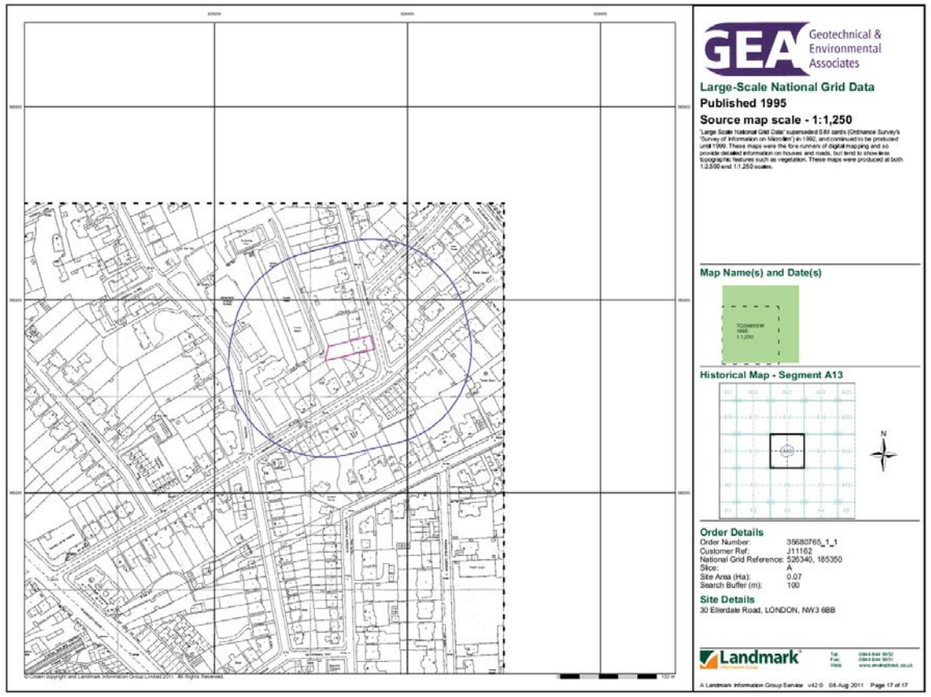
GEA Geotechnical & Environmental Associates
Large-Scale National Grid Data
Published 1995
Source map scale - 1:1,250
Large Scale National Grid Data' superseded 5.5M cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.
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Order Details
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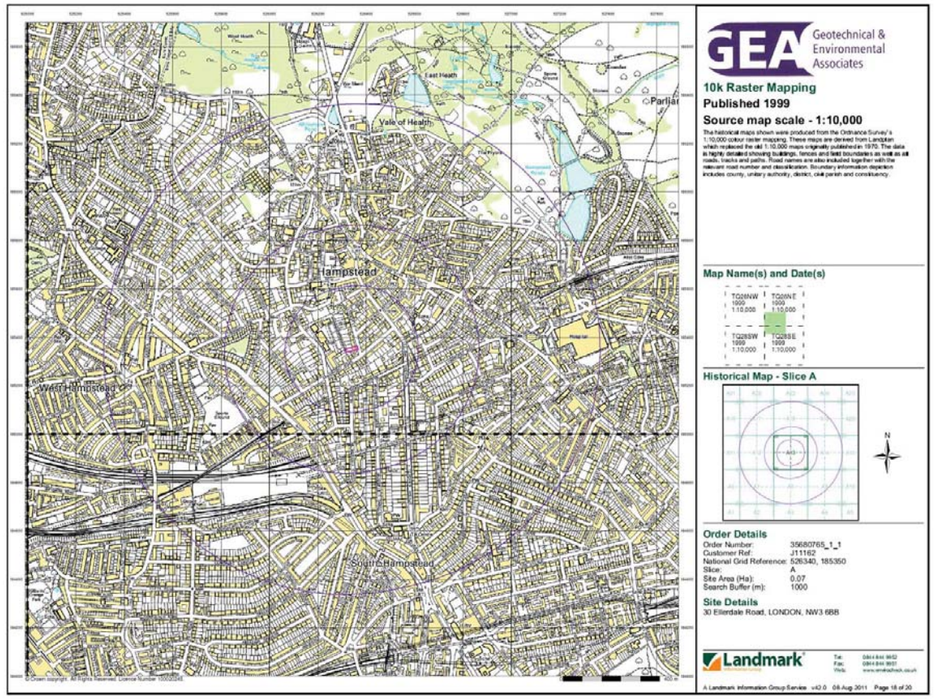
Customer Ref.: J11162
National Grid Reference: 526340, 185350
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100
Site Details
30 Ellerdale Road, LONDON, NW3 6BB
Landmark
A Landmark Information Group Service v42.0 08 Aug 2011 Page 17 of 17


GEA Geotechnical & Environmental Associates
10k Raster Mapping
Published 1999
Source map scale - 1:10,000
The historical maps shown were produced from the Ordnance Survey's 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.
Map Name(s) and Date(s)
Historical Map - Slice A
Order Details
Order Number: 35680765_1_1
Customer Ref.: J11162
National Grid Reference: 526340, 185350
Slice: A
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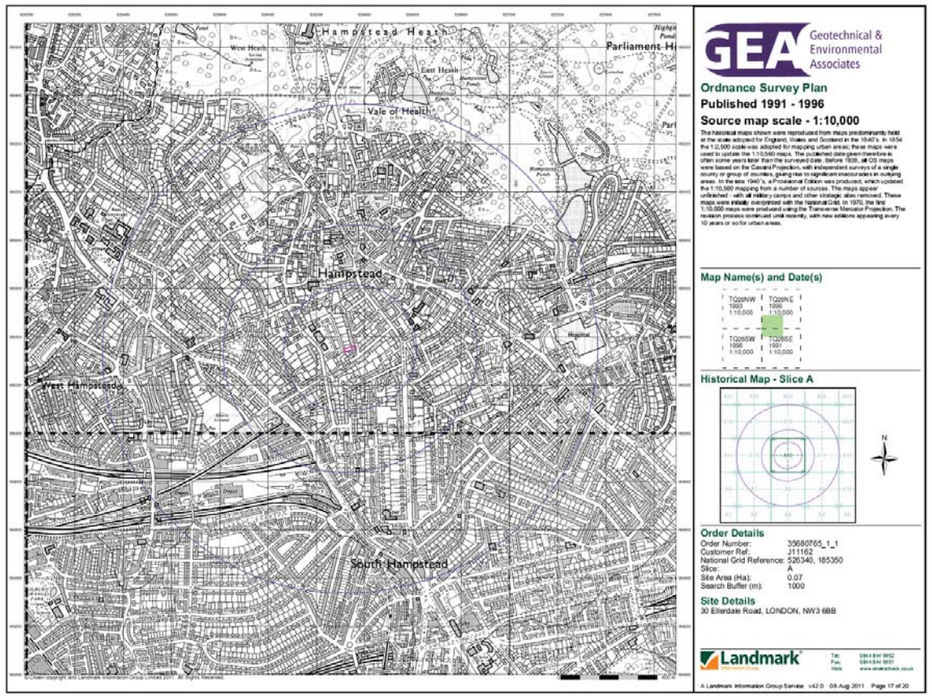
Site Details
30 Ellerdale Road, LONDON, NW3 6BB
Landmark
A Landmark Information Group Service v42.0 08 Aug 2011 Page 18 of 20


