# BASEMENT IMPACT ASSESSMENT

for

REDEVELOPMENT

Of

MANSFIELD BOWLING CLUB SITE

CROFTDOWN ROAD

LONDON NW5 1EP

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| Revision | Date | Status |
|---|---|---|
| 01 | 15 December 2014 | Initial Issue |
| 02 | 19 December 2014 | Coordination with other planning reports |
| 03 | 28 January 2015 | Incorporating comments from C.Geologist |

This report has been prepared by Train and Kemp (Consulting Engineers) LLP using reasonable skill and care in accordance with the instructions of its client. No liability is extended to other parties.



The lead author is a Chartered Engineer. The Hydrology section has been endorsed by Clive Carpenter as a Chartered Geologist.

**Norman Train C.Eng, FIStructE, FICE**

## 1. INTRODUCTION

This Basement Impact Assessment, BIA, has been prepared in support of the planning application for the redevelopment of the Mansfield Bowling Club site at Croftdown Road, NW5. The application is for a tennis club, a residential scheme of 21 units and publicly accessible open space.

Of the 21 residential units, four will include a basement and this BIA, has been prepared in accordance with LB of Camden CPG4, Basements and Lightwells and the Camden Geological, Hydrogeological and Hydrological Study, CGHHS. Section 5, Flooding, also makes reference to Camden Flood Report, 2003, and Surface Water Management Plan, 2013.

CPG4 screening questions are presented in Appendix 1, survey photographs in Appendix 2, and the Site Investigation in Appendix 3.

The BIA has been prepared by Norman Train, a Chartered Engineer, and in accordance with CPG4, Section 3 on Groundwater Flow has been reviewed and endorsed by a Clive Carpenter, a Chartered Geologist, with his letter dated 22.01.15 in Appendix 4. Clive was sent a copy of Revision 2 and the comments that he made has been incorporated in the text of Section 3.

### 1.1 BIA Stages

A Stage 1 Screening has been completed, utilising the questions in CPG4, and these are presented in Appendix 1. An additional question, GW1B, has been added to the Groundwater screen set relating to water issues rather than water table.

The screening has been used to define the Stage 2 Scope of the Assessment.

As part of the Stage 3 site investigations and study, an inspection of the buildings and site was completed in 2012 together with a walk pass of the neighbouring houses on Dartmouth Park Avenue, Laurier Road and York Rise and record photos are included in Appendix 1.. The desk top research included:

i. published geology,
ii. aquifer classification,
iii. flood data
iv. slope gradients from the topographical survey.
v. Northern Line alignment from London Underground

Three boreholes were sunk on 11.06.13 and standpipes installed in two of these. The standpipes were monitored on two further occasions.

JBA's arboricultural assessment of the trees on and around the site has also been used in the Stage 3 study.

The Stage 4 Impact Assessment of the scheme is presented in Sections 3 to 6.

## 2. EXISTING SITE AND PROPOSED DEVELOPMENT

For the purposes of this assessment, Croftdown Road is taken to the north and York Rise to the west. This means that Dartmouth Park Avenue and Laurier Road are to the east and south respectively.

### 2.1 Existing Site and Current Buildings

The Mansfield Bowling Club site is a backland development with access to the western end of the site from Croftdown Road. The site is surrounded by the rear gardens to the houses on the neighbouring streets. As a generalisation, these have shrubs and hedges to the eastern and northern boundaries with more formal fences to the southern and western boundaries.

The Bowling Club clubhouse is a three storey steel framed building in the south-western quadrant of the site. The indoor bowling green is a large enclosure framed in steel trusses across the remainder of the southern half of the site. It is understood that the clubhouse and indoor bowling green enclosure were constructed some 40 years ago.

Externally to the west and south of the Bowling Club buildings is a car park with access from Croftdown Road. To north is a defunct outdoor bowling green to the west and two clay tennis courts and small timber tennis pavilion to the east.

The roofs to the clubhouse and indoor bowling green have an impervious area of 1900m$^2$. The car park areas to the south and west of the Bowing Club have an impervious area of 800m$^2$ and 950m$^2$ respectively. This means that the total impervious area to the southern half of the site is 3650m$^2$.

The Bowling Club closed early in 2014. The tennis club is still operational.

Public Sewer
There is a main Victorian brick sewer that snakes across the site. It commences in Dartmouth Park to the east, entering the site from the rear garden to No 48 Laurier Road before clipping the corner of the indoor bowling green and looping around beneath the outdoor bowling green and western car park to discharge down between Nos 40 and 42 York Rise to the west. The brick sewer is 1.1m x 0.8m. The depth varies between approximately 3m and 4.5m. The main sewer has a feed draining down the rear of the gardens to the houses on Dartmouth Park Avenue and this enters the site to the south of the current tennis courts to join the main run.

London Underground Tunnels
The Northern Line between Tufnell Park and Archway is located beneath Junction Road 400m to the east.

## 2.2 Topography and Levels

The site is on the slopes to the Thames basin dropping from Highgate towards Camden Town; the natural gradient is from north to south.

Since the ground rises to the north, the tennis courts and outdoor bowling green are approximately 1.2m above the ground floor of the club. In forming the green and courts it is likely that the buildings were cut 0.6m into the natural slope with the excavated material used to form the plateau of the external playing areas to the north.

The northern boundary to the site is at +53.5m OD with the back of the pavement along Croftdown Road rising locally to +54.0m OD. The outdoor bowling green is at +53.0m OD and the tennis courts are at +52.7m OD. The clubhouse is at +51.7m OD and the low point of the car park at the access off Croftdown Road is at +51.0m OD. The access road itself drops with the junction on Croftdown Road being +50.7m OD.

This means that the level difference of 2m occurs on a distance of 100m, giving an average gradient of 1 in 50.

There are more significant slopes to the properties along Dartmouth Park Avenue where the gradient to the gardens are typically 1 in 9.

Brookfield Park, which is almost opposite the access road to the Bowling Club car park, has a level at its junction with Croftdown Road of + 51.4m OD. York Rise at its junction with Croftdown Road has a level of + 50.2m OD and drops to the south so that at its junction with Woodscombe Road it is at a level of + 49.8m OD. Woodcombe Road is hence over 1m below the Bowling Club car park.

