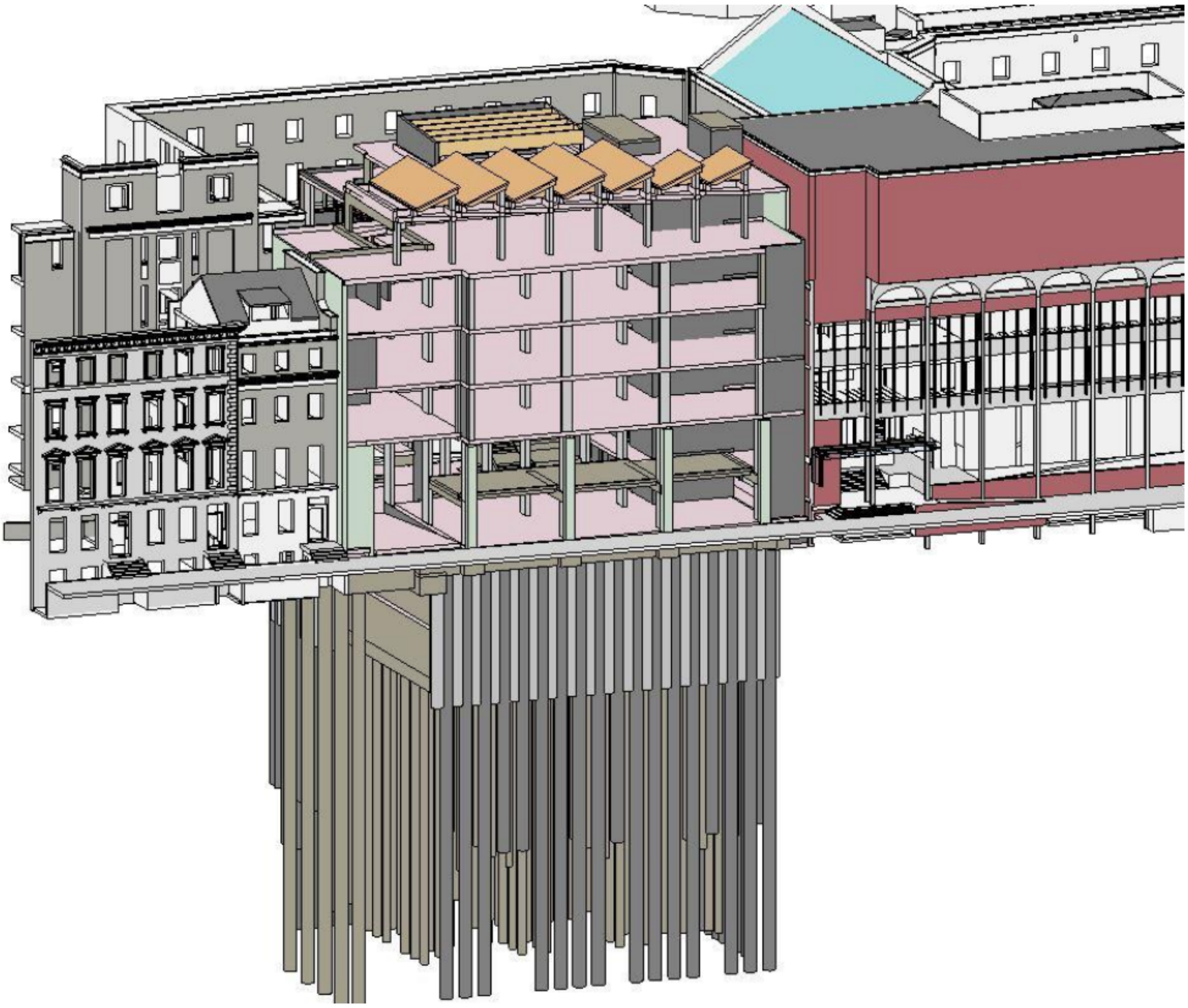
Basement Impact Assessment
Stage 4

University College London
New Student Centre

By Curtins Consulting Ltd
21st August 2015



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Stage 4

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01	First Issue	SE	SS	15/07/2015
02	Updated to include geotechnical review, non-technical summaries and construction sequence	SE	SS-CR	04/08/2015
03	Proposed basement level updated	JJ	SS	21/08/2015