GEA Geotechnical & Environmental Associates
Ordnance Survey Plan
Published 1991 - 1996
Source map scale - 1:10,000
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1935, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.
Map Name(s) and Date(s)
Historical Map - Slice A
Order Details
Order Number: 35680765_1_1
Customer Ref.: J11162
National Grid Reference: 526340, 185350
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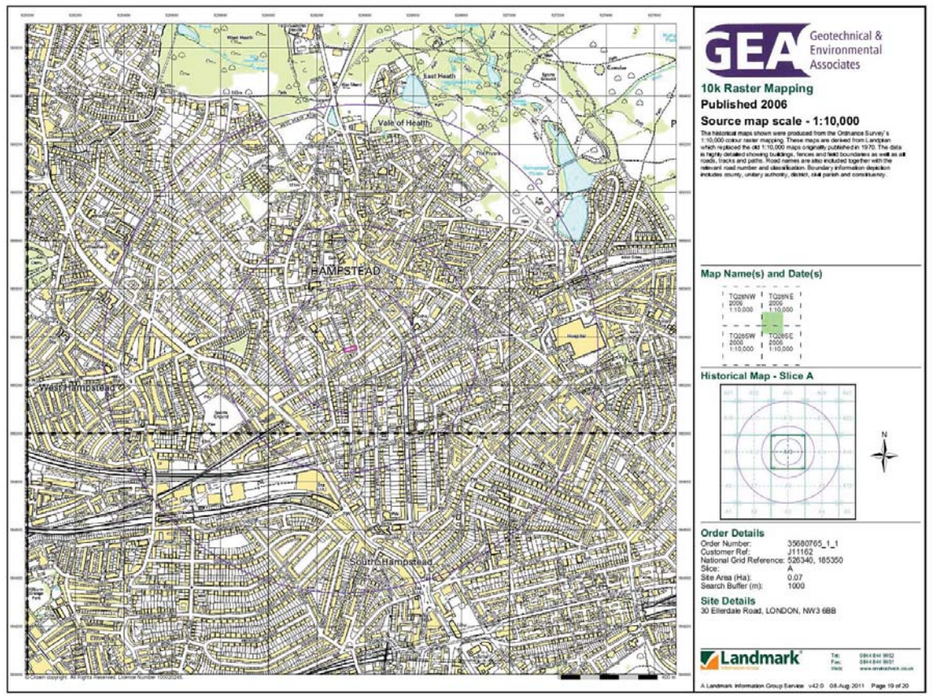
Site Details
30 Ellerdale Road, LONDON, NW3 6BB
Landmark
A Landmark Information Group Service v42.0 08 Aug 2011 Page 19 of 20


GEA Geotechnical & Environmental Associates
10k Raster Mapping
Published 2006
Source map scale - 1:10,000
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Map Name(s) and Date(s)
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Order Details
Order Number: 35680765_1_1
Customer Ref.: J11162
National Grid Reference: 526340, 185350
Slice: A
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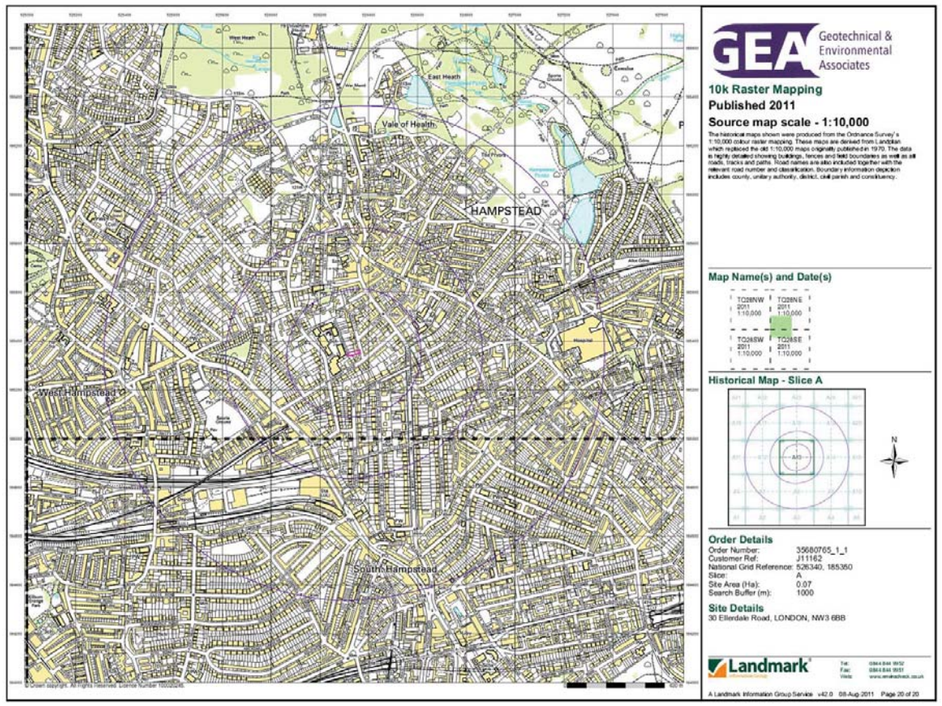
GEA
Geotechnical & Environmental Associates
10k Raster Mapping
Published 2011
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Map Name(s) and Date(s)
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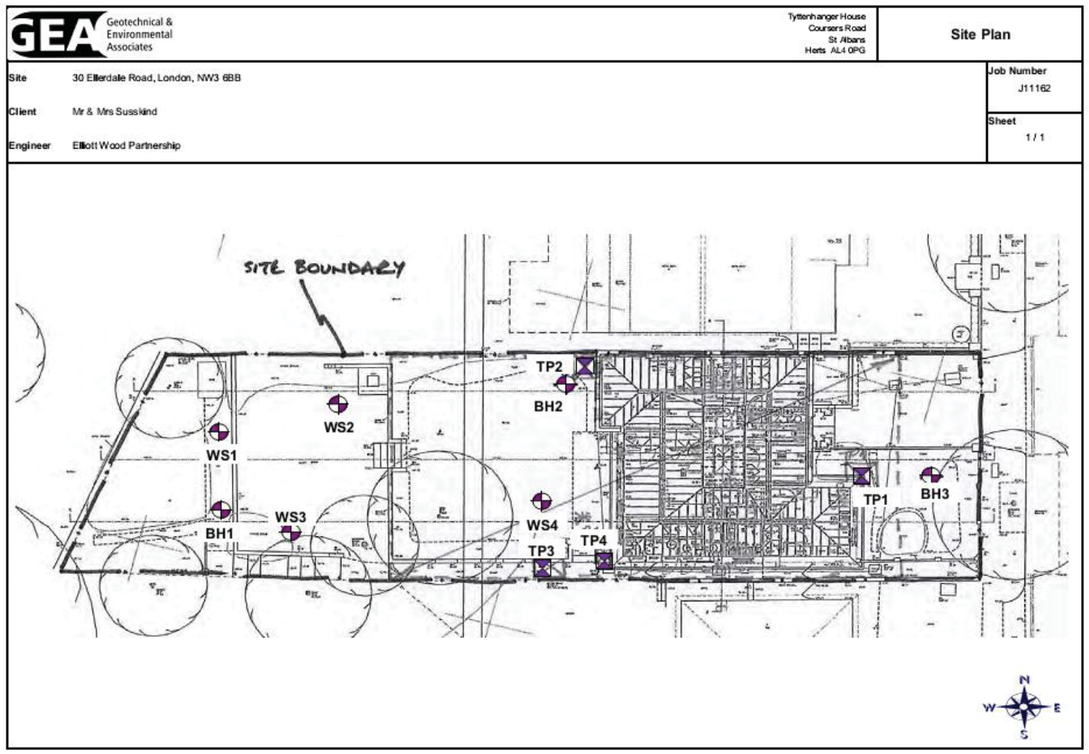
TQ28NE 2011 1:10,000
TQ28SW 2011 1:10,000
TQ28SE 2011 1:10,000
Historical Map - Slice A
N
Order Details
Order Number: 35680765_1_1
Customer Ref: J11162
National Grid Reference: 526340, 185350
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 1000
Site Details
30 Ellerdale Road, LONDON, NW3 6BB
Landmark
A Landmark Information Group Service v42.0 08-Aug-2011 Page 20 of 20
HAMPSTEAD
Vale of Health
East Heath
West Hampstead
South Hampstead