### 2.3 Trees

An arboricultural assessment was completed by JBA in December 2014. As shown on the tree protection plan, JBA Drawing 11/103-TS02, there are 18 individual trees and 2 groups that are on or around the site. There is no vegetation of note to the south of G2 along the eastern boundary of the residential block.

The root protection areas, RPAs, are shown on 11/103-TS02 and the Group G2 RPA is 8m from the basement.

### 2.4 Proposed Scheme

It is proposed to create a new publicly accessible open space; enhanced tennis facilities including the reconfiguration and extension of the courts to provide an additional court and increased playing area to accord with LTA requirements; the provision of a new ancillary pavilion (Class D2) to replace existing ancillary buildings; a new community garden; and the demolition and replacement of the existing bowling club building with a new part three storey, part 2 storey building providing 21 residential dwellings (Class C3) with associated access, parking and landscaping.

The residential development is contained in a footprint of 55m x 35m. This will comprise 11 flats to the east side and 10 houses to the west. The four houses along the south side of the development will have basements which will contain an internal lightwell. None of the other properties will have a basement.

The residential units are located on the footprint of the Bowling Club. To the southwest corner of the block they will be within 1.5m of the boundary to the rear garden to the houses along Laurier Road.

Car parking will again be located to the south and west of the residential block but this will be smaller in area than previous and will contain permeable surfaces and soft landscaping strips and beds.

The new block is 1925m$^2$ and whilst the car parking has a gross additional area of 1000m$^2$ the equivalent impervious area will be smaller. This means the block has a similar impervious area to previous, but the car parking has been reduced significantly.

Given that the basements are all to the southern side of the block, they are remote from the Victorian public sewer.

The houses and flats will have sedum roofs.

### 2.5 Basement and Foundations

<u>Basement</u>
The basements to the four houses will be constructed as a combined concrete box approximately 10m wide by 41m long. The basement storey will be 3.0m deep meaning that the excavation will be just under 4m deep.

<u>Foundations</u>
The foundations will be integrated with the basement box as a concrete raft 0.5m thick with waterproofing, insulation and finishes taking 0.4m.

# 3 GROUNDWATER FLOW

## 3.1 Stage 1 Screening

GW1A The site is not on an aquifer. CGHH Fig 8 shows the site is founded on London Clay as a non productive strata.

GW1B London Clay is an impermeable stratum and there is not a free water surface within the London Clay. The basement will not extend beneath the water table.

GW1C There may be water issues to the base of any made ground on top of the London Clay and also with the more permeable fissured or claystone layers within the clay. Neither of these constitute a continuous subterranean flow or water table.

GW2 There are no water courses or water features in the immediate vicinity of the site. CGHH Fig 11, Watercourses, shows that the tributary of the Fleet from the Highgate Ponds is in the valley between Highgate Road and York Rise, some 120m to the south west of the new houses.

There are no springs in the area

GW3 CGHH Fig 14, Hampstead Heath Catchment, shows that the Hampstead Ponds catchment is 0.7km to the west of the site.

GW4 With the smaller car parking, the impervious area will reduce. With the increase in soft landscaping to the car parks, there will be a marginal increase in the net discharge to ground.

GW5 The current surface water drains will be maintained. With the proposed sedum roof, the attenuation of the discharge will be increased.

GW6 CGHH Fig 12, Surface water features, shows that there are two small ponds in Waterlow Park 0.7km to the north and Highgate Ponds, as a series of ponds, 0.7km to the west of the site.

These are too remote to effect the site

## 3.2 Stage 2 Scoping

- Possible water issues on top of the London Clay or in Claystone bands within the clay itself.
- The impervious area will reduce marginally.
- Possible increase in water discharging to ground

## 3.3 Stage 3 Study and Site Investigation

Study

London Clay is an impervious layer which is classified as an unproductive stratum and means that there are no groundwater flows across the site. The properties of London Clay are well understood with published data. In hydrogeological terms, the site does not have the challenges of the Claygate beds to the Hampstead Ponds catchment nor the alluvial deposits of the Thames basin to the south of the Borough.

As an impervious layer there is no water table with a pheratic surface within the London Clay. The claystone bands within the London Clay can be water bearing but these are minor issues and do not constitute a continuous subterranean flow or water table. There is also the possibility of minor issues and seepages on top of the London Clay but given that up the slope are gardens, these will be dissipated and attenuated and hence will not be significant.

Site Investigation
Three boreholes were sunk to depths ranging between 6.6m and 10m and the letter report, borehole logs and location plan are given in Appendix 4.

The investigation established that there is a minimal made ground mantle, ranging up to 0.7m, overlying weathered, becoming unweathered London Clay with claystone nodules. There were no water seepages and all three boreholes were dry on completion.

Standpipes were installed in two of the boreholes with monitoring readings taken on two subsequent weekly visits. After one week both standpipes were dry. After two weeks water had collected in the southern borehole to a depth of 0.2m at its base; this is at a depth of 7.45m.

As noted in the letter report, *'Water seepage is almost certainly due to the thin bands of claystone which are discontinuous as evidenced by the fact that both boreholes were dry for over a week. The water which has collected at the base of the borehole and is not the actual water table within the London Clay.''*

### 3.4 Stage 4 Impact Assessment

Groundwater Flow
London Clay is impervious and there is no groundwater flow within it.

Water Issues and Seepages
There is no perched water table to the base of the made ground and the seepages in borehole 2 were deeper than the proposed basement.

The lack of any standing water in the boreholes demonstrates that the seepages in the London Clay do not constitute a continuous water flow and the groundwater will not be affected by the excavation

There is a small possibility of water issues with the claystone layers within the London Clay. These will affect the waterproofing details and construction techniques that need to be adopted but will not affect the chosen concrete box solution. Any potential issues will be local to the basement and will not have any impact on the adjoining properties.

