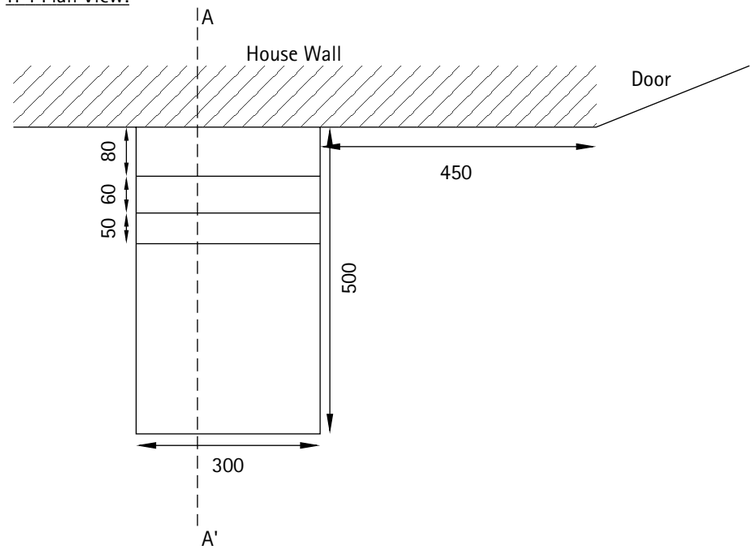
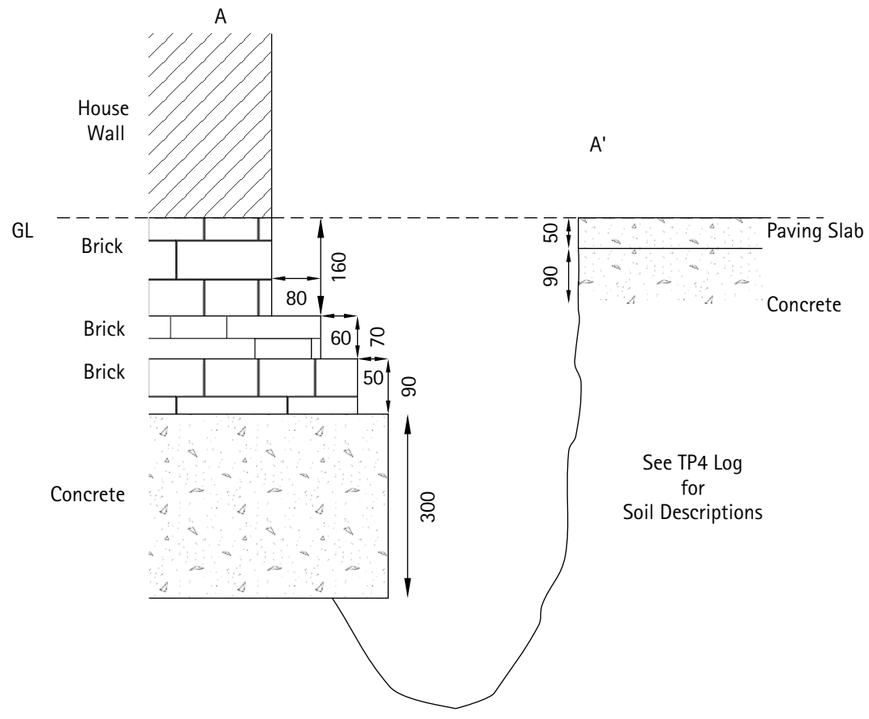
Client: Mr Eric Torner	
Job Title: 77 Lawn Road, London NW3	
Description: Trial Pit Sections	
Drawing No: TP3	
Scale: 1:100	Paper Size: A3
Drawn by: SM	Checked by: DV
Date: 06/01/2015	

TP4 Plan View:



TP4 Section A to A'



Total Depth: 0.8m

Notes

1. All dimensions in mm unless stated otherwise.

Southern Testing
Environmental & Geotechnical

Keeble House, Stuart Way, East Grinstead, West Sussex. RH19 4QA

Tel: 01342 333100 Fax: 01342 410321

www.southerntesting.co.uk

Client: Mr Eric Torner	
Job Title: 77 Lawn Road, London NW3	
Description: Trial Pit Sections	
Drawing No: TP4	
Scale: 1:100	Paper Size: A3
Drawn by: SM	Checked by: DV
Date: 06/01/2015	

APPENDIX C

Field Sampling and in-situ Test Methods & Results

Field Sampling and in-situ Test Methods

Disturbed Samples

Disturbed samples were taken from the trial holes at intervals and stored in sealed glass jars and polythene bags, as appropriate.

Hand Penetrometer Test

The hand penetrometer consists of a spring loaded and calibrated plunger which is forced into the soil. A reading of unconfined compression strength (equal-twice cohesion) is given on a calibrated scale. In common with other hand methods of strength assessment (eg. the shear vane) it does not give an accurate indication of bearing capacity in stiff or fissured soils, because of the small test area. The figures are used for strength classification according-the table below.

Hand Penetrometer Value (kPa)	Undrained Shear Strength cu (kPa)	Undrained Shear Strength of Clays
<20	<10	Extremely Low
20 40	10-20	Very Low
40-80	20-40	Low
80-150	40-75	Medium
150-300	75-150	High
300-600	150-300	Very High
600>	300>	Extremely High

APPENDIX D

Geotechnical Laboratory Test References & Results

Southern Testing | ST Consult

Atterberg and Moisture Content Summary

To BS1377□2:1990□2003□cl.3.2, 3.3, 4.2, 4.3

AGS

Project Name	*77 Lawn Road (London NW3)*			Project Number	*J12507*
Client	*Mr Enric Torner (Architect)*	PE	*DV*	Date Issued	*23-Feb-16*

Location	Depth m	Sample Type	Visual Description	Comments	Natural MC □	Li□uid Limit □	Plastic Limit □	Plasticity Index	Classi□ fication	Passing 425 micron □
WS1	2.00	D	*Stiff light brown CLAY.*		*37*	*83*	*29*	*54*	*CV*	*100*
WS1	4.00	D	*Very stiff light brown CLAY.*		*33*	*81*	*30*	*51*	*CV*	*100*
WS1	5.00	D	*Very stiff brown grey CLAY.*		*33*	*77*	*31*	*46*	*CV*	*100*
WS2	1.50	D	*Firm dark grey mottled yellow brown slightly gravelly CLAY. Gravel consists of fine rounded flint.*		*37*	*72*	*25*	*47*	*CV*	*98*
WS2	2.50	D	*Firm brown slightly sandy CLAY.*		*31*	*73*	*26*	*47*	*CV*	*100*
WS2	4.00	D	*Stiff light brown CLAY.*		*33*	*79*	*30*	*49*	*CV*	*100*

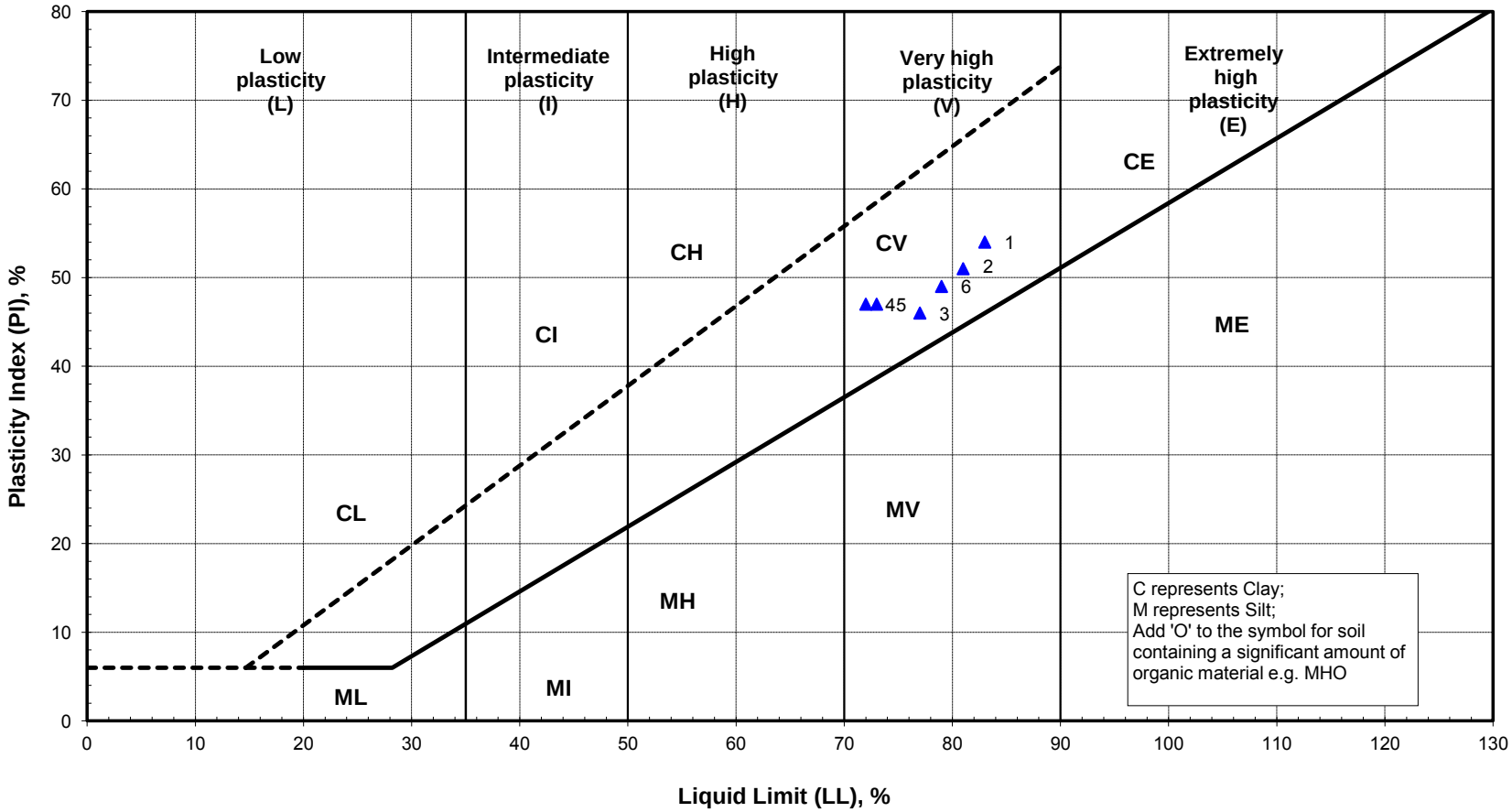
□un 13

Plasticity Chart for Atterberg Limit Tests

Project Name	*77 Lawn Road (London NW3)*			**Project Number**	*J12507*
Client Name	*Mr Enric Torner (Architect)*	**PE**	*DV*	**Date Issued**	*18-Jan-16*

Key

No.	TH No.	Depth
1	WS1	2.00
2	WS1	4.00
3	WS1	5.00
4	WS2	1.50
5	WS2	2.50
6	WS2	4.00



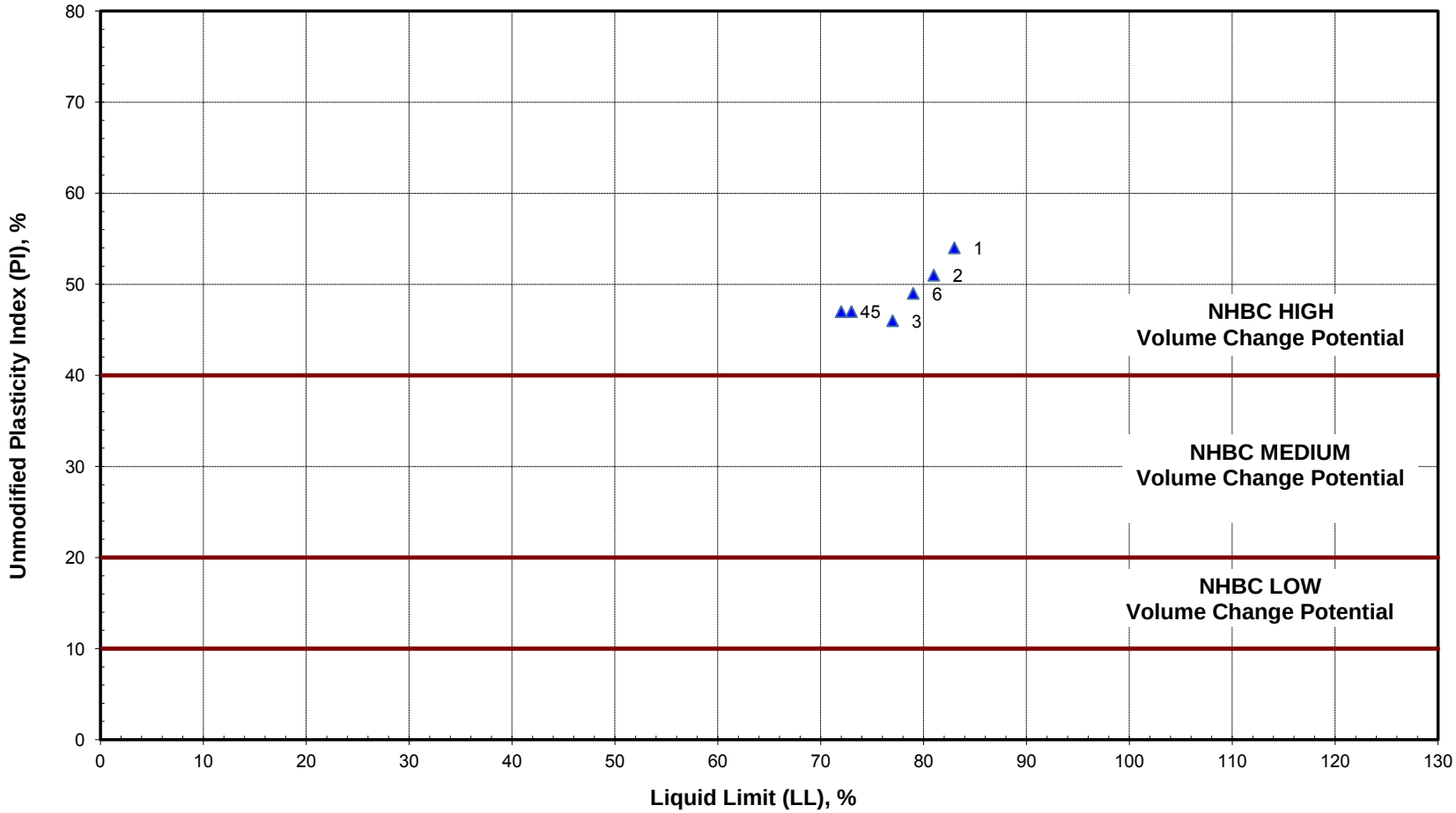
Liquid Limit		**Plastic Limit**		**Plasticity Index**	
Maximum Value	83	Maximum Value	31	Maximum Value	54
Minimum Value	72	Minimum Value	25	Minimum Value	46
Average Value	78	Average Value	29	Average Value	49