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1.0 Introduction

In accordance with London Borough of Camden Development Policy DP27 – Basements and Lightwells and the recent LB Camden guidance document entitled “Camden geological, hydrogeological and hydrological study – Guidance for subterranean development” (Issue 01 – November 2010), a risk-based impact assessment with regard to hydrology, hydrogeology and land stability is being undertaken for the basement development on this project.

1.1 Proposed Development

The site is currently partially occupied by a 4 storey temporary building with an access road to the side and back leading to a service yard behind the neighbouring terraces on Gordon Street. The site is bounded by buildings with single storey basements on three sides and disused coal stores on the street side, similar to the neighbouring terraced houses.

The current proposal is for a 6 storey high building to be used as a student centre, built as a reinforced concrete (RC) frame with 3000mm thick flat slabs. The building will have a two storey secant piled wall basement, up to a depth of approximate of 10m, around the perimeter of the new build footprint.

The foundations to the columns and walls supporting the superstructure will be supported on the capping beam over the secant pile wall, on the internal piled raft and on some pilecaps and ground beams adjacent to the basement, where required.

The stair to the back of the adjacent Bloomsbury Theatre is to be demolished and the building extended in its footprint with a new tunnel linking the plantroom in the new basement with the existing plantroom and network of tunnels at the back of the theatre.

It is likely that the below ground drainage will be required to be designed to meet the requirements of the London Plan. This will require approximately $50m^3$ of storage to be provided on site. At this stage, it is expected to locate this volume of attenuation under the vehicular ramp.

1.2 Site History

The early maps indicate that the site is occupied by the All Saints Church. By 1896 the church has expanded and residential properties are also present on the site.

By 1940 the site has been cleared of buildings and remains this way until the early 1950’s when a large undisclosed building (thought to be associated with the University College London) has been constructed.

All buildings on the site are demolished by the early 1990’s and site remains unchanged until present day.

The early maps show that the majority of the site surrounding area is comprised of inner city terraced properties with some areas of public open space. University College is located adjacent to the sites western boundary. Euston, St Pancras and Kings Cross stations are located between 400 and 700m to the north. Industry in the area comprises of timber yards, saw mills, engineering works, gas works, printing works etc.

1.0 Introduction

Over time and specifically post WW2 much of the residential properties have been demolished either due to bomb damage or through intended redevelopment. By the late 1900's much of the site surrounding area is comprised of commercial and office buildings. University College has expanded significantly and has a number of buildings located within the sites vicinity.

In 2008 a building was proposed for the site and the design progressed sufficiently to allow the installation of a section of the proposed secant pile wall forming the basement, however ultimately the project was abandoned.

2.0 Stage 1 - Screening

This section was completed using the screening tools as provided by the LBC in the Geological, Hydrogeological and Hydrological Study document, prepared by Arup, and was covered in the Planning Application BIA prepared by Curtins and dated March 2015, refer to Appendix A.

A summary of the results is as follows:

- **Surface flow:**
  No potential issues identified

- **Subterranean flow:**
  There is the potential for the ground water flow to be affected by the proposed basement. Check against Crossrail Report Appendix E: analysis of impacts on groundwater.

