

London Borough of Lambeth  
**Lambeth Residential Basement  
Study**  
Report of Findings

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It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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## Executive Summary

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1. With a shortage of development land and rising land values in the London Borough of Lambeth, the development of basements in residential areas is likely to become a popular way of gaining additional space in homes. Basements can affect the environment and nearby structures in a number of ways. The impacts of such development to the geological, hydrological and hydrogeological environment, and to other properties including listed buildings, are of concern to both the Borough and local residents.
2. While small, isolated basements may have little impact, the cumulative effect of incremental development of basements in close proximity, particularly when these are large, potentially creates a significant impact.
3. Extending downwards beneath an existing building, particularly old, masonry-built properties that were not designed to contemporary engineering standards, is a challenging and potentially hazardous undertaking. The work involved is not trivial and it merits input from experienced professional design engineers and contractors, including underpinning specialists. However, for residential basement developments typical project values tend to be relatively small and the fees for design become a higher proportion of the total cost than for large commercial schemes. There is a need therefore to ensure that corners are not inadvertently cut.
4. LB Lambeth policy on basement development is contained within Policies Q11 and EN5, which do not specifically deal with issues related to the geological and hydrological conditions and particular characteristics of the Borough. This study has been carried out with the objective of providing the Borough with technical guidance to assist them in framing revisions to the planning policy.
5. The London Borough of Lambeth includes some varied topography and landscape, and a diverse mix of building and development types including 2,500 listed buildings. The Borough is elongated north-south, with Streatham and Norwood comprising higher ground in the south and Kennington and Vauxhall lying within the natural floodplain of the Thames in the north. In terms of geology and topography, the north of the Borough is predominantly floored by a thin cover of alluvium associated with the present course of the Thames. Further south the clay is overlain by sands and gravels representing the ancient alignment of the river, and the highest ground in the south is formed of exposed London Clay. A “lost” river, the River Effra, runs the full length of the Borough from north to south: it is fully enclosed in culvert, but the former channel is evident in the topography and it continues to influence drainage patterns in the eastern half of the Borough.
6. The potential for flooding in Lambeth is closely related to the topography and the geology: in the north of the Borough the risk is associated with the Thames while in the central area, which is largely underlain by terrace gravels, groundwater flooding due to surcharge of shallow perched aquifers is more likely. Flooding due to overloaded stormwater sewers following intense rainfall is a risk throughout the Borough.
7. This study reviews the physical geography, geology, hydrology and hydrogeology of the Borough of Lambeth in relation to the risks posed by

development of shallow residential basements. Basement construction methods are reviewed, together with the potential impacts of uncontrolled basement construction upon the environment and neighbouring structures including listed buildings. With good design and appropriate consideration of geology and hydrogeology such development can usually be accommodated without increasing the risks.

8. A planning policy framework which recognises the risks and sets appropriate engineering standards for applications should provide the safeguards necessary to minimise adverse impacts. This study concludes that the current planning policy in Lambeth should be strengthened in respect of basement development, and recommends the introduction of a Basement Impact Assessment (BIA) approach to assessing and mitigating ground-related risks. The requirement for a BIA might be introduced in a Supplementary Planning Document.
9. The BIA would follow the format of the Environmental Impact Assessment (EIA) process. The process would be developer-led, with LB Lambeth providing guidance in the earlier stages and using an audit approach to check the adequacy of the BIA.

# 1 Introduction

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## 1.1 Brief

10. Planning applications for development including basements, and in particular those featuring refurbishments and retro-fitting of basements beneath existing properties, are problematic for the planning authorities in London. These developments are not well addressed in planning policy and the highly technical nature of the issues further complicates things. Developers and property owners also find the situation difficult. A lack of clarity about what the rules allow and uncertainty regarding the information required to support an application, add to the cost and stress of carrying out home improvements.
11. London borough of Lambeth (LB Lambeth) has commissioned Arup to carry out a study to consider the potential risks associated with residential basement development in relation to the differing hydrological and geological characteristics across Lambeth. The study will inform revisions to the planning policy currently being considered. A copy of the project brief prepared by LB Lambeth is included in Appendix A.

## 1.2 Scope

12. The scope of this document is defined by the objectives detailed in the project brief. In addressing these objectives, this report:
  - commences with a review of the planning context (Section 2);
  - presents a description of the geological and hydrological character of Lambeth including topography, geology and hydrogeology. This information is provided in summary in a series of thematic maps at 1:15,000 scale (when printed at A0 size) and related cross sections and diagrams which may be used to identify areas in LB Lambeth potentially susceptible to hydrogeological and other ground-related impacts from subterranean development (Section 3);
  - reviews typical subterranean development and construction methodologies (Section 4);
  - identifies what particular ground-related risks might result from basement developments, including whether there is any justification for considering heritage assets differently from other neighbouring buildings, and the principal ways in which these risks might be mitigated (Section 5);
  - considers whether there are particular buildings or types of buildings which are particularly at risk from basement development in the close vicinity, and how this might be managed in policy terms (Section 5);
  - reviews the current Lambeth planning policy relating to residential basement development and considers its sufficiency (Section 6);
  - concludes with a summary of the Basement Impact Assessment approach to management of the hydrological, geological and other ground-related

risks within the planning process, which could be implemented in Lambeth through revisions to policy (Section 7).

13. Appendix B contains a glossary.
14. With regard to the scope defined in the project brief (reproduced below) the sections of this document which address each point are provided in [brackets].
15. *“The study will include a desktop analysis of the hydrological and geophysical character of Lambeth. This should review existing data held by Lambeth, identify any gaps and obtain missing data, to provide an up-to-date picture of the varied existing geological and hydrological conditions in Lambeth including: Topography, Geological conditions (clay, gravel, old river channels etc) and Hydrological and hydro-geological conditions (surface water, shallow and deep aquifers) [Section 3 and Figures].*

*The study will consider whether these differing characteristics across Lambeth will increase risk of flooding and land instability and as such require a differing approach to basement development. It should indicate:*

- *whether there are specific geographical areas or types/ages of buildings (especially on listed buildings) in Lambeth where the risks are such that basement development may be inappropriate [Para.194 and 194];*
- *whether certain forms of basement development may be appropriate in different areas, including any circumstances in which the building of more than one storey of basement may increase risks [Section 4.2 and Para.125];*
- *whether the cumulative impacts of multiple basement developments may increase risk and what these risks are [Section 4.3.5];*
- *the potential impact that basement development beneath a garden may have upon rainwater runoff and surface water flooding [Para. 115];*
- *the potential impact of basement development upon perched water, groundwater flows and upon the aquifer, including at times of storm events [Section 4.3.3];*
- *the measures necessary to mitigate the possible impact of basement construction (e.g permeable soil layer above a garden basement extension and how much of the area underneath a garden should be left undeveloped to allow free flow of ground water and retention of an effective soakaway) [Section 5.1.2];*
- *the measures necessary to mitigate the risk of surface water flooding of the basement to neighbouring dwellings [Section 5.2.2].*