GEA
Geotechnical & Environmental Associates
Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG
Site Plan
Site 30 Ellerdale Road, London, NW3 6BB
Client Mr & Mrs Susskind
Engineer Elliott Wood Partnership
Job Number J11162
Sheet 1 / 1
SITE BOUNDARY
WS1
WS2
WS3
WS4
BH1
BH2
TP1
TP2
TP3
TP4
BH3
N
W
E
S

Geotechnical & Environmental Associates (GEA) is an engineer-led and client-focused independent specialist providing a complete range of geotechnical and contaminated land investigation, analytical and consultancy services to the property and construction industries.

We have offices at

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG
tel 01727 824666
mail@gea-ltd.co.uk

Church Farm
Gotham Road
Kingston on Soar
Notts
NG11 0DE
tel 01509 674888
midlands@gea-ltd.co.uk

Enquiries can also be made on-line at
www.gea-ltd.co.uk
where information can be found
on all of the services that we offer.

GEA Geotechnical & Environmental Associates

3.0 Basement Impact Assessment

Basement Impact Assessment Report

30 Ellerdale Road
London NW3

Client Elliott Wood Partnership

J11162A

March 2014

GEA Geotechnical & Environmental Associates

Document Control

Project title	30 Ellerdale Road, London, NW3 6BB	**Project ref**	J11162A
Report prepared by	Caroline Anderson MEng AUS FGS		
With input from	Martin Cooper BEng CEng MICE FGS	John Evans MSc FGS CGeol	
Report checked and approved for issue by	Steve Branch BSc MSc CGeol FGS FRGS MIEnvSc		

Issue No	Status	Date	Approved for Issue
1	Final	9 August 2012	
2	Final (Revised)	9 September 2013	
3	Final (Revised)	22 January 2014	
4	Final (Revised)	5 March 2014	
5	Final (Revised)	6 March 2014	
6	Final (Revised)	21 March 2014	

This report has been issued by the GEA office indicated below. Any enquiries regarding the report should be directed to the office indicated or to Steve Branch in our Herts office.

☑ Hertfordshire tel 01727 824666 mail@gea-ltd.co.uk

☐ Nottinghamshire tel 01509 674888 midlands@gea-ltd.co.uk

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CONTENTS

1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) Limited has been commissioned by Elliott Wood Partnership to carry out a Basement Impact Assessment of this site at 30 Ellerdale Road, London, NW3, in accordance with guidelines from London Borough of Camden ("the Council") in support of a planning application. The site was previously the subject of a desk study and ground investigation report by GEA (ref J11162, dated October 2011) and the previous findings have been used to inform the BIA where appropriate. The site was also the subject of a ground movement analysis by GEA (ref J11162/CA/2, dated 22 January 2014) and should be referred to in conjunction with this report.

In 2012 a small single storey extension was added to the rear of the existing building and the internal living space and rear garden underwent aesthetic changes which included regrading of the terraced lawn areas and new paved surfacing. Following the changes, a second site walkover was carried out in February 2014.

Revised drawings of the proposed basement have been provided by the scheme architects, KSR Architects, dated 28th November 2013, ref ELL – Proposed Sections Burland, and are referred to where appropriate. Due to the sloping nature of the site, all basement levels are interpolated from a single arbitrary ground level of 95.65 m OD.

1.1 Proposed Development

It is proposed to construct a single storey basement to a maximum depth generally of 6.07 m, locally deepened to 7.47 m to accommodate a swimming pool. The basement will extend below the entire footprint of the existing two-storey property and part of the rear garden.

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.

1.2 Scope and Purpose of Work

The work carried out comprises the screening and scoping elements of a groundwater and land stability (also referred to as slope stability) assessment, which forms part of the Basement Impact Assessment (BIA) procedure specified in the London Borough of Camden Planning Guidance CPG4[1] and their Guidance for Subterranean Development[2] prepared by Arup. An assessment of the impact on surface water is not included and is beyond the scope of this report.

The aim of the work is to provide information on groundwater and land stability of the site and in particular to assess whether the development will affect the neighbouring properties and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3 Qualifications

The land stability portion of the report has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years specialist experience in ground

1 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*
2 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

engineering. The groundwater assessment has been carried out by John Evans, a qualified Hydrogeologist, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The assessment has been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a chartered geologist (CGeol) and Fellow of the Geological Society (FGS) with 25 years' experience in geotechnical engineering and engineering geology. The assessors satisfy the qualification requirements of the Council guidance with respect to land stability and groundwater.

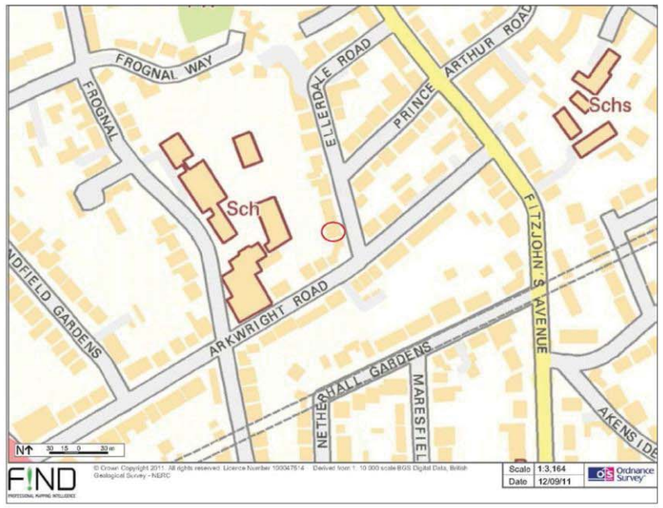
1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the research carried out. The results of the research should be viewed in the context of the work that has been carried out and no liability can be accepted for matters outside the stated scope of the research. Any comments made on the basis of information obtained from third parties are given in good faith on the assumption that the information is accurate. No independent validation of third party information has been made by GEA.

2.0 THE SITE

2.1 Site Description

The site is located in Hampstead, northwest London, approximately 425 m to the southwest of Hampstead London Underground station, and 410 m to the northeast of Finchley Road and Frognal railway station. It may be located by National Grid Reference 526349, 185363 and is shown on the adjacent map.



The site forms a roughly rectangular area with maximum dimensions of approximately 55 m east-west by 15 m north-south and is occupied by No 30 Ellerdale Road, a two-storey detached house with integral garage and associated front and rear gardens. The house fronts onto Ellerdale Road to the east and is bordered to the north and south by Nos 28 and 32 Ellerdale Road respectively and to the west by private gardens associated with houses fronting onto Arkwright Road and tennis courts in the grounds of the adjacent University College School (UCS).


Rear of existing building looking northeast

The front garden comprises a concrete paved driveway in the north and a lawn in the south with planted borders which contain shrubs and bushes. A semi-mature London Plane tree is located outside the boundary, on Ellerdale Road. The rear garden is laid to lawn in its entirety with planted borders which contain shrubs, bushes and deciduous trees.