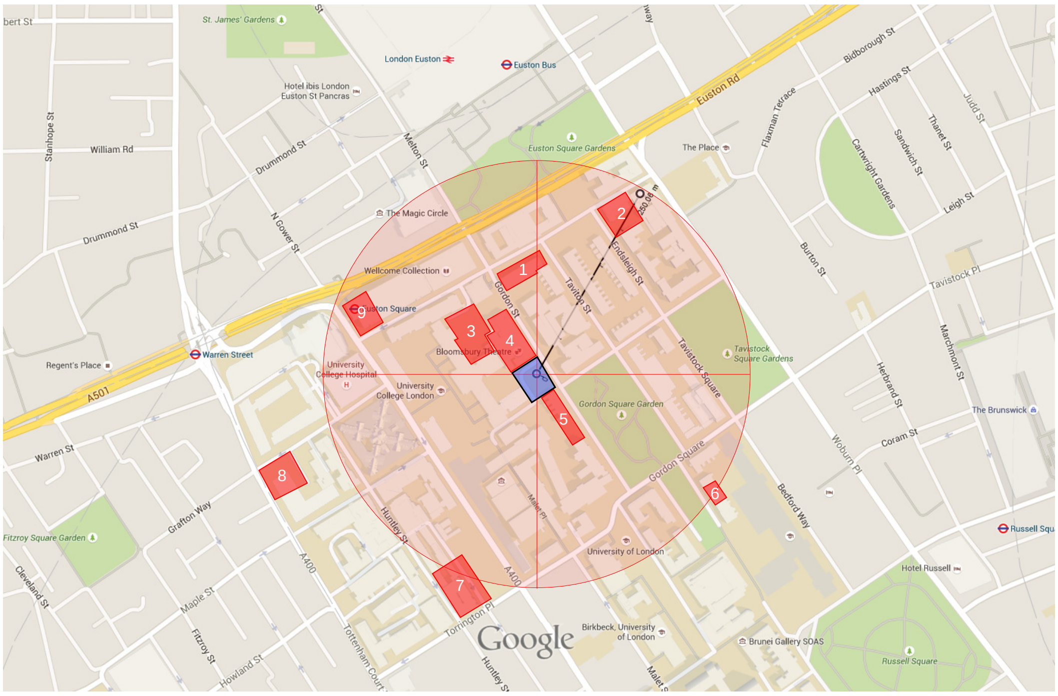
- **Land Stability:**
  There is potential for ground movement from the unloading of the London clay at the base of the excavation within the perimeter of the secant pile wall and potential for damage to the neighbouring properties and public highway from the movement of the secant pile wall. Assess the ground movement as described in CIRIA guide C580 and anticipated damage to the surrounding buildings based on the Burland scale.

3.0 Stage 2 - Scoping

The scoping was discussed as part of the Planning Application BIA prepared by Curtins and dated March 2015, which is included in Appendix A of this report.

To address the items identified in the screening it is proposed that the following are carried out:

1. Calculation of the basement impact on groundwater flow, to include a reconnaissance survey of basements along Gordon Street 250m each way from the proposed development.
2. Interrogate groundwater data collected from adjacent developments.
3. Set up the conceptual model
4. Estimate the damming effect from a similar exercise carried out as part of the EIA for the Crossrail project as presented in a Crossrail report “Appendix E: Analysis of Impacts on Groundwater”.
5. Detailed geotechnical and structural design of the basement and foundations addressing the ground stability issues identified in the ‘slope stability’ screening questions to reduce to acceptable levels the risk of impact on adjacent structures.



Site of proposed UCL Student Centre

1 UCL Wates House - Single storey basement, dry.
2 UCL Faculty of Laws - Two storey basement, dry.
3 UCL Wilkins Terrace - Shallow tunnels, dry.
4 Bloomsbury Theatre - Single storey basement and shallow tunnel, dry.
5 UCL Department of German, Archaeology and other - Single storey basements and semi-basements, dry.
6 Confucius Institute - Single storey basement, dry.
7 UCLH PTBC - Two storey basement, dry upper level (to 4m deep), water ingress in lower level, (7m high).
8 UCLH Cancer Centre - Single storey basement, dry.
9 Euston Station - Underground station, no evidence of water ingress in entrance hall, 6+m deep.