*It will be potentially important to comment from your experience about construction techniques and methods that have the potential to reduce the nuisance from noise, dust and vibration cause by the construction of basement extensions [Para. 109 and 141].*



*The study should identify what hydrological, geological and other technical information applicants should be required to submit with planning applications [Section 7].”*

## 2 Planning context

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### 2.1 General outline

16. The planning system in England is “plan-led” with Local Authorities setting out how planning will be managed for their area in “plans” which outline what can be built and where. Local Authorities are responsible for deciding whether a proposed development should be allowed to go ahead. This is called planning permission.
17. Within certain limits the excavation of basements below the footprint of a dwelling house is treated as Permitted Development and may not need planning permission: the planning system has limited control over these excavations. Permitted Development Rights<sup>1</sup> allow certain alterations to be undertaken without the need to make a formal planning application to the council. These Permitted Development Rights relate to single houses and do not apply to flats/maisonettes.
18. Permitted development Rights do not remove the requirement for Listed Building Consent, nor remove the legal requirement to preserve trees located within a conservation area or subject to a Tree Preservation Order. Listed Building Consent is required for all works of demolition, alteration or extension to a listed building that affect its character as a building of special architectural or historic interest.
19. Where planning permission is not required there is other legislation that may provide some control over the excavation of a basement. This includes:
  - The Party Wall Act;
  - The Highways Act;
  - The Building Regulations; and
  - Environmental Pollution and Control legislation.
20. Most types of development need planning permission, and excavating to create a new basement, a new separate unit of accommodation and/or altering the external appearance of a house, such as adding a lightwell, is likely to require planning permission.

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<sup>1</sup> Statutory Instrument 2008. No. 2362. The Town and Country Planning (General Permitted Development) (Amendment) (No. 2) (England) Order 2008. Note that under Article 4 of GDPO a local planning has authority to make a Direction to withdraw these Permitted Development Rights. LB Lambeth: information on Article 4 Directions in Lambeth can be found on the Council’s website, by checking the ‘constraints’ tab when doing a property search using the planning applications database.

## 2.2 The National Planning Policy Framework

### 2.2.1 Introduction

21. Where planning permission is required, the local planning authority outlines its planning policy in relation to basements through the Local Plan and potentially through a supplementary planning document. Local documents are guided by national planning policies. The National Planning Policy Framework (NPPF)<sup>2</sup>, published in March 2012, replaced almost all existing national planning policy and guidance. The emphasis in the NPPF is on each local planning authority (LPA) producing an up-to-date Local Plan for its area. (The Lambeth Local Plan is discussed in Section 2.5 below). The NPPF does not deal specifically with basements, but (in paragraph 109) identifies “Land Instability” as presenting risks to be taken into account by planning authorities. The NPPF sets out the regime and the methodology for taking account of flooding risk in relation to development.
22. These matters are elaborated in Planning Practice Guidance. This is a web-based set of live documents (<http://planningguidance.communities.gov.uk/blog/guidance/>) which provides guidance on a number of aspects of development and which comprehensively replaces previous policy documents and guidance notes. The superseded documents include Planning Policy Guidance 14 (PPG14) relating to development on unstable land and Planning Policy Statement 25 (PPS25) which dealt with development and flood risk: both of these were relevant to basement construction, and their counterparts in the new framework are guidance no. 45 on Land Stability (ID:45) and guidance no. 7 (ID:7) on Flood Risk and Coastal Change. These are discussed in sections 2.2.2 and 2.2.3 below.

### 2.2.2 Planning Practice Guidance: land stability

23. This guidance does not refer to basements but more generally suggests that:
 

*“planning authorities may need to consider:*

  - *identifying specific areas where particular consideration of landslides, mining hazards or subsidence will be needed;*
  - *including policies that ensure unstable land is appropriately remediated, prohibit development in specific areas, or only allow specific types of development in those areas;*
  - *circumstances where additional procedures or information, such as a land stability or slope stability risk assessment report, would be required to ensure that adequate and environmentally acceptable mitigation measures are in place; and*
  - *removing permitted development rights in specific circumstances.”*

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<sup>2</sup> National Planning Policy Framework, Department for Communities and Local Government, March 2012

24. The guidance permits the authority to specify, where instability is suspected, that it will require applications to be accompanied by a land stability risk assessment report or a slope stability risk assessment report describing and analysing the issues relevant to ground instability and indicating how they would be overcome.

### 2.2.3 Planning Practice Guidance: flood risk and coastal change

25. This guidance requires local authorities to undertake strategic flood risk assessment to inform their local plan preparation and, in areas subject to flood risk, to require developers to undertake site specific flood risk assessments. Authorities are advised to control development in such a way as to avoid increasing flood risk but where the development can only take place in an area subject to flood risk, management and mitigation measures should be form part of the development.

## 2.3 The London Plan

26. The London Plan is the overall strategic plan for London and its production is a requirement of the legislation which established the Greater London Authority. As such, it has a different provenance from the NPPF, which post-dates the current (2011) London Plan. However, following minor alterations made to the London Plan in 2013 the two sets of policies are regarded as fully consistent with one another.
27. A number of the policies in the London Plan have implications for developments which include basements, notably 5.12 “Flood risk management” and 5.13 “Sustainable drainage”. Supplementary planning guidance (SPG) provides guidance on the implementation of London Plan policy with respect to sustainable design and construction, and this includes particular guidance on basements and lightwells as follows:

*Where there is pressure for basement developments, boroughs should consider whether there are any particular local geological or hydrological issues that could particularly effect (sic) their construction, and adopt appropriate policies to address any local conditions.*

*When planning a basement development, developers should consider the geological and hydrological conditions of the site and surrounding area, proportionate to the local conditions, the size of the basement and lightwell and the sensitivity of adjoining buildings and uses, including green infrastructure.*

*When planning and constructing a basement development, developers should consider the amenity of neighbours.*

## 2.4 Other London Boroughs

### 2.4.1 The London Borough of Islington

28. LB Islington provides guidance specifically related to proposals including basement developments through a Supplementary Planning Document “Basement Development” which was adopted in January 2016. This guidance places particular importance on preventing risk to the structural stability of “property, infrastructure and the public”, and sets out the requirement for applicants to provide a Structural Method Statement (SMS) with their submission to the Council. The SMS is comparable to the Basement Impact Assessment approach pioneered in LB Camden, and suggestions are given that the scope should include investigations related to geology, groundwater and flooding, among other matters. The detailed scope of the SMS is left, however, to the “professional judgement made by the qualified person(s) signing the statement” rather than being made the outcome of a systematic risk assessment process as with a BIA.

