Job Number: 150525

CROFT STRUCTURAL ENGINEERS

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Basement Impact Assessment

Property Details

35 Greville Road
London
NW6 5JB

Client

Igor Goighberg

Structural Design Reviewed by Chris Tomlin MEng CEng MIStructE	**Above Ground Drainage Reviewed by** Phil Henry BEng MEng MICE
Ground Water Impact Assessment Hannah Fraser CGeol [Separate report]	**Land Stability Report** Jon Smithson CGeol [Separate Report]
Report compiled by Noma Manzini MEng BEng	

Revision	Date	Comment
-	Aug 2015	First issue
1	Sep 2015	Second issue
2	Feb 2016	Various alterations

LABC Regional winner 2013 awards · constructionline · TRADA · ice · The Institution of Structural Engineers

Contents

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Executive Summary / Non-technical Summary

The London Borough of Camden requires a Basement Impact Assessment (BIA) to be prepared for developments that include basements and lightwells. This document forms the main part of the BIA and gives details on the impact of surface water flow. The scheme design for the proposed subterranean structure is also included.

This document should be used in conjunction with the Land Stability BIA (dated July 2015) and the Groundwater BIA (dated 17 August 2015, Ref. 30092R1D1). These are separate reports and are referred to, where relevant, within this document.

This BIA follows the requirements contained within Camden Council's planning guidance CGP4 – Basements and Lightwells (2015). In summary, the council will only allow basement construction to proceed if it does not:

- cause harm to the built or natural environment and local amenity
- result in flooding
- lead to ground instability.

In order to comply with the above clauses, a BIA must undertake five stages detailed in CPG 4. This report has been produced in line with Camden planning guidance and associated supporting documents such as CPG1, DP23, DP26, DP25 and DP27. Technical information from 'Camden geological, hydrogeological and hydrological study - Guidance for subterranean development', Issue 01, November 2010 (GSD, hereafter) was also used and is referred to in this assessment.

Project Summary

Description of Property

The existing property is a detached house. The main entrance of the property is accessed from Mortimer Crescent, which branches off Greville Road. The building has three stories and a loft storage space area. Load bearing masonry walls transfer the weight of the building and the imposed loads to the foundations. The existing Lower Ground floor level is approximately 1.6 metres below ground level.

Figure 1: Side elevation, viewed from South-west

Proposed Works

The proposed works require the construction of a new basement below the existing building. This will also extend part way below the garden and include:

- Light wells to the front and side
- Roof slab and soil cover over the basement in the garden
- SUDS (Storm water storage above the garden area)

Croft Structural Engineers Ltd has extensive knowledge of constructing new basements. Over the last 10 years Croft Structural Engineers has been involved in the design of over 500 basements in and around London. The outline method to be used at 35 Greville Road is:

1. Partially demolish existing garden lightwell retaining wall batter back soil to form access slope for mini-piling rig to access existing Lower Ground Floor from Garden level.

2. Place a contiguous pile wall along the perimeter of the proposed basement. Needle and prop for temporary openings in existing walls, where access is required for rig.

3. For piling along northern perimeter of proposed basement, needle, prop and demolish for openings in the internal walls to allow for piling from ground level.

4. Excavate to formation level, below the existing Lower Ground Floor slab, within the piled perimeter. Safely and securely support the existing building above and prop the piled wall at the head as the excavation progresses.

5. Construct the foundations for the internal columns, the basement

	slab and the inner reinforced concrete walls. 6. Erect the new Basement to Lower Ground Floor steel support structure below existing Lower Ground Floor 7. Construct reinforced concrete ceiling slab over basement in in garden. 8. Waterproof internal space with a drained cavity system. 9. Proceed with the construction of structural items above Lower Ground floor level (lightwell walls…etc).
Stage 1 – Screening	Screening identified areas of concern and concluded a requirement to proceed to a scoping stage to assess issues relating to land stability, hydrogeology, surface water flow and flooding.
Stage 2 – Scoping	The Scoping stage identified the potential impacts and set the parameters required for further study. This included areas that should be given special attention during the site investigation.
Stage 3 – Site investigation and study	The property was inspected: a walk over survey of the site and the surrounding area was completed by an engineer. The information from this was used to formulate the requirements for a ground investigation and also, where possible, to corroborate data that would be gathered from a desk study. Visual inspections were completed of the adjacent properties to determine if there were signs of structural movement. The adjacent property, No 37 Greville Gardens, is believed to have a basement. A ground investigation was completed. Laboratory testing was undertaken on the soil samples. Ground water was measured over repeat visits to determine water levels. The following was identified: • London Clay Formation • Perched water was found at a maximum height of 0.85m below ground level.
Stage 4 – Impact assessment	**Land Stability** The Geologist has concluded that the construction of the basement should not have significant impacts on land stability provided that: • Groundwater inflow, if encountered is properly controlled • The construction of the basement is carried out by a competent

	building contractor who will adopt suitable measures to maintain the stability of the excavations • Care is taken to minimise disturbance to trees and their roots. • Concrete is designed to account for the sulphate conditions anticipated. • Monitoring of the structures is carried out before and during construction. • The ground movement assessment of the basement construction has been assessed as 'Very Slight' to 'Slight'. **Hydrogeology** There is potential for ground water backing up around the structure. This can be mitigated by ensuring that a permeable layer of soil is maintained near the ground surface (around the perimeter) to facilitate ground water drainage pathways around the structure. During construction there is potential of groundwater inflow into the excavations. Suitable dewatering measures should be adopted. The design of the basement structure should account for the varying levels in of moisture in the ground, in terms of structural stability and waterproofing. Groundwater levels should be monitored before and during construction. **Surface Water Flow & Flooding** Examination of Environment Agency data shows that the site is not situated in a zone which is at risk of surface water flooding from rivers or seas. There will not be a significant increase in hard-surfaced areas. There will be no notable impacts on surface water flow within or around the site.

1. Screening Stage

Camden Council stipulates that any subterranean development proposal should be screened to determine whether a full BIA is required.

The screening stage gives a brief description of the project and identifies areas of concern that will require further investigation.

Description of Property

The site comprises a three storey house with a garden to the side. Over half of the site area is taken up by a soft landscaped garden. The main entrance faces Mortimer Crescent. Vehicular access to the site is from this road. The lowest floor (Lower Ground Floor) is 1.6m below ground level.

Figure 2: Aerial view with approx. site area indicated

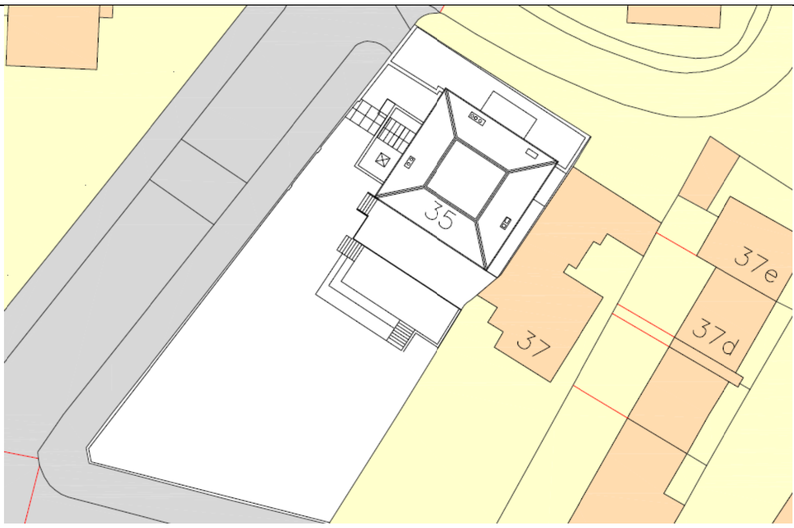

Figure 3: Architect's plan showing site location

The nearest neighbouring property is No 37 Greville Road. There is a boundary wall between the two properties.

Proposed Development

The proposed development involves the construction of a new basement below the existing building.

The outline method to be used at 35 Greville Road is:

1. Partially demolish existing garden lightwell retaining wall batter back soil to form access slope for mini-piling rig to access existing Lower Ground Floor from Garden level.

2. Place a contiguous pile wall along the perimeter of the proposed basement. Needle and prop for temporary openings in existing walls, where access is required for rig.

3. For piling along northern perimeter of proposed basement, needle, prop and demolish for openings between garage, storage room and gym to allow for piling from ground level.

4. Excavate to formation level, below the existing Lower Ground Floor slab, within the piled perimeter. Safely and securely support the existing building above and prop the piled wall at the head as the excavation progresses.

5. Construct the foundations for the internal columns, the basement slab and the inner reinforced concrete walls.

6. Erect the new Basement to Lower Ground Floor steel support structure below existing Lower Ground Floor

7. Construct reinforced concrete ceiling slab over basement in in garden.

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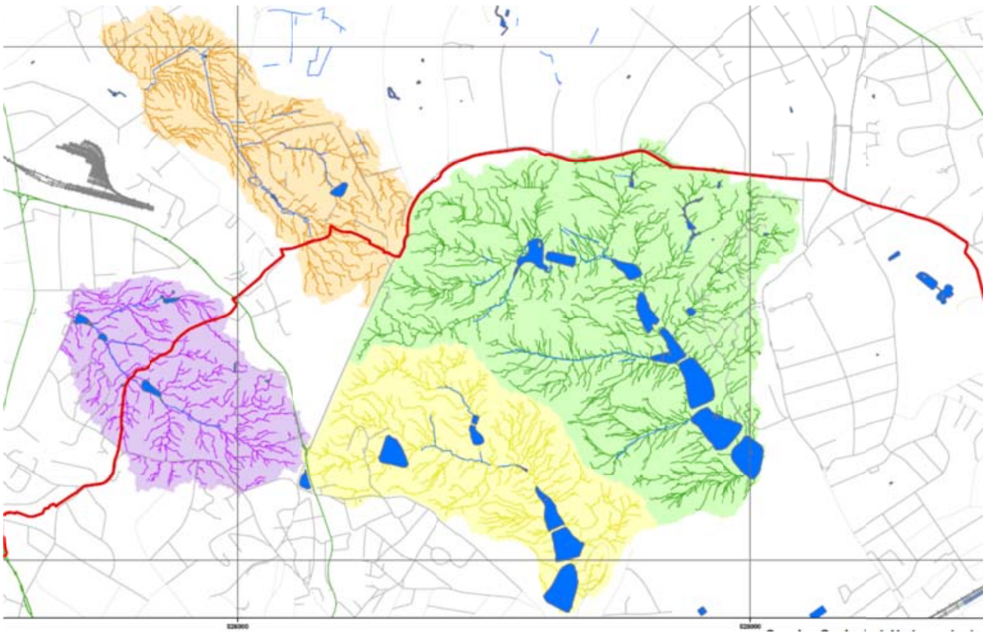
	8. Waterproof internal space with a drained cavity system. 9. Proceed with the construction of structural items above Lower Ground floor level (lightwell walls...etc). A detailed method statement is proposed and appended.
Land Stability	Refer to the assessment on Land Stability (dated July 2015)
Subterranean Flow	Refer to the assessment on Groundwater (dated 17 August 2015, Ref. 30092R1D1)
Surface Flow and Flooding	The questions below are taken from *Camden CPG 4 – Basements and Lightwells*.
	Question 1: Is the site within the catchment of the pond chains on Hampstead Heath?  *Figure 4: Extract from Figure 14 of the GSD (site lies to the south of the shaded areas)* **No**. The site lies outside the areas denoted by Figure 14 of the GSD (extract shown above)
	Question 2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route? **No** – The surface water that flows from the proposed development will be

routed the same way as before.

Question 3. Will the proposed basement development result in a change to the hard surfaced / paved external areas?

Yes –There may be a minor increase in hardstanding due to the construction of additional lightwells for the new basement in the garden. In proportion to the area of the site, this increase is not likely to be significant.

Question 4. Will the proposed basement result in changes to the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?

No. Any additional surface water captured by the new development (ie new lightwells) may enter the existing drainage system. This will not cause any changes to the inflows of surface water received by other properties.

Question 5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?

No. Collected surface water will be from building roofs and paving, as before. The quality of the water received downstream will therefore not change.

Question 6 : Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk from flooding, for example because the proposed basement is below the static water level of nearby surface water feature?

The potential sources of flooding are summarised below:

Potential Source	**Potential Flood Risk at site?**	**Justification**
Fluvial flooding	No	EA Flood Mapping shows Flood Zone 1. Distance from nearest surface watercourse >1km
Tidal flooding	No	Site location is 'inland' and topography > 30mAOD.
Flooding from rising / high groundwater	No	Site is located on low permeability London Clay.
Surface water (pluvial) flooding	No	35 Greville Road is not noted on the flood street list and maps from 1975 or 2002

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Flooding from infrastructure failure	Yes	Drainage at or near the site could potentially become blocked or cracked and overflow or leak. Drainage of the basement terrace areas may rely on pumping.
Flooding from reservoirs, canals and other artificial sources	No	There are no reservoirs, canals or other artificial sources in the vicinity of the site that could give rise to a flood risk.

The answers to Questions 1-5 above indicate that the issues related to surface water flow and flooding are not significant.

In answering Question 6, a flood risk assessment is not considered necessary: the property is not on a street that has flooded in 1975 or 2002 and there are no risks to flooding that are greater than those inherent with all subterranean structures. However, the risks associated with infrastructure failure should be investigated further. The assessment, with regards to Surface Water Flow, should be carried forward to Scoping Stage.

2. Scoping Stage

	This stage identifies the potential impacts of the areas of concern that were highlighted in the Screening phase.
Land Stability	Refer to the assessment on Land Stability (dated July 2015)
Subterranean Flow	Refer to the assessment on Groundwater (dated 17 August 2015, Ref. 30092R1D1)
Surface Flow & Flooding	There will be a very minor increase in surface flow due to the addition of hardstanding. This is within the lightwells and may result in a partial increase in the discharge of water into the existing drainage system. It is evident from the screening study that the only significant flood risks at this property are due to the failure of existing sewers in the vicinity of the site. The flow paths of surface water around the property should be investigated further. <u>Carry forward to Site Investigation & Desk Study</u>

3. Site Investigation and Study

This section identifies the relevant features of the site and its immediate surroundings, providing further scoping where required.

Site, Local Topography & External Features

Desk Study and Walkover Survey

The property is located in a built up and is in the St John's Wood conservation area. Mature trees are present in the vicinity. The surrounding area is relatively flat.