The rear garden is terraced over three levels which would have been formed by a cut and fill exercise, with the upper two terraces reconfigured during modifications made in 2012. The middle terrace is retained by a 1.95 m high retaining wall, while the upper patio terrace is retained by a smaller 0.60 m high retaining wall. The lower terrace (not visible on photo below) is laid to lawn with planted borders. The westernmost boundary of the site is at a level approximately 3 m below the eastern boundary, and given the local topography the site remains elevated relative to the adjacent school to the southwest.


Rear garden area looking southwest

Asite walkover was carried out by GEA on 26 July 2012, with a second walkover carried out on 11 February 2014 and by this time the construction works were completed.

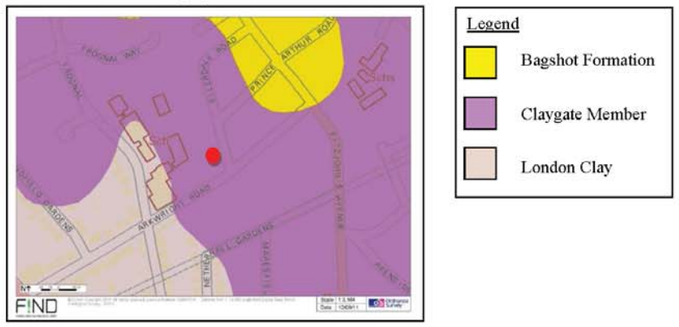
2.2 Topography

The site lies between 96 m to 92 m above ordnance datum (OD) on ground that falls away to about 5 m OD at the River Thames, roughly 7.5 km to the south and rises to an elevation of 134 m OD on Hampstead Heath, some 1.5 km north of the site. More locally, the southern extent of Ellerdale Road is largely level with a gentle slope to the south where it connects to Arkwright Road. The site itself slopes south-westwards towards Frognal and the adjacent UCS. The Camden Geological, Hydrogeological and Hydrological Study Slope Angle Map (Nov 2010) suggests that the site lies within an area that has a slope angle of between 7° and 10°.

3.0 GROUND CONDITIONS

3.1 Soil Conditions

The British Geological Survey map of the area (sheet 256) indicates the site to be underlain by the Claygate Member of the London Clay. The Claygate Member forms the youngest part of the London Clay Formation, the basal boundary of which is shown on the OS map to lie at approximately 85 m OD in this area. However, previous investigations by GEA in this area have indicated that the base of Claygate Member extends some 10 m lower, to about 75 m OD. These records are corroborated by a BGS borehole drilled in Hampstead village, which extended through the full 33.4 m thickness of the Claygate Beds, with the base being penetrated at a level of approximately 73.76 m OD. The geology in this area is generally horizontally bedded such that the strata boundaries roughly follow the contour lines.



As part of the previous investigation by GEA three cable percussion boreholes were drilled to depths of 20.0 m (72.00 m OD). A standpipe was installed in each borehole to a depth of 7.0 m. In addition four window samples were advanced to a depth of 5.0 m and four trial pits were manually excavated in order to expose the existing foundations. The made ground extended to depths of between 1.3 m (93.95 m OD) in Borehole No 2 and Window Sample No 2 and 2.5 m (89.50 m OD) in Borehole No 1 and comprised dark brown silty sandy clay with pockets of orange

brown sand, gravel, brick fragments, roots and occasional ash. The greater thickness of made ground was generally encountered in the west of the site reflecting the placing of fill to create terraces from the formerly sloping ground. Topsoil was only encountered in the east of the site, in Borehole No 3, to a depth 1.0 m (94.40 m OD), and comprised dark grey silty clay over brown medium silty sand.

The underlying Claygate Member initially comprised light brown mottled orange brown fine silty sand to depths of between 3.0 m (89.0 m OD) and 3.4 m (88.60 m OD) in Borehole No 1 and Window Sample No 1 respectively on the western side of the site. Brown silty very clayey fine sand over light brown becoming orange-brown very silty clayey fine sand was encountered to the full depth investigated of 5.00 m (88.05 m OD) in both Window Sample Nos 2 and 3 in the centre of the rear garden.

Beneath the initial layer of silty sand, soft becoming firm light brown mottled orange-brown silty very sandy clay was present to depths of between 4.00 m (91.25 m OD) and 6.00 m (86.00 m OD) in Borehole Nos 2 and 1 respectively. Below this depth firm becoming stiff brown silty very sandy fissured clay interbedded with silty clayey sand extended to depths of 8.30 m (86.95 m OD) and 11.00 m (84.40 m OD) in Borehole Nos 2 and 3 only.

The clay with layers of sand was underlain by firm becoming stiff dark brownish grey very silty sandy fissured clay with occasional shell fragments and partings of fine pale brown silty sand, which extended to the maximum depth investigated of 20.0 m (72.0 m OD) in Borehole Nos 1 to 3. This material may possibly be the upper part (Unit D) of the London Clay and in any case, based on records from GEA archives and the BGS, it is apparent that the boreholes extended close to the base of the Claygate Member. A pocket of water softened clay was encountered at 14.0 m (81.4 m OD) in Borehole No 3, in the east. Plasticity index tests have indicated the clay to be of low to medium shrinkability.

3.2 Groundwater Conditions

The Claygate member in this area is classified as a Secondary 'A' Aquifer by the Environment Agency (EA).

The boundary between the Bagshot Formation and the underlying Claygate Member is located to the north of the site. Existing and historical spring lines are present at the interface of the sandy Bagshot Formation and the underlying less permeable Claygate, and between the Claygate and the underlying essentially impermeable London Clay. These springs have been the source of a number of London's "lost" rivers, notably the Westbourne and Tyburn, which generally rose on Hampstead Heath.

Groundwater was initially encountered during drilling within the Claygate Member at depths of between 6.5 m (85.5 m OD and 88.90 m OD) in Borehole Nos 1 and 3 and 8.50 m (86.75 m OD) in Borehole No 2, and subsequent inflows were encountered in all boreholes during drilling up to a maximum depth of 15.0 m (77.0 m OD). The groundwater inflows encountered in Borehole No 1 in the west, at depths of 8.00 m (84.00 m OD) and 15.00 m (77.00 m OD) both rose to 6.50 m (85.50 m OD) after 20 minute rest periods.

Standpipes were installed immediately following drilling to a depth of 7.0 m in each of the boreholes and subsequent monitoring recorded groundwater at depths of 6.55 m (85.45 m OD),

6.46 m (88.79 m OD), and 6.49 m (88.91 m OD) in Borehole Nos 1, 2 and 3 respectively, approximately one week after installation.

During the site walkover in July 2012 it was only possible to monitor Borehole No 1, in the west of the site and groundwater was recorded at a depth of 6.1 m (85.9 m OD).

3.3 Hydrology and Drainage

The site lies within the surface water catchment of the upper Westbourne stream, a tributary of the River Thames, and outside of the catchment of the Hampstead Heath chain of ponds. Historic maps indicate that the Westbourne flowed approximately 100m to the west of the site. The Westbourne is now entirely covered and culverted and forms part of the surface water sewerage system, running beneath West Hampstead to where it discharges into the Thames to the west of Chelsea Bridge.

There are no surface water features marked on current Ordnance Survey mapping (1:25,000 scale) within 500 m of the site. The site is not located within a Flood Zone as defined by the Environment Agency and Ellerdale Road has not been identified as a street at risk of surface water flooding as a result of sewer surcharging within the London Borough of Camden.