### 2.4.2 The London Borough of Richmond upon Thames

29. The approach to regulating basement development in LBRuT is set out in a Planning Advice Note “Good Practice Guide on Basement Developments”, May 2015. This document appears to contain only two items relating to basements which are additional to the standard requirements, namely a “Structural Impact Assessment to be prepared if “basements are being added to or adjacent to Listed Buildings or the development involves lowering the floor levels of Listed Buildings”, and a Construction Method Statement which is mandatory for all basement developments (otherwise required only if substantial demolition or excavation works are proposed or if sites are in confined locations, and for all major developments).

### 2.4.3 The London Borough of Wandsworth

30. In Wandsworth, which is the neighbouring borough to the west of LB Lambeth, a factsheet “Basements - a Householder Guide” provides information for householders (and therefore developers) about particular issues that might arise with basement developments but refers to the “Housing” SPD for the formal requirements. The Guide encourages the preparation of a Construction Method Statement for basement developments, noting that it is a requirement in the case of Listed Buildings. As far as design considerations are concerned, the Guide stipulates that lightwells should occupy no more than 50% of a front garden and advises that basements should not occupy more than half of the depth of a back garden. (It is not clear whether this is intended to mean half the area of the back garden).

### 2.4.4 The Royal Borough of Kensington and Chelsea

31. In RBKC the policy on basement developments is Policy CL7 in the Consolidated Local Plan of July 2015, together with provisions in Policy CE2 on Flooding. The Council is undertaking a Partial Review of the existing Local Plan but the basement elements have already been subject to extensive

consultation and review. Policy CL7 is supported by a Supplementary Planning Document, issued in revised draft for consultation in June 2015 following consultation on a preliminary draft Basements SPD in February/April 2015.

32. The most significant elements (because they are new restrictions) of the policy are that a basement extension is restricted to 50% of the garden area (but see paragraph 148); basements must not comprise more than one storey, with discretionary exceptions being made for larger commercially orientated development sites; excavations are not allowed immediately under listed buildings. The SPD explains the requirement for a Construction Method Statement (CMS) but the indicated scope for a CMS extends beyond the temporary or construction impacts and includes a requirement to consider the long term effect of the basement development on ground conditions, groundwater and surface water, and so on. The Policy as expanded upon in the SPD requires that, for the planning application, the engineering design should be advanced to ACE Detailed Proposals Stage (equivalent to RIBA Stage 3).

## 2.4.5 The London Borough of Camden

33. The policy framework relating to basement in the London Borough of Camden is set out in Development Policy DP27 which states that LB Camden “*will require an assessment of the scheme’s impact on drainage, flooding, groundwater conditions and structural stability, where appropriate.*” The Council “*will only permit [basement and other underground development that] does not cause harm to the built and natural environment and local amenity and does not result in flooding or ground instability*”. LB Camden “*will require developers to demonstrate by methodologies appropriate to the site that schemes:*
- *maintain the structural stability of the building and neighbouring properties;*
  - *avoid adversely affecting drainage and run-off or causing other damage to the water environment;*
  - *avoid cumulative impacts upon structural stability or the water environment in the local area*”
34. DP27 is supported in LB Camden by a supplementary planning guidance document CPG 4 “Basements and lightwells”, which prescribes a “Basement Impact Assessment” (BIA) approach to preparing an application for a development which includes a basement, or an extension to a basement.

## 2.5 Local guidance in Lambeth

35. The Lambeth Local Plan (LLP), which was adopted in September 2015, forms the new statutory development plan for the borough. The LLP includes Policies Q11 and EN5 which relate to the design of basements and lightwells, and to flood risk.
36. A Supplementary Planning Document, “Building Alterations & Extensions”, dated September 2015 summarises the objectives of Policy Q11 in relation to

basements but only in terms of the need for new basements to conform to the visual (landscape and architectural) nature of the locality.

37. Policy Q11 states that (numbering as in the LLP):
- i) *In normal circumstances the excavation of basements beneath existing properties is acceptable. However, basement extensions are not considered acceptable if they:*
    - i. *entail the roofing over or inappropriate enclosure/alteration of existing basement areas;*
    - ii. *result in the loss of front gardens or entail excessive excavation which would harm the character of the locality or which would undermine the appearance of the host building (especially on heritage assets);*
    - iii. *result in development below gardens which would severely compromise the ability of trees and soft landscaping to thrive without irrigation.*
  - j) *New basement lightwell excavations should:*
    - i. *minimise the size of any excavated area at the front or side;*
    - ii. *be in keeping with the style and design integrity of host building and wider locality;*
    - iii. *minimise the visual impact through good design (in many cases, especially heritage assets, this is likely to mean pavement grilles rather than balustrades); and*
    - iv. *not reduce existing parking bays to below the minimum standard (where this occurs the council will seek the removal of the parking bay).*
38. Policy EN5 is concerned with assessing and minimising flood risk and states, as far as basement development is concerned, that for all developments:
- e) *it must be demonstrated that the development will be safe, and where required, it will reduce fluvial, tidal, surface run-off and groundwater flood risk and manage residual risks through appropriate flood risk measures, including the use of sustainable drainage systems (SuDS) (in accordance with policy EN6).*
  - f) *Basement proposals (excluding self-contained dwellings in Flood Zone 3) shall incorporate appropriate mitigation measures to ensure the development is safe from all forms of flooding and does not increase flood risk elsewhere.*

## 3 The physiographic character of Lambeth

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### 3.1 General context

39. LB Lambeth is a long, narrow borough, about 4.8 km wide and 11 km long, extending from the south bank of the Thames in the north to the Surrey Hills in the south (see Figure 1). It has 3.2 km of River Thames frontage opposite the City of Westminster and is bordered to the west by the London boroughs of Wandsworth and Merton, to the south by Croydon and Bromley, and by Southwark to the east. LB Lambeth is a densely populated borough and has a highly varied socio-economic population. The following statistics were largely taken from the State of the Borough 2014 report and from the council website:

- Land area: 26.8 km<sup>2</sup>
  - Population: 310,000
  - Population density: >100 people per hectare
  - Average size of household: 2.3 persons per property
  - Proportion of owner occupied households: 33%
  - Average household income: £45k (2011-12)
  - Number of listed buildings and structures: 2,500
  - Number of conservation areas: 62
40. The northern tip of the borough, including Waterloo, is similar in character to central London. The inner urban areas of Brixton, Clapham, Herne Hill, Kennington, Stockwell and Vauxhall make up the central part of the borough. South of the South Circular Road are the less built up suburbs of Norwood and Streatham.
41. Much of the stock of purpose-built houses in LB Lambeth is a product of the 19th century, when London expanded rapidly. Developments of flats are largely a product of the 1920s onward. Tall buildings began to appear from the late 1950s onward. Generally, the housing stock is at its oldest in the north of the borough, but historic settlements and older groups of building such as Clapham are exceptions. In the early 19th century grand terraces and suburban villas developed in areas of Stockwell and Kennington, with stock brick and stucco the predominant building materials. Terraces from this period typically have semi-basements.
42. There is quite a lot of development in the borough from the mid to late 19th century and early 20th century (Victorian and Edwardian) and much of it is of good quality. From the mid decades of 19th century basements were no longer incorporated. On modest terraced houses of this period there is only space for a small garden passage down the side. In the inter-war years suburban development in the form of short terraces and symmetrical semi-detached pairs can be found in the southern parts of Lambeth. These properties are typically two storeys high. There is normally amenity space to

the side of end terrace and semi-detached properties. Purpose-built blocks of flats also became common at this time.

## 3.2 Topography

43. The highest ground is in the south of the borough where the elevation reaches +110mOD in Gipsy Hill. The land surface generally falls towards the north, where the flat (former) floodplain of the Thames is at about +3mOD. Figure 2 is a relief map of the borough.

## 3.3 Geology

### 3.3.1 Geological strata in the London Basin

44. LB Lambeth is within the geological feature known as the London Basin. This is an elongated sedimentary basin approximately 250 kilometres long which underlies London and a large area of south east England. It extends into south eastern East Anglia and the adjacent North Sea. The basin is an asymmetrical syncline plunging (deepening) to the east with its axis aligned broadly SW-NE.
45. The youngest rocks in a synclinal structure occur in the centre, with older strata cropping out in succession away from the axis. The oldest rocks of the London Basin are of Cretaceous age, principally the Chalk and the Wealden Group of sands and clays, and they outcrop in a vee-shape (westward-pointing) forming the high ground of the Berkshire and Marlborough Downs and the Chilterns to the north and the North Downs to the south. Overlying the Chalk stratigraphically and outcropping adjacent to the Cretaceous strata in the centre of the basin are Palaeocene and Eocene strata which comprise fine grained sand, clayey sands, pebble beds and clay. These strata include the London Clay, which floors a large part of the centre of the basin.
46. The River Thames flows across the centre of the London basin and deposits of alluvial sand, gravel and clay associated with the river form a superficial cover on top of the London Clay over much of the urban area. Terrace deposits, principally of gravel, occur at different levels on the higher ground to the north and south of the present course of the river, reflecting earlier channels during and since glacial times (0.5 million years approximately). The most recent deposits of alluvium occur adjacent to the present river channel, at the lowest levels.
47. The geological succession within the London Basin is summarised in Table 1. Other rocks occur beneath the Chalk but do not outcrop anywhere within the London Basin and are not relevant to this study.



Table 1 – Stratigraphy of the London Basin

Geological period	Groups	Formations	Typical thickness where present (m)
QUATERNARY		Alluvium River Terrace Deposits Glacial Deposits	Variable
PALAEOGENE	THAMES	Bagshot Formation: sand, fine-grained with thin clay beds	10-25
		Claygate Member: clayey silt, sandy silt, silty sand London Clay Formation: clay	90 - 130
		Harwich Formation: sand, clayey fine grained sand and pebble beds	≤10
	LAMBETH	Reading, Woolwich & Upnor Formations: clay mottled with fine grained sand, laminated clay, flint pebble beds and shelly clay	10-20
		Thanet Sand Formation: fine grained sand	≤30
CRETACEOUS	CHALK	Upper, Middle and Lower Chalk, each subdivided into different formations	180-245

### 3.3.2 Geology of Lambeth

48. Figure 3 is a map showing the geology of Lambeth. The sequence of soil and rock strata that lie beneath the topsoil in Lambeth are (youngest first):

#### Superficial geology

- Made Ground, worked ground
- Langley Silt Deposits in some areas (commonly known as brickearth)
- Head Deposits (*central and south parts of the borough*)
- River Terrace Deposits
- Alluvium (*north of the borough only*)

#### Solid geology

- London Clay including the Claygate Member
  - Lambeth Group
  - Thanet Formation
  - Chalk Group
49. London Clay underlies almost the entire borough. There is a small area at Brockwell Park close to the eastern boundary with Southwark where a patch of Lambeth Group strata outcrops. (Elsewhere, of course, the Lambeth Group strata, which are older than the London Clay, are present beneath the London

- Clay.) This anomaly is probably the result of faulting (the Streatham Fault). Also, an area of outcropping sand, silt and clay belonging to the Claygate Member runs along Church Road as far as Sydenham Hill and just extends into the south-eastern corner of the borough. The Claygate Member is stratigraphically at the top of the London Clay.
50. Apart from Streatham and West Norwood in the south and south-east, superficial deposits cover the London Clay across much of the borough.
  51. The geological deposits nearest to the ground surface across the borough can be broadly grouped into three distinct zones:
    - The South Bank area from the Thames as far south as the edge of Brixton, where the ground is flat and low-lying, which is floored by recent alluvium and the Kempton Park Gravel Formation;
    - The west-central area of Clapham, Brixton and Streatham Hill which has low relief but rising in elevation southwards, where the surface geology comprises the older terrace gravels and Head deposits; and
    - The higher ground of Streatham, West Norwood and Dulwich in the south and east of the borough where the London Clay crops out at the surface. In some areas, for instance in Streatham Hill and Streatham South, the outcrop of London Clay is covered by a thin veneer of Head deposits.
  52. River Terrace Gravels and Head deposits are present in the lower lying areas of Streatham South and St Leonard's to the south of the borough. The terrace deposits represent materials deposited along the prehistoric flood plains of the "ancestral" River Thames. They are thought to have been deposited during cold periods when periglacial activity increased the sediment load carried by the river water. Repeated sequences of flooding, causing partial erosion of the previous deposits, and renewed deposition left behind a complex series of "terraces" of flood plain debris
  53. The engineering behaviour of the River Terrace Deposits is mainly dominated by the sand and gravel that it contains. In engineering terms, the River Terrace Deposits comprise a large-grained, non-cohesive soil. The design of foundations in the River Terrace Deposits is governed by its frictional, rather than short term properties.
  54. The River Terrace Deposits have a high permeability and allow water to flow through them with comparative ease. Since the deposits are underlain by the London Clay Formation which comprises of relatively low permeability clays, water sits on the London Clay surface within the pores between the soil grains that make up the River Terrace Deposits.
  55. There are two major geological faults on the south side of the London Basin. These are generally known as the Greenwich Fault and the Wimbledon Fault, although the latter is sometimes referred to as the Wimbledon-Streatham Fault. The two faults are collinear and together extend from Chessington in the west to Beckton in the east, passing through Malden, Wimbledon, Mitcham, West Norwood, Lewisham, and Greenwich. The central part of the feature is sometimes also separately identified as Streatham Fault, and this is the section that runs from the Upper Tooting area in the south east of Wandsworth and into the borough area. The downthrown side is to the north,