Noma Manzini, a Structural Engineer from Croft Structural Engineers, visited the site on 8th June 2015 to observe and report the salient features required for the impact assessment.

The site comprises a residential building with a garden and has a combined footprint area of approximately 800m^2. At least half of the site is taken up by a soft landscaped garden. There are mature trees present.

Figure 5: South-west elevation

	 *Figure 6: View of garden, looking towards south-west* The building is constructed from masonry walls, which transfer the loads from the roof and floors to the foundations. There is one adjoining residential property. This is No 37 Greville Road. There are other properties close by. These buildings are further than 20m from the site boundary. The main entrance to the site is accessed from Mortimer Crescent.
Proposed Development	The proposed development involves the construction of a new basement below the existing building. Part of the basement will extend below the garden. With the exception of roof-lights to this structure, this part of the basement will be covered with soil. Architectural drawings showing the proposed layout are produced by FK Project Management Ltd and are submitted separately. The new basement level will be approximately 4.3m below ground level. The anticipated excavation level for the basement slab will be approximately 4.8m below ground level.
Site History	**What was the previous usage of the site?**

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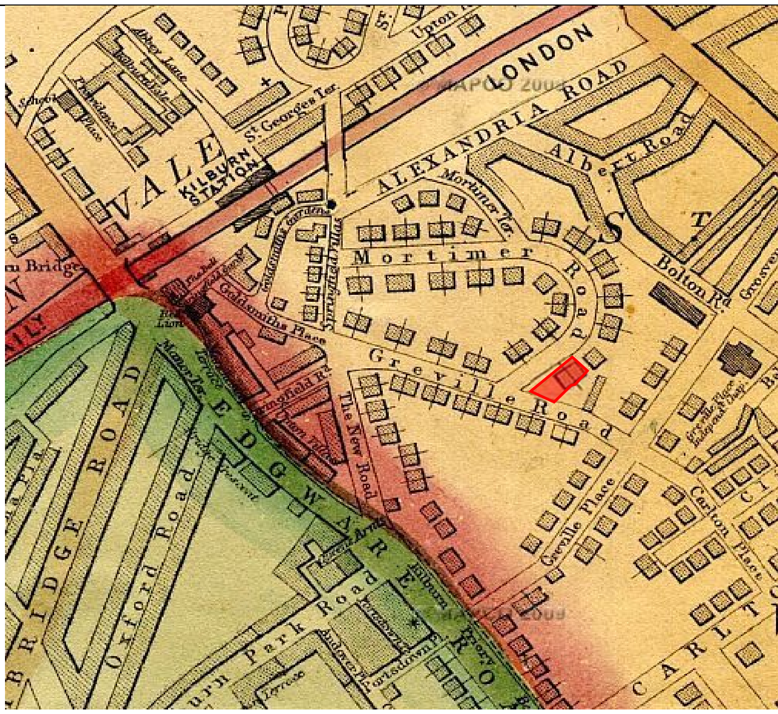

Figure 7: Map of London 1868 - Edward Weller

The site and vicinity have been residential for over a hundred years.

Local Bombing

A high-explosive bomb is recorded in the Aggregate Night Time Bomb Census as having been dropped between 7 October 1940 and 6 June 1941, close to the site. The property did not experience a direct hit.

Figure 8: Bomb sight map

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<table>
<tr><td></td><td></td></tr>
<tr><td>Listed Buildings and Conservation Areas</td><td>

Data from Historic England shows that that the existing building is not listed. However, the same source indicates that No 37 Greville Road is a listed building

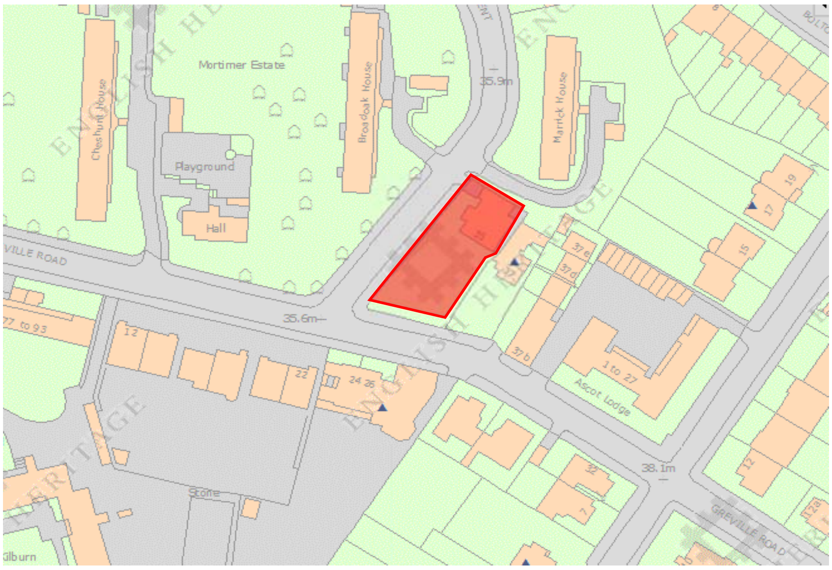

Figure 9: Extract showing listed buildings(indicated with a triangle)

The site is on the edge of a St Johns Wood conservation area. In accordance with CPG4, as the property is in a conservation area, the contractor should develop a suitable management plan for demolition and construction in line with guidance contained within CPG6. This is not included with this document and is not within the Croft Structural Engineer's Brief. The contractor should be expected to prepare such a plan at detailed design stage. The contractor should also register the site and the works with the Considerate Constructors Scheme (CCS).

</td></tr>
<tr><td>Highways, National Rail and London Underground</td><td>

The basement wall will be further than 5m away from the public highway.

The site is more than 30m away from the nearest train line.

</td></tr>
<tr><td>UK Power Networks</td><td>

There are no significant items of electrical infrastructure or assets belonging to utility/power companies (such as pylons or substations) in the immediate vicinity.

</td></tr>
<tr><td>Vicinity of Trees</td><td>

Trees and shrubbery occupy the site. There are mature trees close to the south-western boundary. There is also a large tree close to the proposed lightwell.

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</table>

Building Defects	A visual inspection was undertaken of the existing building, with particular attention given to any suspected associated movement. The defects noted were: • Fine cracking was noted above ground floor door lintel • Fine to moderate cracking was noted on the garage walls  *Figure 10: Cracking on garage walls* These cracks are believed to be non-structural. Further investigation should be carried out at detailed design stage to determine the extent of these cracks.
Geology	The site is on made ground (approximately 600mm deep) overlying London Clay. The existing Lower Ground floor extends into the London Clay. Refer to the Ground Investigation report Land Stability assessment for more details of the ground conditions.

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Adjacent Properties

The closest neighbouring property is No 37 Greville Road.

Figure 11: Areal map of 35 Greville Road and 37 Greville Road

Besides this, the next closest properties are blocks of flats on Mortimer Crescent (Broadoak House and Marrick House). These properties are approximately 20m away and are not considered as 'directly affected neighbours'.

During the structural engineer's site visit, the external facades of No 37 Greville Road were inspected.

No 37 Greville Road

No 37 Greville Road is a detached two storey residential property. The main building dates from the mid-nineteenth century and is constructed from brickwork and timber. Extensions have been added since the original construction. The building is Grade II listed. The front entrance of the property faces Greville Road.

Figure 12: 37 Greville Road front/side corner elevation

Figure 13: 37 Greville Road - rear (north)elevation

There were applications for the construction of a basement in 2010 (Applications Numbers 2010/5861/P and 2010/5948/L. Permission for this was granted on 28 March 2011. It is not known whether this was constructed. Drawings from this, showing a proposed basement, are shown below.

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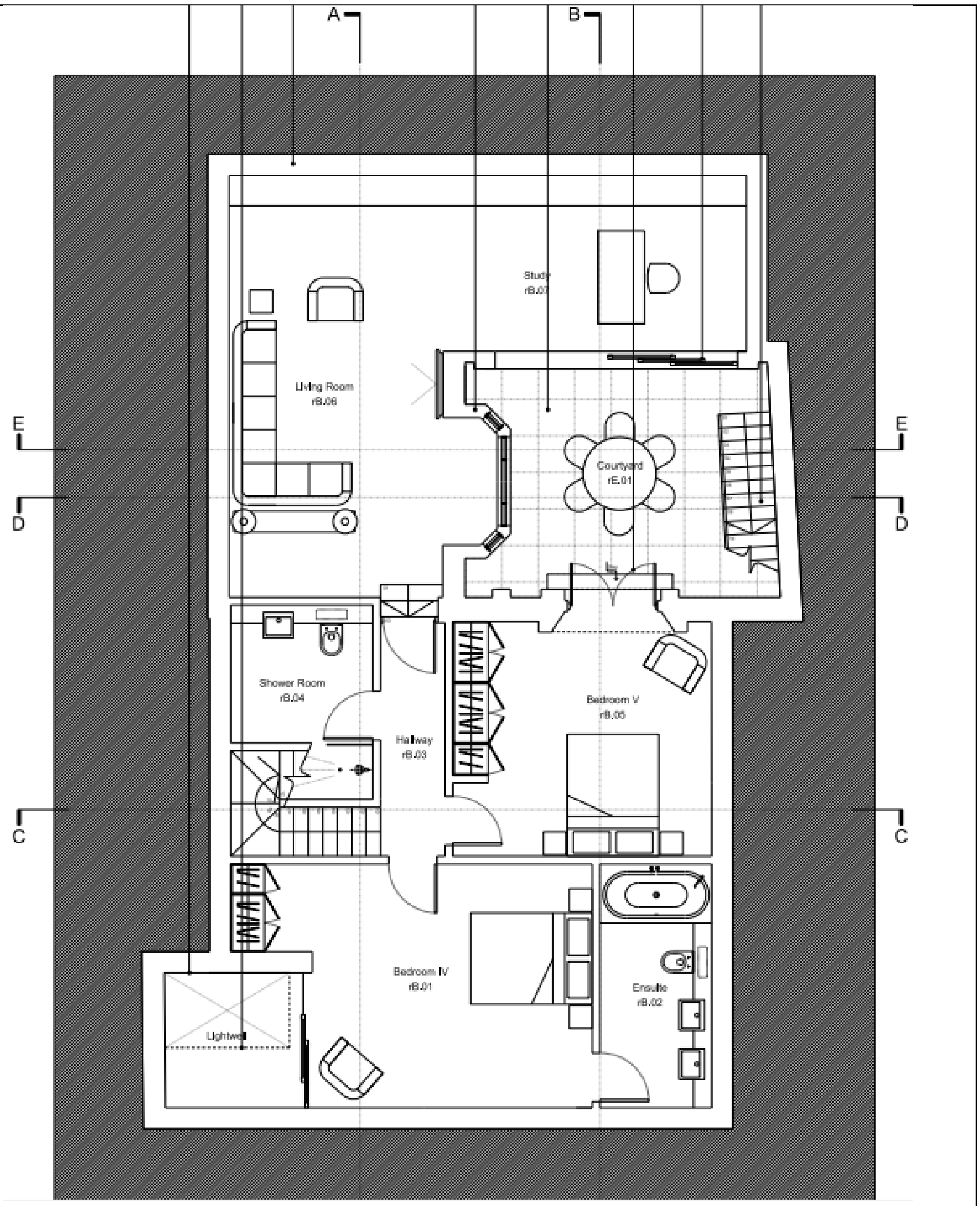

Figure 14: 37 Greville Road Proposed Basement Plan from planning application

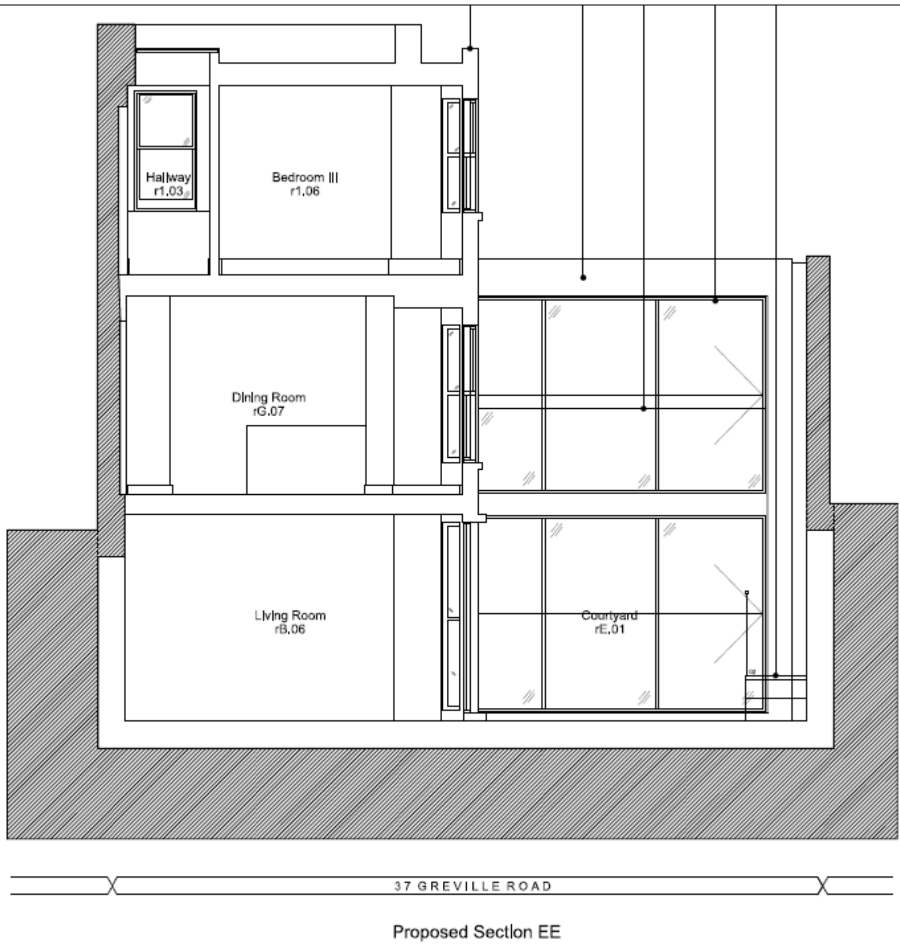

Figure 15: 37 Greville Road Proposed Section from planning application

Monitoring, Reporting and Investigation

The ground investigation report, which has data from initial site investigations and data from subsequent groundwater monitoring, is available as a separate report.