NHBC Classification for Volume Change Potential

Project Name	*77 Lawn Road (London NW3)*			**Project Number**	*J12507*
Client Name	*Mr Enric Torner (Architect)*	**PE**	*DV*	**Date Issued**	*18-Jan-16*

Key

No.	TH No.	Depth
1	WS1	2.00
2	WS1	4.00
3	WS1	5.00
4	WS2	1.50
5	WS2	2.50
6	WS2	4.00



Liquid Limit		**Plastic Limit**		**Unmodified Plasticity Index**	
Maximum Value	83	Maximum Value	31	Maximum Value	54
Minimum Value	72	Minimum Value	25	Minimum Value	46
Average Value	78	Average Value	29	Average Value	49

Southern Testing | ST Consult

CHEMICAL & ELECTROCHEMICAL TESTING SUMMARY

To BS1377-3:1990(2003) cl 5.6 & 9.5

AGS

Project Name	77 Lawn Road (London NW3)						Project Number		J12507	
Client	Mr Enric Torner (Architect)			PE	*DV*		Date Issued		*18-Jan-16*	
TH No.	Depth m	Sample Type	Visual Description	Comments	Passing 2mm %	pH Value	Soil Sulphate 2:1 Water Extract		Groundwater Sulphate	
							g/l SO_3	BRE mg/l SO_4	g/l SO_3	BRE mg/l SO_4
WS1	3.00	D	Very stiff light brown CLAY.		100.0	7.6	0.82	979		
WS2	2.00	D	Stiff light brown CLAY.		100.0	7.2	0.08	96		
WS2	3.50	D	Very stiff light brown CLAY.		100.0	7.5	0.35	422		

APPENDIX E

Photographs

TP1

TP2

TP3

TP4

APPENDIX F

Contamination Laboratory Test Results

Table 1 - Tier 1 Screening Values

Contaminant	Units	Proposed Land Use					
		Residential with homegrown produce consumption	Residential without homegrown produce consumption	Open Space* (Residential)	Open Space* (Park)	Allotments	Commercial / Industrial
Arsenic (As) [2]	mg/kg	37	40	79	170	43	640
Cadmium (Cd) [2]	mg/kg	11	85	120	555	1.9	190
Trivalent Chromium (CrIII) [2]	mg/kg	910	910	1,500	33,000	18,000	8600
Hexavalent Chromium (CrVI) [2]	mg/kg	6	6	7.7	220	1.8	33
Lead (Pb) [3]	mg/kg	200	310	630	1300	80	2330
Mercury (Hg) [1,2,7]	mg/kg	7.6-11	9.2-15	40	68-71	6.0	29-320
Selenium (Se) [2]	mg/kg	250	430	1,100	1,800	88	12,000
Nickel (Ni) [2,4]	mg/kg	180	180	230	3,400	230	980
Copper (Cu) [2,4]	mg/kg	2,400	7,100	12,000	44,000	520	68,000
Zinc (Zn) [2,4]	mg/kg	3,700	40,000	81,000	170,000	620	730,000
Phenol [1,2]	mg/kg	120-380	440-1200	440-1300	440-1300	23-83	440-1300
Benzo[a]pyrene [1,5]	mg/kg	1.7-2.4	2.6	4.9	10	0.67-2.7	36
Naphthalene [1,2]	mg/kg	2.3-13	2.3-13	77-430^{+}	77-430^{+}	4.1-24	77-430^{+}
Total Cyanide (CN) [6]	mg/kg	/	/	/	/	/	/
Free Cyanide [6]	mg/kg	/	/	/	/	/	/
Complex Cyanides [6]	mg/kg	/	/	/	/	/	/
Thiocyanate [6]	mg/kg	/	/	/	/	/	/

Notes:

***** Open Space levels calculated on the basis of the exposure modelling developed in the C4SL research.

+ Screening values constrained to saturation limit. Higher values may be acceptable on a site specific basis.

[1] Where ranges of values are given for organic contaminants the screening value is dependant on the Soil $^{+}$Organic Matter.

[2] LQM/CIEH S4UL (2014). Copyright Land Quality Management Ltd reproduced with permission; Publication Number S4UL 3116. All rights reserved.

[3] C4SL (DEFRA 2014).

[4] Copper, Zinc and Nickel may have phototoxic effects at the given concentrations. Alternative criteria should be adopted for importation of Topsoil or other soils for cultivation. BS3882:2007 and BS8601:2013 suggest values of 200 to 300mg/kg for Zn, 100 to 200mg/kg for Cu, and 60 to 110mg/kg for Ni, for topsoil and subsoil, depending on pH.

[5] Based on the Surrogate Marker approach and modelled using the modified exposure parameters of C4SL but retaining 'minimal risk' HCV.

[6] Screening criteria derived on a site specific basis if test results indicate.

[7] S4UL for Methyl Mercury, higher concentrations may be tolerable if inorganic mercury is the only species present. Lower concentrations apply for elemental Mercury.

These screening values are valid at the time of writing but may be subject to change and any such changes will have implications for the assessments based on them. Their validity should be confirmed at the time of site development.

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CM7 2RT
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Scientific Analysis Laboratories Ltd

Certificate of Analysis

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

Report Number: 538797-1

Date of Report: 20-Jan-2016

Customer: Southern Testing Laboratories
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

Customer Contact: Mr David Vooght

Customer Job Reference: J12507
Customer Purchase Order: J12507_1 David
Customer Site Reference: 77 Lawn Road (London NW3)
Date Job Received at SAL: 12-Jan-2016
Date Analysis Started: 13-Jan-2016
Date Analysis Completed: 20-Jan-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 :
Chelsea Entwistle
Project Management

Issued by :
Chelsea Entwistle
Project Management

SAL Reference: 538797
Project Site: 77 Lawn Road (London NW3)
Customer Reference: J12507

Soil Analysed as Soil
STL Key Contamintion Suite

				SAL Reference	**538797 001**	**538797 002**	**538797 003**	**538797 004**
				Customer Sample Reference	**TP4 @ 0.30m**	**WS1 @ 1.00m**	**WS1 @ 1.50m**	**WS2 @ 2.00m**
				Date Sampled	**06-JAN-2016**	**06-JAN-2016**	**06-JAN-2016**	**06-JAN-2016**
				Type	**Clay**	**Clay**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**				
Arsenic	T257	A40	2	mg/kg	**17**	**14**	**18**	**19**
Cadmium	T257	A40	0.1	mg/kg	**0.3**	**0.1**	<0.1	<0.1
Chromium	T257	A40	0.5	mg/kg	**24**	**27**	**53**	**49**
Copper	T257	A40	2	mg/kg	**57**	**34**	**28**	**26**
Lead	T257	A40	2	mg/kg	**460**	**160**	**21**	**17**
Mercury	T245	A40	1.0	mg/kg	**1.8**	<1.0	<1.0	<1.0
Nickel	T257	A40	0.5	mg/kg	**17**	**15**	**60**	**61**
Selenium	T257	A40	3	mg/kg	<3	<3	<3	<3
Zinc	T257	A40	2	mg/kg	**230**	**62**	**79**	**70**
Asbestos ID	T27	A40			Asbestos not detected	Asbestos not detected	Asbestos not detected	-
Chromium VI	T6	A40	1	mg/kg	<1	<1	<1	<1
Fraction Organic Carbon - F(oc)	T917	A40	0.001	%	**0.027**	**0.024**	**0.002**	**0.002**
pH	T7	A40			**8.0**	**7.0**	**7.7**	**7.8**
Soil Organic Matter	T287	A40	0.1	%	**4.7**	**4.1**	**0.3**	**0.3**
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	**0.05**	**0.02**	**0.59**	**0.02**
Sulphide	T4	A40	10	mg/kg	<10	<10	<10	<10
Cyanide(Total)	T921	AR	1	mg/kg	<1	<1	<1	<1
Phenols(Mono)	T921	AR	1	mg/kg	<1	<1	<1	<1
Moisture @105C	T162	AR	0.1	%	**24**	**17**	**23**	**26**
Retained on 2mm	T2	A40	0.1	%	<0.1	<0.1	<0.1	<0.1

SAL Reference: 538797
Project Site: 77 Lawn Road (London NW3)
Customer Reference: J12507

Soil Analysed as Soil
Total and Speciated USEPA16 PAH (SE) (MCERTS)

				SAL Reference	**538797 001**	**538797 002**	**538797 003**	**538797 004**
				Customer Sample Reference	**TP4 @ 0.30m**	**WS1 @ 1.00m**	**WS1 @ 1.50m**	**WS2 @ 2.00m**
				Date Sampled	**06-JAN-2016**	**06-JAN-2016**	**06-JAN-2016**	**06-JAN-2016**
				Type	**Clay**	**Clay**	**Clay**	**Clay**
Determinand	**Method**	**Test Sample**	**LOD**	**Units**				
Naphthalene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Acenaphthene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Fluorene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Phenanthrene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Fluoranthene	T16	AR	0.1	mg/kg	**0.3**	<0.1	<0.1	<0.1
Pyrene	T16	AR	0.1	mg/kg	**0.2**	<0.1	<0.1	<0.1
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Chrysene	T16	AR	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	**0.1**	<0.1	<0.1	<0.1
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1
PAH(total)	T16	AR	0.1	mg/kg	**0.8**	<0.1	<0.1	<0.1

Index to symbols used in 538797-1

Value	Description
AR	As Received
A40	Assisted dried < 40C
S	Analysis was subcontracted
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Asbestos subcontracted to REC Limited
Retained on 2mm is removed before analysis
Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis

Method Index

Value	Description
T27	PLM
T917	OX/IR (SE)
T4	Colorimetry
T921	Colorimetry (CF) (MCERT)
T2	Grav
T16	GC/MS
T162	Grav (1 Dec) (105 C)
T242	2:1 Extraction/ICP/OES (TRL 447 T1)
T7	Probe
T257	ICP/OES (SIM) (Aqua Regia Extraction)
T287	Calc TOC/0.58
T6	ICP/OES
T245	ICP/OES(Aqua Regia Extraction)

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Arsenic	T257	A40	2	mg/kg	M	001-004
Cadmium	T257	A40	0.1	mg/kg	M	001-004
Chromium	T257	A40	0.5	mg/kg	M	001-004
Copper	T257	A40	2	mg/kg	M	001-004
Lead	T257	A40	2	mg/kg	M	001-004
Mercury	T245	A40	1.0	mg/kg	U	001-004
Nickel	T257	A40	0.5	mg/kg	M	001-004
Selenium	T257	A40	3	mg/kg	U	001-004
Zinc	T257	A40	2	mg/kg	M	001-004
Asbestos ID	T27	A40			SU	001-003
Chromium VI	T6	A40	1	mg/kg	N	001-004
Fraction Organic Carbon - F(oc)	T917	A40	0.001	%	N	001-004
pH	T7	A40			M	001-004
Soil Organic Matter	T287	A40	0.1	%	N	001-004
(Water Soluble) SO4-- expressed as SO4	T242	A40	0.01	g/l	M	001-004
Sulphide	T4	A40	10	mg/kg	N	001-004
Cyanide(Total)	T921	AR	1	mg/kg	M	001-004
Phenols(Mono)	T921	AR	1	mg/kg	M	001-004
Moisture @105C	T162	AR	0.1	%	N	001-004
Retained on 2mm	T2	A40	0.1	%	N	001-004
Naphthalene	T16	AR	0.1	mg/kg	U	001-004
Acenaphthylene	T16	AR	0.1	mg/kg	U	001-004
Acenaphthene	T16	AR	0.1	mg/kg	M	001-004
Fluorene	T16	AR	0.1	mg/kg	M	001-004
Phenanthrene	T16	AR	0.1	mg/kg	U	001-004
Anthracene	T16	AR	0.1	mg/kg	M	001-004
Fluoranthene	T16	AR	0.1	mg/kg	N	001-004
Pyrene	T16	AR	0.1	mg/kg	N	001-004
Benzo(a)Anthracene	T16	AR	0.1	mg/kg	M	001-004
Chrysene	T16	AR	0.1	mg/kg	M	001-004
Benzo(b)fluoranthene	T16	AR	0.1	mg/kg	U	001-004
Benzo(k)fluoranthene	T16	AR	0.1	mg/kg	N	001-004
Benzo(a)Pyrene	T16	AR	0.1	mg/kg	M	001-004
Indeno(123-cd)Pyrene	T16	AR	0.1	mg/kg	M	001-004

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Dibenzo(ah)Anthracene	T16	AR	0.1	mg/kg	M	001-004
Benzo(ghi)Perylene	T16	AR	0.1	mg/kg	M	001-004
PAH(total)	T16	AR	0.1	mg/kg	U	001-004

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Scientific Analysis Laboratories Ltd

Certificate of Analysis

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Fax : 01376 552923

Report Number: 538797-1 A

Date of Report: 20-Jan-2016

Customer: Southern Testing Laboratories
Keeble House
Stuart Way
East Grinstead
West Sussex
RH19 4QA