4.0 Stage 3 – Site Investigations

Two site investigations have been carried out at the site to cover both the geotechnical and geo-environmental aspects. The information provided by the two reports have been used together with the structural design of the secant pile wall carried out as part of the previous Panopticon building design proposals for the site to produce the ground movement and damage category assessment report. This has been included in appendix C of this document.

4. 1 Desk study

Refer to the Phase 2 Intrusive Ground Condition Investigation dated July 2013 by Curtins Consulting, included in Appendix F.

4.2 Intrusive testing

Intrusive investigations are covered by both the factual report on Ground Investigations dated March 2007 by Soil Mechanics (Appendix G) and by the phase 2 intrusive ground condition investigations dated July 2013 by Curtins Consulting (Appendix F). The findings are summarised in the planning Application BIA prepared by Curtins and dated March 2015 (Appendix A).

4.3 Monitoring

The data from 2006 revealed perched groundwater at 5m below ground level. This is in line with what observed during the works on the nearby Wates House site, approximately 50m away.

4.4 Interpretation

The phase 2 intrusive ground condition investigations dated July 2013 by Curtins Consulting provide an interpretation of the ground investigations previously carried out by Soil Mechanics and confirm the original design assumptions are to be used in the design of the secant pile wall for the previous development proposed for the site.

The previous proposals are particularly relevant as the position of the basement secant wall for the current proposals are almost identical to the previous scheme, the depth of the current basement is only marginally shallower and the majority of the south elevation secant pile wall was installed as part of the previous Panopticon project and the intention is to incorporate them in the current design.

To comply with the requirements for the London Borough of Camden for a BIA Curtins have produced a Ground movement and damage category assessment included in appendix C of this report.

5.0 Stage 4 – Impact Assessment

5.1 Surface flow

The BIA screening process did not identify any potential issues for surface flow. Additionally a flood risk assessment has been carried out by Curtins in February 2015.

The site will discharge surface water to the existing drainage network/Thames Sewer via suitable flow controls and SuDS techniques in line with the London Plan.

The online EA flood map and SFRA for North London show the development site in Flood Zone 1.

In line with table 3 of the NPPF, the site is suitable for classification therefore, if the principles set out within the FRA report are followed and developed at detailed design stage the site can be considered to have a low probability of suffering from any form of flooding and will not increase the probability of flood risk to the local catchment area.

5.2 Subterranean flow

In January 2013, Curtins were instructed by University College London (UCL) to undertake a Phase 2 Intrusive Investigation on the site located off Gordon Street, London, document reference EB1029/DJS/2872 dated July 2013 (Appendix F).

Site investigation fieldwork was undertaken in two phases as follows:

- February 2013 Harrison Group undertook the advancement of three window sample boreholes. The window samples were advanced to depths of between 1.20m and 4.00m below ground level (bgl) and confirmed the anticipated geology of sandy gravelly clay made ground, underlined by a gravelly sand and clay Lynch Hill Gravel Member. Groundwater was not encountered during the advancement of all three window sample boreholes.

- September 2006, three deeper cable percussive boreholes were undertaken by Soil Mechanics. The boreholes were advanced to depths of between 35.75m and 40.50m bgl. Made ground was recorded between 2.70m and 3.00m bgl and below this the Lynch Hill Gravel Member lies, comprising gravelly sands and clays extending to depths of between 5.7m to 6.30m bgl.

As also detailed in the next section, the London Clay Formation was encountered below the Lynch Hill Gravel and was recorded to depths between 13.40m and 18.70m. Below the London Clay is the Lambeth Group, which comprises very stiff locally dark grey sandy clay to depths of around 35mbgl, which in turn is underlain by Thanet Sands and Chalk.

During advancement of these deeper holes, the Lynch Hill Gravel was recorded as damp with only ‘possible seepage’ noted in BH02 at 5m just above the boundary with the London Clay. The remaining natural largely cohesive material was recorded as ‘dry’.