Ground Investigation

Ground Investigation Brief	The ground investigation was completed by Ground & Water Ltd. From the Scoping stage Croft considered that the brief should cover: • One borehole to a depth of 6m below ground level. • Stand pipe to be inserted to monitor ground water record initial strike and the water level after 1 month. • Site testing to determine in-situ soil parameters. SPT testing to be undertaken. • Laboratory testing to confirm soil make up and properties. • The Historic maps and walk over survey did not highlight any significant contamination sources, therefore no site test of the ground has been requested. • Factual Report on soil conditions. • Interpretative reports • Calculation of bearing pressures from SPT. • Indication of Ø (angle of friction) from SPT. • Indication of soil type Refer to the ground investigation report by Ground & Water Ltd [Ref. GWPR1303/GIR], which is submitted as a separate document.

Land Stability	Refer to the assessment on Land Stability (dated July 2015) for land stability issues addressed to Stage 3.
Subterranean Flow	Refer to the assessment on Groundwater (dated 17 August 2015, Ref. 30092R1D1) or hydrogeological issues addressed to Stage 3.
Surface Flow & Flooding	A walk over survey has confirmed that there are no surface water features, either within or close to the site. The survey also confirmed that the areas of the site that are not occupied by the building are soft-landscaped. The combined existing soft-landscaped area is approximately 400m^2.

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4. Basement Impact Assessment

Subterranean Flow	Refer to the assessment on Land Stability (dated July 2015). Conclusions re stated in the Non-technical Summary
Land Stability	Refer to the assessment on Groundwater (dated 17 August 2015, Ref. 30092R1D1). Conclusions re stated in the Non-technical Summary.
Surface water flow and flooding	As described in previous sections, there is an abundance of soft landscaping on the site. This will be left largely unaltered, and will allow the rainwater to discharge directly into the ground as before. There will be a minor loss in this capacity due to the lightwells. However, in relation to the size of the site, this is not significant. The most significant risks of flooding are those to the basement itself. These risks are inherit in all subterranean structures, such as flooding due to unexpected failure of the drainage, water mains, etc. For this reason, Croft would recommend the following measures to reduce these risks: • To reduce the likelihood of flooding into the lightwells, these should be designed (at detailed design stage) with upstands above ground level. • A pumping mechanism with a non-return valve should be installed for the proposed basement. There is a likelihood that this may fail and allow excess water to accumulate. If this were to occur, the build-up of water would be gradual and noticeable before it becomes a significant life-threatening hazard. • Install a dual pumping system to maintain operation in the event of a failure. This should include a battery backup and a suitable alarm system for warning purposes. There is a risk of flooding due to the failure of the pumping system but this can be reduced to acceptable levels with appropriate design and installation measures. SUDS aims to mimic the route that rainwater would take in a natural environment. In this development this is achieved by ensuring that there is a soil cover above the basement ceiling, where it extends into the garden.
Misc	There is a mature tree close to the proposed lightwell. This will require relocation or substitution using the same species. There is a Horse Chestnut tree on the southern boundary of the site. This will not be affected by the works

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Ground Movement Assessment & Predicted Damage Category

This assessment covers movements relating to the construction of the piled retaining walls. The design and construction methodology aims to limit damage to the existing building on the site, and to the neighbouring buildings, to Category 2 or lower as set out in Table 2.5 of CIRIA report C580. For construction that may result in damage within Category 1 or Category 2, Camden Council's CPG4 (2015) requires mitigation measures to be included with the proposed scheme. For this development, the proposed measures are in the form of suitable temporary propping during the construction phase. This is described in the Basement Method Statement (appended).

The ground movement assessment is contained within the Land Stability BIA (July 2015).

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Mitigation Measures

A method statement, appended, has been formulated with Croft's experience of over 500 basements completed without error. As mentioned previously, the procedures described in this statement will mitigate the impacts that the construction of the basement will have on nearby properties.

The works must be carried out in accordance with the Party Wall Act and condition surveys will be necessary at the beginning and the end of the works. The Party Wall Approval procedure will reinforce the use of the proposed method statement and, if necessary, require it to be developed in more detail with more stringent requirements than those required at planning stage.

It is not expected that any cracking will occur in nearby structures during the works. However, Croft's experience advises that there is a risk of movement to the neighbouring property.

To reduce the risk to the development:

- Employ a reputable firm that has extensive knowledge of basement works.
- Employ suitably qualified consultants Croft Structural Engineers has completed over 500 basements in the last five years.
- Provide method statements for the contractors to follow
- Investigate the ground this has now been done.
- Record and monitor the properties close by. This is completed by a condition survey under the Party Wall Act, before and after the works are completed. Refer to the end of the appended Basement Construction Method Statement.

With the measures listed above, the maximum level of cracking anticipated is 'Hairline' cracking. This can be repaired with normal decorative works. Under the Party Wall Act, minor damage, although unwanted, can be tolerated it is permitted to occur to a neighbouring property as long as repairs are suitability undertaken to rectify this. To mitigate this risk, the Party Wall Act is to be followed and a Party Wall Surveyor will be appointed.

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Monitoring

In order to safeguard the existing structures during underpinning and new basement construction, movement monitoring is to be undertaken.

Risk Assessment

Monitoring Level proposed	Type of Works.
Monitoring 1 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works.	Loft conversions, cross wall removals, insertion of padstones Survey of LUL and Network Rail tunnels. Mass concrete, reinforced and Piled foundations to new build properties
Monitoring 2 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate.	Removal of lateral stability and insertion of new stability fames Removal of main masonry load bearing walls. Underpinning works less than 1.2m deep
Monitoring 3 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment	Lowering of existing basement and cellars more than 2.5m Underpinning works less than 3.0m deep in clays Basements up to 2.5m deep in clays

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	Monitoring 4 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment Lateral movement between walls by laser measurements	New basements greater than 2.5m and shallower than 4m Deep in gravels Basements up to 4.5m deep in clays Underpinning works to grade I listed building
	Monitoring 5 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & Lateral monitoring movement by theodolite at specific times during the projects.	Underpinning works to Grade I listed buildings Basements to Listed building Basements deeper than 4m in Gravels Basements deeper than 4.5m in clays Underpinning, basements to buildings that are expressing defects.
	Monitoring 6 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & Lateral monitoring	Double storey basements supported by piled retaining walls in gravels and soft sands. (N<12)

	movement by electronic means with live data gathering. Weekly interpretation	
	Monitoring 7 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & Lateral monitoring movement by electronic means with live data gathering with data transfer.	Larger Multi storey basements on particular projects.
Monitoring Conclusion	The level of monitoring Croft recommends for this development is:	
	Monitoring 4 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment Lateral movement between walls by laser measurements	New basements greater than 2.5m and shallower than 4m Deep in gravels <u>Basements up to 4.5m deep in clays</u> Underpinning works to grade I listed building
	Before the works begin, a detailed monitoring report is required to confirm the implementation of the monitoring. The items that this should cover are: • Risk Assessment to determine level of monitoring	

	• Scope of Works • Applicable standards • Specification for Instrumentation • Monitoring of Existing cracks • Monitoring of movement • Reporting • Trigger Levels using a RED AMBER GREEN System Recommend levels are shown within the proposed monitoring statement (appended).

Basement Design & Construction Impacts and Initial Design Considerations

Structural Scheme

A reinforced concrete slab and a contiguous piled wall will form the new foundation of the property.

The investigations highlight that water is present. The walls are designed to cope with the hydrostatic pressure. It is possible that a water main may break causing a local high water table. To account for this, the wall is designed for water at full height.

The detailed design should consider floatation as a risk. However, by inspection, the weight of the building is likely to be greater than the uplift forces from the water, resulting in a stable structure.

The site is not within 5m of a road surface the basement wall is further away. There is therefore no need to apply highways loading as a surcharge.

Drawings are appended. The details given on these should not be used for construction: detailed design will follow, after the planning application process.

Intended use of structure and user requirements

Family/domestic use

Loading Requirements (EC1-1)

	UDL kN/m²	Concentrated Loads kN
Domestic Single Dwellings	1.5	2.0

Part A3 Progressive collapse

Number of Storeys 4 over basement

Is the Building Multi Occupancy? No

Class 1	Single occupancy houses not exceeding 4 storeys
Class 2A	5 storey single occupancy houses

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<table>
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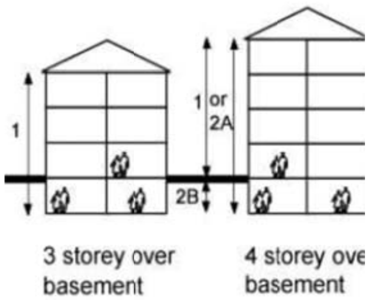
To NHBC guidance compliance is only required to other floors if a material change of use occurs to the property.

<table>
<tr><td>Initial Building Class</td><td>1</td></tr>
<tr><td>Proposed Building Class</td><td>2A</td></tr>
<tr><td>If class has changed material change has occurred</td><td>No</td></tr>
</table>

<u>Class 2A – Design provision of effective horizontal ties or , or effective anchorage of suspended floor to walls</u>



</td></tr>
<tr><td>Exposure and wind loading conditions</td><td>Basic wind speed V_b = 21 m/s to EC1-2
Topography not considered significant.</td></tr>
<tr><td>Stability Design</td><td>The inner reinforced concrete walls should be suitable for resisting the lateral earth pressures the piles should be designed to resist the vertical loads.</td></tr>
<tr><td>Lateral Actions</td><td>Lateral loads will be applied from retained soil and from hyrdrostatic forces.

Lateral pressures from surcharge loads will also be applied.</td></tr>
<tr><td>Retained soil Parameters</td><td>Design overall stability to K_a & K_p values. Lateral movement necessary to achieve K_0 mobilisation is height/500 (from Tomlinson). This is tighter than the deflection limits of the concrete wall.</td></tr>
<tr><td>Water Table</td><td>A ground investigation has been carried out. This has included ground water monitoring. The highest ground water reading was at approximately 0.9m below ground level.
As described previously, the lateral loading on the basement structure will account for water to the full height of the basement.</td></tr>
<tr><td>Drainage and Waterproofing</td><td>Drainage and damp-proofing is by others: details are not provided within Croft SE's brief.

It is recommended that a water proofing specialist is employed to ensure all the water proofing requirements are met. Croft SE is neither the</td></tr>
</table>

	waterproofing designer nor is acting as the structural waterproofing designer. The waterproofing specialist must name their structural waterproofer. The structural waterproofer must inspect the structural details and confirm that he is happy with the robustness. Due to the segmental construction nature of the basement, it is not possible to water proof the joints. All water-proofing must be made by the waterproofing specialist. He should review Croft's details and advise if water bars and stops are necessary. The waterproofing designer must not assume that the structure is watertight. To help reduce water flow through the joints, the following measures should be applied: • All faces should be cleaned of all debris and detritus • Faces between concrete segments should be needle hammered to improve key for bonding • All pipe work and other penetrations should have puddle flanges or hydrophilic strips
Localised Dewatering	Localised dewater to pins may be necessary. Some engineers may raise the theoretical questions about pumping of water causing localised settlement. We believe that this argument is a red herring when applied to single storey basements and our reason for stating this is: • The water table in the area is variable, • The water level naturally rises and falls over time and does not lead to subsidence • The water table has naturally been rising and falling for over the last 20,000 years, any fines that will have been removed from the soil would have done so already. • If the water table rises and falls naturally why does this not cause subsidence due to fine removals every year? It does not because the soil has been soil is naturally consolidated by the rise and fall of the water table in the area. • The effect of local pumping for small excavations will not affect the local area. • There is only a risk of subsidence from large scale pumping of soil which lowers the water table below is natural lowest level.

Temporary Works	Temporary propping details will be required and this must be provided by the contractor. Their details should be forwarded to Croft Structural Engineers.
Noise and Nuisance Control	The contractor is to follow the good working practices and guidance laid down in the 'Considerate Constructors Scheme'. The hours of working will be limited to those allowed 8am to 5pm Monday to Friday and Saturday Morning 8am to 1pm. None of the practices cause undue noise that one would typically expect from a construction site. The conveyor belt typically runs at around 70dB. The site has car parking to the front to which the skip will be stored. The site will be hoarded with 8' site hoarding to prevent access. The hours of working will further be defined within the Party Wall Act. The site is to be hoarded to minimise the level of direct noise from the site. The Lower Ground floor slab is not being removed. This minimises the vibration and sound to adjacent properties. While working in the basement, the work generally requires hand tools to be used. The level of noise generally will be no greater than that of digging of soil. The noise is reduced and muffled by the works being undertaken underground. A level of noise from a basement is lower than typical ground level construction due to this.
CTMP	The council may require a Construction Traffic Management plan to be produced. This should be made available at the design stage, prior to the start of works. This is outside the brief of the Basement Impact Assessment and is not covered within Croft's brief

Appendix A : Calculations

These calculations are for the scheme design only and should not be used at detailed design or construction stage.

DESIGN CONCEPT

The design parameters for the most heavily loaded wall are presented in this section. This is the wall closest to No 37 Greville Road. This will resist loading from the existing perimeter wall and also loading from the neighbouring wall. The loads from these will be spread and applied to the basement walls.

Contiguous pile walls will be installed to allow for excavations to progress below the existing lower ground floor. In the temporary condition (during the construction phase), these will be propped at the head.

In the permanent condition, reinforced concrete (RC) walls will be constructed around the basement perimeter to help resist lateral pressures. In the permanent condition the RC walls will be propped at the base by the basement floor slab and at the top by the Lower Ground Floor structure.