The surrounding higher ground has houses and roads. The foundations to the houses and the service trenches in the roads will tend to act as interceptors to any water that collects on top of the London Clay

Changes in Impervious Area
The formal car parking to the south and west are reduced in area and more permeable paving will be incorporated in the scheme. This means that there will be a marginal increase in the discharge of surface water to the ground. The soft landscape areas will be isolated strips and beds that are too small to have any formal French drains or soakaways. Any increased ground water flow would affect the houses down slope of the site along York Rise. Given that the soft landscaping is distributed across the whole of the southern side of the site and the York Rise buildings are 15m from the boundary, the changes are not significant.

Reinstatement of Basement Excavations
Any variations to the groundwater regime will be local to the redevelopment itself. This can be mitigated by:

i. Ensuring that the backfilling around the basement reinstates as far as possible the permeability of the undisturbed ground.
ii. Ensure that any groundwater flow in the made ground can move around the basement structure unimpeded.

Mitigation can be achieved by backfilling below the made ground with compacted clay arisings to reinstate the lower permeability of the London Clay and installing a shallow land drain in the made ground to route any intermittent perched waters around the basement box to discharge to the lower ground to the southwest. It should be noted that the land drain will not increase the discharge rates because seepage into the drain will be controlled by the made ground permeability on the higher ground to the north east of the basement box.

# 4 GROUND STABILITY

## 4.1 Stage 1 Screening

Stab 1. The average gradient across the site is 1 in 50. CGHH Fig 16, Slope Angle Map, shows that the slopes on this part of Dartmouth Park are less than $7^{o}$ [1 in 8].

The maximum slope to the gardens to the houses along Dartmouth Park Avenue is 1 in 9.

Stab 2. There will be no significant remodelling of the slopes

Stab 3. CGHH Fig 10, Topographical Map shows that the contours on this part of Dartmouth Park are all < 1 in 8

Stab 4. The site topographical survey shows that the level difference across the site is from a high point of +53.5m to a low point of +51.5, a fall of 2.0m in 100m giving a gradient of 1 in 50.

Stab 5. Whilst the site is founded on London Clay, the slopes to the surrounding area are all < 1 in 8

Stab 6. Two trees, T1 and T2 are to be removed along the northern side of the residential block.

The trees along the eastern boundary will be maintained.

Stab 7. The current clubhouse and indoor bowling green were constructed over 40 years ago and have not suffered any significant movement.

Stab 8. There are no water courses or water features in the immediate vicinity of the site.

Stab 9. The site is landlocked, being surrounded on all sides by the rear gardens to established houses. There are no level changes across the boundaries and whilst there has been some levelling in forming the tennis courts and bowling green, there is no evidence of any workings on the site.

Stab 10 A CGHH Fig 8 shows the site is founded on London Clay as a non productive stratum

Stab 10. B The site is not on an aquifer

Stab 11. The site is 0.7km to the east of Highgate Pond No.1

Stab 12. There are no adopted roads on the site. The internal circulation area to the south of the residential units is 5m from the basement box.

Stab 13. The adjoining properties are 20m from the proposed residential block and their foundations will not be affected by the basement.

Stab 14. The Northern Line tunnels are beneath Junction Road, 0.4km to the east of the site.

## 4.2 Stage 2 Scoping

- The site is found on London Clay
- Two trees are to be removed

## 4.3 Stage 3 Study and Site Investigation

Condition of Surrounding Properties
From the eastern boundary, a visual assessment was made of the rear of the houses along Dartmouth Park Avenue and Laurier Road. The houses are four storey to the rear and there is no evidence that these are exhibiting any significant movement or structural distress. Photos 1 to 2. The fronts of these houses were assessed along their road frontages from the pavement and again there is no evidence of any significant movement or structural distress. Photo 3.

Land Stability
Both the site walkover and the records in CGHHS show that there are no problems of land stability in the vicinity of the site.

Whilst the site is founded on London Clay, the slope angle on the site is generally 1 in 50 and ground stability is not an issue.

Given the slope of the rear gardens to Dartmouth Park Avenue, the base of the slope along the eastern boundary was examined and there were no signs of any slippage.

Trees
The JBA tree protection plan 11/103-TS002 shows both the individual tress and the Group around the houses. These are too remote for the basement construction to impact on their root protection areas.

Site Investigation
The topsoil and made ground mantle extends to a depth of 0.7m overlying London Clay. This means that the basement will be founded in the London Clay.

The upper weathered London Clay is firm to stiff, becoming stiff below 2.0m. The unweathered London Clay below 3m to 4m is very stiff with claystone nodules.

Along the eastern boundary, tree roots were found to a depth of 2.4m.

After two weeks, water had collected in the base of one of the standpipes, demonstrating that water will not be an issue with the construction.

### 4.4 Stage 4 Impact Assessment

The proposed foundation is for a 3.5m deep concrete box as a traditional, buildable and robust solution. With stiff clay, the excavations can generally be battered back, apart from the pinch points; these are discussed below.

Stability of Adjacent Buildings
There is no movement in the adjoining houses along Dartmouth Park Avenue and Laurier Road. The buildings are remote from the basement excavation and their structural integrity will not be compromised.

The nearest building will be the rear outriggers to the houses along Laurier Road which are 20m from the basement.

Land Stability
The existing gradients are all shallower than 1 in 8 and there are no land slippage or ground stability problems within or adjacent to the site.

Slope Stability
There are no slopes being introduced in the scheme.

Ground Movement
The basement excavation will extend to a depth of some 4m below ground level so the reduction in load on the underlying ground will be around 70kN/$m^2$. The self weight of the structure will be in the order of

45kN/m$^2$. With occupation the total load will be nearer 60kN/m$^2$. Hence there will be no long term ground movement.

Trees
Tree roots were encountered to a depth of 2.4m. The basement will be deeper than this and the foundations will not be affected by the seasonal movement of trees.

T1 and T2 will be removed from along the northern side of the residential block. These are over 25m from the basement and are too remote to have any effect on the basement. Potential heave will have to be considered in design of the shallow foundations at both these locations.

Protective fencing and Construction Exclusion Zones, CEZs will be used to protect the T3 during the demolition and construction works.