Without evidence to the contrary, groundwater flow beneath the site is anticipated to follow topographic contours toward the southwest. The Westbourne stream is considered to rise from springs and seepages from the Bagshot Formation sands on Hampstead Heath and is considered to be perched on the London Clay Formation strata.

4.0 SCREENING ASSESSMENT

The Council's guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full BIA is required.

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E which includes a series of questions within a screening flowchart for three categories; groundwater flow; land stability; and surface water flow. Responses to the questions are tabulated below.

4.1 Subterranean (groundwater) Screening Assessment

Question	Response for 30 Ellerdale Road
1a. Is the site located directly above an aquifer?	*Yes. The Site is underlain by the Claygate Member of the London Clay Formation which is designated a Secondary Aquifer by the Environment Agency, capable of supporting baseflow to watercourses.*
1b. Will the proposed basement extend beneath the water table surface?	*Yes. Groundwater has been measured at a minimum depth of 6.49 m (88.91 m OD) and the deepest basement excavation extends to 88.18 m OD.*
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential springline?	No - Historic maps indicate the Westbourne stream flowed c.100 m to the west of the Site. This watercourse is not present at surface and has been culverted to form part of the local surface water sewer.

3. Is the site within the catchment of the pond chains on Hampstead Heath?	No – The site is outside the catchment areas of Hampstead Heath Ponds.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No - The overall amount of hardstanding areas remains unchanged.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No - The clay rich nature of the Claygate Member strata is anticipated to be unsuitable for receiving discharge to ground.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No - There are no local ponds or spring lines present within 100 m of the Site.

The screening exercise has identified the following potential issues which should be assessed:

Q1a The Site is located on a Secondary Aquifer.

4.2 Land Stability Screening Assessment

Question	Response for 30 Ellerdale Road
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No – the site drops by approximately 3 m over a distance of approximately 55 m, giving a rise of about 3.1° east-west.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	*Yes - the 'Slope Angle Map' from the Camden Geological, Hydrogeological and Hydrological Study suggests that the site lies within an area that can have a slope angle between 7° and 10°.*
5. Is the London Clay the shallowest strata at the site?	No
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	No
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes - the Hampstead area is prone to these effects as a result of the presence of shrinkable London Clay and abundant mature trees.*
8. Is the site within 100 m of a watercourse or potential spring line?	No
9. Is the site within an area of previously worked ground?	No
10. Is the site within an aquifer?	*Yes - the Site is located on a Secondary Aquifer.*
11. Is the site within 50 m of Hampstead Heath ponds?	No
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes - the site fronts onto a public road.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes – the development will increase foundation depths. Neighbouring foundations at No 32 are assumed to be of a similar shallow depth as No 30. There is a single level basement present at No 28.*
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	No

The above assessment has identified the following potential issues that need to be assessed:

Q4 The wider area includes slopes with an angle between 7° and 10°.
Q7 The site is in an area of seasonal shrink-swell.
Q10 The site is located within an aquifer.
Q12 The site is within 5 m of a public highway on one side.
Q13 The development will increase the foundation depths relative to the neighbouring properties to a relatively significant extent.

5.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified potential impact factors.

The investigation of the potential impacts is carried out through a suitable site investigation and this has been carried out by GEA in October 2011. It is considered that the scope of the investigation complies with the guidance issued by the Council and is therefore a suitable basis on which to assess the potential impacts.

5.1 Potential Impacts

The following potential impacts have been identified.

Subterranean (Groundwater) Scoping

Potential Impact	Site Investigation Conclusions
(Q1a) Site underlain by Secondary Aquifer – the basement may extend into the underlying aquifer and affect the groundwater flow regime	Groundwater has been measured at a minimum depth of 6.49 m (88.91 m OD) and the deepest basement excavation extends to 88.18 m OD.
(Q1b) The proposed basement extends beneath the water table surface	As above.

Land Stability and Scoping Assessment

Potential Impact	Site Investigation Conclusions
(Q4) Wider area includes slopes with an angle between 7° and 10° – the development may cause instability	No evidence of slope movement was observed during the investigation and no conditions have been encountered that lead this site to be at an increased risk compared to any other sloping site.
(Q7) Seasonal shrink-swell can result in foundation movements and in particular if a new basement is dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties	The investigation has indicated that the site has a cover of made ground and naturally reworked clay, but that shrinkable clay is present within a depth that can be affected by tree roots. The subject property is however not structurally linked to adjacent properties.
(Q10) The site is located within an aquifer	Groundwater has been measured at a minimum depth of 6.49 m (88.91 m OD) and the deepest basement excavation extends to 88.18 m OD.
(Q12) Location of public highway – excavation of basement could lead to damage	The investigation has not indicated any specific problems, such as weak or unstable ground, voids, high water table, that would make working within 5 m of public infrastructure particularly problematic at this site.

Potential Impact	Site Investigation Conclusions
(Q13) Founding depths relative to neighbours – excavation may lead to structural damage to neighbouring properties if there is a significant differential depth between adjacent properties	The subject property is not structurally linked to adjacent properties, but consideration may need to be given to the impact of the new basement upon the existing basement at No 28 and the assumed shallow foundations at No 32 Ellerdale Road.

6.0 LAND STABILITY AND GROUNDWATER IMPACT ASSESSMENT

The screening identified a number of potential impacts. The results of the site investigation have therefore been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

(Q1a, Q1b) Site underlain by Secondary Aquifer / The proposed basement extends beneath the water table surface

The ground investigation has confirmed the presence of the Claygate Member beneath the site. Groundwater levels were established to be 6.49 m below ground level (88.91 m OD) and the revised plans show the proposed single storey basement to extend locally to 7.47 m (88.18 m OD) in the rear garden area to accommodate a new swimming pool. Although the groundwater level is above the proposed basement level in this area of the excavation, the Claygate Member strata does not support flow to any ponds or watercourses within 100 m of the site and it is not considered that the proposed basement will result in a significant change to the groundwater flow regime in the vicinity of the proposal.

(Q4) Retaining Walls and wider hillside setting

The existing retaining walls are located in the rear garden and the retained height is not greater than 1.95 m at each terrace. The site itself slopes south-westwards towards Frognal and the adjacent UCS. The area to the west of the site includes slopes between 7° and 10°. This area is downslope of the development and the new basement will not affect the existing slopes.

(Q7) Seasonal Shrink-Swell

The Claygate Member is known to be susceptible to seasonal shrink-swell, predominantly as a result of tree root growth. There are no trees on or close to the site and none are proposed as part of the redevelopment. In any case the existing foundations have already been underpinned below what would be expected as a depth of influence of shrub vegetation. It is not considered that the shrink-swell issues in the local area have any bearing on the proposed development.

(Q10) The site is located within an aquifer

Although the groundwater level is above the proposed basement level in this area of the excavation, the Claygate Member strata does not support flow to any ponds or watercourses within 100 m of the site and it is not considered that the proposed basement will result in a significant change to the groundwater flow regime in the vicinity of the proposal.

(Q12) Location of public highway

The basement will be at least 5 m from the public highway to the east if it is kept within the footprint of the building. The basement excavation should not affect the highway. There is nothing unusual or exceptional in the proposed development that give rise to any concerns with regard to stability over and above any development of this nature. The existing foundations will need to be underpinned prior to construction of the basement or will need to be supported by new retaining walls.