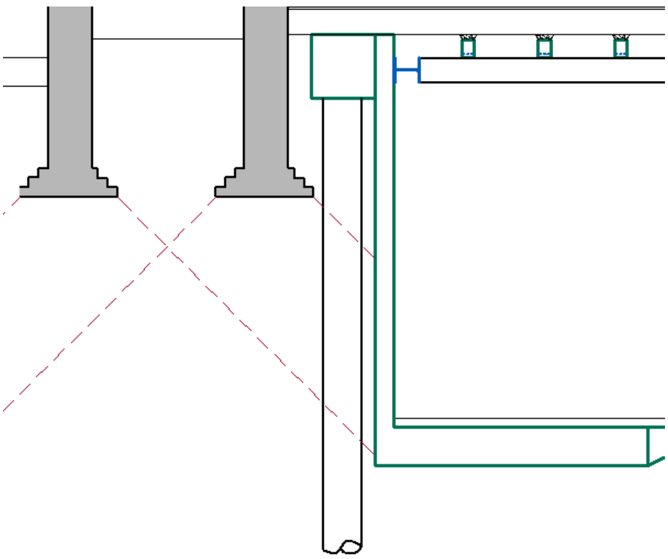
WALL ADJACENT TO NO 37

Vertical loadings to be allowed for in the detailed design are as follows:

Location	Area			Type	L	Load	Load kN			
	L	W	m^2			kN/m^2	Dead	%	Live	Total
wall adj to No 37										
roof DL	4.0	1.0	4.0	g_k		1.05	4.2			
roof LL				q_k		0.75			3.0	
loft DL	4.0	1.0	4.0	g_k		0.63	2.5			
loft DL				q_k		1.50			6.0	
2nd fl DL	4.0	1.0	4.0	g_k		4.62	18.5			
2nd fl LL				q_k		1.50			6.0	
2nd fl partitions	3.0	1.0	3.0	g_k		2.60	7.8			
1st fl DL	4.0	1.0	4.0	g_k		4.62	18.5			
1st fl LL				q_k		1.50			6.0	
1st fl partitions	3.0	1.0	3.0	g_k		2.60	7.8			
ground fl DL	4.0	1.0	4.0	g_k		4.62	18.5			
ground fl LL				q_k		1.50			6.0	
grd fl partitions	3.0	1.0	3.0	g_k		2.60	7.8			
walls	9.0	1.0	9.0	g_k		10.00	90.0			
							175.6	kN/m	27.0	kN/m

from 37 greville road										
roof DL	2.0	1.0	2.0	g_k		1.05	2.1			
roof LL				q_k		0.75			1.5	
loft DL	2.0	1.0	2.0	g_k		0.63	1.3			
loft DL				q_k		1.50			3.0	
2nd fl DL	2.0	1.0	2.0	g_k		4.62	9.2			
2nd fl LL				q_k		1.50			3.0	
2nd fl partitions	3.0	1.0	3.0	g_k		2.60	7.8			
1st fl DL	2.0	1.0	2.0	g_k		4.62	9.2			
1st fl LL				q_k		1.50			3.0	
1st fl partitions	3.0	1.0	3.0	g_k		2.60	7.8			
ground fl DL	2.0	1.0	2.0	g_k		4.62	9.2			
ground fl LL				q_k		1.50			3.0	
grd fl partitions	3.0	1.0	3.0	g_k		2.60	7.8			
walls	9.0	1.0	9.0	g_k		10.00	90.0			
							144.5	kN/m	13.5	kN/m

As described previously, the loads from two existing walls will be spread and resisted by the basement walls. This is indicated below.



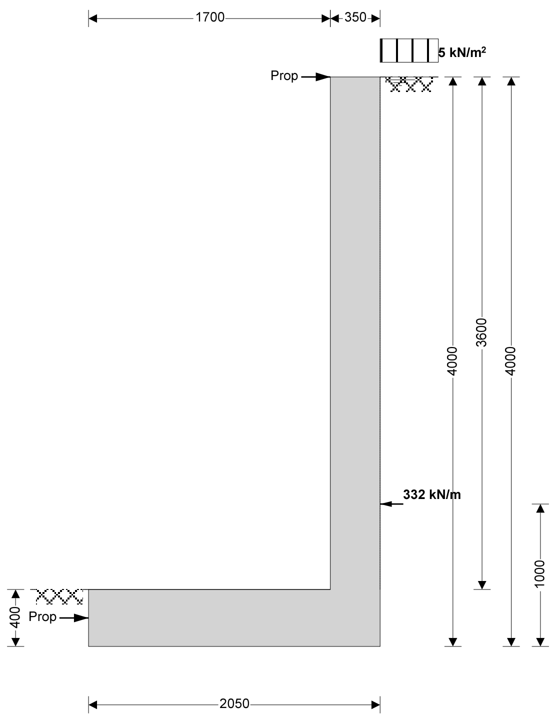
At detailed design stage, these loads would both have to be accounted for.

The following analysis is used to indicate the relevant lateral loads required for the wall design and also for the propping forces that will be required for the props to the capping beam. The diagrams given in the analysis are not indicative of the final structure that will be used for the design of the basement walls.

RETAINING WALL ANALYSIS & DESIGN (BS8002)

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

Retaining wall type	**Cantilever**		
Height of wall stem	h_{stem} = **3600** mm	Wall stem thickness	t_{wall} = **350** mm
Length of toe	l_{toe} = **1700** mm	Length of heel	l_{heel} = **0** mm
Overall length of base	l_{base} = **2050** mm	Base thickness	t_{base} = **400** mm
Height of retaining wall	h_{wall} = **4000** mm		
Depth of downstand	d_{ds} = **0** mm	Thickness of downstand	t_{ds} = **400** mm
Position of downstand	l_{ds} = **1200** mm		
Depth of cover in front of wall	d_{cover} = **0** mm	Unplanned excavation depth	d_{exc} = **0** mm
Height of ground water	h_{water} = **4000** mm	Density of water	γ_{water} = 9.81 kN/m^3
Density of wall construction	γ_{wall} = **23.6** kN/m^3	Density of base construction	γ_{base} = **23.6** kN/m^3
Angle of soil surface	β = **0.0** deg	Effective height at back of wall	h_{eff} = **4000** mm
Mobilisation factor	M = **1.5**		
Moist density	γ_m = **18.0** kN/m^3	Saturated density	γ_s = **21.0** kN/m^3
Design shear strength	ϕ' = **24.2** deg	Angle of wall friction	δ = **0.0** deg
Design shear strength	ϕ'_b = **20.0** deg	Design base friction	δ_b = **18.6** deg
Moist density	γ_{mb} = **18.0** kN/m^3	Allowable bearing	$P_{bearing}$ = **50** kN/m^2

Using Coulomb theory

Active pressure	K_a =**0.419**	Passive pressure	K_p = **3.374**
At-rest pressure	K_0 = **0.590**		

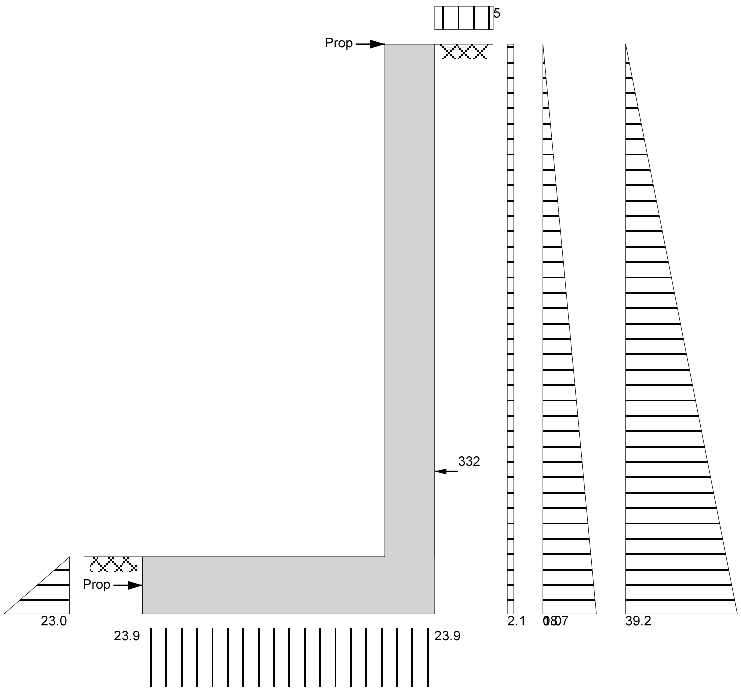
Loading details

Surcharge load — Surcharge = **5.0** kN/m^2

Vertical dead load — W_{dead} = **0.0** kN/m — Vertical live load — W_{live} = **0.0** kN/m

Horizontal dead load — F_{dead} = **287.0** kN/m — Horizontal live load — F_{live} = **45.0** kN/m

Position of vertical load — l_{load} = **0** mm — Height of horizontal load — h_{load} = **1000** mm



Loads shown in kN/m, pressures shown in kN/m^2

Calculate propping force

Propping force — F_{prop} = **435.2** kN/m

Check bearing pressure

Total vertical reaction — R = **49.1** kN/m — Distance to reaction — x_{bar} = **1025** mm

Eccentricity of reaction — e = **0** mm

Reaction acts within middle third of base

Bearing pressure at toe — p_{toe} = **23.9** kN/m^2 — Bearing pressure at heel — p_{heel} = **23.9** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Calculate propping forces to top and base of wall

Propping force to top of wall — F_{prop_top} = **102.900** kN/m — Propping force to base of wall — F_{prop_base} = **332.291** kN/m

Appendix B : Construction Method Statement

CROFT STRUCTURAL ENGINEERS

Basement Method Statement

Site:

35 Greville Road
London
NW6 5JB

Client:

Igor Gokhberg

35 Greville Road

1. Basement Formation Suggested Method Statement.

1.1. This method statement provides an approach which will allow the basement design to be correctly considered during construction, and the temporary support to be provided during the works. The Contractor is responsible for the works on site and the final temporary works methodology and design on this site and any adjacent sites.

1.2. This method statement for the development of 35 Greville Road. It has been written by a Chartered Engineer. The overall sequence is shown on drawing SD-12.

1.3. This proposed method has been developed to allow for improved costings and for inclusion in the Party Wall Award. Should the contractor provide alternative methodology, the changes shall be at their own costs, and an Addendum to the Party Wall Award will be required.

1.4. Contact party wall surveyors to inform them of any changes to this method statement.

1.5. Contact the developers of any nearby sites to inform them of the proposed works.

1.6. The approach followed in this design is:

i. Partially demolish existing garden lightwell retaining wall batter back soil to form access slope for mini-piling rig to access existing Lower Ground Floor from Garden level.
ii. Install a contiguous piled wall with capping beam around the perimeter
iii. Excavate within the contiguous piled walls;
   - provide adequate propping, with propping to the head and include mass concrete thrust blocks for prop support at base
iv. Construct the new building from basement level upwards.

1.7. A soil investigation has been undertaken. The soil conditions are London Clay formation

1.8. The water table is expected at approximately 0.8m below ground level. Following piling around the perimeter, and during the subsequent excavations, dewater locally (create sumps from which water can be pumped out of).

1.9. The structural water proofer (not Croft) must comment on the proposed waterproofing design and ensure that this will provide adequate water proofing.

1.10. Provide engineers with concrete mix, supplier, deliver and placement methods 2 weeks prior to first pour. Site mixing of concrete should not be employed apart from in small sections <1m^3. Contractor must provide method on how to achieve site mixing to the correct specification; the contractor must undertake tool box talks with staff to ensure site quality is maintained.

2. Enabling Works

2.1. The site is to be hoarded with ply sheet to 2.2m to prevent unauthorised access.

2.2. Licences for skips and conveyors to be posted on hoarding

2.3. Provide protection to public if conveyor extends over footpath. Depending on the requirements of the local authority, construct a plywood bulkhead onto the pavement. Hoarding to have a plywood roof covering, night-lights and safety notices.

2.4. On commencement of construction, the contractor should report any discrepancies to the structural engineer in order that the detailed design may be modified as necessary.

2.5. Excavate soil in garden behind the lightwell retaining wall to form a slope (max 20 degrees) from garden level down to the Lower Ground floor level.

2.6. Carefully demolish the wall to the existing retaining wall. Following this, a mini piling rig can access the Lower Ground floor from garden level.

2.6.1. Prior to bringing the piling rig on site, check with the piling contractor the requirements of a working platform and install to their design and specification if required

3. Piling Sequencing

<u>For general piling procedures, refer to the piling contractor's method statement.</u> The anticipated sequence is as follows:

3.1. Piles are to be installed at different levels and positions around the development. All piles are installed from the same level and cut down as required.

3.1.1. Mark out datum line to determine various surface heights

3.1.2. Mark out pile sequence locations as specified by Engineer's detailed design stage drawings.

3.1.3. Following the sequencing guidance from the Engineer's detailed design stage drawings, mark out proposed pile position with a pair of reference markers at 1.0m from the pile pin, each forming a line to the pile, mutually rotated at 90 degrees.

3.1.4. Rig operator to set up over the pile pin position and position auger relative to reference marks. Directed and checked by banks man.

3.1.5. The flap at the tip of the auger is closed and secured. Auger tip lowered to ground level and position rechecked. Drilling to commence upon banks man approval.

3.1.6. Concrete is prepared while piling gang grout up concrete pump, hoses and flight, concrete pump operator to check concrete complies with design mix. Concrete held in agitator.

3.1.7. Rig operator augers to require design depth. Reference makers are to be used to check pile position during the first few meters of drilling.

3.1.8. If obstruction encountered, Engineer to be notified of pile number and depth. Move rig to next pile position whilst obstruction removal is dealt with. Contractor to be advised on procedure should obstruction not be removable. If necessary, pile bores to be backfilled and made safe. Open excavation to be protected when open.

3.1.9. When design depth reached, the auger is to be kept rotating to allow spoil in the bore to rise.

3.1.10. Concrete can be pumped to rig while rig operator monitors instrumentation and adjust auger rate of withdrawal accordingly.

3.1.11. Pressure, concrete flow and over-break to be monitored throughout operation.

3.1.12. During the withdrawal the rig operator is to activate the flight cleaner. If an automatic cleaner is not fitted to the rig then the piling gang must clean the flight manually to prevent spoil/ arising travelling above head height – this will be controlled by the piling foreman who must ensure the auger is not rotating when it is manually cleaned.

3.1.13. When auger tip reaches platform level, concrete pumping is stopped.

3.1.14. Attendant excavator as directed by the banks man clears spoil and concrete slurry from pile heap.

3.1.15. Banks man to check position of the cage in the pile, centring where necessary. Reinforcement generally to be installed flush with Piling Platform Level (PPL). Anchor pile reinforcement or threaded bars that project above piling platform to have protective caps.

3.1.16. Concrete testing cube samples to be taken as per engineering specification.

3.1.17. Rig is moved onto next pile in the sequence and positioned as above, with piles installed as per points 3.1.4 – 3.1.11

3.1.18. Equipment to be cleaned and maintained as per normal methods.

3.1.19. This sequence of piling is to continue until all perimeter piles and piles for internal columns have been installed.

3.1.19.1. As piling progresses wound perimeter, construct reinforced concrete capping beam to piles.

3.1.20. Excavate within the contiguous piled wall perimeter, construct mass concrete thrust blocks and install props as excavations progress.