Adjoining Foundations
None of the buildings on the site are being maintained and the nearest buildings are the rear outriggers to the houses on Laurier Road which are 20m from the residential block. These are too remote to be affected by the basement construction.

The Victorian brick sewer just clips the north east corner of the residential block at a depth that is comparable with the basement; since this is over 25m from the basement it will not be affected by it.

Highways
The terraces are remote from the Public Highway. They are some 5m from the private circulation areas and the basement will not need to be designed for highway loadings.

## 5 SURFACE FLOW AND FLOODING

### 5.1 Stage 1 Screening

Flood 1. The site is not within Hampstead Ponds Catchment

Flood 2. There are no material changes in surface water flows

Flood 3. The impervious area decreases and hence the impact on the surface water sewers will be to reduce the likelihood of flooding downstream..

Flood 4. There will be no changes in flow rate onto neighbouring land

Flood 5. There will be no changes in quality of water discharge

Flood 6. Floods in Camden [2003] records that York Rise and Woodsome Road flooded in 1975, but these are 0.8m and 1.2m respectively below the site's south western boundary..

The Surface Water Management Plan, 2013, extends the zone of the Local Flooding Risk Zone, LFRZ 3034, York Road, is to the east of Brookfield Park, to the north of the site, and along York Road as the western boundary to the site.

### 5.2 Stage 2 Scoping

Possible issue with site located to side of LFRZ 3034, York Rise.

### 5.3 Stage 3 Study and Site Investigation

Flooding in Camden, 2003 and Managing Surface Water 2011 were used in the screening.

### 5.4 Stage 4 Impact Assessment

The records show that York Rise and Woodsome Road flooded in 1975 whereas Croftdown Road did not. Whilst not recorded in Floods in Camden 2003, the Surface Water Management Plan 2011, SWMP, records that York Rise also flooded in 2002; ref SWMP 3.8.4

Part of the SWMP was to analyse the impact of heavy rainfall events by assessing flow paths, velocities and catchment response. The dominant surface water flood mechanism is pluvial flooding where water from the extreme rainfall event is not able to drain into the ground due to the heavy urban development. A direct rainfall method was used in the modelling approach that incorporated conservative allowance for the drainage network and infiltration and this modelling generated seven potential Local Flood Risk Zones, LFRZs, in Camden. These are potential flood areas and whilst they tend to encapsulate the previous historical records, the modelling means that the zones are extrapolated and extended.

The SWMP defines LFRZ 3034, York Rise, as being characterised by steep topography with high ground to the north and lower flatter ground to the south. This steep gradient causes relatively fast flows from Dartmouth Park to flow down Brookfield Park and channel down York Rise towards the railway line.

Brookfield Park, at its junction with Croftdown Road, is at a level of +51.4m OD. This is same level as the Bowling Club car park. York Rise is over 1m below the Bowling Club southern car parking area. Because the houses are to the east of the LFRZ, it is not considered that there are any surface water flow or flooding issues with the construction of the basement.

## 6 ADDITIONAL IMPACT ASSESSMENTS

### 6.1 Construction Plan

The existing access on Croftdown Road will be used for both material deliveries and muck away.

Generally the excavation for the basement will be battered back to ground level. The exception is the southeast corner of the new block where sheet trenching will be required because of the close proximity of the boundary.

### 6.2 Sustainable Construction

The inclusion of a sedum roof to the houses will mean that the surface water flows will be attenuated.

### 6.3 Amenity and Landscape

The amenity will be improved with the external public space and improved facilities for the tennis club.

### 6.4 Lightwells

The lightwells are internally within the houses and do not impact on the neighbours.

### 6.5 Third Party Considerations and Impact on Neighbours

The rear gardens to the surrounding properties acts as a buffer and there will not be a significant impact on these.

The greatest impact during construction will be with the construction traffic. All construction traffic will enter and egress the site using the existing entrance on Croftdown Road. Vehicle movements will be managed and wheel washing used to ensure that Croftdown Road is kept clean.

### 6.6 Cumulative Impacts

The environmental setting is such that the impacts of the proposed scheme are minimal and as such there is no cumulative impact.

## 7 SUMMARY

The site is founded on London Clay as a stable impervious layer and the gradient of the ground is such that there are no problems of ground stability or groundwater. Whilst the site is beside the York Rise LFRZ the surface water flowing down from Dartmouth Park channels down York Rise and the houses are on higher ground to the east of this. The two trees that are to be removed from the northern side of the residential block are remote from the basement and the trees that remain will be protected with construction exclusion zones. This means that there are no concerns with the environmental setting of the site.

The excavation of the new basement will use established techniques and there is sufficient clearance to existing buildings or the site boundary to ensure that the excavation can generally be battered back, with trench sheeting only required to the southeast corner beside the eastern boundary.

There is nothing in this BIA to suggest that the construction of a basement to the four houses will have a detrimental impact on the site, neighbouring sites or natural environment.