and the fault brings the chalk into horizontal contact with the Thanet Sand, which contacts the Lambeth Group at Lewisham. The maximum displacement is approximately 30m. The fault itself therefore affects only the deep strata, which are below any potential basement activity, but as noted above, it is the cause of the small outcrop of Lambeth Group strata near Brockwell Park.

### 3.3.3 The South Bank area

56. Until the early 19th century much of north Lambeth (now known as the South Bank) was marsh. The settlement of Lambeth Marsh was built on a through-road crossing the marsh lands on a causeway, potentially dating back to Roman times. Lambeth Marsh was drained during the 18th century, it is commemorated by the street name of Lower Marsh<sup>3</sup>.
57. Much of the area from the South Bank and Stockwell is underlain by Alluvium and Kempton Park Gravel. The Alluvium is confined to the areas nearest the Thames but reaches a maximum thickness of 10m. This material is of variable composition but typically comprises clay, silt and fine sand with some gravel. The Kempton Park Gravel is generally between 3m and 10m thick but up to 15m in some locations (see Figure 4).

### 3.3.4 The west-central area

58. Here the older Terrace Gravels (Hackney Gravel, Lynch Hill Gravel and Taplow Gravel) crop out, generally at higher elevations than the younger terrace deposits such as the Kempton Park Gravel.
59. Much of the area is also covered by the material known as Head. Head is a periglacial deposit, formed adjacent to glaciers and ice sheets. Repeated freezing and thawing of the ground exposed at the surface caused disintegration of the exposed strata above a permafrost layer. The resulting unfrozen mix of gravel and fine material was carried downslope by gravity, to form a cover of material over the solid geology, locally with lenses of silt, clay, peat and organic material. Head forms more or less in situ, so the lithology is closely related to that of the parent material. In the central part of the borough the Head is likely to be composed of sand and silt, with some gravel, having been derived from the River Terrace Deposits whereas on the slopes further south the Head is more like the underlying London Clay. The Head is generally less than 2 metres thick.
60. The thickness of superficial deposits in this west-central area is less than that in the northern part of the borough, generally ranging from 2m to 8m (see Figure 4).
61. Minor outcrops of Langley Silt occur to the east and west of Stockwell. Langley Silt, or Brickearth, was formed from windblown dust and comprises silt sized particles. This formation occurs mainly on gentle slopes overlying River Terrace Deposits and was deposited across Europe under extremely cold, dry conditions following the Devensian glacial period which ended approximately 10,000 years ago

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<sup>3</sup> Wikipedia.

### 3.3.5 The south and east

62. Hilly ground to the south of the borough primarily comprises London Clay outcrop. There are minor outliers of Black Park Gravel, Sand and Gravel (unknown age) and Hackney Gravel (Streatham South), and a variable coverage of Head.
63. London Clay is a brown or grey, firm to stiff, silty clay. The London Clay developed from fine sediment that was gradually deposited on the seabed of a tropical sea that covered much of south-eastern England between 55 and 52 million years ago. Although nowadays it is present at or close to the current ground surface, the London Clay has, during its geological history, been buried hundreds of metres below the then ground surface. This cover material has since been completely eroded. However, its great weight acted overtime to compress and stiffen the London Clay (it is therefore termed an “overconsolidated clay”)
64. In engineering terms, the London Clay is a fine-grained, cohesive soil. The design of foundations in the London Clay is governed by its cohesive, rather than frictional, properties
65. Although the majority of the London Clay is considered to be a fine grained cohesive soil, there are sandier units present, particularly toward the deeper parts of the London Clay. These tend to be interbedded sandy clayey silts and sandy silts with beds up to 5m thick.
66. The London Clay is predominately composed of clay minerals, including smectite, illite, kaolinite and chlorite. The clayey minerals in the London Clay make it responsive chemically to water. Moisture present within the clay can bond chemically with particles of clay minerals and cause the particles to swell. The well-known phenomenon of seasonal swelling (in wet winters) and shrinkage (in dry summers) of London Clay is caused by this chemical bonding.
67. Claygate Beds outcrop along the very highest ground in Gipsy Hill and represent (stratigraphically) the youngest solid geology in the borough. The Claygate Member consists of alternating beds of clayey silt, very silty clay, sandy silt and silty fine sand.
68. The most common mineral in the Claygate Member is quartz, which at times constitutes more than half the soil type. Clay minerals are next in importance quantitatively with the order of relative abundance of clay minerals being montmorillonite, kaolinite and chlorite. These minerals may exhibit a tendency for swelling and shrinking depending on the moisture content of the soil. The silts and clays in the Claygate Member range from soft to very stiff. The sands in the Claygate Member are fine grained.
69. Geological mapping shows a small amount of Made Ground is present at a small number of locations in the borough. Although only present in these areas according to the geological maps, within such a largely developed area, variable amounts of Made Ground would be expected to be present throughout the borough. Made Ground is typically highly variable in composition having been emplaced or re-worked by human activity.

## 3.4 Hydrogeology

### 3.4.1 Introduction

70. There are two main water bearing aquifers in the London Basin. These are separated from each other by the relatively impermeable London Clay. The aquifers are referred to as:
- Upper aquifer – this comprises the groundwater within the River Terrace Deposits and gravelly soils (including the Claygate Member and also the Head) which overlie the London Clay.
  - Lower aquifer – this comprises the groundwater within the Upnor, Thanet Sand and Chalk Formations (which lie beneath the London Clay).
  - Groundwater may be present within Alluvium and Head deposits, but these units do not generally form very extensive continuous aquifers due to the lithological variability and limited thickness of the deposits. The water is also perched above impermeable strata such as the London Clay, and separated hydraulically from the main groundwater bearing aquifers.
71. The Environment Agency classifies geological units according to their aquifer characteristics (see box below). Strata designated as aquifers are subject to protection under the Water Resources Act (1991).