Customer Contact: Mr David Vooght

Customer Job Reference: J12507
Customer Purchase Order: J12507_1 David
Customer Site Reference: 77 Lawn Road (London NW3)
Date Job Received at SAL: 12-Jan-2016
Date Analysis Started: 13-Jan-2016
Date Analysis Completed: 20-Jan-2016

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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

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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

Report checked
and authorised by :
Chelsea Entwistle
Project Management

Issued by :
Chelsea Entwistle
Project Management

Waste Acceptance Criteria

Customer Sample Reference : WS1 @ 1.50m
SAL Sample Reference : 538797 003
Project Site : 77 Lawn Road (London NW3)
Customer Reference : J12507
Test Portion Mass (g) : 87.5
Date Sampled : 06-JAN-2016
Type : Clay

Soil Summary					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
pH	Probe			M	7.7		>6.0	
Loss on Ignition @450C	Ign 450C/Grav	0.1	%	M	5.4			10.0
Total Organic Carbon	OX/IR	0.1	%	N	0.2	3.0	5.0	6.0
Acid Neutralising Capacity (pH 7)	Titration	2.0	Mol/kg	N	<2.0			
Moisture @105C	Grav (1 Dec) (105 C)	0.1	%	N	23			
Retained on 2mm	Grav	0.1	%	N	<0.1			
BTEX (Sum)	Calc	0.040	mg/kg	U	<0.040	6.0		
Coronene	GC/MS (MCERTS)	0.1	mg/kg	N	<0.1			
PAH (Sum)	Calc	1.6	mg/kg	N	<1.6	100.0		
PCB EC7 (Sum)	Calc	0.00035	mg/kg	U	<0.14	1.0		
TPH (C10-C40)	GC/FID (SE)	10	mg/kg	M	<10	500.0		

10:1 Leachate					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
Antimony (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.06	0.7	5.0
Arsenic (Dissolved)	Calc / ICP/MS (Filtered)	0.0020	mg/kg	N	0.0025	0.5	2.0	25.0
Barium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.086	20.0	100.0	300.0
Cadmium (Dissolved)	Calc / ICP/MS (Filtered)	0.00020	mg/kg	N	<0.00020	0.04	1.0	5.0
Chloride	Calc / Discrete Analyser	10	mg/kg	N	13	800.0	15000.0	25000.0
Chromium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	70.0
Copper (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.016	2.0	50.0	100.0
Dissolved Organic Carbon	Calc / OX/IR	10	mg/kg	N	30	500.0	800.0	1000.0
Fluoride	Calc / Discrete Analyser	0.50	mg/kg	N	11	**10.0**	150.0	500.0
Lead (Dissolved)	Calc / ICP/MS (Filtered)	0.0030	mg/kg	N	<0.0030	0.5	10.0	50.0
Mercury (Dissolved)	Calc / ICP/MS (Filtered)	0.00050	mg/kg	N	<0.00050	0.01	0.2	2.0
Molybdenum (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	30.0
Nickel (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.014	0.4	10.0	40.0
Phenols(Mono)	Calc / Colorimetry (CF)	0.20	mg/kg	N	<0.20	1.0		
Selenium (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.0056	0.1	0.5	7.0
SO4--	Calc / Discrete Analyser	5.0	mg/kg	N	930	1000.0	20000.0	50000.0
Total Dissolved Solids	Calc	100	mg/kg	N	1900	4000.0	60000.0	100000.0
Zinc (Dissolved)	Calc / ICP/MS (Filtered)	0.020	mg/kg	N	0.023	4.0	50.0	200.0

From: EC Directive 99/31/EC and Landfill Regulations 2002 (as ammended)

Note:- Sample failed to produce sufficient eluate within the specified time after vacuum filtration for 1 hour and centrifugation for 30 minutes. Therefore, the exact application of the two-step leaching test is precluded on technical grounds. (ref: Section 5.2.4 BS EN 12457-3:2002) Results are derived from a single step leaching at L/S 10/1 as prescribed by the EA guidance. (Ref Section C4.1.1 Guidance on Sampling and Testing of Wastes to meet Landfill Waste Acceptance Procedures Version 1 April 2005, Environment Agency)

Notes:- Cumulative release at L/S=10 (mg/kg of dry matter) in accordance with BS EN 12457. Soil leaching procedure is not covered by our UKAS accreditation

Waste Acceptance Criteria

Customer Sample Reference : WS2 @ 2.00m
SAL Sample Reference : 538797 004
Project Site : 77 Lawn Road (London NW3)
Customer Reference : J12507
Date Sampled : 06-JAN-2016
Test Portion Mass (g) : 87.5
Type : Clay

Soil Summary					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
pH	Probe			M	7.8		>6.0	
Loss on Ignition @450C	Ign 450C/Grav	0.1	%	M	5.1			10.0
Total Organic Carbon	OX/IR	0.1	%	N	0.2	3.0	5.0	6.0
Acid Neutralising Capacity (pH 7)	Titration	2.0	Mol/kg	N	<2.0			
Moisture @105C	Grav (1 Dec) (105 C)	0.1	%	N	26			
Retained on 2mm	Grav	0.1	%	N	<0.1			
BTEX (Sum)	Calc	0.040	mg/kg	U	<0.040	6.0		
Coronene	GC/MS (MCERTS)	0.1	mg/kg	N	<0.1			
PAH (Sum)	Calc	1.6	mg/kg	N	<1.6	100.0		
PCB EC7 (Sum)	Calc	0.00035	mg/kg	U	<0.14	1.0		
TPH (C10-C40)	GC/FID (SE)	10	mg/kg	M	<10	500.0		

10:1 Leachate					Result	Inert Waste Landfill	Stable non reactive	Hazardous Waste Landfill
Determinand	**Technique**	**LOD**	**Units**	**Symbol**				
Antimony (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.06	0.7	5.0
Arsenic (Dissolved)	Calc / ICP/MS (Filtered)	0.0020	mg/kg	N	0.0050	0.5	2.0	25.0
Barium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.067	20.0	100.0	300.0
Cadmium (Dissolved)	Calc / ICP/MS (Filtered)	0.00020	mg/kg	N	<0.00020	0.04	1.0	5.0
Chloride	Calc / Discrete Analyser	10	mg/kg	N	17	800.0	15000.0	25000.0
Chromium (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	70.0
Copper (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	0.015	2.0	50.0	100.0
Dissolved Organic Carbon	Calc / OX/IR	10	mg/kg	N	70	500.0	800.0	1000.0
Fluoride	Calc / Discrete Analyser	0.50	mg/kg	N	9.3	10.0	150.0	500.0
Lead (Dissolved)	Calc / ICP/MS (Filtered)	0.0030	mg/kg	N	<0.0030	0.5	10.0	50.0
Mercury (Dissolved)	Calc / ICP/MS (Filtered)	0.00050	mg/kg	N	<0.00050	0.01	0.2	2.0
Molybdenum (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	<0.010	0.5	10.0	30.0
Nickel (Dissolved)	Calc / ICP/MS (Filtered)	0.010	mg/kg	N	0.015	0.4	10.0	40.0
Phenols(Mono)	Calc / Colorimetry (CF)	0.20	mg/kg	N	<0.20	1.0		
Selenium (Dissolved)	Calc / ICP/MS (Filtered)	0.0050	mg/kg	N	<0.0050	0.1	0.5	7.0
SO4--	Calc / Discrete Analyser	5.0	mg/kg	N	27	1000.0	20000.0	50000.0
Total Dissolved Solids	Calc	100	mg/kg	N	400	4000.0	60000.0	100000.0
Zinc (Dissolved)	Calc / ICP/MS (Filtered)	0.020	mg/kg	N	0.036	4.0	50.0	200.0

From: EC Directive 99/31/EC and Landfill Regulations 2002 (as ammended)

Note:- Sample failed to produce sufficient eluate within the specified time after vacuum filtration for 1 hour and centrifugation for 30 minutes. Therefore, the exact application of the two-step leaching test is precluded on technical grounds. (ref: Section 5.2.4 BS EN 12457-3:2002) Results are derived from a single step leaching at L/S 10/1 as prescribed by the EA guidance. (Ref Section C4.1.1 Guidance on Sampling and Testing of Wastes to meet Landfill Waste Acceptance Procedures Version 1 April 2005, Environment Agency)

Notes:- Cumulative release at L/S=10 (mg/kg of dry matter) in accordance with BS EN 12457. Soil leaching procedure is not covered by our UKAS accreditation

SAL Reference: 538797
Project Site: 77 Lawn Road (London NW3)
Customer Reference: J12507

Soil Analysed as Soil
Total and Speciated USEPA16 PAH (SE) (MCERTS)

				SAL Reference	**538797 003**	**538797 004**
				Customer Sample Reference	**WS1 @ 1.50m**	**WS2 @ 2.00m**
				Test Sample	**AR**	**AR**
				Date Sampled	**06-JAN-2016**	**06-JAN-2016**
				Type	**Clay**	**Clay**
Determinand	**Method**	**LOD**	**Units**	**Symbol**		
Naphthalene	GC/MS	0.1	mg/kg	U	<0.1	<0.1
Acenaphthylene	GC/MS	0.1	mg/kg	U	<0.1	<0.1
Acenaphthene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Fluorene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Phenanthrene	GC/MS	0.1	mg/kg	U	<0.1	<0.1
Anthracene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Fluoranthene	GC/MS	0.1	mg/kg	N	<0.1	<0.1
Pyrene	GC/MS	0.1	mg/kg	N	<0.1	<0.1
Benzo(a)Anthracene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Chrysene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Benzo(b)fluoranthene	GC/MS	0.1	mg/kg	U	<0.1	<0.1
Benzo(k)fluoranthene	GC/MS	0.1	mg/kg	N	<0.1	<0.1
Benzo(a)Pyrene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Indeno(123-cd)Pyrene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Dibenzo(ah)Anthracene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Benzo(ghi)Perylene	GC/MS	0.1	mg/kg	M	<0.1	<0.1
Polyaromatic Hydrocarbons (Total)	GC/MS	0.1	mg/kg	U	<0.1	<0.1

SAL Reference: 538797
Project Site: 77 Lawn Road (London NW3)
Customer Reference: J12507

Soil Analysed as Soil
BTEX

				SAL Reference	**538797 003**	**538797 004**
				Customer Sample Reference	**WS1 @ 1.50m**	**WS2 @ 2.00m**
				Test Sample	**AR**	**AR**
				Date Sampled	**06-JAN-2016**	**06-JAN-2016**
				Type	**Clay**	**Clay**
Determinand	**Method**	**LOD**	**Units**	**Symbol**		
Benzene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	<10
EthylBenzene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	<10
Meta/Para-Xylene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	<10
Ortho-Xylene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	<10
Toluene	GC/MS(Head Space)(MCERTS)	10	µg/kg	M	<10	<10

SAL Reference: 538797
Project Site: 77 Lawn Road (London NW3)
Customer Reference: J12507

Soil Analysed as Soil
PCBs EC7 (SE)

				SAL Reference	**538797 003**	**538797 004**
				Customer Sample Reference	**WS1 @ 1.50m**	**WS2 @ 2.00m**
				Test Sample	**AR**	**AR**
				Date Sampled	**06-JAN-2016**	**06-JAN-2016**
				Type	**Clay**	**Clay**
Determinand	**Method**	**LOD**	**Units**	**Symbol**		
Polychlorinated biphenyl BZ#101	GC/MS	20	µg/kg	M	<20	<20
Polychlorinated biphenyl BZ#118	GC/MS	20	µg/kg	M	<20	<20
Polychlorinated biphenyl BZ#138	GC/MS	20	µg/kg	M	<20	<20
Polychlorinated biphenyl BZ#153	GC/MS	20	µg/kg	M	<20	<20
Polychlorinated biphenyl BZ#180	GC/MS	20	µg/kg	M	<20	<20
Polychlorinated biphenyl BZ#28	GC/MS	20	µg/kg	M	<20	<20
Polychlorinated biphenyl BZ#52	GC/MS	20	µg/kg	M	<20	<20

Index to symbols used in 538797-1 A

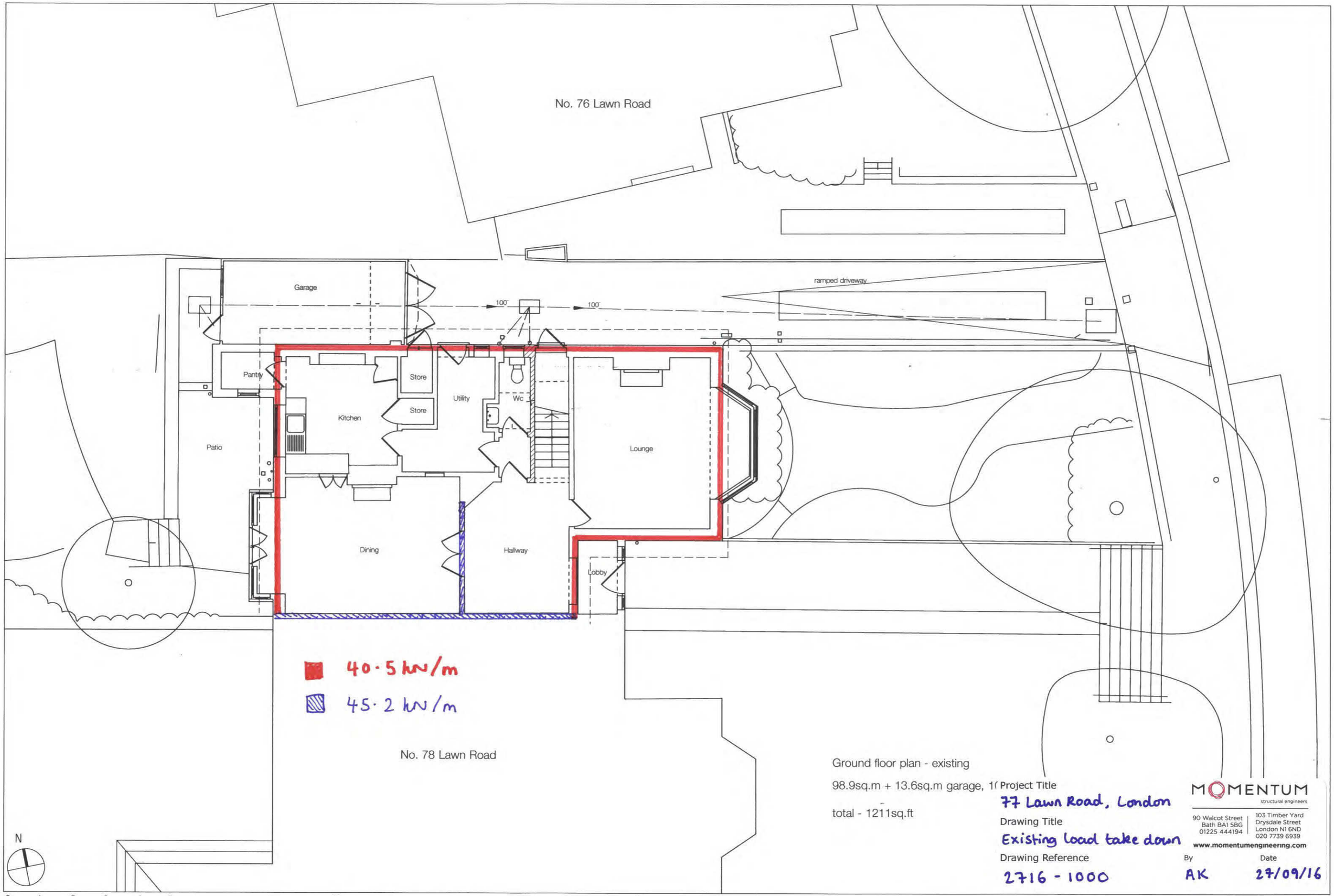
Value	Description
8:1	Leachate to BS EN 12457-3 (8:1)
A40	Assisted dried < 40C
2:1	Leachate to BS EN 12457-3 (2:1)
AR	As Received
M	Analysis is MCERTS accredited
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Notes