Water level monitoring was undertaken in BH2 and BH3, across October to December 2006, in pipes and/or piezometers in the Lynch Hill Gravel, London Clay and the Lambeth Group. Monitoring showed the water levels to be relatively consistent at around 5m bgl. It is considered that groundwater would flow in a southerly direction, i.e. towards and in the direction of flow of the River Thames.

In addition groundwater was not encountered in the three window sample boreholes undertaken in February 2013 to depths between 1.20m and 4.00. It is proposed that further monitoring is carried out prior to construction to confirm the groundwater levels.

When considering the depth of the basement construction, the lower 4m will be excavated in London Clay a generally impermeable strata with little appreciable water flow and thus the basement excavation in this strata will not affect the groundwater regime across the site.

Consideration of the Lynch Hill Gravel shows that this stratum will be fully removed for the extent, in depth and plan, of the basement construction. Although upper gravels are typically water bearing, in this location the investigation and monitoring has shown very little water present in the Lynch Hill Gravel. Consequently the basement construction will not significantly affect the flow of water in this stratum.

The monitoring has shown a potential artesian water level in the Lambeth Group, and underlying Thanet Sands and Chalk, but this is well below the basement construction and the basement construction does not penetrate this stratum.

It is concluded therefore that the construction of the basement to its full depth will not intercept significant water flow and hence will not affect the groundwater regime across the site and result in any inundation on the site or immediate surroundings.

Furthermore, Curtins have reviewed the groundwater information available for two nearby projects, Wates House and the Wilkins Terrace and the available data is in line with the results of the investigations for the proposed site, with perched groundwater encountered at approximately 4m below ground level.

To address the hydrogeological issue identified in the screening, an assessment of the basement impact on groundwater flow has been carried out. The proposals have been assessed against the finding of the Crossrail line 1 Assessment of Water Impacts produced by Mott MacDonald and in particular appendix E: Analysis of Impacts on Groundwater, section E.6 Shallow aquifer: Impact on New structures, included in appendix H of this report.

As part of the Crossrail assessment a simple groundwater model was created to calculate the likely impacts of groundwater levels from a new structure acting as a barrier to groundwater flow in the shallow aquifer. This was based on the width of the structure and the hydraulic properties of the aquifer with the expectation that a wider structure across the direction of the flow will have a larger impact on the water table and that the amount of rise in the water levels with reduce with distance from the structure.

The conceptual model adopted is fully described in the Crossrail report with the results of the assessment of the change in water level summarised in table E.16, next page:

5.0 Stage 4 – Impact Assessment

Table E.16: Model Results

Scenario	Width of Structure	Change in Water Level from Base Case Scenario (m)			
		Upgradient		Downgradient	
		20 m	5 m	20 m	50 m
A1	40	-0.12	-0.2	0.14	0.08
A1	60	-0.2	-0.3	0.24	0.14
A1	80	-0.27	-0.39	0.35	0.21
A2	30	-0.07	-0.15	0.1	0.05
A2	40	-0.11	-0.2	0.15	0.07
A2	60	-0.18	-0.29	0.25	0.13
A2	80	-0.26	-0.37	0.35	0.2
A2	120	-0.39	-0.52	0.56	0.35
A5	40	-0.09	-0.16	0.13	0.07
A5	60	-0.15	-0.24	0.22	0.13
A5	80	-0.21	-0.32	0.32	0.19
B1	80	-0.15	-0.21	0.18	0.1

Table E.16 from Crossrail line 1 Assessment of Water Impacts produced by Mott MacDonald

The modelling shows that for a structure the size of the student centre, with a basement of less than 30m x30m, the change in water level would be minimal, less than 200mm upgradient rise in water level.

Additionally, all the adjacent basements are much shallower than the proposed building summary below:

Proposed basement	SSL: +15.750
Bloomsbury Theatre	SSL: +19.600
ACBE Laboratory	SSL: +21.150 (approx.)
No 26 Gordon Street	SSL: +22.700 (approx.)