(Q13) Founding depths relative to neighbours

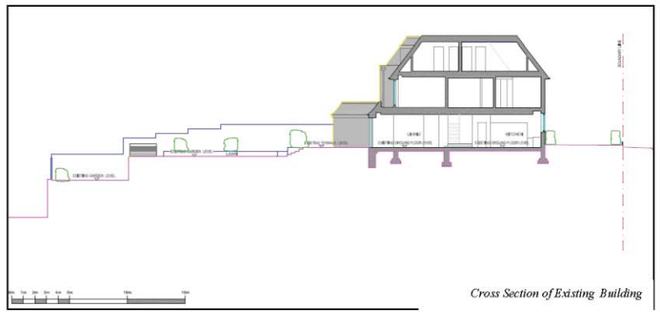
There is a single level basement at No28 and the depths of adjacent foundations at No 32 are not known, but they do not immediately abut the new basement excavation. The basement excavation can be readily managed using standard engineering solutions to ensure that the stability of the adjacent foundations is maintained. A ground movement analysis has been carried out based on the existing proposals to determine the likely building damage category as a result of the proposed basement excavation; the results are presented in Section 7.0 of this report. During construction it would be prudent to undertake a monitoring regime. Should movements be found to exceed the predicted magnitude further measures will need to be considered to maintain stability of the adjacent properties. The investigation has not highlighted any issues that give rise to concerns regarding the effectiveness of these normal engineering solutions at this particular site.

7.0 GROUND MOVEMENT ANALYSIS

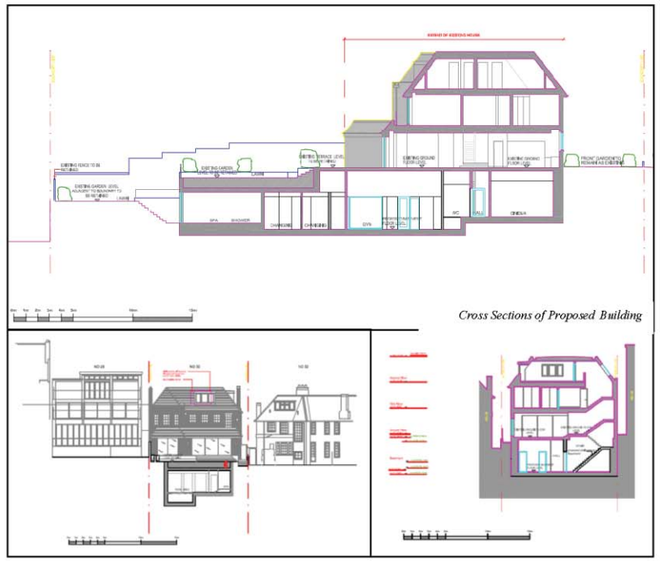
7.1 Proposed Development

It is proposed to construct a single storey basement to a maximum depth generally of 6.07 m, locally deepened to 7.47 m. It is understood the basement will be formed using reinforced concrete underpinning methods by means of a "hit and miss" approach. The basement will extend below the entire footprint of the existing two-storey property and part of the rear garden.

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.



Cross Section of Existing Building



Cross Sections of Proposed Building

7.2 Ground Movements

It is expected that settlement will occur at the proposed basement level as a result of the new underpins transferring the existing load from the building above to the Claygate Member at a greater depth than has hitherto been the case.

The lateral movement of material behind the new underpinned basement walls is unlikely to exceed 2 mm due to the construction process and anticipated stiffness of the walls, although this will depend on the workmanship and quality of the wall during construction.

The settlement will comprise an "immediate" component that may be expected to occur following loading of the soils, together with long term settlement due to consolidation of the clay that would theoretically occur over a period of many years. The excavation of the proposed basement will however result in heave of the underlying Claygate Member which is likely to reduce the estimated settlements.

7.3 Basis of analysis

Our analyses of potential ground movements has been carried out based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains.

The table below summarises the assumed soil profile used in the analysis. Soil profile levels are based on Borehole Nos 1 to 3 (see section appended), and the existing foundations are based on Trial Pit Nos 1, 2 and 4.

Soil Profile	Level of Base of Stratum (m OD)	Young's Modulus (E' - kN/m2)	Young's Modulus (E_u - kN/m2)	Unit Weight (γ- kN/m3)
Claygate Beds	-20.00	20250 to 90,000	33,750 to 150,000	19,50
* Strengths interpolated based upon an assumed linear strength profile.				

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. This relates values of E_u and E', the drained and undrained stiffness respectively, to values of undrained cohesion, as described by Padfield and Sharrock[3], Butler[4] and more recently O'Brien and Sharp[5]. For the purpose of this analysis, the following relationship has been adopted:

$Eu = 500\ c_u$ $\quad E' = 300\ c_u$

On the basis of the above we have determined values of stiffness from the undrained cohesion profiles described above. Drained and undrained parameters have been used throughout, to provide an estimate of the total 'long term' and 'short term' movement. More recently published data[6] suggests higher values, and predictions are therefore considered to be conservative.

As the basement excavations are relatively large the change in stress theoretically extends to a significant depth. However, with increasing depth the soil becomes relatively incompressible and we have therefore assumed that the soil is entirely incompressible to the rigid boundary at -20.00 m OD.

[3] Padfield CJ and Sharrock MJ (1983) *Settlement of structures on clay soils.* CIRIA Special Publication 27
[4] Butler FG (1974) *Heavily overconsolidated clays: a state of the art review.* Proc Conf Settlement of Structures, Cambridge, 531-578, Pentech Press, Lond
[5] O'Brien AS and Sharp P (2001) *Settlement and heave of overconsolidated clays - a simplified non-linear method.* Part Two, Ground Engineering, Nov 2001, 48-53
[6] Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension. CIRIA Special Publication 200

7.3.1 Assumptions:

1. Existing house loading = 130 kN/m², and distributes evenly to spread foundations;
2. Existing footings assumed to found onto Claygate Member;
3. Depth of existing footing = 650 mm;
4. Width of existing footing = 1000 mm;
5. Width of No 28 Ellerdale Road = 11.3 m, with building 1 m from site boundary;
6. Width of No 32 Ellerdale Road = 10.6 m, with building 1 m from site boundary;
7. Proposed underpins found at basement excavation level and will be cast immediately following excavation of the underpin;
8. Proposed underpins are 1 m wide and extend around the full perimeter of the basement; and
9. All depths taken from a conservative level of existing floor level of 95.65 m OD.

The basement for the majority is founded at a level of 89.58 m OD, with a local deepening within the rear garden area. It is anticipated that new underpins founding at a level of 89.58 m OD will result in an immediate settlement of about 7 mm. In addition, there will theoretically be an additional 15 mm of consolidation settlement that will occur over many years, but this will be offset by heave movements arising from the basement excavation.

The combination of the heave and settlement movements directly adjacent to Nos 28 and 32 Ellerdale Road will result in approximately 5 mm of heave movement in the short term, with an additional 5 mm to 10 mm of heave movement in the long term.

8.0 CONCLUSIONS

8.1 Basement Impact Assessment

A Land (or Slope) Stability and Groundwater Assessment has been carried out following the information and guidance published by the London Borough of Camden. Information from a Site Investigation has been used to assess potential impacts identified by the screening process.

It is concluded that standard safe working practices and measures that will be adopted to construct the basement mean that the proposed development is unlikely to result in any specific groundwater, land or slope stability issues.

8.2 Ground Movement Analysis

On the basis of these results for the total movements, the building damage assessments for the adjacent structures of Nos 28 and 32 Ellerdale Road fall within Category 2 of the Building Damage Assessment, indicating a slight class of damage which could include, for example, cracks up to 5 mm in width. All estimates of movement may be expected to have a tolerance of + / - 20 %, but this would still fall within Category 2.