Retained on 2mm is removed before analysis
pH, LOI & TOC were performed on assisted dried samples (<40 degree centigrade). All other results relate to samples as received.
Reported results on as received samples are corrected to a 105 degree centigrade dry weight basis except ANC

APPENDIX G

Ground Movement Analysis Figures and Plots



Ground floor plan - existing

98.9sq.m + 13.6sq.m garage, 1(Project Title

total - 1211sq.ft

77 Lawn Road, London

Drawing Title

Existing load take down

Drawing Reference

2716 - 1000

By AK

Date 27/09/16

MOMENTUM
structural engineers
90 Walcot Street
Bath BA1 5BG
01225 444194
103 Timber Yard
Drysdale Street
London N1 6ND
020 7739 6939
www.momentumengineering.com

Ground floor - as existing, 77 Lawn Road, London NW3, A3 - 1:100, July 2015

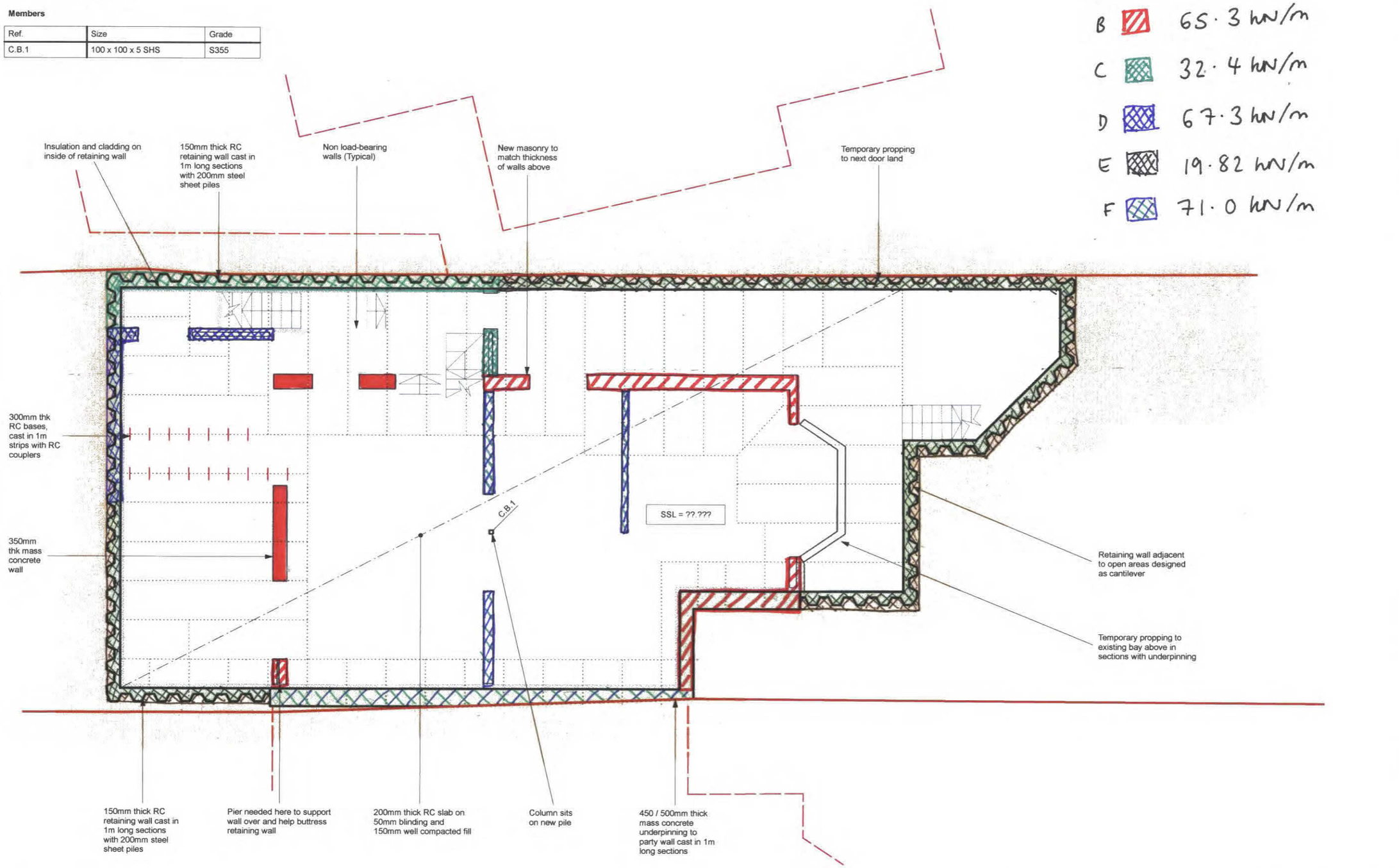
FIGURE 1

A3

Column Schedule

Members

Ref.	Size	Grade
C.B.1	100 x 100 x 5 SHS	S355



A 73·4 kN/m

B 65·3 kN/m

C 32·4 kN/m

D 67·3 kN/m

E 19·82 kN/m

F 71·0 kN/m

GA Plan . Basement Level
1:100

PROPOSED

Project Title
77 Lawn Road , London

Drawing Title
Proposed Load take down

Drawing Reference
2716 - 1001

By AK

Date 27/09/16

NOT FOR CONSTRUCTION

Revision	Date of Issue	By
00	15.03.16	JDP

Issue History

Work Stage - ACE / (RIBA)
Outline Proposals

Issue Status
Preliminary

Project Title
77 Lawn Road
London

Client
Xavier Menguy

Architect
Torner Architects

Drawing Title
GA Plan
Basement Level

Scale	Drawn	Checked
1 : 100	RB	RH

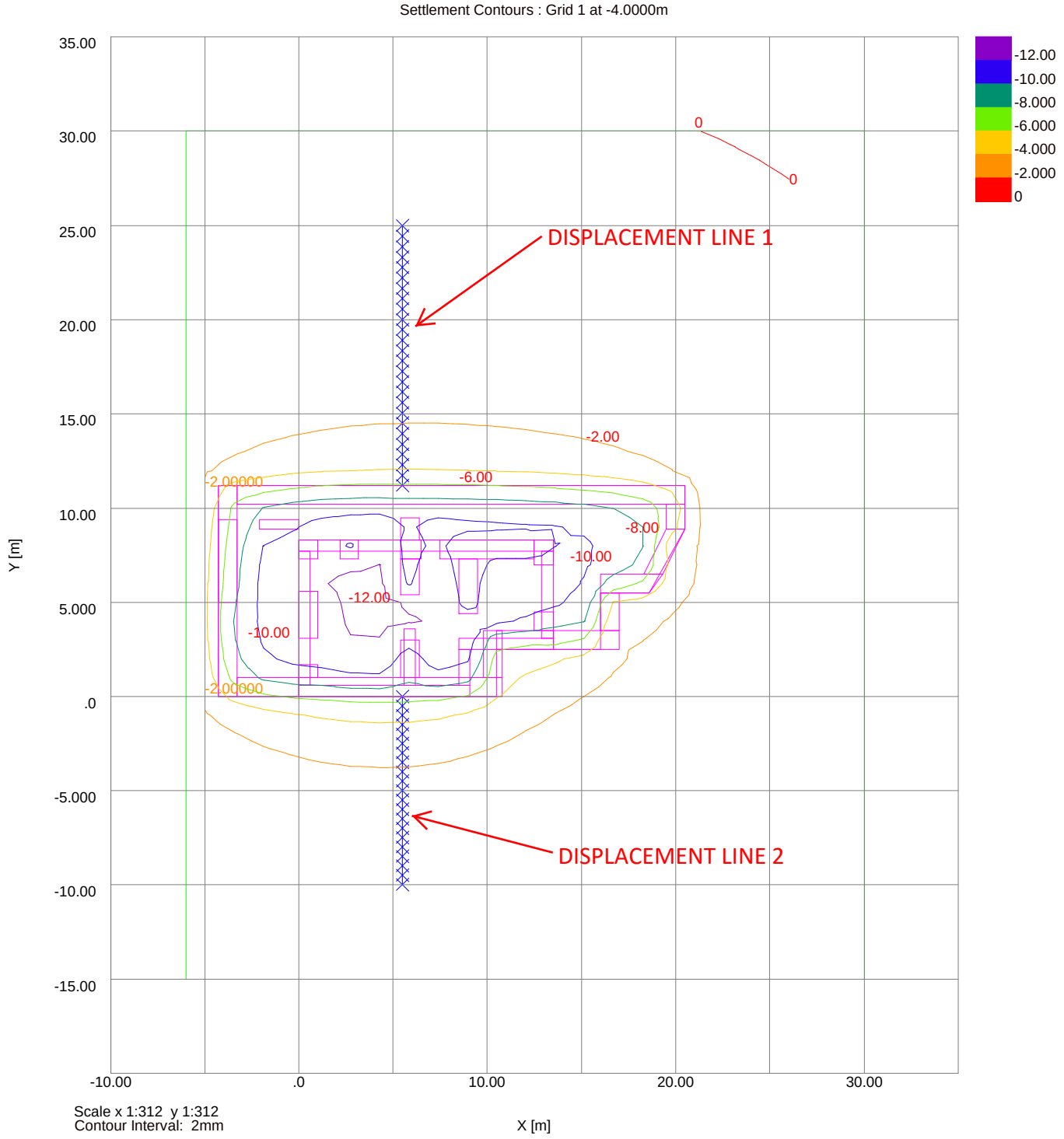
MOMENTUM structural engineers

90 Walcot Street Bath BA1 5BG 01225 444194 | 103 Timber Yard Drysdale Street London N1 6ND 020 7739 6939

www.momentumengineering.com

Drawing Reference
2716 200 00

FIGURE 2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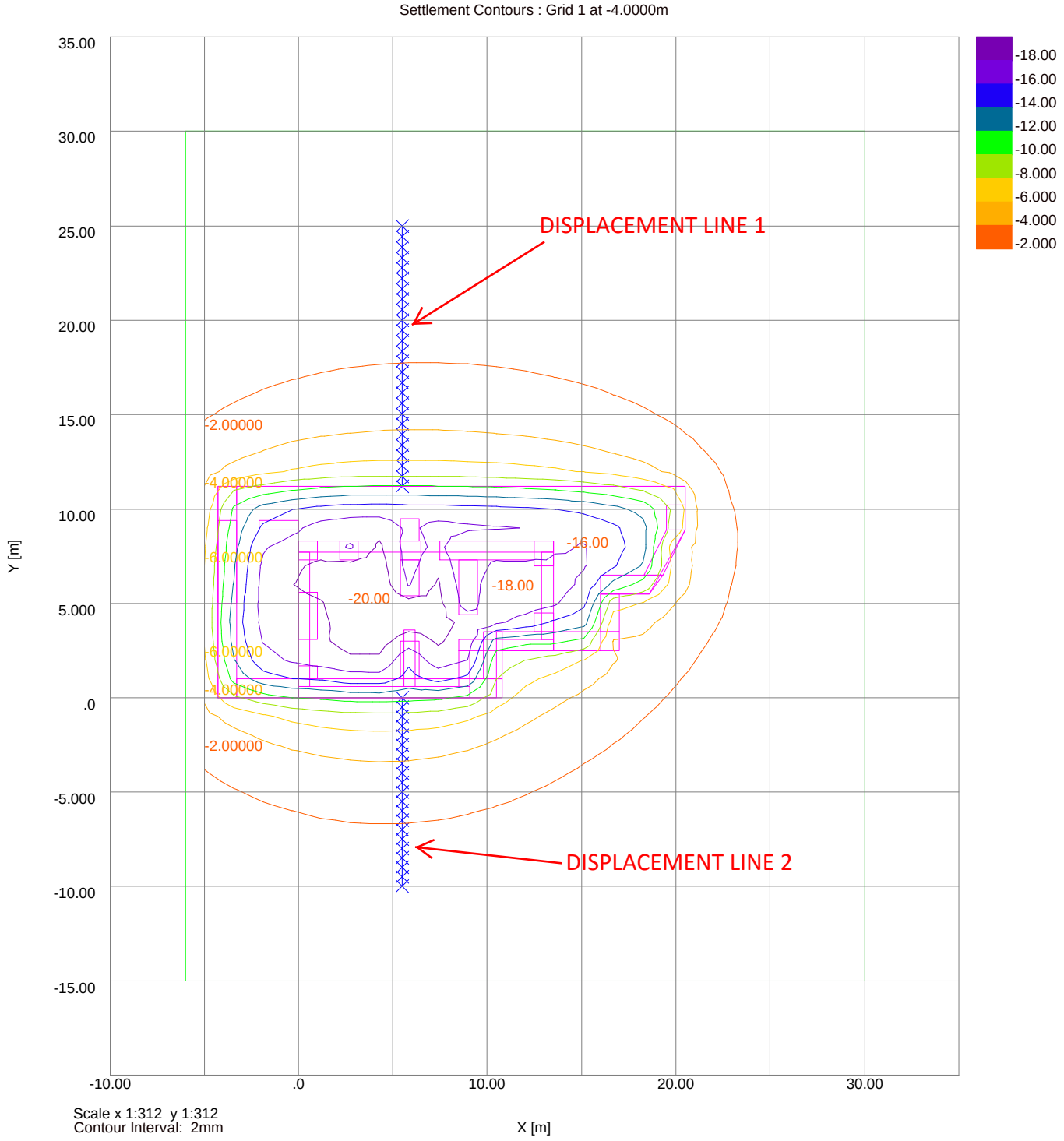
-12.00
-10.00
-8.000
-6.000
-4.000
-2.000
0
DISPLACEMENT LINE 1
DISPLACEMENT LINE 2
-2.00
-6.00
-8.00
-10.00
-12.00
-2.00000
Y [m]
X [m]
35.00
30.00
25.00
20.00
15.00
10.00
5.000
.0
-5.000
-10.00
-15.00
-10.00
.0
10.00
20.00
30.00
Scale x 1:312 y 1:312
Contour Interval: 2mm