**EA aquifer designation of strata outcropping within LB Lambeth\***

The Environment Agency (EA) protects groundwater by identifying different types of aquifer. (An aquifer is underground layers of water-bearing permeable soil or rock from which groundwater can be extracted). The EA's aquifer designation data is based on geological mapping provided by the British Geological Survey (see Figure 5). The table below shows the aquifer designation and classification of soils in LB Lambeth. The maps are based on the geology at the surface.

The Lower aquifer which comprises of the Upnor, Thanet Sand and Chalk Formations is classified as "Principal" Aquifer. These are layers of rock or soil that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow, on a strategic scale.

Geological Unit		Permeability	Hydrogeological Significance
Superficial Geology	Head	Very low to very high	Secondary (Undifferentiated). Variable (probably an aquitard but sand or gravel horizons may locally form an aquifer)
	River Terrace Deposits (Black Park Gravel Member, Lynch Hill Gravel Member, Boyn Hill Gravel Member, Kempton Park Gravel Formation, Hackney Gravel Member and Taplow Gravel)	High to very high	Secondary Aquifer (A)
	Alluvium along River Thames	Not defined / not permeable	Secondary (Undifferentiated)
	Langley Silt Member	Not defined / not permeable	Unproductive strata
Solid Geology	Claygate Member	Low to high	Secondary Aquifer (A)
	London Clay Formation	Very low to low	Aquiclude
	Harwich Formation	High to very high	Secondary Aquifer (A)
	Lambeth Group	Very low to moderate	Secondary Aquifer (A)
	Thanet Sand Formation	High	Secondary Aquifer (A)
	Chalk Formation	Very high	Principal Aquifer

\* Table based on Table 1 in the Lambeth Surface Water Management Plan<sup>4</sup>

Groundwater in the River Terrace Deposits and the Claygate Member is "controlled water" in terms of the Water Resources Act (1991). The flow, level and quality are protected.

### 3.4.2 Upper aquifer

72. It is only the Upper aquifer which is relevant for basements in Lambeth. This aquifer potentially contains the water table that could be encountered when

<sup>4</sup> URS Scott Wilson, SWMP for London Borough of Lambeth, Sept 2011.

digging a basement, against which the basement should be designed structurally and waterproofed. It is also the aquifer in which, potentially, flow patterns could be interrupted or altered by the presence of basements in the ground. In general, the “natural” trend in groundwater flow directions within the Upper aquifer would have been towards river courses incised in the River Terrace Deposits.

73. In the 18th century, Streatham's natural springs, known as Streatham Wells, were first celebrated for their health-giving properties (see box below). Wellfield Road, which had previously been known as Leigham Lane, was renamed to reflect its role as the main route from the village centre to one of the well locations. Another mineral well was located on the south side of Streatham Common, in an area that now forms part of The Rookery.

**What accounts for the springs that appear now and again on the Common (and in Norbury Grove)?**

The answer lies in the geomorphology of the area. Streatham Common occupies a swathe of land at the western extremity of the Crystal Palace ridge, the focal watershed of South London. The upper Common, at its interface with the Rookery and Norwood Grove, attains heights between 75 and 85 metres above mean sea level; the lower Common falls away to a lowest point of 45 metres in the vicinity of Streatham High Road. Most of the lower and upper Common areas consist of London Clay, but the highest point – with adjoining areas of Norwood Grove – has a capping of “pebbly gravel and sand ... of uncertain origin”, according to the British Geological Survey. This isolated capping at Streatham Common is exposed and easily identified along informal pathways through the wooded areas. The junction between the gravel capping and the underlying London Clay forms a spring line (an occurrence seen at other points around the Crystal Palace ridge, as at Sydenham) that gave rise to the historic spa industry in various localities. Today, the spring line is visible in the form of an intermittent stream that flows down a ditch marking historic administrative boundaries. The streamlet in turn forms part of the Norbury Brook within the wider drainage system of the River Graveney, an element within the Wandle Basin.

From: <http://streathamcommon.org/common/geomorphology/>

### 3.4.3 Lower aquifer

74. The Lower aquifer is the larger of the two aquifer systems in London. It has been utilised for the purpose of water supply for industry and drinking water since the late 18<sup>th</sup> century and is a protected resource. It is also referred to as the Chalk, or Chalk-basal sands aquifer.
75. Basements constructed within LB Lambeth are unlikely to impact upon the Lower aquifer. Although the piezometric level is between +0mOD and +10mOD, which is not far from ground surface in the northern part of the borough, the Chalk aquifer is deeply confined beneath London Clay, and is well below the level of any existing or potential basements.<sup>5</sup>

<sup>5</sup> Since the 1990s there has been concern that changes in the level of the Lower aquifer could impact upon deep basements and subterranean infrastructure, unless mitigating measures were undertaken. Industrial abstraction from the Lower aquifer had been increasing until around late 1960s causing groundwater levels to drop significantly below the natural baseline level that

76. The Environment Agency annual report ‘Management of the London Basin Chalk Aquifer’ for 2015 comments that: “The area between Lewisham, Brixton, Streatham, and Beckenham in south London has seen water levels fall since 2000 leading to dewatering of the Thanet Sands. This area has also seen a growing area of Chalk dewatering, where previously groundwater in 2000 was largely under pressure in the Lambeth Group.”

#### 3.4.4 Groundwater occurrence in the London Clay

77. The London Clay Formation is considered in hydrogeological terms to be an “unproductive stratum” meaning a rock or soil deposit with low permeability that has negligible significance for water supply or river base flow. It is also classified by the Environment Agency as Unproductive Strata, as noted above. The hydrogeological significance of the London Clay, however, is as a hydraulic confining layer and an impermeable cap protecting the Lower aquifer. Although groundwater is contained within the microscopic pores of the London Clay, it permeates so slowly, due to the narrow pores, that in practice it is generally considered a barrier to groundwater. Where the clay is highly fractured or present as localised zones that contain a higher proportion of sands or silts, groundwater flow may be more significant. However, even in these zones, groundwater flow will be significantly slower than in other strata in the borough such as the River Terrace Deposits.

#### 3.4.5 Groundwater level

78. Groundwater levels in the discontinuous, thin superficial deposits which constitute the Upper aquifer are generally between about 2m and 5m below the surface but may be less than this near the edge of outcrops or in depressions or valleys.
79. Groundwater levels (piezometric) in the deep aquifer in 2014 varied from around +0mOD to -30mOD.

#### 3.4.6 Water supply

80. Water in LB Lambeth is supplied by Thames Water Utilities Ltd (TWUL). The source of supply is predominantly surface water, but TWUL operates two supply boreholes, at Streatham and at Brixton. The latter was drilled in 2000-2001 as part of the GARDIT action plan to manage rising groundwater levels in the Lower aquifer. Both boreholes pump into the Thames Water ring main system.