Appendix 1: CPG4 Stage 1 Screening

# Basement Impact Assessment to CPG4
## Stage 1 Screening

| Screen | Response | Amplification |
|---|---|---|
| **Subterranean (groundwater) flow** | | |
| GW1A Is the site founded on an aquifer | No | CGHH Fig 8, Aquifer Designation Map, shows the site is founded on London Clay as a non productive stratum |
| GW1BWill the basement extend beneath the water table | No | There is not a free water surface within the London Clay. Any water issues within the London Clay will be associated with the more permeable fissured or claystone layers, as minor perched tables, but these do not constitute a continuous subterranean flow or water table. |
| GW1C Will the basement encounter water issues | Possible | There may be water issues on top of the London Clay and with the more permeable fissured or claystone layers within it. These do not constitute a continuous subterranean flow or water table. |
| GW2. Is the site within 100m of a watercourse | No | CGHH Fig 11, Watercourses, shows that the tributary of the Fleet from the Highgate Ponds is in the valley between Highgate Road and York Rise, some 120m to the south west of the new houses.<br><br>There are no springs in the area |
| GW3. Is the site within Hampstead Ponds catchment | No | CGHH Fig 14, Hampstead Heath Catchment, shows that the Hampstead Ponds catchment is 0.7km to the west of the site |
| GW4. Will proportions of impermeable areas change | Yes | Whilst the area of the buildings will be similar to previous, the area of impervious car parking will be reduced. |
| GW5. Will more surface water discharge to ground | Possible | The current surface water drains will be maintained. With the increase in soft landscaping there will be a marginal increase in the net discharge to ground. |
| GW6. Is the lowest excavation lower than any nearby water feature. | No | CGHH Fig 12, Surface water features, shows that there are two small ponds in Waterlow Park 0.7km to the north and Highgate Ponds, as a series of ponds, 0.7km to the west of the site.<br><br>These are too remote to effect the site |
| **Ground stability** | | |
| Stab1. Are existing slopes > 1 in 8 | No | CGHH Fig 16, Slope Angle Map, shows that the slopes on this part of Dartmouth Park are less than $7^{o}$ [1 in 8].<br><br>The maximum slope to the gardens to the houses along Dartmouth Park Avenue is 1 in 9. |
| Stab2. Will remodelled slopes be > 1 in 8 | No | There will be no significant remodelling of the slopes |
| Stab3. Does neighbouring land slope > 1 in 8 | No | CGHH Fig 10, Topographical Map shows that the contours on this part of Dartmouth Park are all < 1 in 8 |
| Stab4. Is site on hillside with slope > 1 in 8 | No | The site topographical survey shows that the level difference across the site is from a high point of +53.5m to a low point of +51.5, a fall of 2.0m in 100m giving a gradient of 1 in 50. |

| Screen | Response | Amplification |
|---|---|---|
| Stab5. Is the site founded on London Clay | Yes | Whilst the site is founded on London Clay, the slopes to the surrounding area are all < 1 in 8 |
| Stab6. Will any trees be felled | Yes | Two trees are to be removed along the northern side of the residential block boundary. |
| Stab7. Is there a history of seasonal movement | No | The current clubhouse and indoor bowling green were constructed over 40 years ago and have not suffered any significant movement. |
| Stab8. Is the site within 100m of watercourse or spring | No | See answer to GW2. |
| Stab9. Is the site on worked ground | No | The site is landlocked, being surrounded on all sides by the rear gardens to established houses. There are no level changes across the boundaries and whilst there has been some levelling in forming the tennis courts and bowling green, there is no evidence of any workings on the site. |
| Stab10A Is the site on an aquifer | No | CGHH Fig 8 shows the site is founded on London Clay as a non productive stratum |
| Stab10. B If so will excavation be below water table | No | See amplification to GW1A |
| Stab11. Is the site within 50m of Hampstead Ponds | No | The site is 0.7km to the east of Highgate Pond No.1 |
| Stab12. Is site within 5m of highway | No | There are no adopted roads on the site. The circulation area to the south of the residential block is 5m from the basements. |
| Stab13. Will the basement increase the differential depth of foundations relative to adjoining properties | No | The adjoining properties are 20m from the proposed residential block. |
| Stab14. Is the site over tunnels | No | The Northern Line tunnels are beneath Junction Road, 0.4km to the east of the site. |
| **Surface Water and Flooding** | | |
| Flood 1. Is site within Hampstead Ponds Catchment | No | |
| Flood 2. Material changes in surface water flows | None | |
| Flood 3. Changes in impervious area | Yes | The impervious area decreases and hence the impact on the surface water sewers will be to reduce the likelihood of flooding downstream. |
| Flood 4. Changes in flow rate onto neighbouring land | No | |
| Flood 5. Changes in quality of water discharge | No | |
| Flood 6. Is site in area of risk from surface water flooding | Possible | Floods in Camden [2003] records that York Rise and Woodsome Road flooded in 1975, but these are 0.8m and 1.2m respectively below the site south western boundary.<br><br>The Surface Water Management Plan, 2013, defines the Local Flooding Risk Zone, LFRZ 3034, to the east of Brookfield Park, to the north of the site, and along York Rise to the south. |

## Stage 2 Scoping

The key areas that need further investigation and clarification are:

- The impervious area will decrease
- The site is found on London Clay
- Trees are being removed

Possible areas that need further consideration and discussion are:

- Water issues to the top of the London Clay
- Marginal increases in surface water discharge to ground.
- Site Adjacent to a Local Flood Risk Zone

Appendix 2: Site Photographs

Photo 1 Rear gardens of houses to Dartmouth Park Avenue
Note 1 No evidence of movement in rear elevations

Photo 2 Rear gardens of houses to Dartmouth Park Avenue
Note 1 No evidence of movement to rear elevations

Photo 3 Front elevation of houses on Dartmouth Park Avenue
Note 1 No signs of movement.

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Appendix 3 Site Investigation

TRAIN AND KEMP
ENGINEERING BUSINESS SOLUTIONS

# SITE INVESTIGATION

at

MANSFIELD BOWLING CLUB

CROFTDOWN ROAD

LONDON NW5 1EP

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*FOREWORD*

1. This Report has been prepared by Train and Kemp (Consulting Engineers) LLP with all reasonable skill, and care in accordance with the instructions of Generator Group LLP and no liability is extended to other parties.

2. This Report is preliminary; it is informative for initial design and costings but should not be used for engineering or contractual purposes.



**Document Control**

| Rev | Date | Details |
|---|---|---|
| 01 | 29 June 2013 | Final Issue |

## 1. Introduction

1.1 It is proposed to construct eight houses, with basements in the grounds of Mansfield Bowling Club. The houses will comprise 2 blocks of 4 units with a combined basement box excavated to a depth of 4.0m.

1.2 The Generator Group LLP instructed Train and Kemp to undertake a site investigation to establish:

- The soil profile;
- The strength/depth profile of the London Clay for the design of the basement foundations;
- Any perched water table on top of the London Clay and any water bearing issues within the London Clay
- The root action of the trees along the eastern boundary

1.3 The published geology shows that the site is founded on London Clay and consequently the three boreholes were located around the proposed houses; see location plan in Appendix 2. Boreholes 1 & 2 were located along the northern and eastern boundaries respectively close to the existing trees and at the base of the slopes to the adjoining rear gardens. Borehole 3 was located in the disused bowling green to the west of the proposed houses.