Settlement Contours : Grid 1 at -4.0000m
DISPLACEMENT LINE 1
DISPLACEMENT LINE 2
-2.00000
-4.00000
-6.00000
-16.00
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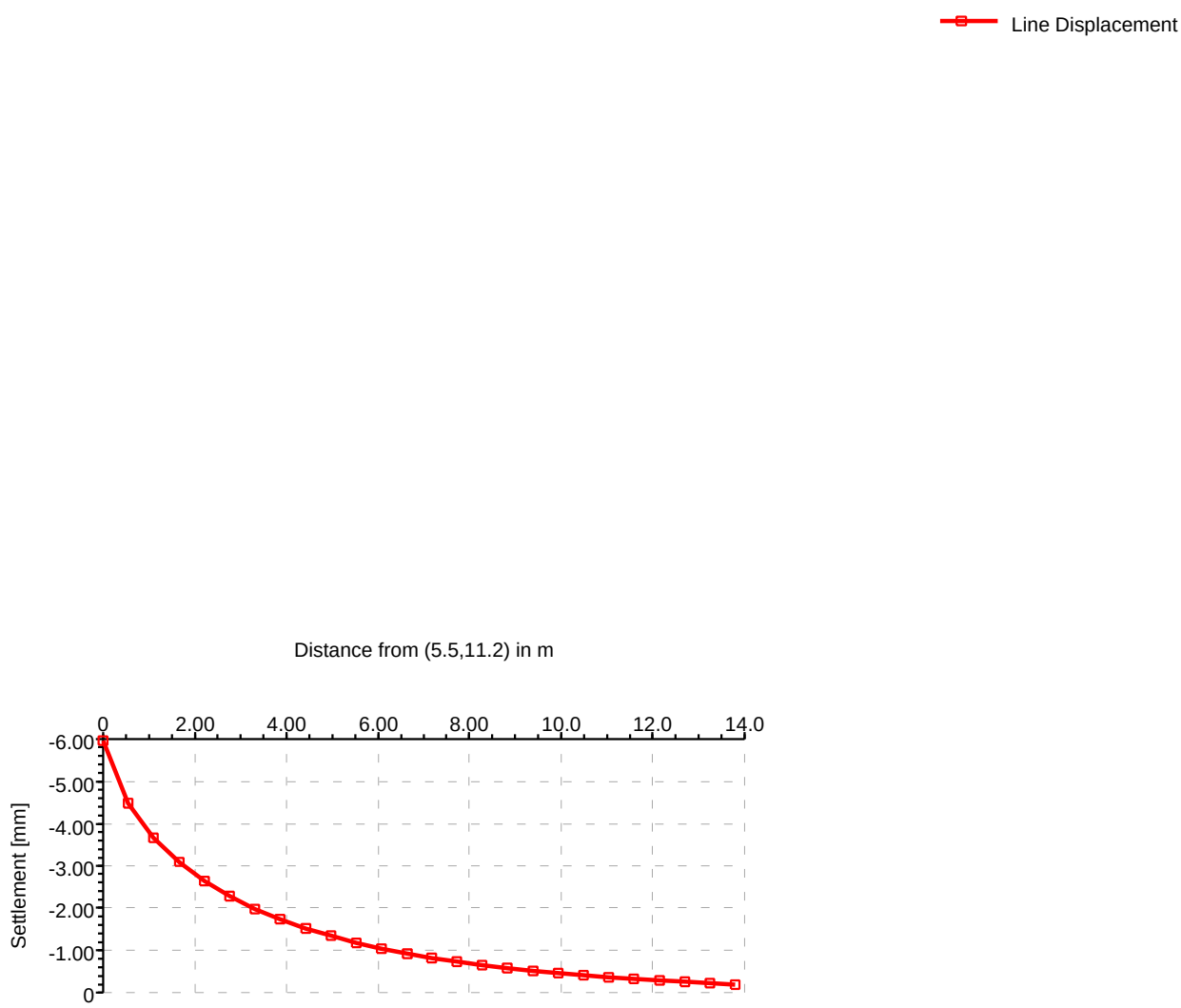
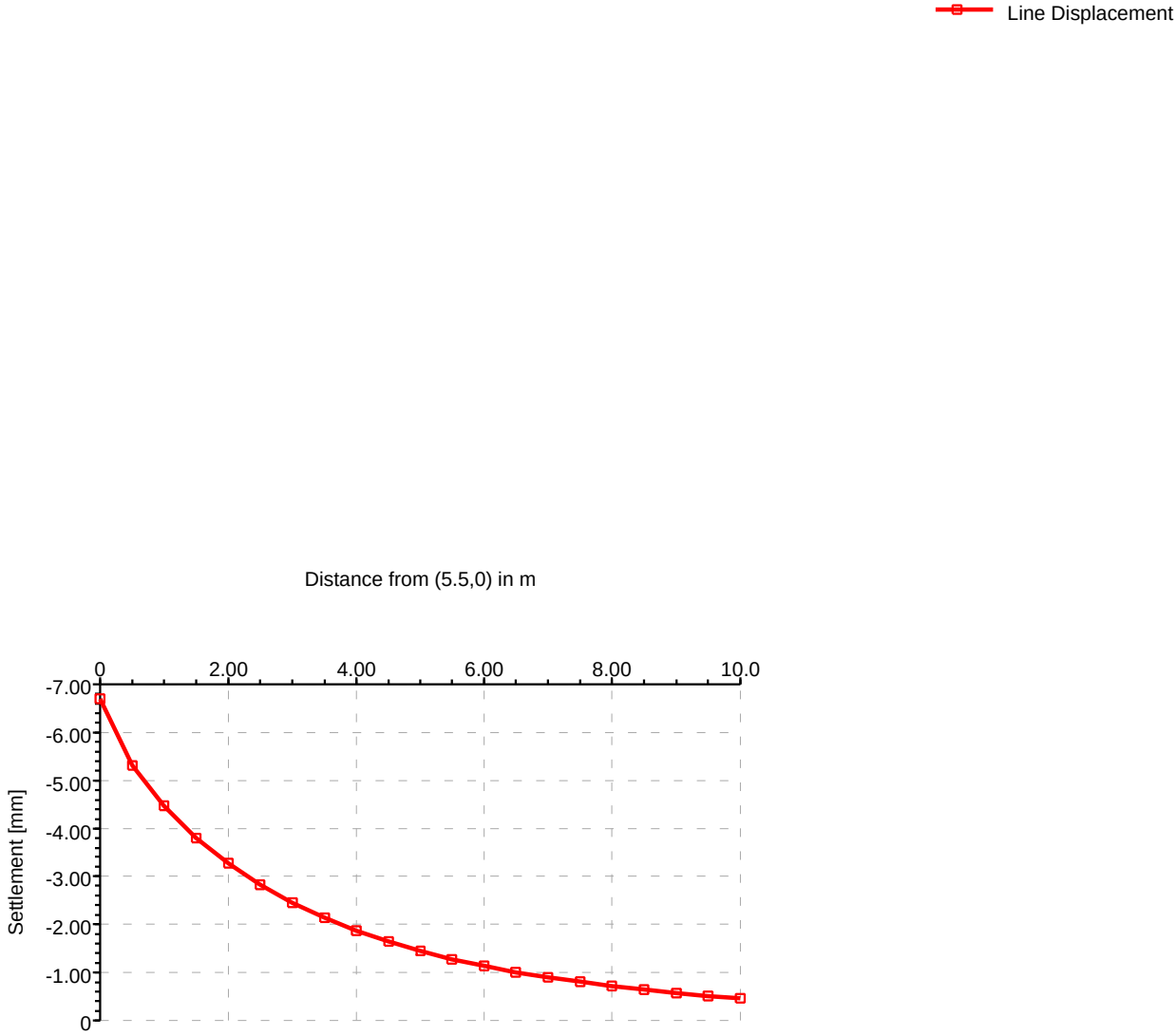
-20.00
-18.00
-16.00
-14.00
-12.00
-10.00
-8.000
-6.000
-4.000
-2.000
35.00
30.00
25.00
20.00
15.00
10.00
5.000
.0
-5.000
-10.00
-15.00
Y [m]
-10.00
.0
10.00
20.00
30.00
X [m]
Scale x 1:312 y 1:312
Contour Interval: 2mm

Displacement for Line 1



Displacement for Line 2



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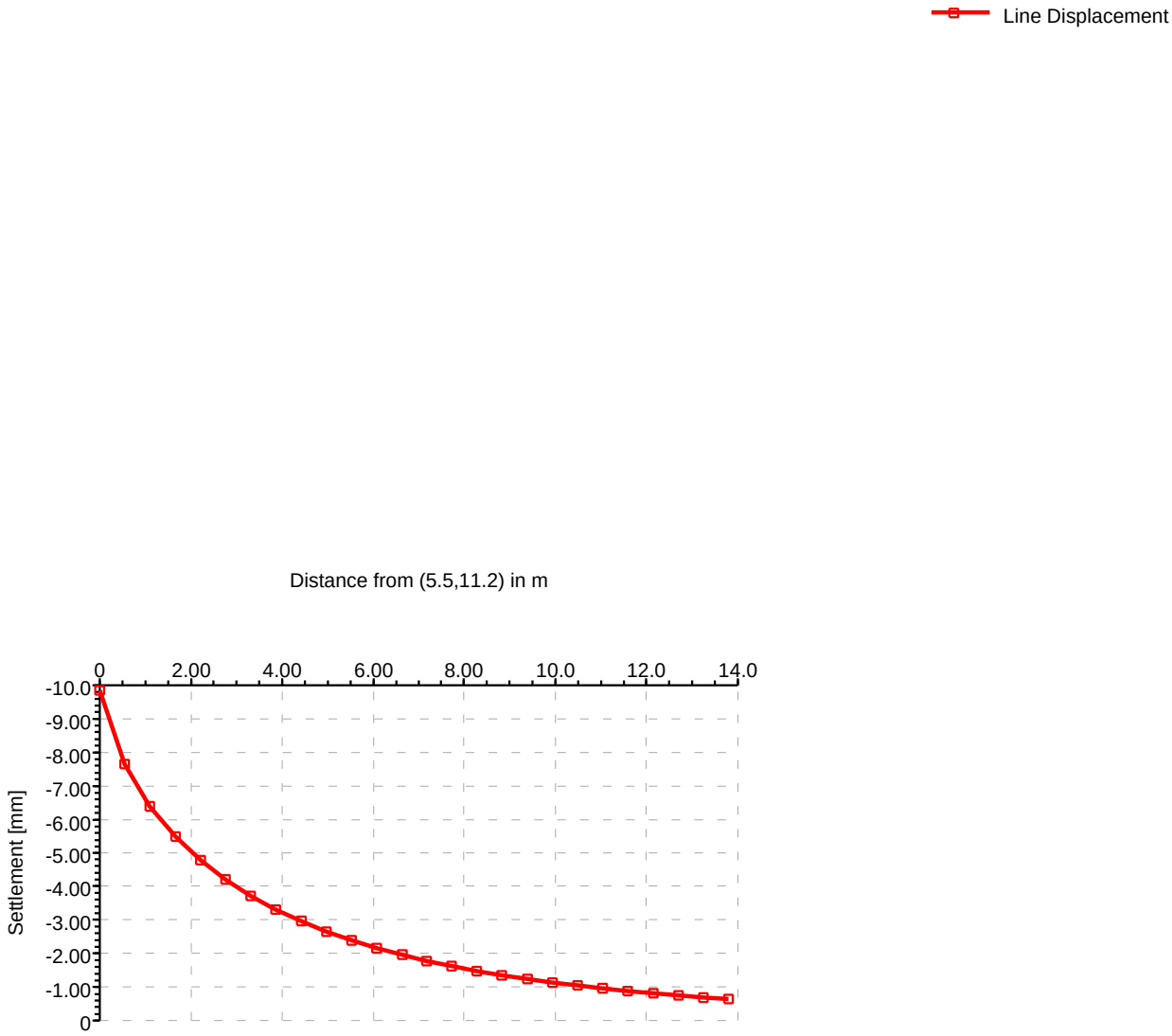