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characterised the Lower aquifer prior to significant abstraction for industrial purposes. In the post-industrial era, water levels in the aquifer had started to increase towards pre-industrial levels so much so that it became apparent that if the water level continued to rise, the water pressures in the sands and clays above the Chalk would increase, causing ground movements in the clays. These pressure changes and associated ground movement could damage some large buildings and underground infrastructure. This recognition, documented in a CIRIA Special Publication No.69, led to action plans being developed in the GARDIT (General Aquifer Research Development and Investigation Team) strategy. A programme of aquifer dewatering was undertaken to control the groundwater level. By 2000 it was considered that the ongoing programme of dewatering had stabilised groundwater levels, thus protecting deep foundations, deep basements and subterranean infrastructure from adverse impacts.



81. There are two source protection zones in the borough of Lambeth, one around the Brixton pumping station off waterworks Road in the central part of the borough, and the second centred on Streatham pumping Station, off Conyers Road to the south west.

### 3.4.7 Hydrology and drainage (surface and foul)

82. There are no natural watercourses within the borough of Lambeth. The tidal River Thames forms part of the northern boundary of the borough, and the River Effra, one of the so-called “lost rivers of London” which now runs in enclosed culvert for its entire course, flows through the borough in a northerly direction passing through Herne Hill, Brockwell Park, Brixton and on to Kennington before flowing out into the Thames. A short stretch of the river Graveney crosses the south-westernmost extension of the borough and runs in an open culvert for about a kilometre eastwards through the Streatham - Norbury area to join the River Wandle at South Wimbledon. These former rivers, although running in artificial channels, still substantially follow their original course and largely function as surface water drains, as they did naturally. The Effra, however, is used periodically as an overflow from the combined sewer system.
83. The majority of the drainage in the borough, approximately 98% by length, is by a network of combined sewers carrying rainwater and foul sewage. A combined sewer system carries both foul sewage and surface runoff: during dry weather (and small storms), all flows are routed to the treatment works but during large storms the relief structure allows some of the combined stormwater and sewage to be discharged directly to a receiving water body (such as the Thames), untreated.
84. The combination of engineered drainage and hard surfacing of much of the surface area of the borough means that a higher proportion of rainfall (than in pre-development times) is carried away and does not enter the groundwater system. Originally, before the city was built, the shallow geological strata in the London area would have received recharge from infiltrating rainwater, both directly and from infiltration from streams and minor watercourses where these flowed across permeable ground. In Lambeth, a significant proportion of rainfall would, under natural conditions, have entered the river terrace deposits (in the central and northern part of the borough) and the alluvium (in the north) without joining the surface drainage system.
85. Dense urban development results in greatly reduced recharge from this source. At the same time as causing a reduction in natural recharge, however, urbanisation introduces a new source of recharge in the form of leaking water mains and sewers. A study funded by CIRIA and reported in 1993 found that leakage from mains and sewers accounted for 90% of all recharge to the gravel aquifer in London<sup>6</sup>. It also found that the two-thirds of the volume of water in the gravels is from this source. Although the CIRIA study was carried out more than 20 years ago, leakage rates from water mains in London have not reduced significantly and a more recent review with an international perspective concluded that “Urbanisation greatly modifies the ‘groundwater cycle’ through...substantial increases in recharge, because the

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<sup>6</sup> The catchments studied were the Tyburn and the Peck.

reduction consequent upon land impermeabilisation is more than compensated by water mains leakage, wastewater seepage, stormwater soakaways and excess garden irrigation”<sup>7</sup>. The net quantitative effect of urbanisation therefore, as far as groundwater in the superficial deposits is concerned, may have been quite small. The quality may have changed, however.

### 3.4.8 Historic flooding

86. A detailed list of flooding incidents in Lambeth is given in the Lambeth Surface Water Management Plan (SWMP), 2011.
87. A total of 57 groundwater flooding incidents are recorded between 2000 and 2010. 42 of these were classed as poor drainage or being downslope of superficial deposits/springs/seepages rather than true groundwater flooding. This assessment was based on ground conditions at the site of flooding.
88. Figure 3.5.1 in the SWMP presents “Increased Potential for Elevated Groundwater”. This figure shows there to be potential for groundwater flooding at the surface across much of northern part of the borough.
89. There is less risk where London Clay or Lambeth Group strata outcrop.
90. There is potential for groundwater flooding of below-ground properties in much of Clapham, Brixton and some of Streatham. Basements installed in these areas have the potential to affect groundwater levels (by damming) potentially leading to an increase risk of groundwater flooding.

## 3.5 Slope stability

91. In simple terms, slopes or retained ground will only fail if the forces contributing to movement (e.g. gravity, water pressure) exceed those resisting movement (e.g. strength of material, frictional resistance, structural resistance). Slope movement can be initiated by changes in any of these factors individually or in combination and be associated with pre-failure (pre-collapse) conditions as well as failure (collapse) conditions. Under natural conditions, slopes may be stable if undisturbed but the effect of human activities in developing and using the land will sometimes be sufficient to activate movement<sup>8</sup>.
92. In the context of retained ground, slope stability refers to the overall stability of the retaining structure and the ground it retains.
93. Within LB Lambeth there are three instances of landslide documented by the British Geological Survey (BGS)<sup>9</sup>: at Knight’s Hill to the northeast of Tulse Hill station in London Clay (validated by BGS), at Tulse Hill though the location is poorly defined (not validated by BGS) and to the south of Gypsy Hill station in London Clay or Head (not validated by BGS).

<sup>7</sup> Resilient Cities & Groundwater, International Association of Hydrogeologists, 2015

<sup>8</sup> Department of the Environment, 30 April 1990. *Planning Policy Guidance 14: Development on Unstable Land*.

<sup>9</sup> British Geological Survey, National Landslide Database.