3.1.20.1. Provide vertical props to the Lower Ground floor structure as the excavation progresses.

3.1.20.2. <u>The piled wall should be propped until the permanent structure is complete (refer to item 3.2). Propping should include props to the head, ie to the capping beam. The contractor should provide proposals for propping to the structural</u>

engineer who is responsible for the detailed design of the permanent structure at least two weeks before the excavations commence.

3.1.20.3. For column bases, trim piles to new basement level and cast pile caps.

3.1.20.4. Cast basement slab

3.2. Once all piles have been installed and the pile caps have been cast, erect steel columns from Basement to Lower Ground Floor level. The steelwork beams to support the Lower Ground floor can then be inserted. In the permanent condition, this will prop the external perimeter of the basement.

4. Demolition, Recycling, Dust/Noise Control and Site Hoarding

4.1. Demolition work is to take place within the hoarded confines of the materials such as stock bricks, timber etc. are to be recycled where possible. To minimise dust and dirt from demolition the following measures shall be implemented:

4.1.1. Any debris or dust or dirt falling on the street and public highway will be cleared as it occurs by designated cleaners and washed down fully every night.
4.1.2. Demolished materials are to be removed to a skip placed in front of the site which will be emptied regularly as required.
4.1.3. All brickwork and concrete demolition work is to be constantly watered to reduce airborne dust.

4.2. Building work which can be heard at the boundary of the site will not be carried out on Sundays or bank holidays and will be carried out within working hours as agreed by the council.

Appendix C : Monitoring Proposals

Job Number: 150525

CROFT STRUCTURAL ENGINEERS

Croft Structural Engineers
Clock Shop Mews
Rear of 60 Saxon Road
London SE25 5EH

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E: enquiries@croftse.co.uk
W: www.croftse.co.uk

Structural Monitoring Statement

Property:

35 Greville Road
London
NW6 5JB

Client:

Igor Gokhberg

Revision	Date	Comment
-	18 Feb 2016	First Issue

CROFT STRUCTURAL ENGINEERS

Contents

1. Introduction

Basement works are intended at 35 Greville Road. The structural works for this require Party Wall Awards. This statement describes the procedures for the Principal Contractor to follow to observe any movement that may occur to the existing properties, and also describes mitigation measures to apply if necessary.

2. Risk Assessment

The purpose of this risk assessment is to consider the impact of the proposed works and how they impact the party wall. There are varying levels of inspection that can be undertaken and not all works, soil conditions and properties require the same level of protection.

Monitoring Level Proposed	Type of Works.
Monitoring 1 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works.	Loft conversions, cross wall removals, insertion of padstones Survey of LUL and Network Rail tunnels. Mass concrete, reinforced and piled foundations to new build properties

Monitoring 2 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate.	Removal of lateral stability and insertion of new stability fames Removal of main masonry load bearing walls. Underpinning works less than 1.2m deep
Monitoring 3 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment	Lowering of existing basement and cellars more than 2.5m Underpinning works less than 3.0m deep in clays Basements up to 2.5m deep in clays
Monitoring 4 Visual inspection and production of condition survey by Party Wall Surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical monitoring movement by standard optical equipment Lateral movement between walls by laser measurements	New basements greater than 2.5m and shallower than 4m Deep in gravels Basements up to 4.5m deep in clays Underpinning works to Grade I listed building
Monitoring 5 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Vertical & lateral monitoring movement by theodolite at specific times during the projects.	Underpinning works to Grade I listed buildings Basements to Listed building Basements deeper than 4m in gravels Basements deeper than 4.5m in clays Underpinning, basements to buildings that are expressing defects.
Monitoring 6 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and	Double storey basements supported by piled retaining walls in gravels and soft

also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by electronic means with live data gathering. Weekly interpretation	sands. (N<12)
Monitoring 7 Visual inspection and production of condition survey by Party wall surveyors at the beginning of the works and also at the end of the works. Visual inspection of existing party wall during the works. Inspection of the footing to ensure that the footings are stable and adequate. Vertical & lateral monitoring movement by electronic means with live data gathering with data transfer.	Larger multi-storey basements on particular projects.

3. Scheme Details

This document has been prepared by Croft Structural Engineers Ltd. It covers the proposed construction of a new basement for 35 Greville Road. Most of the basement will require excavations no greater than 3.5m deep. To the rear of the property, a portion of the basement will require excavations greater than 4.5m (down to 6m below ground level). Therefore monitoring level 5 is proposed for this development.

Scope of Works

The works comprise:

- Visual Monitoring of the party wall
- Attachment of Tell tales or Demec Studs to accurately record movement of significant cracks.
- Attachment of levelling targets to monitor settlement.
- The monitoring of the above instrumentation is in accordance with Appendix A. The number and precise locations of instrumentation may change during the works; this shall be subject to agreement with the Principal Contractor (PC).
- All instruments are to be adequately protected against any damage from construction plant or private vehicles using clearly visible markings and suitable head protection e.g. manhole rings or similar. Any damaged instruments are to be immediately replaced or repaired at the contractors own cost.
- Reporting of all data in a manner easily understood by all interested parties.

- Co-ordination of these monitoring works with other site operations to ensure that all instruments can be read and can be reviewed against specified trigger values both during and post construction.
- Regular site meetings by the Principal Contractor (PC) and the Monitoring Surveyor (MS) to review the data and their implications.
- Review of data by Croft Structural Engineers

In addition, the PC will have responsibility for the following:

- Review of methods of working/operations to limit movements, and
- Implementation of any emergency remedial measures if deemed necessary by the results of the monitoring.

The Monitoring Surveyor shall allow for settlement and crack monitoring measures to be installed and monitored on various parts of the structure described in Table 1 as directed by the PC and Party Wall Surveyor (PWS) for the Client.

Item	Instrumentation Type
Party Wall Brickwork	
Settlement monitoring	Levelling equipment & targets
Crack monitoring	Visual inspection of cracking, Demec studs where necessary

Table 1: Instrumentation

General

The site excavations and substructure works up to finished ground slab stage have the potential to cause vibration and ground movements in the vicinity of the site due to the following:

a) Removal of any existing redundant foundations / obstructions;
b) Installation of reinforced concrete retaining walls under the existing footings;
c) Excavations within the site

The purpose of the monitoring is a check to confirm building movements are not excessive.

This specification is aimed at providing a strategy for monitoring of potential ground and building movements at the site.

This specification is intended to define a background level of monitoring. The PC may choose to carry out additional monitoring during critical operations. Monitoring that should be carried out is as follows:

a) Visual inspection of the party wall and any pre-existing cracking
b) Settlement of the party wall

All instruments are to be protected from interference and damage as part of these works.

Access to all instrumentation or monitoring points for reading shall be the responsibility of the Monitoring Surveyor (MS). The MS shall be in sole charge for ensuring that all instruments or monitoring points can be read at each visit and for reporting of the data in a form to be agreed with the PWS. He shall inform the PC if access is not available to certain instruments and the PC will, wherever possible, arrange for access. He shall immediately report to the PC any damage. The Monitoring Surveyor and the Principal Contractor will be responsible for ensuring that all the instruments that fall under their respective remits as specified are fully operational at all times and any defective or damaged instruments are immediately identified and replaced.

The PC shall be fully responsible for reviewing the monitoring data with the MS - before passing it on to Croft Structural Engineers - determining its accuracy and assessing whether immediate action is to be taken by him and/or other contractors on site to prevent damage to instrumentation or to ensure safety of the site and personnel. All work shall comply with the relevant legislation, regulations and manufacturer's instructions for installation and monitoring of instrumentation.

Applicable Standards and References

The following British Standards and civil engineering industry references are applicable to the monitoring of ground movements related to activities on construction works sites:

1. BS 5228: Part 1: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 1.Code of practice for basic information and procedures for noise and vibration control, Second Edition, BSI 1999.
2. BS 5228: Part 2: 1997 - Noise and Vibration Control on Construction and Open Sites -Part 2.Guide to noise and vibration control legislation for construction and demolition including road construction and maintenance, Second Edition, BSI 1997.
3. BS 7385-1: 1990 (ISO 4866:1990) - Evaluation and measurement for vibration in buildings - Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings, First Edition, BSI 1990.
4. BS 7385-2: 1993 - Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground-borne vibration, First Edition, BSI 1999.
5. CIRIA SP 201 - Response of buildings to excavation-induced ground movements, CIRIA 2001.

SPECIFICATION FOR INSTRUMENTATION

General

The Monitoring Contractor is required to monitor, protect and reinstall instruments as described. The readings are to be recorded and reported. The following instruments are defined:

a) Automatic level and targets: A device which allows the measurement of settlement in the vertical axis. To be installed by the MS.

b) Tell-tales and 3 stud sets: A device which allows measurement of movement to be made in two axes perpendicular to each other. To be installed by the MS.

Monitoring of existing cracks

The locations of tell-tales or Demec studs to monitor existing cracks shall be agreed with Croft Structural Engineers.

CROFT STRUCTURAL ENGINEERS

Instrument Installation Records and Reports

Where instrumentation is to be installed or reinstalled, the Monitoring Surveyor, or the Principal Contractor, as applicable, shall make a complete record of the work. This should include the position and level of each instrument. The records shall include base readings and measurements taken during each monitoring visit. Both tables and graphical outputs of these measurements shall be presented in a format to be agreed with the CM. The report shall include photographs of each type of instrumentation installed and clear scaled sections and plans of each instrument installed. This report shall also include the supplier's technical fact sheet on the type of instrument used and instructions on monitoring.

Two signed copies of the report shall be supplied to the PWS within one week of completion of site measurements for approval.

Installation

All instruments shall be installed to the satisfaction of the PC. No loosening or disturbance of the instrument with use or time shall be acceptable. All instruments are to be clearly marked to avoid damage.

All setting out shall be undertaken by the Monitoring Surveyor or the Principal Contractor as may be applicable. The precise locations will be agreed by the PC prior to installation of the instrument.

The installations are to be managed and supervised by the Instrumentation Engineer or the Measurement Surveyor as may be applicable.

Monitoring

The frequencies of monitoring for each Section of the Works are given in Appendix A.

The following accuracies/ tolerances shall be achieved:

Party Wall settlement	$\pm$1.5mm
Crack monitoring	$\pm$0.75mm

REPORT OF RESULTS AND TRIGGER LEVELS

General

Within 24 hours of taking the readings, the Monitoring Surveyor will submit a single page summary of the recorded movements. All readings shall be immediately reviewed by Croft Structural Engineers prior to reporting to the PWS.

Within one working day of taking the readings the Monitoring Contractor shall produce a full report (see below).

The following system of control shall be employed by the PC and appropriate contractors for each section of the works. The Trigger value, at which the appropriate action shall be taken, for each section, is given in Table 2, below.

The method of construction by use of sequential piles limits the deflections in the party wall.

Between the trigger points, which are no greater than 2 m apart, there should be no more than:

Allowable movement to BS5950 for brittle finishes

<u>Vertical</u> = Span / 360 = 4000mm / 360 = 11.1mm

Croft proposes a tighter recommendation of Span / 500
= Span / 750 = 4000mm / 750 = <u>5mm</u>

Above Monitoring Level 3, lateral movement is required to be measured and the figures should be:

<u>Horizontal</u> = Height / 500 = 6300mm / 500 = 13mm

Croft proposes a tighter recommendation of
= Height /900 = 6300mm / 900 = <u>7mm</u>

The reference height is the sum of the depth of the excavation (4.8m) and the position of the monitoring stud above Lower Ground level (1.5m)

During works measurements are taken, these are compared with the limits set out below:

MOVEMENT		CATEGORY	ACTION
Vertical	Horizontal		
0mm-5mm	0-7mm	Green	No action required
5mm-7mm	7-9mm	AMBER	Detailed review of Monitoring: Check studs are OK and have not moved. Ensure site staff have not moved studs. If studs have moved reposition. Relevel to ensure results are correct and tolerance is not a concern. Inform Party Wall surveyors of amber readings. Double the monitoring for 2 further readings. If stable revert back. Carry out a local structural review and inspection. Preparation for the implementation of remedial measures should be required. Double number of lateral props
7mm-10mm	9-11mm		Implement remedial measures review method of working and ground conditions
>10mm	>11mm	RED	Implement structural support as required; Cease works with the exception of necessary works for the safety and stability of the structure and personnel; Review monitoring data and implement revised method of works

Table 2 – Movement limits between adjacent sets of Tell-tales or stud sets

Any movements which exceed the individual amber trigger levels for a monitoring measure given in Table 2 shall be immediately reported to the PWS, and a review of all of the current monitoring data for all monitoring measures must be implemented to determine the possible causes of the trigger level being exceeded. Monitoring of the affected location must be increased and the actions described above implemented. Assessment of exceeded trigger levels must not be carried out in isolation from an assessment of the entire monitoring regime as the monitoring measures are inter-related. Where required, measures may be implemented or prepared as determined by the specific situation and combination of observed monitoring measurement data.

Standard Reporting

1 No. electronic copy of the report in PDF format shall be submitted to the PWS.

The Monitoring Surveyor shall report whether the movements are within (or otherwise) the Trigger Levels indicated in Table 2. A summary of the extent of completion of any of the elements of works and any other significant events shall be given. These works shall be shown in the form of annotated plans (and sections) for each survey visit both local to the instrumentation and over a wider area. The associated changes to readings at each survey or monitoring point shall be then regulated to the construction activity so that the cause of any change, if it occurs, can be determined.

The Monitoring Surveyor shall also give details of any events on site which in his opinion could affect the validity of the results of any of the surveys.

The report shall contain as a minimum, for each survey visit the following information:

a) The date and time of each reading:
b) The weather on the day:
c) The name of the person recording the data on site and the person analysing the readings together with their company affiliations;
d) Any damage to the instrumentation or difficulties in reading;
e) Tables comparing the latest reading with the last reading and the base reading and the changes between these recorded data;
f) Graphs showing variations in crack width with time for the crack measuring gauges; and
g) Construction activity as described. It is very important that each set of readings is associated with the extent of excavation and construction at that time. Readings shall be accompanied by information describing the extent of works at the time of readings. This shall be agreed with the PC.

Spread-sheet columns of numbers should be clearly labelled together with units. Numbers should not be reported to a greater accuracy than is appropriate. Graph axis should be linear and clearly labelled together with units. The axis scales are to be agreed with the PC before the start of monitoring and are to remain constant for the duration of the job unless agreed otherwise. The specified trigger values are also to be plotted on all graphs.