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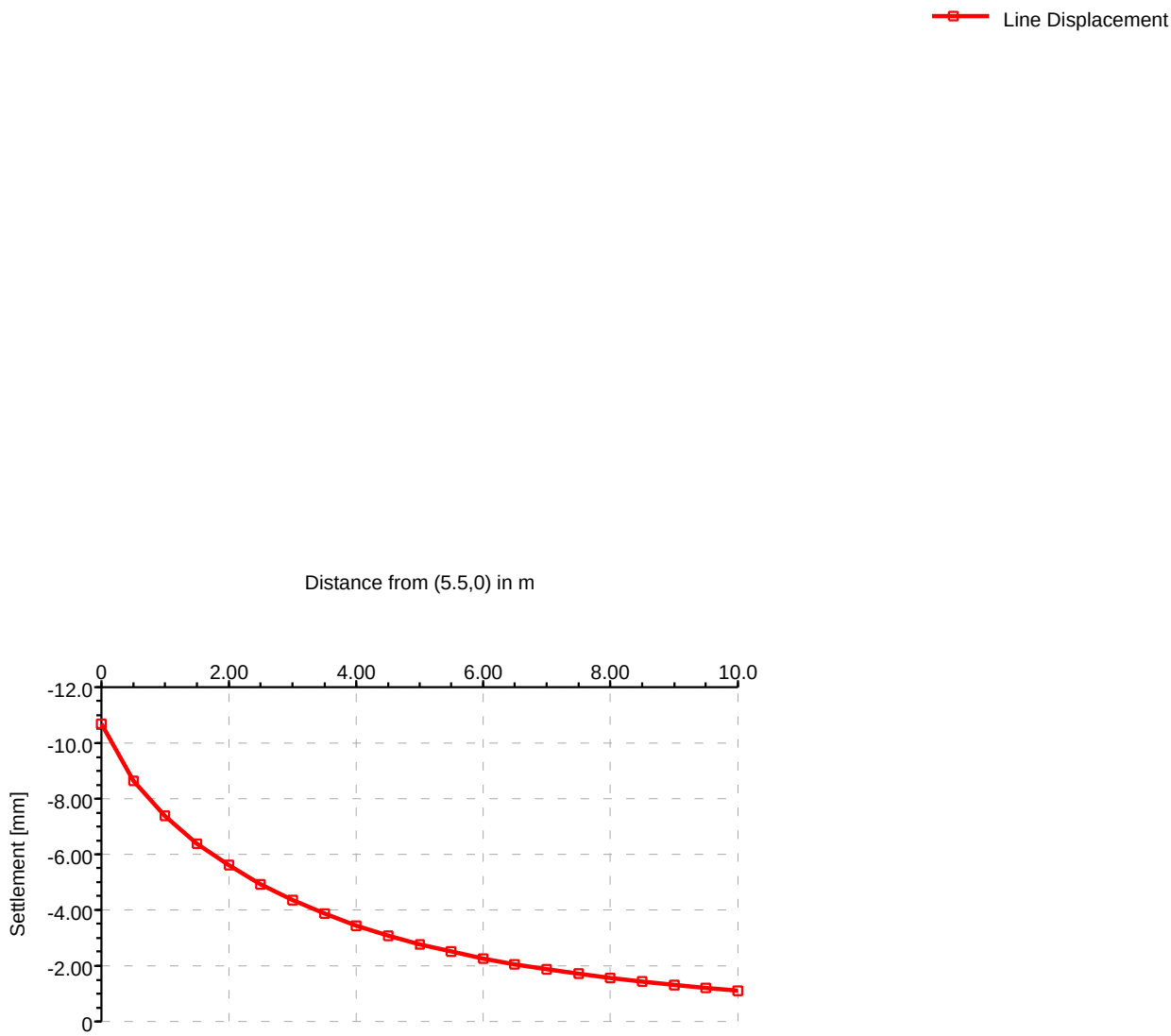
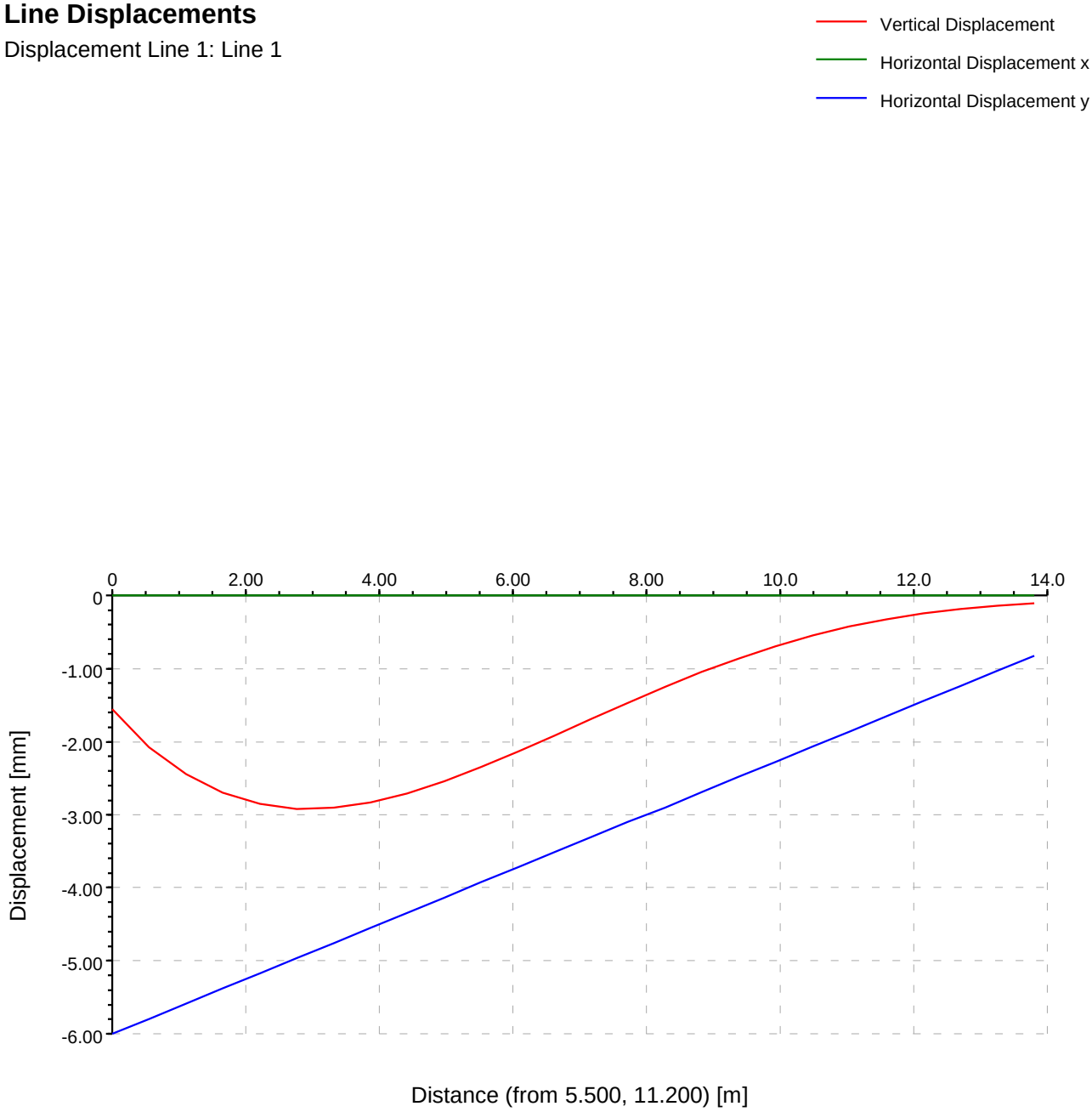