1.4 The fieldwork was undertaken by KF Geotehcics using a flight auguer rib. The boreholes were excavated to depths ranging between 6.6.m and 10m on 11.06.13 and standpipes were installed in two of these. The location of the boreholes and their logs is given in Appendix 2.

1.5 The records of the standpipe readings are given in Appendix 1.

## 2. Soil Profile

2.1 The soil profile is top soil and made ground to a maximum depth of 0.7m overlying London Clay. The top of the London Clay is weathered to a brown orange mantle, but this becomes grey unweathered London Clay below 2m.

2.2 The weathered London Clay is firm to stiff, with a cohesion of 70kN/$m^2$, whereas the unweathered clay is stiff with cohesion values in excess of 140kN/$m^2$. The competency of the clay improves with depth with claystone nodules being found below 4.7m; Borehole 1 hit refusal on a claystone layer at 6.6m.

2.3 Tree roots were encountered in Boreholes 1 and 2 to depths of 1.9m and 2.4m respectively.

## 3. Groundwater

3.1 All three boreholes were dry on completion. Standpipes were installed in Boreholes 2 & 3 at 7.7m and 6.6m respectively. These standpipes were monitored one and two weeks after their installation and the results are given in Appendix 1.

3.2 There was no water in either standpipe after one week with the end of the probe remaining dry. After two weeks, Borehole 3 was dry but Borehole 2 had water to a depth of 7.45m. This is 0.25m above the base of the standpipe.

3.3 Given that there was no water after one week, it is likely that the water in Borehole 2 does not represent the actual water table but is entrapped water from issues that cannot flow away with the impervious plug of the surrounding London Clay. It demonstrates that there are minor issues that have filled the bottom 0.25m of the borehole.

3.4 The water table is not in the top 6m and the construction of the basements will not have any detrimental affect on the groundwater regime in and around the site.

## 4. Design Parameters

4.1 The London Clay will provide a competent bearing for the basement raft. At 3.5m depth, this is on the cusp between the weathered and unweathered clay with a bearing capacity of over 250kN/$m^2$.

4.2 With an excavation to 4.0m, the surcharge relief will be of the order of 70kN/m2 and this will have to be factored into the design, particularly with the lightwells which will be lightly loaded.

4.3 The tree roots extend to depths of around 2.5m and consequently these will not affect the basement foundations.

4.4 There is a possibility of water issues with the claystone nodules, particularly in wet winder periods. If these are found to be significant an intercepting drain will need to be constructed around the perimeter of the excavation

## 5. Conclusion

5.1 The London Clay will give a competent bearing stratum and at a depth of over 3m this will be below any tree root action.

5.2 The water table is more than 6m below the ground and the construction of the basements will not affect the hydro-geological regime in the area. There are minor water issues that may have to be taken into account, particularly during wet winter periods; this however is a construction issue.

Appendix 1: Standpipe Records

| Date | BH 2<br>Standpipe depth: 7.7m | BH 3<br>Standpipe depth:6.7m |
|---|---|---|
| 11.06.13 | Dry | Dry |
| 18.06.13 | Dry | Dry |
| 27.06.13 | 7.45m | Dry |

Appendix 2: Site Location Plan and Borehole Logs

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GU14 6BN
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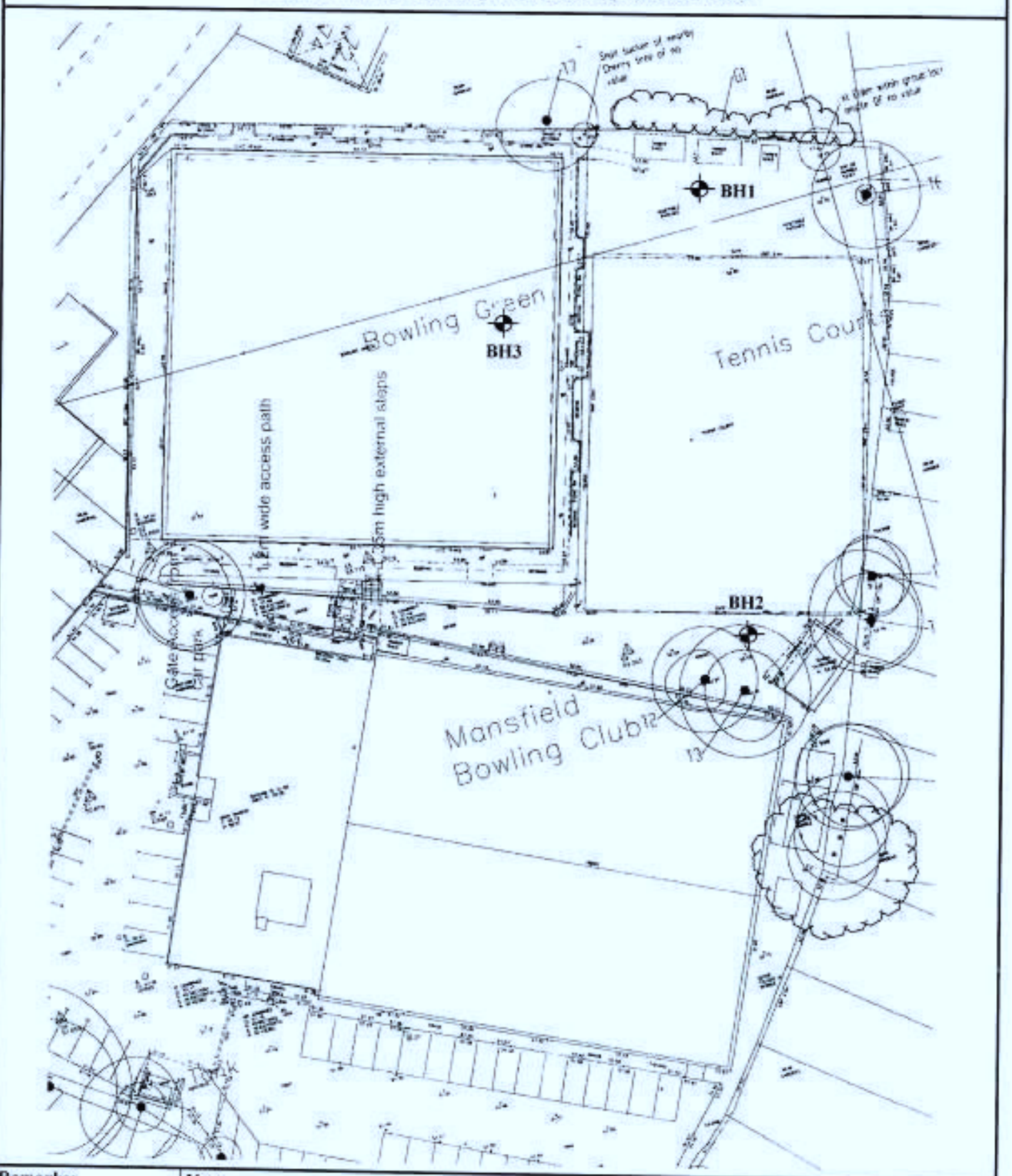
# SITE LOCATION PLAN