The reports are to include progress photographs of the works both general to the area of each instrument and globally to the main Works. In particular, these are to supplement annotated plans/sections described above. Wherever possible the global photographs are to be taken from approximately the same spot on each occasion.

Erroneous Data

All data shall be checked for errors by the Monitoring Surveyor prior to submission. If a reading that appears to be erroneous (i.e. it shows a trend which is not supported by the surrounding instrumentation), he shall notify the PC immediately, resurvey the point in question and the neighbouring points and if the error is repeated, he shall attempt to identify the cause of the error. Both sets of readings shall be processed and submitted, together with the reasons for the errors and details of remedial works. If the error persists at subsequent survey visits, the Monitoring Surveyor shall agree with the PC how the data should be corrected. Correction could be achieved by correcting the readings subsequent to the error first being identified to a new base reading.

The Monitoring Surveyor shall rectify any faults found in or damage caused to the instrumentation system for the duration of the specified monitoring period, irrespective of cause, at his own cost.

Trigger Values

Trigger values for maximum movements as listed in Table 2. If the movement exceeds these values then action may be required to limit further movement. The PC should be immediately advised of the movements in order to implement the necessary works.

It is important that all neighbouring points (not necessarily a single survey point) should be used in assessing the impact of any movements which exceed the trigger values, and that rechecks are carried out to ensure the data is not erroneous. A detailed record of all activities in the area of the survey point will also be required as specified elsewhere.

Responsibility for Instrumentation

The Monitoring Surveyor shall be responsible for: managing the installation of the instruments or measuring points, reporting of the results in a format which is user friendly to all parties; and immediately reporting to all parties any damage. The Monitoring Surveyor shall be responsible for informing the PC of any movements which exceed the specified trigger values listed in Table 2 so that the PC can implement appropriate procedures. He shall immediately inform the PWS of any decisions taken.

CROFT STRUCTURAL ENGINEERS

APPENDIX A
MONITORING FREQUENCY

INSTRUMENT	FREQUENCY OF READING
Settlement monitoring and Monitoring existing cracks	**Pre-construction** Monitored once. **During construction** Monitored after every pile is cast for first **4** no. piles to gauge effect of piling. If all is well, monitor after every other pile. **Post construction works** Monitored once.

CROFT STRUCTURAL ENGINEERS

APPENDIX B

An Analysis on allowable settlements of structures (Skempton and MacDonald (1956))

The most comprehensive studies linking self-weight settlements of buildings to structural damage were carried out in the 1950's by Skempton and MacDonald (1956) and Polshin and Tokar. These studies show that damage is most often caused by differential settlements rather than absolute settlements. More recently, similar empirical studies by Boscardin and Cording (1989) and Boone (1996) have linked structural damage to ground movements induced by excavations and tunnelling activities.

In 1955 Skempton and MacDonald identified the parameter $\delta\rho/L$ as the fundamental element on which to judge maximum admissible settlements for structures. This criterion was later confirmed in the works of GRANT *et al.* [1975] and WALSH [1981]. Another important approach to the problem was that of BURLAND and WROTH [1974], based on the criterion of maximum tensile strains.

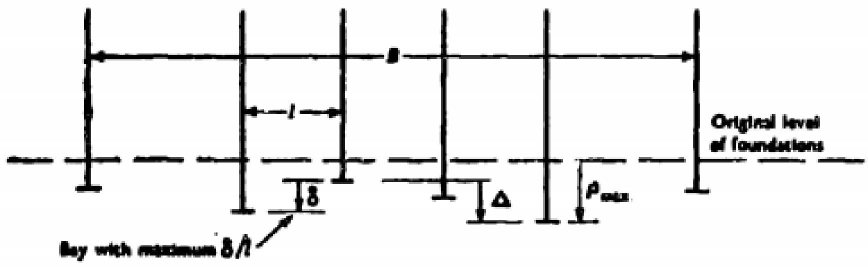


Figure 2.1 – Diagram illustrating the definitions of maximum angular distortion, δ/l, maximum settlement, ρ_{max}, and greatest differential settlement, Δ, for a building with no tilt (Skempton and MacDonald, 1956).

Figure 1: Diagram illustrating the definitions of maximum angular distortion, δ/l, maximum settlement, ρ_{max}, and greatest differential settlement ,Δ , for a building with no tilt (Skempton and MacDonald, 1956)

The differential settlement is defined as the greatest vertical distance between two points on the foundation of a structure that has settled, while the angular distortion, is the difference in elevation between two points, divided by the distance between those points.

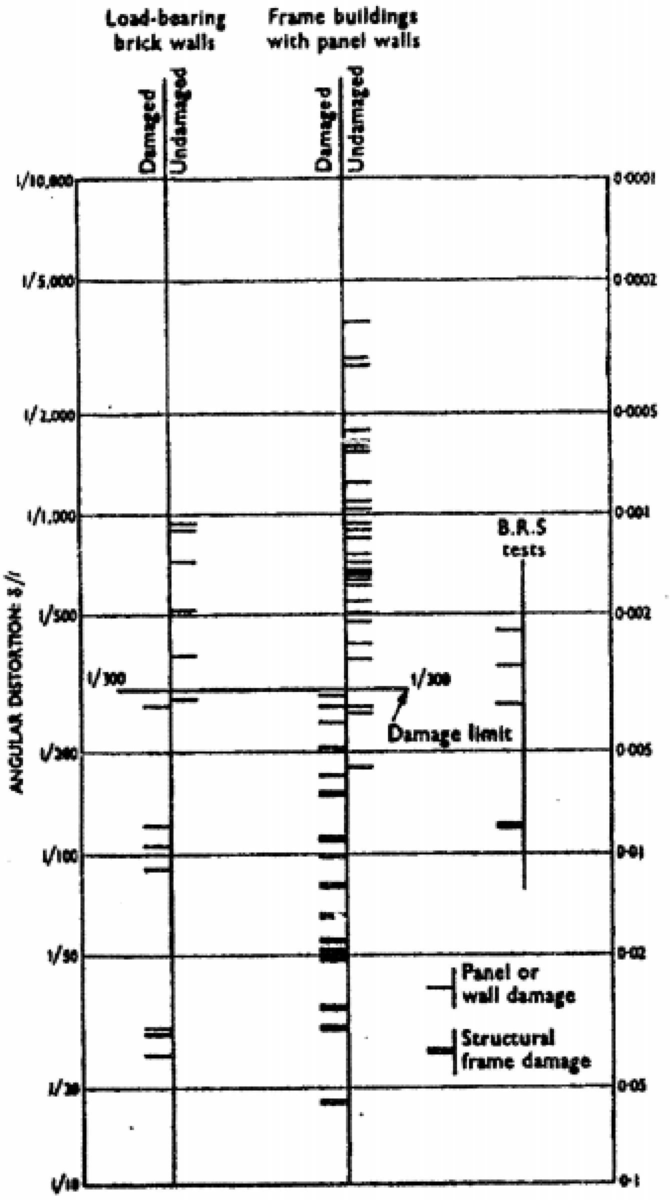
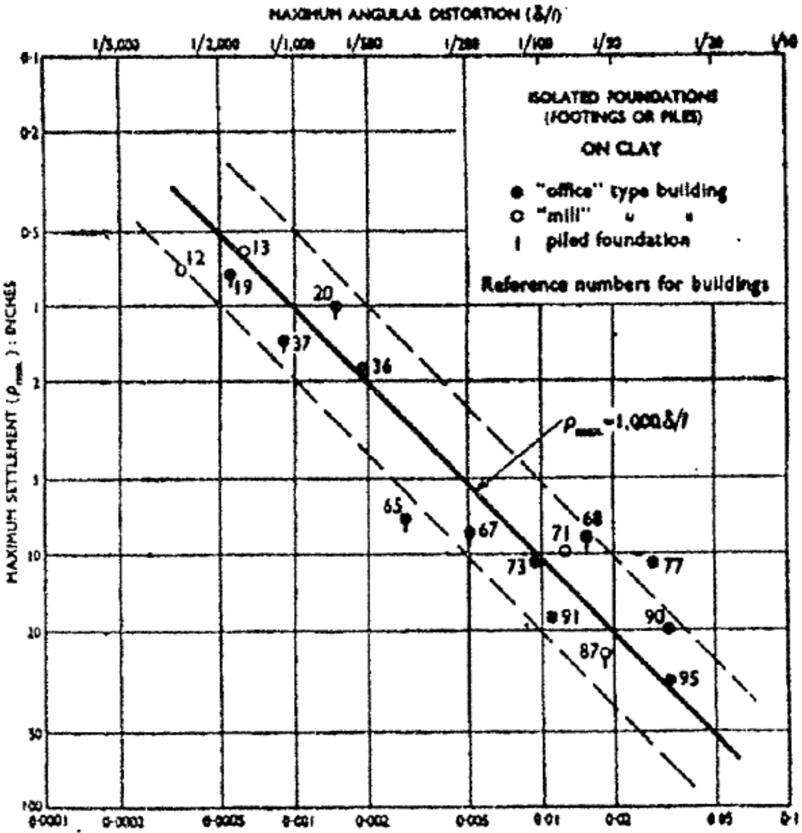
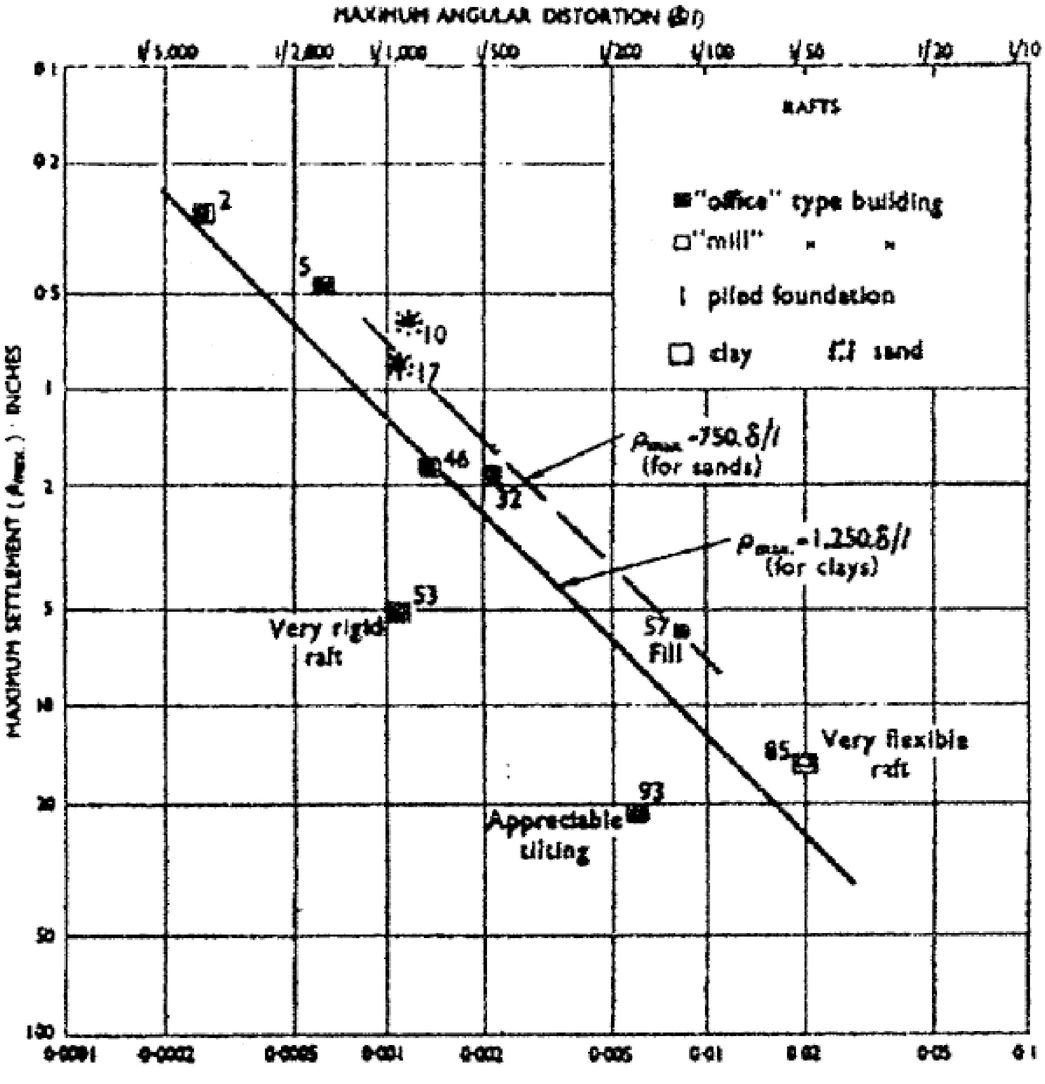