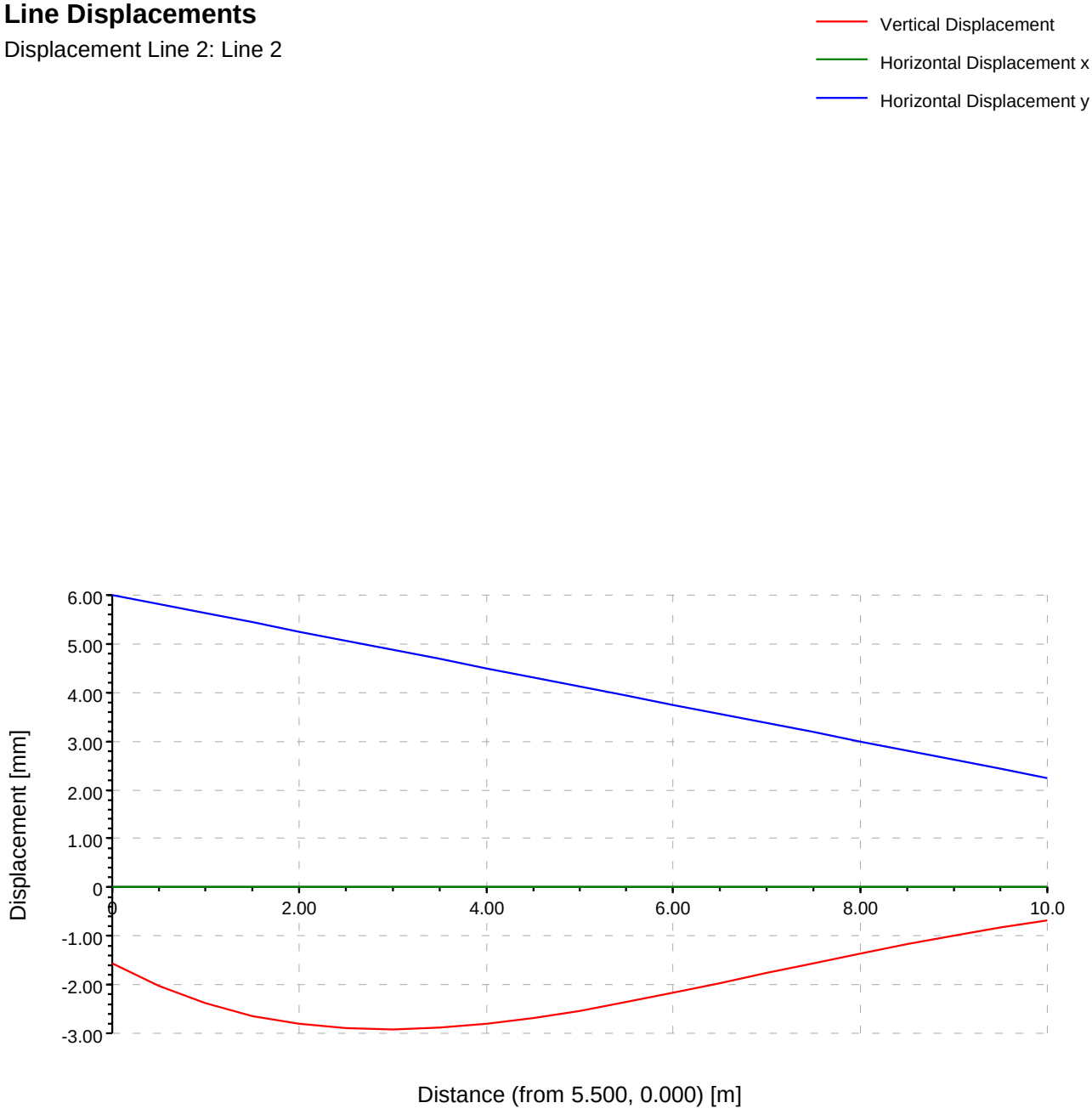
Line Displacements

Displacement Line 1: Line 1



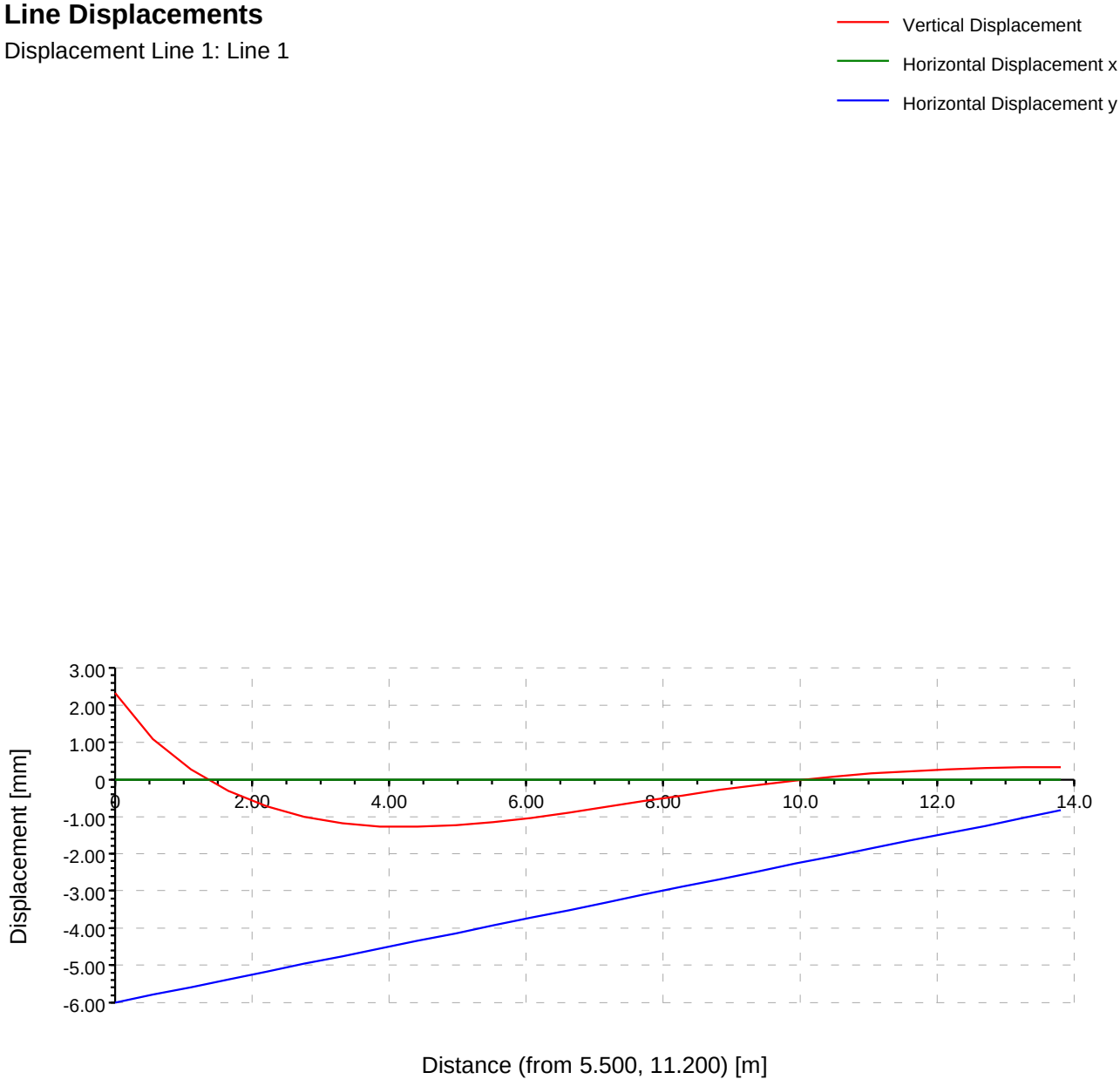
Line Displacements

Displacement Line 2: Line 2



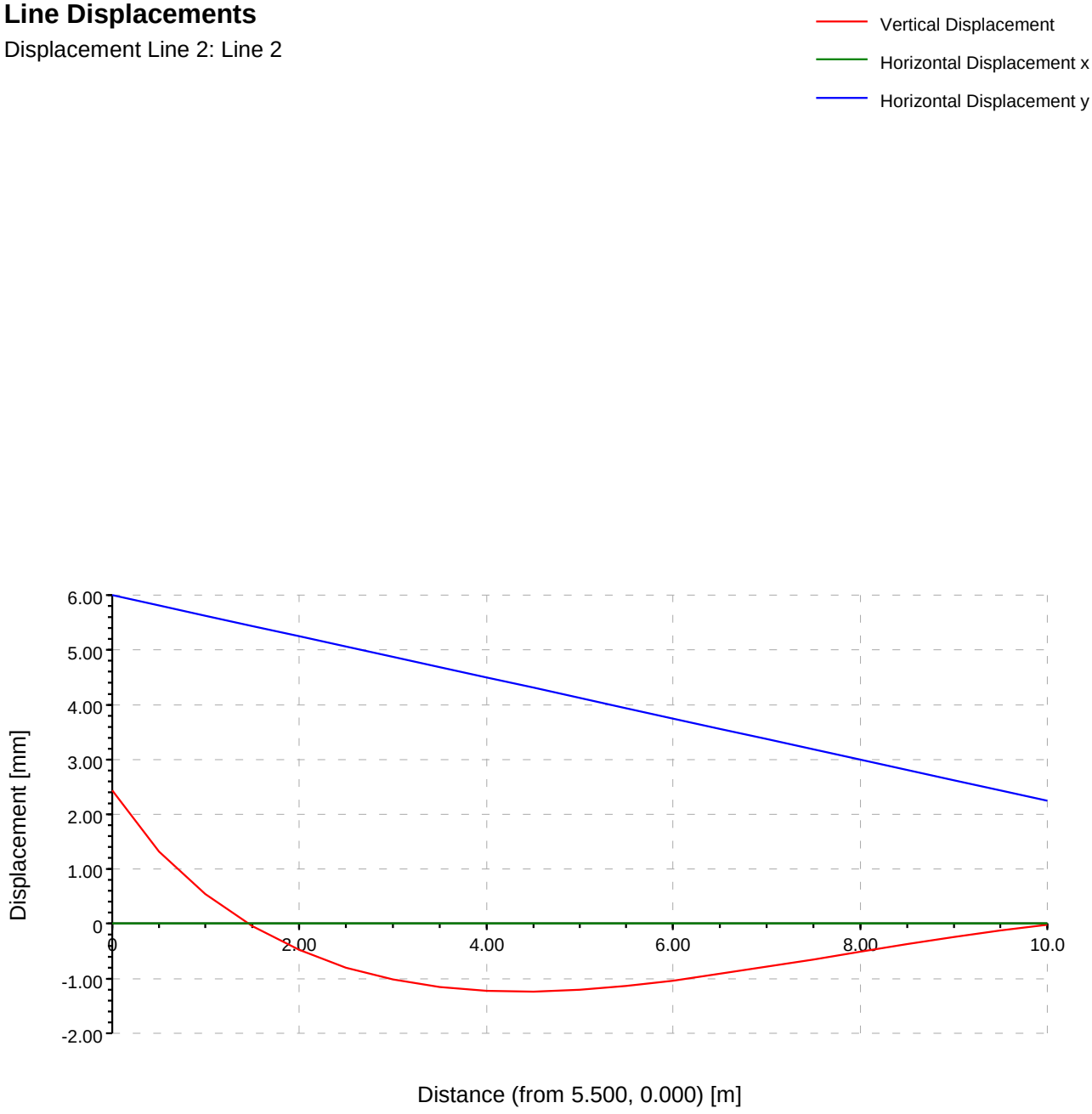
Line Displacements

Displacement Line 1: Line 1



Line Displacements

Displacement Line 2: Line 2



Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Specific Building Damage Results - Horizontal Displacements

Structure: No 76 | Sub-structure: Sub 1

Dist.	Coordinates x	y	z	Displacements x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	5.50000	11.20000	0.00000	0.0	-6.0000	-6.0000	0.0
0.55200	5.50000	11.75200	0.00000	0.0	-5.7930	-5.7930	0.0
1.1040	5.50000	12.30400	0.00000	0.0	-5.5860	-5.5860	0.0
1.6560	5.50000	12.85600	0.00000	0.0	-5.3790	-5.3790	0.0
2.2080	5.50000	13.40800	0.00000	0.0	-5.1720	-5.1720	0.0
2.7600	5.50000	13.96000	0.00000	0.0	-4.9650	-4.9650	0.0
3.3120	5.50000	14.51200	0.00000	0.0	-4.7580	-4.7580	0.0
3.8640	5.50000	15.06400	0.00000	0.0	-4.5510	-4.5510	0.0
4.4160	5.50000	15.61600	0.00000	0.0	-4.3440	-4.3440	0.0
4.9680	5.50000	16.16800	0.00000	0.0	-4.1370	-4.1370	0.0
5.5200	5.50000	16.72000	0.00000	0.0	-3.9300	-3.9300	0.0
6.0720	5.50000	17.27200	0.00000	0.0	-3.7230	-3.7230	0.0
6.6240	5.50000	17.82400	0.00000	0.0	-3.5160	-3.5160	0.0
7.1760	5.50000	18.37600	0.00000	0.0	-3.3090	-3.3090	0.0
7.7280	5.50000	18.92800	0.00000	0.0	-3.1020	-3.1020	0.0
8.2800	5.50000	19.48000	0.00000	0.0	-2.8950	-2.8950	0.0
8.8320	5.50000	20.03200	0.00000	0.0	-2.6880	-2.6880	0.0
9.3840	5.50000	20.58400	0.00000	0.0	-2.4810	-2.4810	0.0
9.9360	5.50000	21.13600	0.00000	0.0	-2.2740	-2.2740	0.0
10.488	5.50000	21.68800	0.00000	0.0	-2.0670	-2.0670	0.0
11.040	5.50000	22.24000	0.00000	0.0	-1.8600	-1.8600	0.0
11.592	5.50000	22.79200	0.00000	0.0	-1.6530	-1.6530	0.0
12.144	5.50000	23.34400	0.00000	0.0	-1.4460	-1.4460	0.0
12.696	5.50000	23.89600	0.00000	0.0	-1.2390	-1.2390	0.0
13.248	5.50000	24.44800	0.00000	0.0	-1.0320	-1.0320	0.0
13.800	5.50000	25.00000	0.00000	0.0	-0.82500	-0.82500	0.0

Structure: No78 | Sub-structure: Sub 2

Dist.	Coordinates x	y	z	Displacements x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	5.50000	0.00000	0.00000	0.0	6.0000	-6.0000	0.0
0.50000	5.50000	-0.50000	0.00000	0.0	5.8125	-5.8125	0.0
1.0000	5.50000	-1.00000	0.00000	0.0	5.6250	-5.6250	0.0
1.5000	5.50000	-1.50000	0.00000	0.0	5.4375	-5.4375	0.0
2.0000	5.50000	-2.00000	0.00000	0.0	5.2500	-5.2500	0.0
2.5000	5.50000	-2.50000	0.00000	0.0	5.0625	-5.0625	0.0
3.0000	5.50000	-3.00000	0.00000	0.0	4.8750	-4.8750	0.0
3.5000	5.50000	-3.50000	0.00000	0.0	4.6875	-4.6875	0.0
4.0000	5.50000	-4.00000	0.00000	0.0	4.5000	-4.5000	0.0
4.5000	5.50000	-4.50000	0.00000	0.0	4.3125	-4.3125	0.0
5.0000	5.50000	-5.00000	0.00000	0.0	4.1250	-4.1250	0.0
5.5000	5.50000	-5.50000	0.00000	0.0	3.9375	-3.9375	0.0
6.0000	5.50000	-6.00000	0.00000	0.0	3.7500	-3.7500	0.0
6.5000	5.50000	-6.50000	0.00000	0.0	3.5625	-3.5625	0.0
7.0000	5.50000	-7.00000	0.00000	0.0	3.3750	-3.3750	0.0
7.5000	5.50000	-7.50000	0.00000	0.0	3.1875	-3.1875	0.0
8.0000	5.50000	-8.00000	0.00000	0.0	3.0000	-3.0000	0.0
8.5000	5.50000	-8.50000	0.00000	0.0	2.8125	-2.8125	0.0
9.0000	5.50000	-9.00000	0.00000	0.0	2.6250	-2.6250	0.0
9.5000	5.50000	-9.50000	0.00000	0.0	2.4375	-2.4375	0.0
10.000	5.50000	-10.00000	0.00000	0.0	2.2500	-2.2500	0.0

Specific Building Damage Results - Vertical Displacements

Structure: No 76 | Sub-structure: Sub 1

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	5.50000	11.20000	0.00000	1.5596
0.55200	5.50000	11.75200	0.00000	2.0694
1.1040	5.50000	12.30400	0.00000	2.4436
1.6560	5.50000	12.85600	0.00000	2.6986
2.2080	5.50000	13.40800	0.00000	2.8502
2.7600	5.50000	13.96000	0.00000	2.9131
3.3120	5.50000	14.51200	0.00000	2.9012
3.8640	5.50000	15.06400	0.00000	2.8273
4.4160	5.50000	15.61600	0.00000	2.7035
4.9680	5.50000	16.16800	0.00000	2.5408
5.5200	5.50000	16.72000	0.00000	2.3493
6.0720	5.50000	17.27200	0.00000	2.1384
6.6240	5.50000	17.82400	0.00000	1.9161
7.1760	5.50000	18.37600	0.00000	1.6901
7.7280	5.50000	18.92800	0.00000	1.4666
8.2800	5.50000	19.48000	0.00000	1.2514
8.8320	5.50000	20.03200	0.00000	1.0488
9.3840	5.50000	20.58400	0.00000	0.86279
9.9360	5.50000	21.13600	0.00000	0.69599
10.488	5.50000	21.68800	0.00000	0.55028
11.040	5.50000	22.24000	0.00000	0.42660
11.592	5.50000	22.79200	0.00000	0.32496
12.144	5.50000	23.34400	0.00000	0.24445
12.696	5.50000	23.89600	0.00000	0.18324
13.248	5.50000	24.44800	0.00000	0.13859
13.800	5.50000	25.00000	0.00000	0.10681

Structure: No78 | Sub-structure: Sub 2

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	5.50000	0.00000	0.00000	1.5596
0.50000	5.50000	-0.50000	0.00000	2.0275
1.0000	5.50000	-1.00000	0.00000	2.3827
1.5000	5.50000	-1.50000	0.00000	2.6377
2.0000	5.50000	-2.00000	0.00000	2.8042
2.5000	5.50000	-2.50000	0.00000	2.8936
3.0000	5.50000	-3.00000	0.00000	2.9164
3.5000	5.50000	-3.50000	0.00000	2.8824
4.0000	5.50000	-4.00000	0.00000	2.8010
4.5000	5.50000	-4.50000	0.00000	2.6810
5.0000	5.50000	-5.00000	0.00000	2.5304
5.5000	5.50000	-5.50000	0.00000	2.3567
6.0000	5.50000	-6.00000	0.00000	2.1667
6.5000	5.50000	-6.50000	0.00000	1.9666
7.0000	5.50000	-7.00000	0.00000	1.7622
7.5000	5.50000	-7.50000	0.00000	1.5582
8.0000	5.50000	-8.00000	0.00000	1.3592
8.5000	5.50000	-8.50000	0.00000	1.1689

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
9.0000	5.50000	-9.00000	0.00000	0.99033
9.5000	5.50000	-9.50000	0.00000	0.82607
10.000	5.50000	-10.00000	0.00000	0.67798

Specific Building Damage Results - All Segments

Structure: No 76 | Sub-structure: Sub 1

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	5.7722	Sagging	0.011676	0.037500	0.047384	-374.86E-6	-461.84E-6	2565.9	0 (Negligible)
	2	5.7722	5.8278	Hogging	0.0045303	0.037500	0.039567	-374.86E-6	409.37E-6	10688.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: No78 | Sub-structure: Sub 2

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	6.9605	Sagging	0.018121	0.037500	0.055313	-374.86E-6	-935.34E-6	2161.6	1 (Very Slight)
	2	6.9605	1.3395	Hogging	394.55E-6	0.037500	0.037542	-374.86E-6	408.79E-6	20960.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 76 | Sub-structure: Sub 1

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.011676	0.037500	-461.84E-6	2.9128	0.047384	-374.86E-6	-461.84E-6	10688.	2565.9	0 (Negligible)

Structure: No78 | Sub-structure: Sub 2

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.018121	0.037500	-935.34E-6	2.9148	0.055313	-374.86E-6	-935.34E-6	20960.	2161.6	1 (Very Slight)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start [m]	End [m]	Curvature	Max Slope	Max Settlement [mm]	Max Tensile Strain [%]	Min Radius of Curvature (Hogging) [m]	Min Radius of Curvature (Sagging) [m]	Damage Category
No 76	Max Slope	Sub 1	1	0.0	5.7722	Sagging	**461.84E-6**	2.9128	0.047384	-	2565.9	0 (Negligible)
	Max Settlement	Sub 1	1	0.0	5.7722	Sagging	461.84E-6	**2.9128**	0.047384	-	2565.9	0 (Negligible)
	Max Tensile Strain	Sub 1	1	0.0	5.7722	Sagging	461.84E-6	2.9128	**0.047384**	-	2565.9	0 (Negligible)
	Min Radius of Curvature (Hogging)	Sub 1	2	5.7722	11.600	Hogging	409.37E-6	1.7736	0.039567	**10688.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Sub 1	1	0.0	5.7722	Sagging	461.84E-6	2.9128	0.047384	-	**2565.9**	0 (Negligible)
No78	Max Slope	Sub 2	1	0.0	6.9605	Sagging	**935.34E-6**	2.9148	0.055313	-	2161.6	1 (Very Slight)
	Max Settlement	Sub 2	1	0.0	6.9605	Sagging	935.34E-6	**2.9148**	0.055313	-	2161.6	1 (Very Slight)
	Max Tensile Strain	Sub 2	1	0.0	6.9605	Sagging	935.34E-6	2.9148	**0.055313**	-	2161.6	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Sub 2	2	6.9605	8.3000	Hogging	408.79E-6	1.7783	0.037542	**20960.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Sub 2	1	0.0	6.9605	Sagging	935.34E-6	2.9148	0.055313	-	**2161.6**	1 (Very Slight)

Specific Building Damage Results - All Combined Segments

Structure: No 76 | Sub-structure: Sub 1

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	

No structures have segments combined.