8.3 Recommendations

It should be ensured that the Claygate Member will not be left unsupported during the excavation of the underpins and basement, but its ability to remain unsupported should be checked by trial excavation.

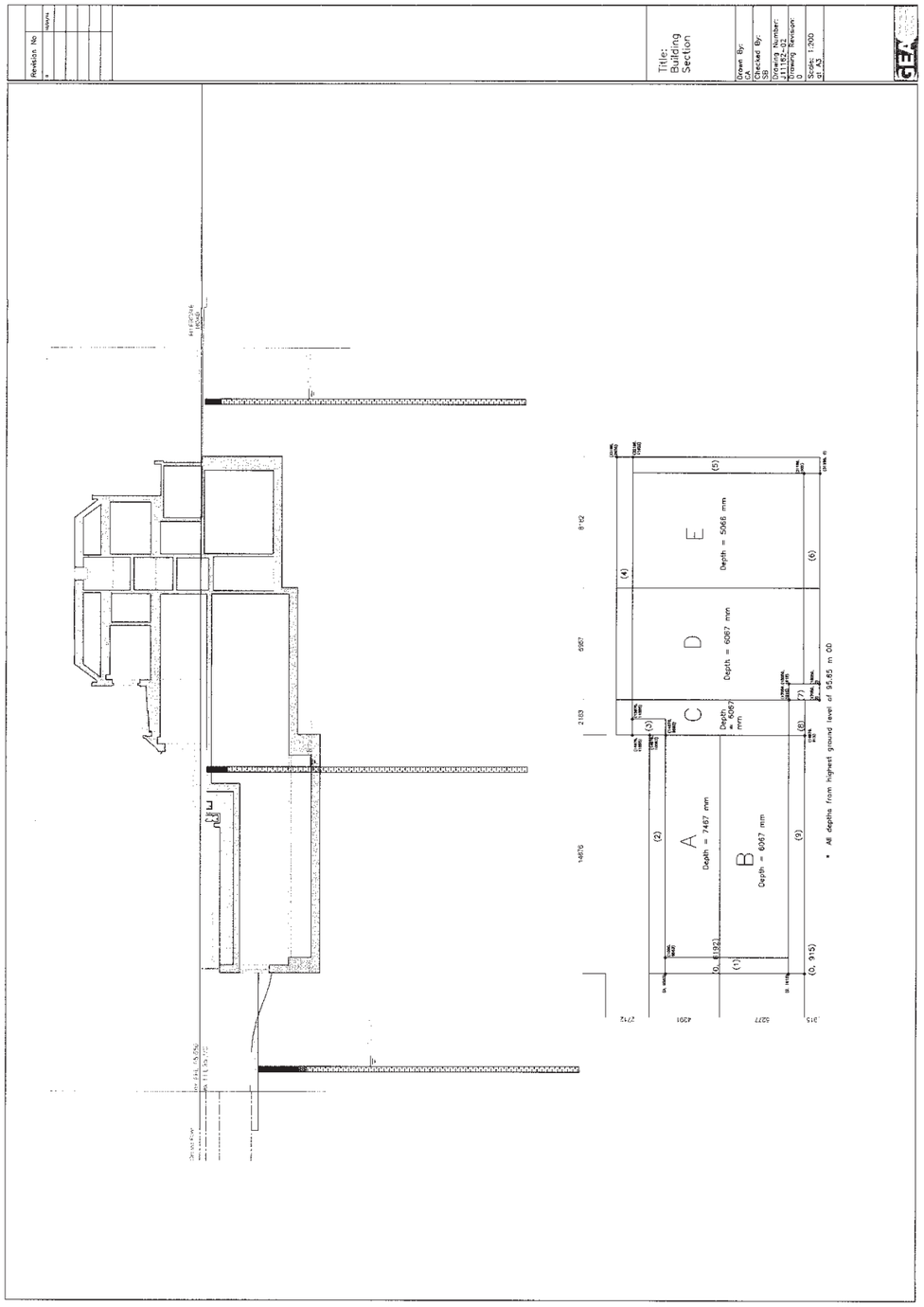
APPENDIX

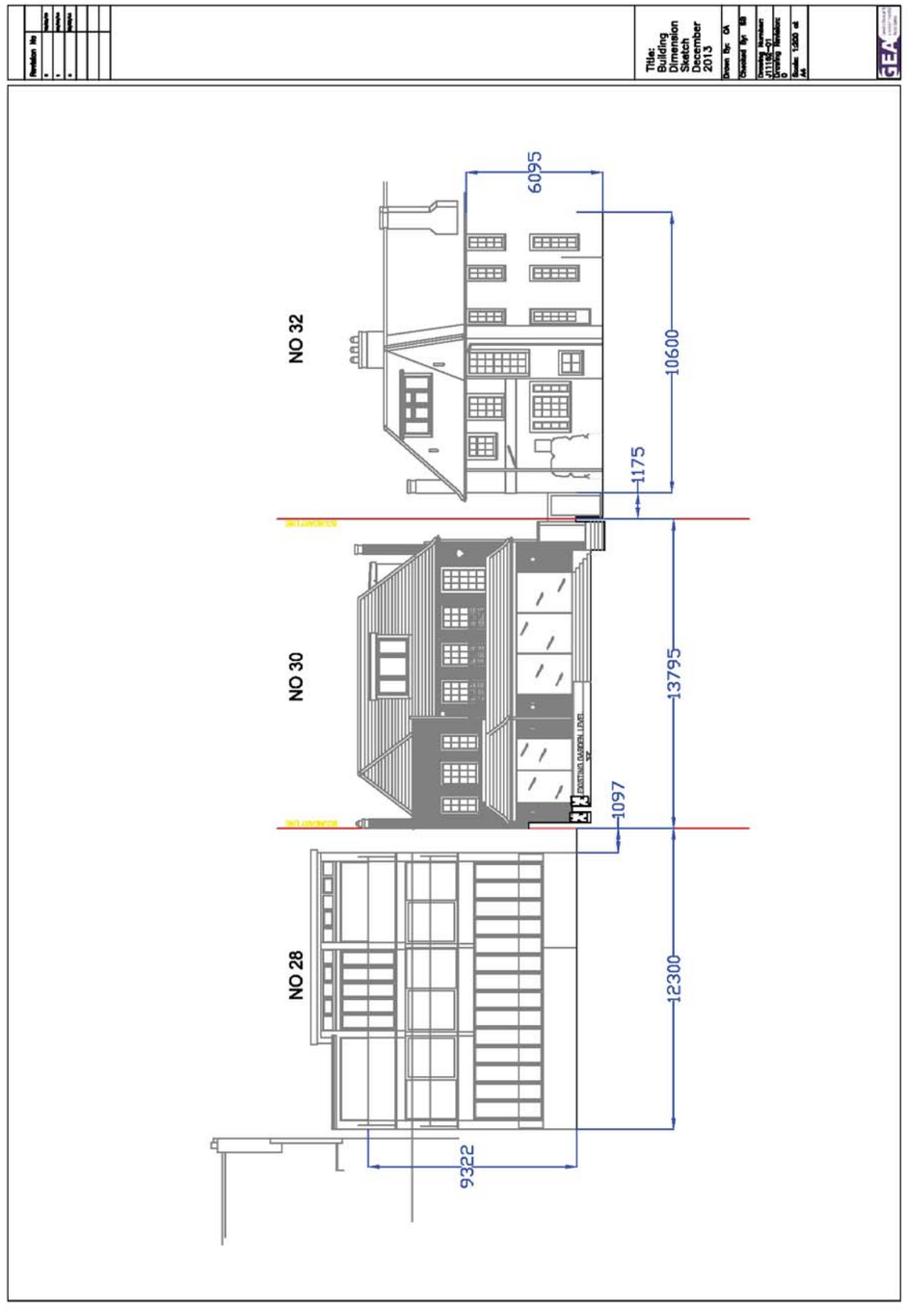
Site Elevation Drawing

Building Dimension Sketch

Manual Building Damage Assessment Calculation

Building Damage Interactive Map





GEA Geotechnical & Environmental Associates
Tyttenhanger House
Coursers Road
St Albans
Herts AL4 0PG