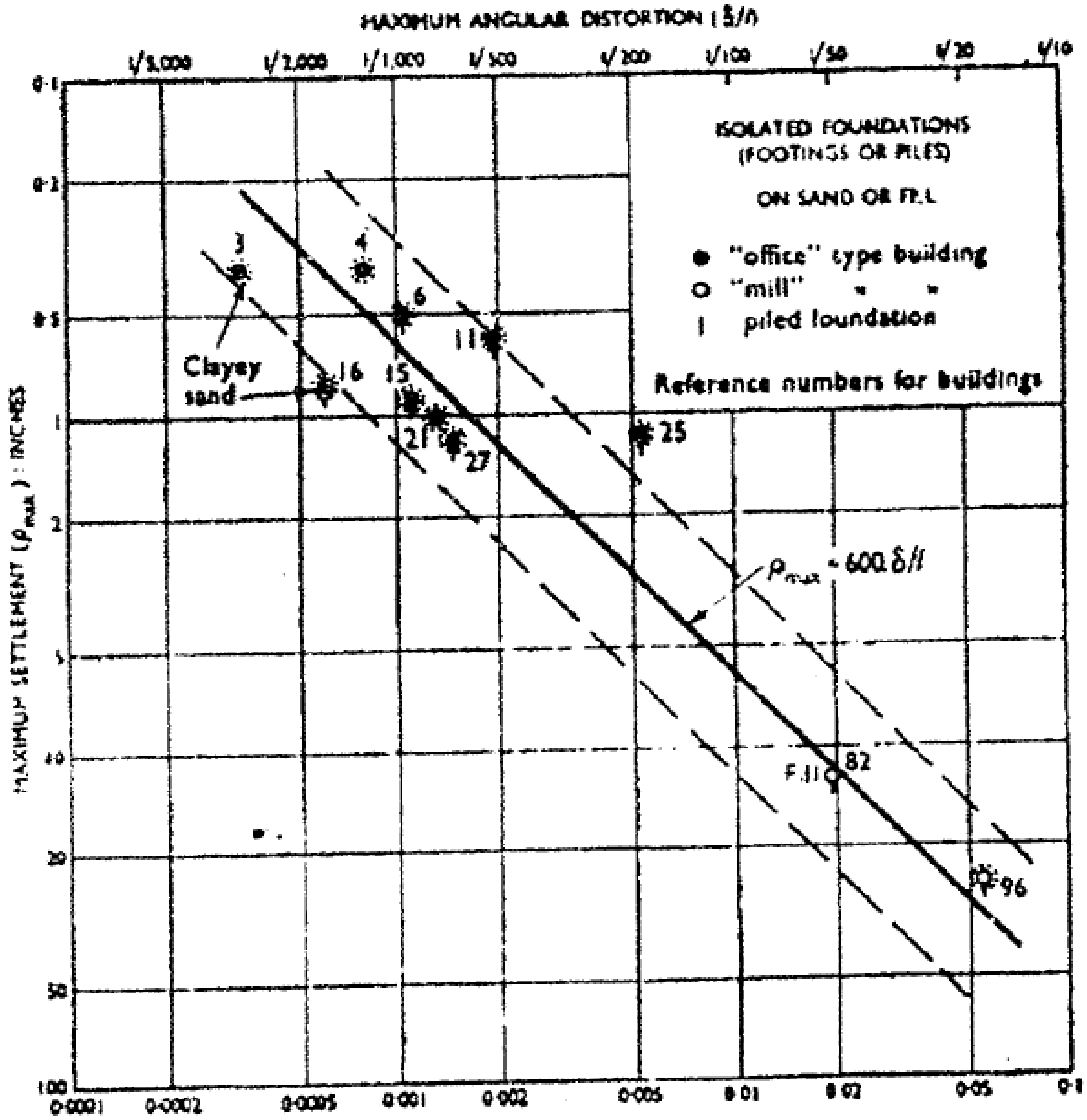
Figure 2: Skempton and MacDonald's analysis of field evidence of damage on traditional frame buildings and loadbearing brick walls

Data from Skempton and MacDonald's work suggest that the limiting value of angular distortion is 1/300. Angular distortion, greater than 1/300 produced visible cracking in the majority of buildings studied, regardless of whether it was a load bearing or a frame structure. As shown in the figure 2.

Other key findings by Skempton and MacDonald include limiting values of δ/l for structure, and a relationship between maximum settlement, ρ_{max} and δ/l for structures founded on sands and clays. The charts below show these relations for raft foundations and isolated footings.






MAXIMUM ANGULAR DISTORTION (δ/l)
1/5,000
1/2,000
1/1,000
1/500
1/200
1/100
1/50
1/20
1/10
ISOLATED FOUNDATIONS
(FOOTINGS OR PILES)
ON SAND OR FILL
"office" type building
"mill"
piled foundation
Reference numbers for buildings
Clayey sand
$\rho_{max} = 600\, \delta/l$
MAXIMUM SETTLEMENT (ρ_{max}) : INCHES
0·1
0·2
0·5
1
2
5
10
20
50
100
0·0001
0·0002
0·0005
0·001
0·002
0·005
0·01
0·02
0·05
0·1
3
4
6
11
16
15
21
27
25
F.11
82
96

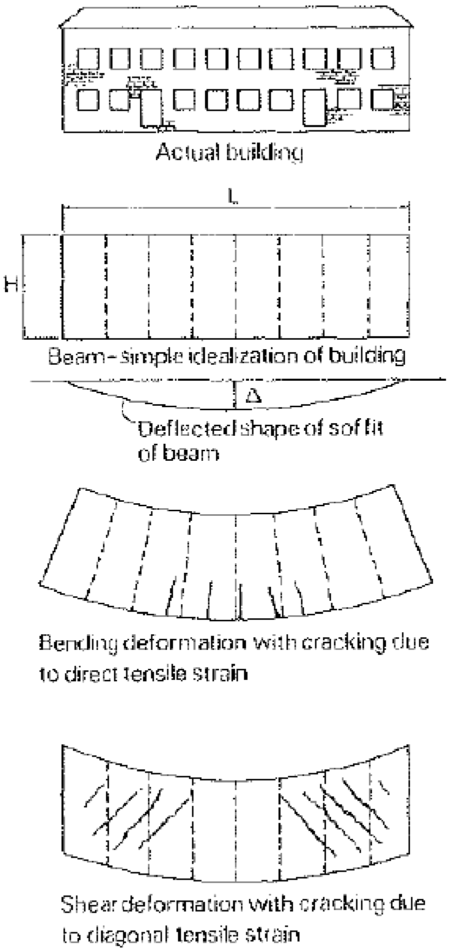


TABLE I

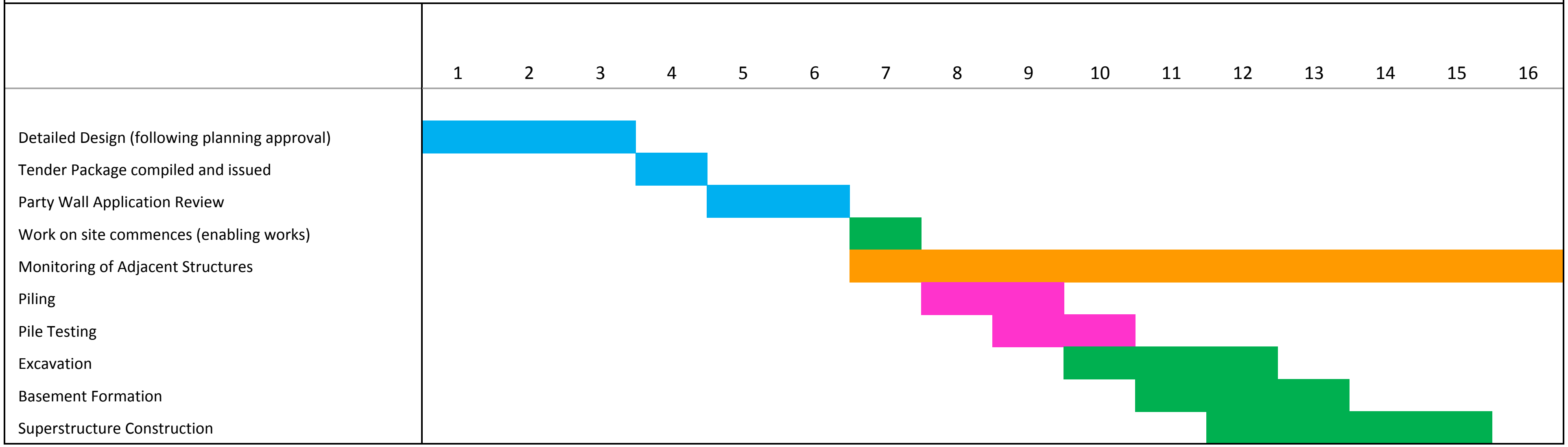
Angular distorsion	Characteristic situation
1/300	Cracking of the panels in frame buildings of the traditional type, or of the walls in load-bearing wall buildings;
1/150	Structural damage to the stanchions and beams;
1/500	Design limit to avoid cracking;
1/1000	Design limit to avoid any settlement damage.

Appendix D : Outline Construction Programme

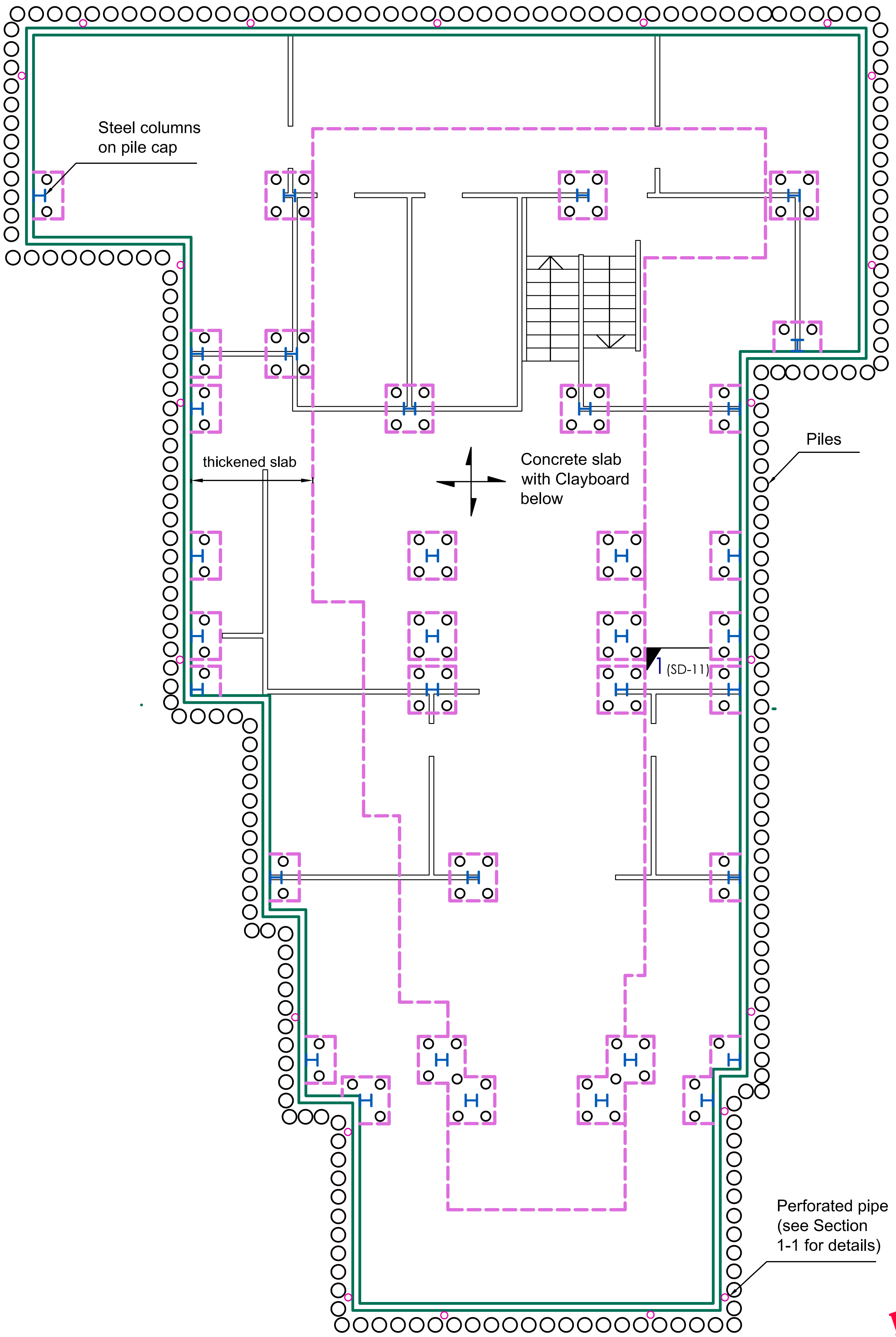
The Contractor is responsible for the final construction programme

Outline Construction Programme for 35 Greville Road

NOTE: PROGRAMME IS FOR PLANNING PURPOSES ONLY. FINAL PROGRAMME TO BE PRODUCED BY CONTRACTOR



Appendix E : Structural Drawings



Basement plan

Scale (1:100)

PLANING ISSUE: NOT FOR CONSTRUCTION

Rev	Date	Amendments
1	18/02/2016	Slab details and external drainage details added
-	27/08/15	First issue for comment

Client: Igor Gokhberg

Project: 35 Greville Road

Title : Proposed Basement Scheme Design

Job No.s	Drawn	Date
150525	NM	Aug 15
Dwg Nos	**Rev**	**Scale**
SL-10	1	As Shown @ A3

Croft Structural Engineers

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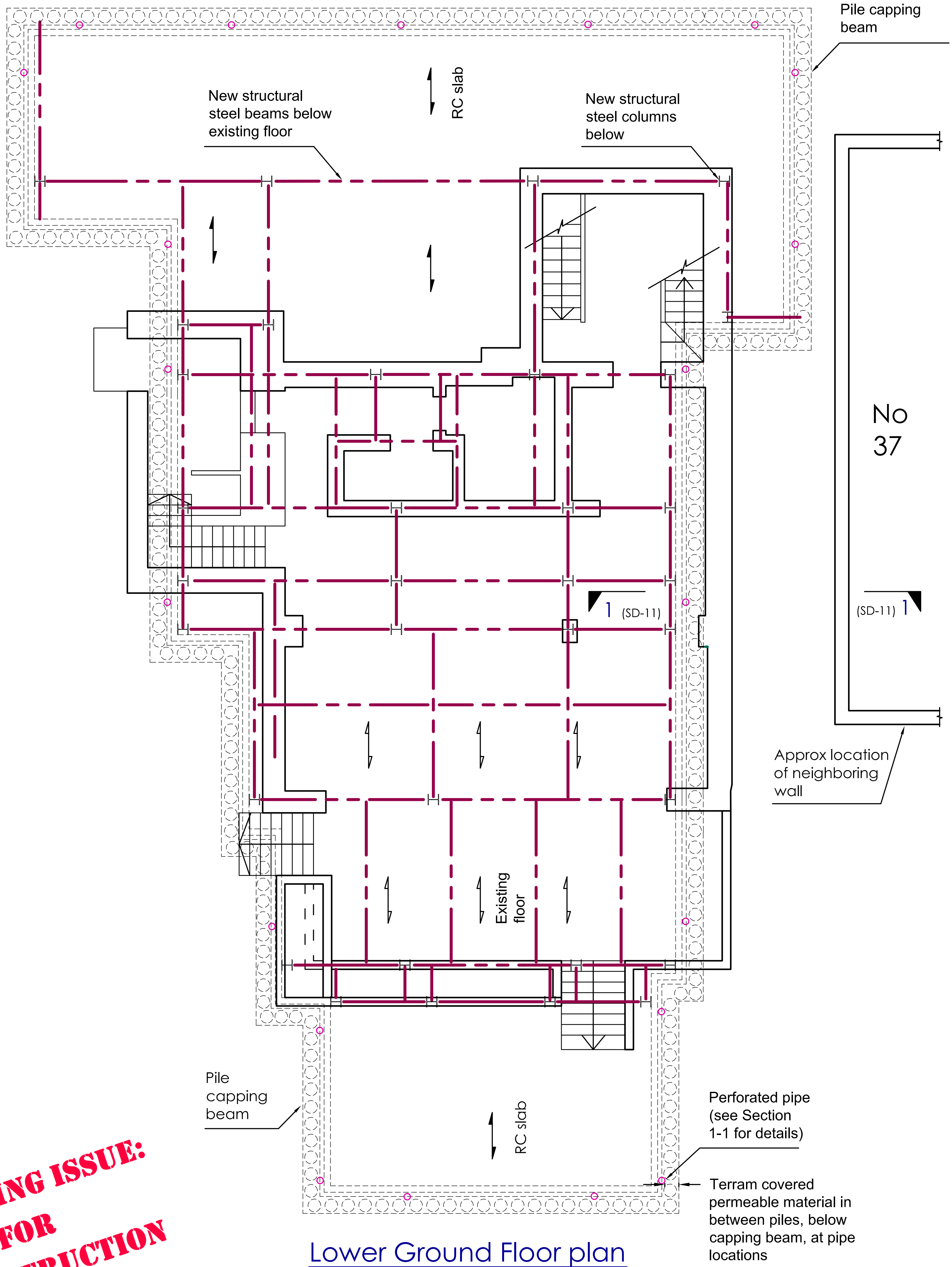