Structure: No78 | Sub-structure: Sub 2

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	

No structures have segments combined.

Utility Strain Calculation Options

Neglect beneficial contribution of axial strains : No

Specific Building Damage Results - Horizontal Displacements

Structure: No 76 | Sub-structure: Sub 1

Dist.	Coordinates					Displacements	
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	5.50000	11.20000	0.00000	0.0	-6.0000	-6.0000	0.0 d
0.55200	5.50000	11.75200	0.00000	0.0	-5.7930	-5.7930	0.0 d
1.1040	5.50000	12.30400	0.00000	0.0	-5.5860	-5.5860	0.0 d
1.6560	5.50000	12.85600	0.00000	0.0	-5.3790	-5.3790	0.0 d
2.2080	5.50000	13.40800	0.00000	0.0	-5.1720	-5.1720	0.0 d
2.7600	5.50000	13.96000	0.00000	0.0	-4.9650	-4.9650	0.0 d
3.3120	5.50000	14.51200	0.00000	0.0	-4.7580	-4.7580	0.0 d
3.8640	5.50000	15.06400	0.00000	0.0	-4.5510	-4.5510	0.0 d
4.4160	5.50000	15.61600	0.00000	0.0	-4.3440	-4.3440	0.0 d
4.9680	5.50000	16.16800	0.00000	0.0	-4.1370	-4.1370	0.0 d
5.5200	5.50000	16.72000	0.00000	0.0	-3.9300	-3.9300	0.0 d
6.0720	5.50000	17.27200	0.00000	0.0	-3.7230	-3.7230	0.0 d
6.6240	5.50000	17.82400	0.00000	0.0	-3.5160	-3.5160	0.0 d
7.1760	5.50000	18.37600	0.00000	0.0	-3.3090	-3.3090	0.0 d
7.7280	5.50000	18.92800	0.00000	0.0	-3.1020	-3.1020	0.0 d
8.2800	5.50000	19.48000	0.00000	0.0	-2.8950	-2.8950	0.0 d
8.8320	5.50000	20.03200	0.00000	0.0	-2.6880	-2.6880	0.0 d
9.3840	5.50000	20.58400	0.00000	0.0	-2.4810	-2.4810	0.0 d
9.9360	5.50000	21.13600	0.00000	0.0	-2.2740	-2.2740	0.0 d
10.488	5.50000	21.68800	0.00000	0.0	-2.0670	-2.0670	0.0 d
11.040	5.50000	22.24000	0.00000	0.0	-1.8600	-1.8600	0.0 d
11.592	5.50000	22.79200	0.00000	0.0	-1.6530	-1.6530	0.0 d
12.144	5.50000	23.34400	0.00000	0.0	-1.4460	-1.4460	0.0 d
12.696	5.50000	23.89600	0.00000	0.0	-1.2390	-1.2390	0.0 d
13.248	5.50000	24.44800	0.00000	0.0	-1.0320	-1.0320	0.0 d
13.800	5.50000	25.00000	0.00000	0.0	-0.82500	-0.82500	0.0 d

d - Displacements include imported displacements.

Structure: No78 | Sub-structure: Sub 2

Dist.	Coordinates					Displacements	
	x	y	z	x	y	Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	5.50000	0.00000	0.00000	0.0	6.0000	-6.0000	0.0 d
0.50000	5.50000	-0.50000	0.00000	0.0	5.8125	-5.8125	0.0 d
1.0000	5.50000	-1.00000	0.00000	0.0	5.6250	-5.6250	0.0 d
1.5000	5.50000	-1.50000	0.00000	0.0	5.4375	-5.4375	0.0 d
2.0000	5.50000	-2.00000	0.00000	0.0	5.2500	-5.2500	0.0 d
2.5000	5.50000	-2.50000	0.00000	0.0	5.0625	-5.0625	0.0 d
3.0000	5.50000	-3.00000	0.00000	0.0	4.8750	-4.8750	0.0 d
3.5000	5.50000	-3.50000	0.00000	0.0	4.6875	-4.6875	0.0 d
4.0000	5.50000	-4.00000	0.00000	0.0	4.5000	-4.5000	0.0 d
4.5000	5.50000	-4.50000	0.00000	0.0	4.3125	-4.3125	0.0 d
5.0000	5.50000	-5.00000	0.00000	0.0	4.1250	-4.1250	0.0 d
5.5000	5.50000	-5.50000	0.00000	0.0	3.9375	-3.9375	0.0 d
6.0000	5.50000	-6.00000	0.00000	0.0	3.7500	-3.7500	0.0 d
6.5000	5.50000	-6.50000	0.00000	0.0	3.5625	-3.5625	0.0 d
7.0000	5.50000	-7.00000	0.00000	0.0	3.3750	-3.3750	0.0 d
7.5000	5.50000	-7.50000	0.00000	0.0	3.1875	-3.1875	0.0 d
8.0000	5.50000	-8.00000	0.00000	0.0	3.0000	-3.0000	0.0 d
8.5000	5.50000	-8.50000	0.00000	0.0	2.8125	-2.8125	0.0 d
9.0000	5.50000	-9.00000	0.00000	0.0	2.6250	-2.6250	0.0 d
9.5000	5.50000	-9.50000	0.00000	0.0	2.4375	-2.4375	0.0 d
10.000	5.50000	-10.00000	0.00000	0.0	2.2500	-2.2500	0.0 d

d - Displacements include imported displacements.

Specific Building Damage Results - Vertical Displacements

Structure: No 76 | Sub-structure: Sub 1

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	5.50000	11.20000	0.00000	-2.3266 d
0.55200	5.50000	11.75200	0.00000	-1.0949 d
1.1040	5.50000	12.30400	0.00000	-0.28390 d
1.6560	5.50000	12.85600	0.00000	0.29976 d
2.2080	5.50000	13.40800	0.00000	0.71475 d
2.7600	5.50000	13.96000	0.00000	0.99582 d
3.3120	5.50000	14.51200	0.00000	1.1684 d
3.8640	5.50000	15.06400	0.00000	1.2530 d
4.4160	5.50000	15.61600	0.00000	1.2668 d
4.9680	5.50000	16.16800	0.00000	1.2247 d
5.5200	5.50000	16.72000	0.00000	1.1397 d
6.0720	5.50000	17.27200	0.00000	1.0232 d
6.6240	5.50000	17.82400	0.00000	0.88542 d
7.1760	5.50000	18.37600	0.00000	0.73510 d
7.7280	5.50000	18.92800	0.00000	0.57989 d
8.2800	5.50000	19.48000	0.00000	0.42628 d
8.8320	5.50000	20.03200	0.00000	0.27972 d
9.3840	5.50000	20.58400	0.00000	0.14457 d
9.9360	5.50000	21.13600	0.00000	0.024211 d
10.488	5.50000	21.68800	0.00000	-0.079017 d
11.040	5.50000	22.24000	0.00000	-0.16375 d
11.592	5.50000	22.79200	0.00000	-0.22960 d
12.144	5.50000	23.34400	0.00000	-0.27715 d
12.696	5.50000	23.89600	0.00000	-0.30796 d
13.248	5.50000	24.44800	0.00000	-0.32452 d
13.800	5.50000	25.00000	0.00000	-0.33029 d

d - Displacements include imported displacements.

Structure: No78 | Sub-structure: Sub 2

Dist.	Coordinates			Displacements
	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
Vertical Offset 1				
0.0	5.50000	0.00000	0.00000	-2.4349 d
0.50000	5.50000	-0.50000	0.00000	-1.3140 d
1.0000	5.50000	-1.00000	0.00000	-0.54118 d
1.5000	5.50000	-1.50000	0.00000	0.041803 d
2.0000	5.50000	-2.00000	0.00000	0.47997 d
2.5000	5.50000	-2.50000	0.00000	0.79942 d
3.0000	5.50000	-3.00000	0.00000	1.0196 d
3.5000	5.50000	-3.50000	0.00000	1.1568 d
4.0000	5.50000	-4.00000	0.00000	1.2247 d
4.5000	5.50000	-4.50000	0.00000	1.2359 d
5.0000	5.50000	-5.00000	0.00000	1.2012 d
5.5000	5.50000	-5.50000	0.00000	1.1304 d
6.0000	5.50000	-6.00000	0.00000	1.0322 d
6.5000	5.50000	-6.50000	0.00000	0.91446 d
7.0000	5.50000	-7.00000	0.00000	0.78405 d

Dist.	Coordinates x	y	z	Displacements z
[m]	[m]	[m]	[m]	[mm]
7.5000	5.50000	-7.50000	0.00000	0.64703 d
8.0000	5.50000	-8.00000	0.00000	0.50865 d
8.5000	5.50000	-8.50000	0.00000	0.37344 d
9.0000	5.50000	-9.00000	0.00000	0.24515 d
9.5000	5.50000	-9.50000	0.00000	0.12686 d
10.000	5.50000	-10.00000	0.00000	0.020926 d

d - Displacements include imported displacements.

Specific Building Damage Results - All Segments

Structure: No 76 | Sub-structure: Sub 1

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	6.4144	Sagging	0.017226	0.037500	0.053388	-374.86E-6	-0.0010570	1553.9	1 (Very Slight)
	2	6.4144	5.1856	Hogging	0.0034551	0.037500	0.038909	-374.86E-6	281.09E-6	12422.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: No78 | Sub-structure: Sub 2

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	7.6561	Sagging	0.029532	0.037500	0.068654	-374.86E-6	-0.0022410	645.23	1 (Very Slight)
	2	7.6561	0.64389	Hogging	156.71E-6	0.037500	0.037508	-374.86E-6	276.65E-6	50632.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure

Structure: No 76 | Sub-structure: Sub 1

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.017226	0.037500	-0.0010570	1.2658	0.053388	-374.86E-6	-0.0010570	12422.	1553.9	1 (Very Slight)

Structure: No78 | Sub-structure: Sub 2

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Max Slope	Max Settlement	Max Tensile Strain	Max Gradient of Horizontal Displacement Curve	Max Gradient of Vertical Displacement Curve	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
[m]	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.029532	0.037500	-0.0022410	2.4349	0.068654	-374.86E-6	-0.0022410	50632.	645.23	1 (Very Slight)

Specific Building Damage Results - Critical Segments within Each Structure

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Max Slope	Max Settlement	Max Tensile Strain	Min Radius of Curvature (Hogging)	Min Radius of Curvature (Sagging)	Damage Category
				[m]	[m]			[mm]	[%]	[m]	[m]	
No 76	Max Slope	Sub 1	1	0.0	6.4144	Sagging	**0.0010570**	1.2658	0.053388	-	1553.9	1 (Very Slight)
	Max Settlement	Sub 1	1	0.0	6.4144	Sagging	0.0010570	**1.2658**	0.053388	-	1553.9	1 (Very Slight)
	Max Tensile Strain	Sub 1	1	0.0	6.4144	Sagging	0.0010570	1.2658	**0.053388**	-	1553.9	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Sub 1	2	6.4144	11.600	Hogging	281.09E-6	0.61182	0.038909	**12422.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Sub 1	1	0.0	6.4144	Sagging	0.0010570	1.2658	0.053388	-	**1553.9**	1 (Very Slight)
No78	Max Slope	Sub 2	1	0.0	7.6561	Sagging	**0.0022410**	2.4349	0.068654	-	645.23	1 (Very Slight)
	Max Settlement	Sub 2	1	0.0	7.6561	Sagging	0.0022410	**2.4349**	0.068654	-	645.23	1 (Very Slight)
	Max Tensile Strain	Sub 2	1	0.0	7.6561	Sagging	0.0022410	2.4349	**0.068654**	-	645.23	1 (Very Slight)
	Min Radius of Curvature (Hogging)	Sub 2	2	7.6561	8.3000	Hogging	276.65E-6	0.60382	0.037508	**50632.**	-	0 (Negligible)
	Min Radius of Curvature (Sagging)	Sub 2	1	0.0	7.6561	Sagging	0.0022410	2.4349	0.068654	-	**645.23**	1 (Very Slight)

Specific Building Damage Results - All Combined Segments

Structure: No 76 | Sub-structure: Sub 1

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	

No structures have segments combined.

Structure: No78 | Sub-structure: Sub 2

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	

No structures have segments combined.

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