Calculation Sheet

Site	30 Ellerdale Road, London, NW3 6BB	**Date** 05/03/14	**Job No** J11162	**Sheet** 1 of 1
Title	Manual Building Damage Assessment Calculation	**Engineer** CA		
		Checked by SB		

No 28

Length, L = 11.3 m

Height, H = 9.3 m

L / H = **1.22**

$$\varepsilon_h = \frac{\delta h}{L} = \left(\frac{1.5}{11300}\right) \times 100$$

$$= \quad 0.013$$

$$\frac{\Delta}{L} = \left(\frac{9}{11300}\right) \times 100$$

(9 mm obtained from ground movement prediction at approximate point of neighbouring building)

$$= \quad 0.080$$

≈ Damage category 2

No 32

Length, L = 10.6 m

Height, H = 6 m

L / H = **1.77**

$$\varepsilon_h(\%) = \frac{\delta h}{L} = \left(\frac{1.5}{10600}\right) \times 100$$

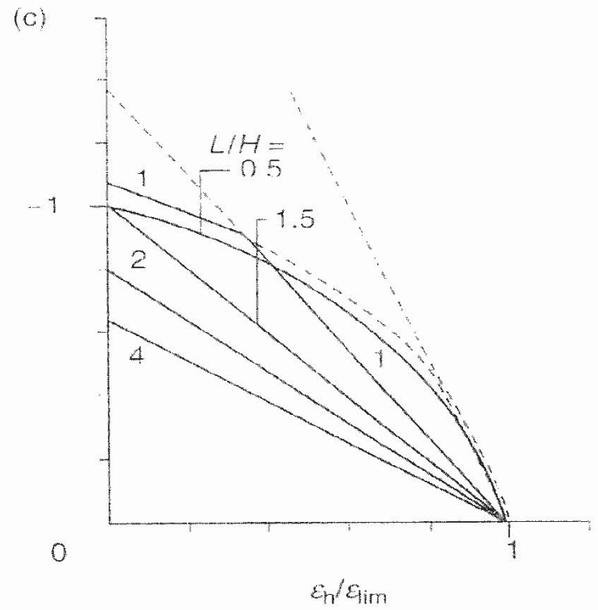
$$= \quad 0.014$$

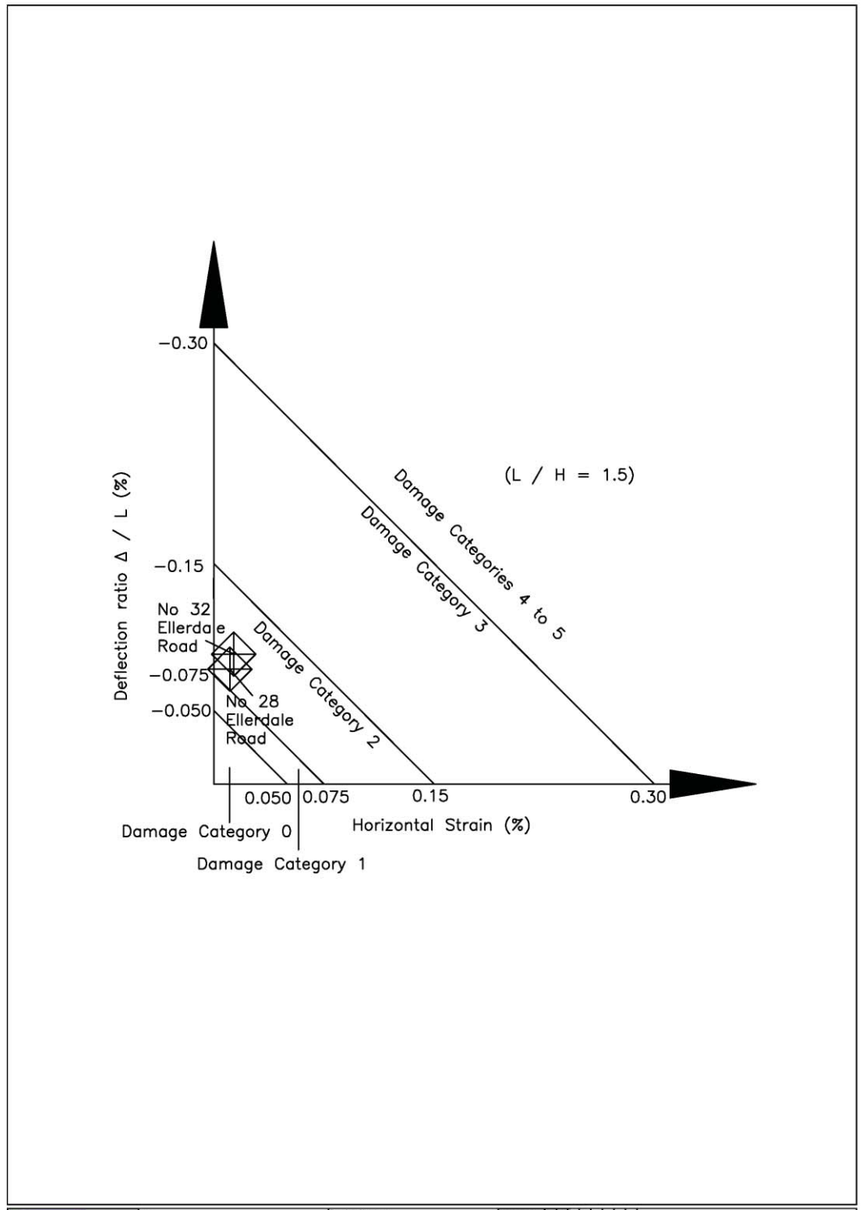
$$\frac{\Delta}{L}(\%) = \left(\frac{9}{10600}\right) \times 100$$

(9 mm obtained from ground movement prediction at approximate point of neighbouring building)

$$= \quad 0.085$$

≈ Damage category 2


(c)
L/H =
0.5
1
1.5
2
4
1
-1
0
1
$\varepsilon_h/\varepsilon_{lim}$


(L / H = 1.5)
Damage Categories 4 to 5
Damage Category 3
Damage Category 2
Deflection ratio Δ / L (%)
−0.30
−0.15
−0.075
−0.050
No 32 Ellerdale Road
No 28 Ellerdale Road
0.050
0.075
0.15
0.30
Horizontal Strain (%)
Damage Category 0
Damage Category 1
GEA Geotechnical & Environmental Associates
Title: Building Damage Interaction Map
Drawing Number: J11162-03
Drawing Revision: 3
Drawn By: CA
Checked By: SB
Revision No 0 1 2 3
Date of Issue

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We have offices at

Tyttenhanger House
Coursers Road
St Albans
AL4 0PG
tel 01727 824666
mail@gea-ltd.co.uk

Church Farm
Gotham Road
Kingston on Soar
Notts
NG11 0DE
tel 01509 674888
midlands@gea-ltd.co.uk

Enquiries can also be made on-line at
www.gea-ltd.co.uk
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