Ref: G/061319/101

| Sheet: | Scale: | Date: |
|---|---|---|
| 1 of 1 | N/A | 11 June 2013 |

Client: Train & Kemp

Location: **MANSFIELD BOWLING CLUB, LONDON NW5**




**Remarks:**

**Key:**

| | | | | | |
|---|---|---|---|---|---|
| Borehole (BH) | | SVP | Soil Vent Pipe | MH | Manhole |
| Trial pit (TP) | | RWP | Rainwater Pipe | G | Gully |
| Sample (S) | | Soakaway (SW) | | | Tree/Bush (approx. ht in m) |

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| | | | |
|---|---|---|---|
| Borehole 1 | | | Ref: G061319 |
| Sheet: 1 | Scale: 1:50 | | Date: 11/06/13 |
| Client: TRAIN AND KEMP | | | |
| Equipment & Method : Restricted Access Flight Auger | Location: MANSFIELD BOWLING CLUB, LONDON NW5 | | |

| Description of Strata [thickness] | Reduced Level | Legend | Depth | Samples Type | Samples Depth | Tests Type | Tests Value | Field Notes |
|---|---|---|---|---|---|---|---|---|
| Turf over MADE GROUND: firm dark brown gravelly silty clay with numerous brick fragments (0.60) | | | | D | 0.30 | | | |
| | -0.60 | | 0.60 | | | | | |
| Firm brown/orange grey veined silty CLAY with laminations of silt and fine sand (1.10) | | | | | | | | |
| | -1.70 | | 1.70 | | | | | |
| Stiff as above (1.00) | | | | D | 2.00 | V | 70 | Roots of live appearance to 1.9m |
| | | | | D | 1.50 | | | |
| | | | | D | 2.00 | V | 108 | |
| | | | | D | 2.50 | | | |
| | -2.70 | | 2.70 | | | | | |
| Very stiff as above with claystone nodules (3.60) | | | | D | 3.00 | V | 126 | |
| | | | | D | 4.00 | V | 140+ | |
| | | | | D | 5.00 | V | 140+ | |
| | | | | D | 6.00 | V | 140+ | |
| | -6.30 | | 6.30 | | | | | |
| Claystone (0.30) | | | | | | | | |
| Base of Borehole | -6.60 | | 6.60 | | | | | |

Where 0.3m penetration has not been achieved, the number of blows for the quoted penetration is given. (Not the N value)
All depths and reduced levels are in metres.
Water level observations during boring are given on the last sheet of the log.

U Undisturbed Sample
D Disturbed Sample
B Bulk Sample
W Water Sample
S Standard Penetration Test
V Vane Test
MP Mackintosh Probe

Remarks
Borehole dry and open on completion

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| | | | |
|---|---|---|---|
| Borehole 2 | | | Ref: G061319 |
| Sheet: 1 | Scale: 1:50 | | Date: 11/06/13 |
| Client: TRAIN AND KEMP | | | |
| Equipment & Method : Restricted Access Flight Auger | Location: MANSFIELD BOWLING CLUB, LONDON NW5 | | |

| Description of Strata [thickness] | Reduced Level | Legend | Depth | Samples Type | Samples Depth | Tests Type | Tests Value | Field Notes |
|---|---|---|---|---|---|---|---|---|
| Turf over MADE GROUND: stiff brown gravelly sandy silty clay with brick fragments (0.50) | | | | D | 0.30 | | | |
| | -0.50 | | 0.50 | | | | | |
| Stiff brown/orange grey veined silty CLAY with laminations of silt and fine sand (0.70) | | | | | | | | |
| | -1.20 | | 1.20 | | | | | |
| Firm as above (1.20) | | | | D | 2.00 | V | 102 | |
| | | | | D | 1.50 | | | |
| | | | | D | 2.00 | V | 72 | |
| | -2.40 | | 2.40 | D | 2.50 | | | Roots of live appearance to 2.4m |
| Stiff as above (2.30) | | | | D | 3.00 | V | 110 | |
| | | | | D | 4.00 | V | 120 | |
| | -4.70 | | 4.70 | | | | | |
| Very stiff as above with claystone nodules (3.40) | | | | D | 5.00 | V | 140+ | |
| | | | | D | 6.00 | V | 140+ | |
| | | | | D | 8.00 | V | 140+ | |
| Base of Borehole | -8.10 | | 8.10 | | | | | |

Where 0.3m penetration has not been achieved, the number of blows for the quoted penetration is given. (Not the N value)
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Water level observations during boring are given on the last sheet of the log.