5.3 Site geology and geotechnical properties

Section 3 of the previous BIA summarises the site geology. The stratigraphy reported of the site is as noted in Table 1.

Strata	Thickness (m)	Top of Stratum (m AOD)
Made Ground	2.7-3	+24.13 to +24.24
River Terrace Deposits (Lynch Hill Gravel)	2.7-4.3	+21.19 to +21.43
London Clay	7.7-12.4	+17.83 to +18.49
Lambeth Group	16.7-22.3	+5.43 to +10.79
Thanet Sand	4-4.3	-11.51 to -16.17

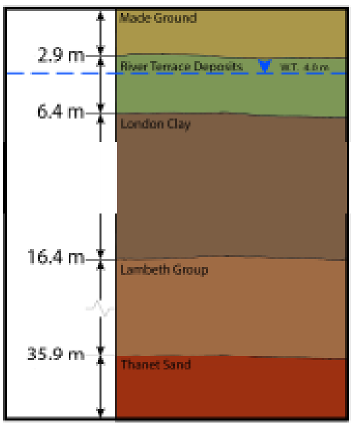


Table 1: Stratigraphy from previous investigations

The formation level of the proposed development is in the London Clay with the longer load bearing piles extending into the Lambeth Group. The excavation of the basement will result in a heave of approximately 180kN/m^2, as determined by the Phase 2 Intrusive Ground Condition Investigation dated July 2013 by Curtins Consulting. The movement of the ground within the perimeter of the secant pile wall surrounding the basement will be mitigated by the introduction of anti-heave material that allows the soil to expand without introducing uplift to the underside of the structure.

The proposed basement will have no effect on the site geology and geotechnical properties of the soil.

5.4 Ground movement analysis

A detailed assessment of the ground movement around the perimeter of the building due to the construction of the basement has been carried out and can be found in the Ground movement and damage category assessment report included in appendix C of this document.

The ground movement has been analysed with regards to take into account the piled wall installation and wall deflection. Additionally heave and long term ground movement have also been considered.

The basement excavation will result in the unloading and instantaneous movement of the soil. The short term instantaneous heave movement will be removed as part of the excavation however long term heave needs to be considered. The maximum vertical displacement will be in the centre of the excavation gradually reducing towards the perimeter where the presence of the piled secant wall will contain the heave movement within the site perimeter as the proposed loads on the secant wall are fairly high and will mitigate the potential for uplift movement.

The proposed basement development is a very common form of construction and the structural design is such to mitigate the effects of ground movement.

5.5 Damage category assessment

The results from the ground movement analysis reported in the Ground movement and damage category assessment report included in appendix C of this document have been used, in the same report, to assess the potential damage to the surrounding buildings from the construction of the proposed development. The damage category assessment does not exceed a Category 2 at any place around the perimeter of the excavation emphasising that there could be slight damage but cracks can be easily filled and some repointing may be required externally. This is a normal category damage for a type of building nestled closely between two or three buildings.

5.6 Conclusions

The screening process of the Basement Impact Assessment identified the subterranean water flow and the land stability from the movement of the ground as the two potential issues for the development. Both have been assessed and found to be within the guidelines of acceptable values with slight damage likely to result from the movement of the ground subsequent to the excavation of the basement and only a very small potential change in water level likely from the damming effect of the secant wall on the groundwater.

The proposed basement will not result in flooding of the area and will not cause instability of the surrounding ground and structures.

6.0 Non-structural Implications

6.1 Amenity of Neighbours

Based on the ground movement assessment it is not considered that the amenity of neighbours will be harmed.

6.2 Loss of open space or trees of townscape or amenity value

The site for the proposed building is currently occupied by a 4 storey temporary building and an access road to UCL buildings to the back of Gordon Street therefore the proposals will not result in a loss of open spaces or trees of townscape or amenity value.

6.3 Appearance

The building above ground immediately over the basement has been developed in consultation with the LBC planning and a public exhibition held on the proposals. In addition the building has been sensitively designed to respect and enhance the character of the surrounding area and the adjacent listed buildings in particular.