PLANING ISSUE: NOT FOR CONSTRUCTION

Lower Ground Floor plan

Scale (1:100)

Rev	Date	Amendments
1	18/02/2016	Proposed external drainage details added
-	27/08/15	First issue for comment

Client: Igor Gokhberg

Project: 35 Greville Road

Title : Proposed Lower Ground Floor Scheme Design

Job No.s	Drawn	Date
150525	NM	Aug 15
Dwg Nos	**Rev**	**Scale**
SL-20	1	As Shown @ A3

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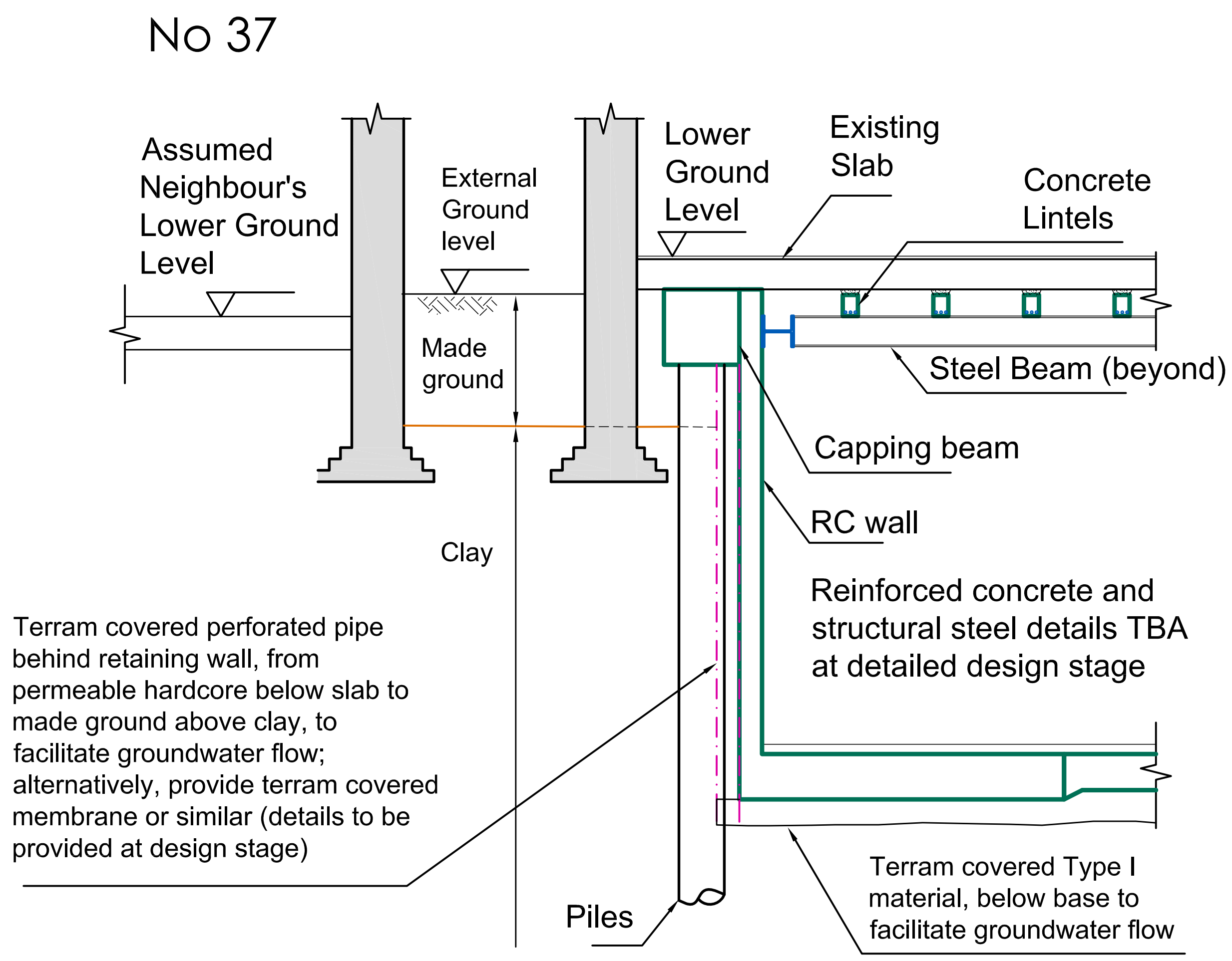

Section 1-1

Scale (1:50)

PLANING ISSUE: NOT FOR CONSTRUCTION

Rev	Date	Amendments
1	17/02/2016	Design stage details removed. Section altered
-	27/08/15	First issue for comment

Job No.s: 150525	Client: Igor Gokhberg
Dwg Nos: SD-11	Project: 35 Greville Road
Date: Aug 15	Title : Section through basement wall
Drawn: NM	Chk'd: CT
Scale: As shown @ A3	Rev: 1

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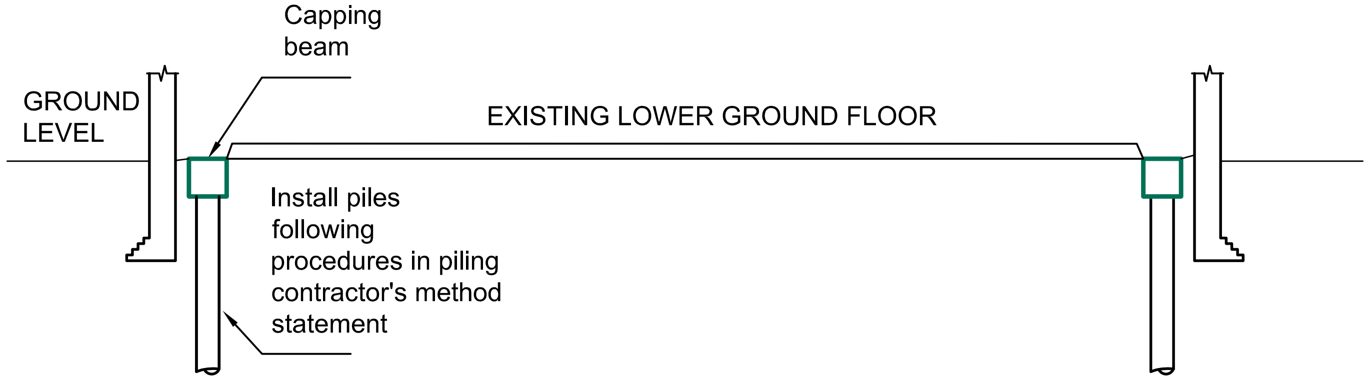
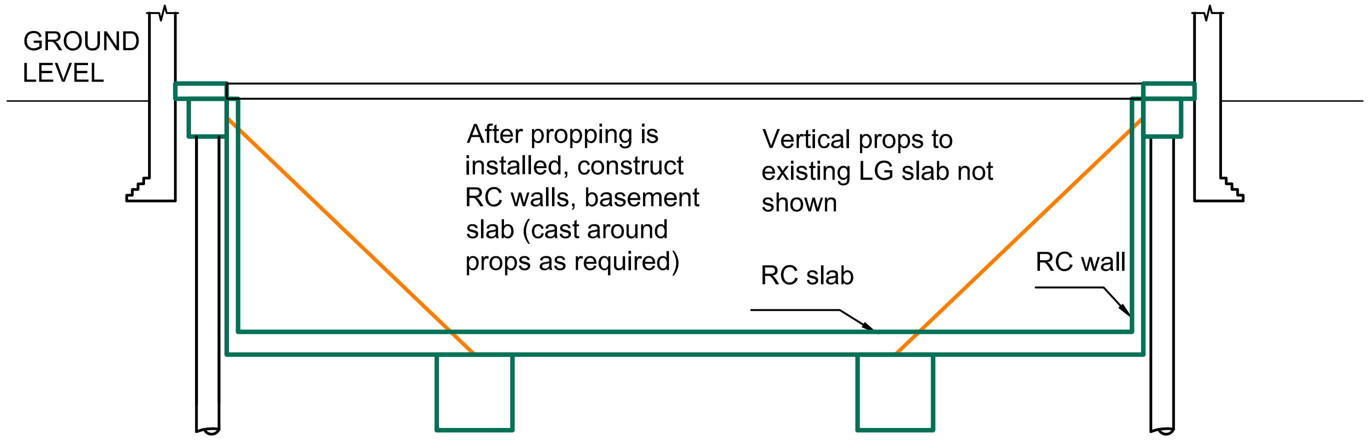


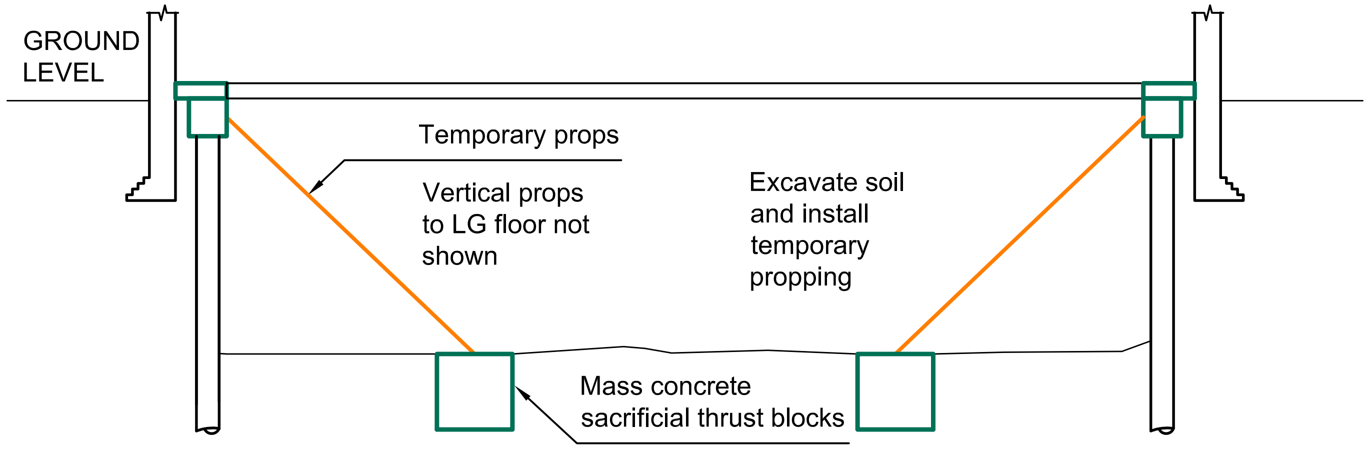
Temporary Works - Phase 1 - Piling & capping beam construct'n
Typical Section through building

(1:100)



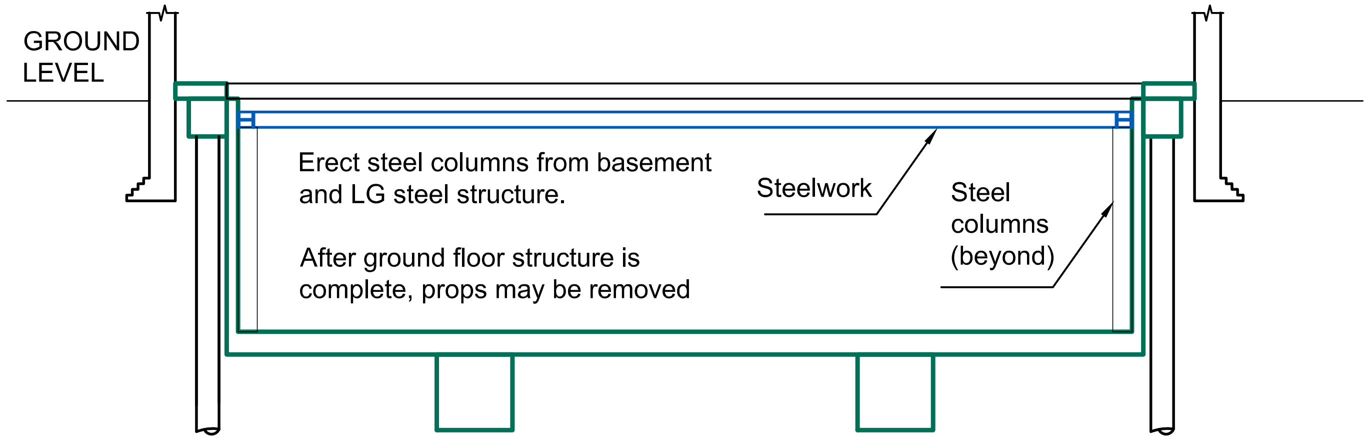
Temporary Works - Phase 3 - RC wall construction
Typical section through building

(1:100)



Temporary Works - Phase 2 - Excavation and propping
Typical section through building

(1:100)



Temporary Works - Phase 4 - Ground Floor construction
Typical section through building

(1:100)

PLANING ISSUE:
NOT FOR
CONSTRUCTION

Rev	Date	Amendments
-	17/02/2016	First issue for comment

Job No.s 150525	Client: Igor Gokhberg	
Dwg Nos SD-12	Project: 35 Greville Road	
Date February 2016	Title : Proposed Temporary Works Sequnce	
Drawn GW / Chk'd GW		
Scale As shown @ A3 / Rev -		

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