U Undisturbed Sample
D Disturbed Sample
B Bulk Sample
W Water Sample
S Standard Penetration Test
V Vane Test
MP Mackintosh Probe

**Remarks**

Borehole dry and open on completion
Too dense to auger below 8.1m (claystone)
Standpipe installed

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| | | | |
|---|---|---|---|
| Borehole 3 | | | Ref: G061319 |
| Sheet: 1 | Scale: 1:50 | | Date: 11/06/13 |
| Client: TRAIN AND KEMP | | | |
| Equipment & Method : Restricted Access Flight Auger | Location: MANSFIELD BOWLING CLUB, LONDON NW5 | | |

| Description of Strata (thickness) | Reduced Level | Legend | Depth | Samples Type | Samples Depth | Tests Type | Tests Value | Field Notes |
|---|---|---|---|---|---|---|---|---|
| Turf over MADE GROUND: loose dark grey silty sand (0.50) | | | | D | 0.30 | | | |
| MADE GROUND: firm brown gravelly silty clay with brick fragments (0.20) | -0.50 | | 0.50 | | | | | |
| Firm brown/orange grey veined silty CLAY with laminations of silt and fine sand (1.10) | -0.70 | | 0.70 | | | | | |
| Stiff as above (2.90) | -1.80 | | 1.80 | D | 2.00 | V | 48 | |
| | | | | D | 1.50 | | | |
| | | | | D | 2.00 | V | 80 | |
| | | | | D | 2.50 | | | |
| | | | | D | 3.00 | V | 110 | |
| | | | | D | 4.00 | V | 124 | |
| Very stiff as above with claystone nodules (5.30) | -4.70 | | 4.70 | | | | | |
| | | | | D | 5.00 | V | 140+ | |
| | | | | D | 6.00 | V | 140+ | |
| | | | | D | 8.00 | V | 140+ | |
| Base of Borehole | -10.00 | | 10.00 | D | 10.00 | V | 140+ | |

Where 0.3m penetration has not been achieved, the number of blows for the quoted penetration is given. (Not the N value)
All depths and reduced levels are in metres.
Water level observations during boring are given on the last sheet of the log.

U Undisturbed Sample
D Disturbed Sample
B Bulk Sample
W Water Sample
S Standard Penetration Test
V Vane Test
MP Mackintosh Probe

Remarks

Borehole dry and open on completion
Standpipe installed to 7m

Appendix 4: Chartered Geologist's Review and Endorsement

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GWP Report No: 150113

Our ref: nt220115.docx
Your ref:

22 January 2015

Dear Mr Train

**Groundwater Component of Basement Impact Assessment for re-development of Mansfield Bowling Club Site, Croftdown Road, London, NW5 1EP**

Please accept this letter as my contribution towards addressing Groundwater Flow matters, as part of the Basement Impact Assessment for redevelopment of Mansfield Bowling Club Site, Croftdown Road, London NW5 1EP.

My qualifications to undertake this work are as follows:

- BSc (Hons) in Geology Class 2.i,
- MSc in Hydrogeology and Groundwater Resources;
- Fellow of the Geological Society of London (FGS);
- Chartered Geologist (C.Geol);
- European Geologist (EurGeol)
- Chartered Member of the Chartered Institute of Water and Environmental Management (MCIWEM C.WEM).

I am a practising Hydrogeologist and have more than 25 years of experience in groundwater matters.

I have reviewed the public domain geological and topographic maps as well as the site specific ground investigation data for the site. This information confirms the site to be located in a shallow valley depression on the London Clay, a low permeability deposit, generally considered to be incapable of meaningful groundwater flow. There is therefore no aquifer directly beneath or surrounding the property, and hence no groundwater table within the immediately underlying strata.

The 3 No. cable percussion boreholes describe encountering firm to stiff clay and claystone over their full depth (6.60 – 10.00m), overlain by 0.50 to 0.70m thickness of Made Ground. The Made Ground is described as gravelly silty clay with brick fragments with some loose silty sand. The top 1m or so of the London Clay is described as brown/orange will some silt laminations – this is consistent with a weathered zone.

All boreholes were found to be dry on drilling. Standpipes were installed in 2 of the boreholes, although no installation construction details are available. Monitoring of water levels over the following two weeks (in June 2013) showed one standpipe to have water in its base, and one to be dry.

My interpretation of the above ground investigation and subsequent monitoring, is that the Made Ground, and perhaps to a lesser extent the highly weathered Clay horizon, is capable of transmitting rainfall percolating through the overlying soils, and perching on the underlying impermeable London Clay. As the topography falls to the south, one would expect the perched water to move in this direction. These seepages are likely to be intermittent, slow and limited in nature.

Any existing building foundations, service ducts, utilities or other ground disturbances within this shallow ground may interact with the Made Ground in terms of providing either potential flow conduits or flow barriers, either directly, or indirectly through their backfill. The sewer line crossing the site would be one such potential example. The Made Ground will therefore already be highly disturbed.

It is understood the re-development of the site is to include four basements in a concrete box, approximately 10m wide by 41m long, with an excavation depth of 4m. This excavation will therefore pass through the Made Ground and weathered London Clay and into the un-weathered Clay beneath. Depending on the exact construction methods of the basements and the ground restoration, there is the potential to restrict or accelerate these shallow Made Ground seepages beneath and around the re-development.

The Basement Impact Assessment prepared by Train and Kemp has, in my opinion, correctly categorised the site geology and hydrogeology, identified the potential for minor impacts, the scale of these impacts and how these affect the basement design.

Any groundwater impacts will be local to the re-development itself. These can be mitigated by i) re-instating a similar level of permeability to the ground disturbed in undertaking the excavation, as that which existed before the re-development, and ii) ensuring Made Ground water can move around the basement structure unimpeded. This would typically entail backfilling of excavations below the Made Ground to achieve a similar 'impermeability' to that of the *in-situ* London Clay (by compaction of excavated London Clay spoil), whilst also providing shallow land drains within the Made Ground to route any intermittent perched waters around the basement box to the lower ground elevation side. Seepages through the land drains are unlikely to occur more quickly than the pre-development rate because seepage into the land drains will be controlled by the surrounding Made Ground permeability.

To conclude, it is my opinion that the Groundwater sections of the Basement Impact Assessment prepared by Train and Kemp are fit-for-purpose. I would recommend the addition of a small section on the mitigation measures, as identified in the last paragraph, to demonstrate that even site scale impacts will be mitigated.

Yours sincerely,

Clive Carpenter
BSc (Hons) MSc FGS CGeol MICWEM EurGeol AMAE

Chief Hydrogeologist and Equity Partner