6.4 Archaeology

It is not anticipated that the site has potential for archaeological remains and it has been agreed with the Local Planning Authority that and archaeological assessment is not required.

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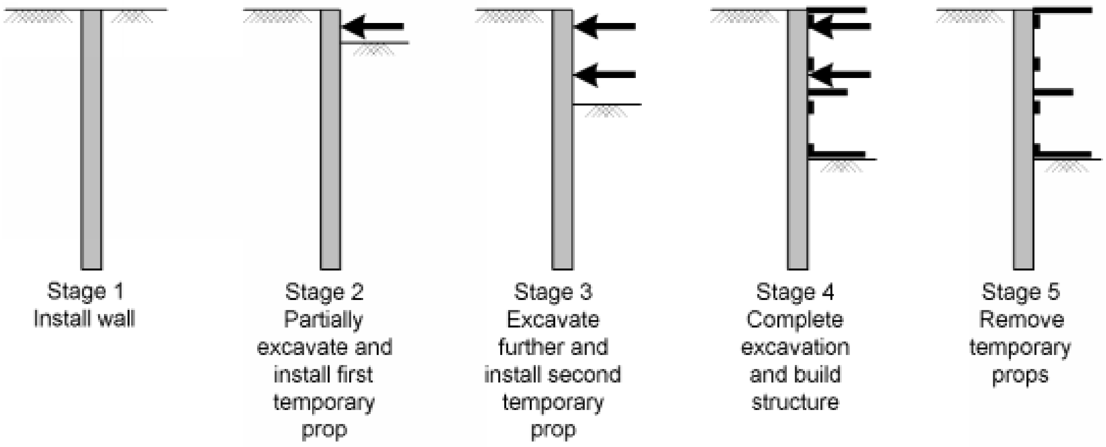
A – Planning Application BIA prepared by Curtins and dated March 2015

B – Construction method statement

The construction of the basement will follow a standard bottom up sequence of construction, as outlined in CIRIA guide C580. The following figure, from CIRIA C580, shows the typical bottom up construction.



Proposed Construction sequence

1. The piles are first installed in the required position and to the designed depth to resist the required vertical and lateral loads (Stage 1).
2. The capping beam is constructed around the perimeter of the building.
3. The basement is excavated to the base of the capping beam to allow the installation of the first level of props (Stage 2). Approximate level of the props +23.000 +24.000m AOD depending on the level of the capping beam, which is stepped. The props will be locate 1m below the slab SSL.
4. With the first level of props in place the basement is excavated to +19.500 (B1 level) and the second line of props installed at this level (Stage 3), 1m above the proposed slab SSL.
5. Once the second level of props is installed the basement excavation is taken to the formation level of the basement slab.
6. The excavation is taken to the formation level of the basement slab and a third line of props installed at approximately +16.850 AOD, 1m above the proposed B2 SSL.
7. The basement piles are installed once the excavation reaches the bottom followed by anti-heave measures and the basement slab.
8. Once the basement slab is constructed the third level of props is removed.
9. The lining wall from B2 to B1 is constructed followed by the B1 slab.
10. The second level of props is removed.
11. The lining wall from B1 to the ground floor is constructed followed by the ground floor slab.
12. The first line of props is removed, completing Stage 5.

A full construction method statement for the construction of the basement will be produced by the Contractor together with detailed calculations of the basement secant pile wall once they are appointed. Both will have to follow the principles outlined in this document in order to keep within the outlined ground movement estimate.

All the necessary propping will be designed by the piling contractor.

C – Ground movement and damage category assessment

D – Monitoring

E – Flood risk assessment

F - Phase 2 Intrusive Ground Condition Investigation dated July 2013 by Curtins Consulting

G – Factual report on Ground Investigations dated March 2007 by Soil Mechanics

H - Crossrail line 1 Assessment of Water Impacts produced by Mott MacDonald