94. In the London area, slope movement is mainly associated with steep slopes on the London Clay. A slope of 10 degrees is considered by Skempton<sup>10</sup> to be the critical angle for London Clay. That is, a slope of less than 10 degrees is stable and slopes greater than 10 degrees are potentially subject to movement. Hutchinson<sup>11</sup> observes that the critical angle for London Clay has, in some instances, been lower at 8 degrees, especially where the groundwater level in the clay is close to the surface and flowing, albeit very slowly, parallel to or out of the slope.
95. Potential land movement is not confined to areas of steep, outcropping London Clay. The Claygate Member can be vulnerable to slope instability particularly when its sandier layers become waterlogged. Ellison et al and Deness et al report slopes of 8 degrees or greater on the Claygate Member are potentially unstable.<sup>12,13</sup>
96. The Lambeth Group is described by Ellison et al as being broadly similar to the London Clay in engineering terms<sup>12</sup>. This is supported in terms of slope stability by data given in Hight et al<sup>14</sup>. A critical slope angle of 8 degrees would appear to be applicable.
97. Head deposits are materials that have moved downslope by solifluction (movement due to freezing and thawing). A key feature is the shallow angle at which solifluction occurs and at which old shear surfaces can be reactivated. Old shear surface at slopes of around 4 degrees have been observed<sup>15</sup>. Reactivation is often a result of construction activity, changes in loading, changes in drainage, or a combination thereof.
98. Whilst granular soils such as the various sand and gravel deposits can be stable at much steeper slopes than the above mentioned strata, they are more likely be affected by erosion from surface water flow if not protected. This will result in instability if the slope becomes too steep.
99. Figure 6 shows areas in LB Lambeth where slopes have been calculated to be in ranges defined by 3, 7 and 10 degrees. The calculation was undertaken using the LB Lambeth relief data (see Figure 2). The selection of 3 and 7 degrees assumes a 1 degree margin of error on 4 and 8 degrees which, as reported above, are lower bound angles at which instability has been observed. It is these areas (i.e. where  $\geq 3$  degree slopes coincide with Head and where  $\geq 7$  degree slopes coincide with London Clay or Lambeth Group)

<sup>10</sup> Skempton, A.W., and De Lory, F.A., 1957. *Stability of natural slopes in London Clay*. Proceedings of the 4th International Conference on Soil Mechanics and Foundation Engineering, vol 2, pp 378-381.

<sup>11</sup> Hutchinson, J.N., 1967. *The free degradation of London Clay cliffs*. Proceedings of the Geotechnical Conference, Oslo, 1967, Vol. 1, pp113-118.

<sup>12</sup> Ellison, R.A., Woods, M.A., Allen, D.J., Forester, A., Pharoah, T.C., and King, C. 2004. *Geology of London: Special memoir for 1:50000 Geological sheets 256 (North London), 257 (Romford), 270 (South London), 271 (Dartford)*. British Geological Survey.

<sup>13</sup> Deness, B and Riddols, B W., 1976. *The influence of geological factors on slope stability in the London clay of south Essex, England*. Bulletin of Engineering Geology and the Environment. Volume 13, Number 1, 37-40.

<sup>14</sup> Hight, D.W., Ellison, R.A. and Page D.P., *Engineering in the Lambeth Group*, CIRIA Report C583, London, 2004.

<sup>15</sup> Hutchinson, J. N. 1991. Periglacial and slope processes. In Quaternary Engineering Geology. Eds. Forster, A., Culshaw, M. G., Cripps, J. C., et al. Geological Society, London, Special Publications, 7, 3-38.

that are potentially most prone to becoming unstable. Figure 7 shows the mapping of slope instability by the BGS which is based on factors including geology, groundwater and slope angle<sup>16</sup>.

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<sup>16</sup> British Geological Survey, Geosure dataset, Version 7, 2014.

## 4 Subterranean development

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### 4.1 Residential subterranean development

100. Subterranean developments (“basements”) below residential properties and their gardens, including new construction and extension to existing construction, are increasingly popular within the borough. In general, household basement projects are not of a size or cost to attract major engineering design or construction firms, and there have arisen numerous smaller companies who specialise in this type of work. Where a new residential basement is close to other houses, especially in terraces, the potential risk of damage to adjacent properties is often of greater concern to neighbouring owner-occupiers than would be the case for a subterranean development in a non-residential, business district. Similarly the potential ‘nuisance’ caused by being so close to such works is also of concern to neighbours.

### 4.2 Typical construction methodology for basements

#### 4.2.1 Introduction

101. This section is intended as descriptive only, and it should not be considered as presenting technical guidance.
102. As background to understanding the context of basement developments in the borough, this section summarises the construction techniques that are typically used to form small basements, that is, new basements and basement extensions of the type most typically encountered in residential properties. Large basements such as those beneath residential tower blocks or commercial buildings are beyond the scope of this study.
103. This section summarises the construction methods that are typically adopted for small basements typical of subterranean developments in residences. This includes new basements and basement enlargements, both beneath house footprints and under gardens. The wide variety in the existing building stock of residential structures within the borough in terms of age, method of construction, and quality of construction means that a site-specific approach to any major structural intervention, including basement works, is an essential element of any individual project. The discussion herein is general.
104. A generic nineteenth or early twentieth century house can be considered. In London, the foundations of traditionally-built, two-storey residential buildings typically comprise “strip” mass concrete and/or brick footings that support the external and internal main walls. Such foundations often extend only 300-400 mm below the level of the lowest floor. Since the minimum headroom required for a habitable space is 2.1 m, the creation of a single-level basement would require a deepening of about 2m below the underside of the existing footings in order to reach the new basement’s floor level. Moreover, in order to maintain overall stability, it will usually be necessary to undertake further deepening beneath the basement floor level in order to form new foundations.

105. The most usual construction methodology adopted for basement construction and enlargement under existing buildings is traditional underpinning.
106. Alternatively, if the area above a proposed basement is fully accessible to construction plant and equipment, as is often the case for a basement being built in a garden, then the piled cut and cover technique can be used. Where adverse groundwater conditions preclude the use of traditional underpins, a variation on the piled cut and cover technique can be used within a residence. Alternatively, groundwater control by dewatering or grouting might be employed.
107. As well as the structural engineering aspects of the basement works, other relevant issues include waterproofing, drainage, flooding, ventilation and lighting. For the latter two, there is a broad range of options and these are not considered in detail in this report. Waterproofing is a key element in the successful design of a basement: most insurance claims about basements are for water leaks. Even well-built concrete basement walls will not reliably keep out dampness in the long term. Membranes can be applied either externally (in contact with the soil) or on the interior faces of the basement sidewalls and base slab. The membranes can either be designed to constitute a physical barrier to the water, or they can be designed to convey any incoming water into a drainage system, where it can flow to a collector equipped with pumps. Similarly a drained cavity wall can be built in front of the concrete basement wall and linked to a sump pump.
108. It is appropriate to consider some practical issues that relate to the construction process for new basements beneath existing buildings, including the need for site facilities such as washrooms, plant and machinery, site deliveries, access down into the subterranean work area, space for stockpiling excavated soil, storage of construction materials, protective hoardings etc. The availability of space for construction works in a residential area is usually relatively limited, and therefore optimisation of the site layout is an important issue in practice. Construction facilities can occupy gardens or backyards where available, otherwise some overspill onto public space, such as footways and roadsides, may be needed, where permitted.
109. Concerns over damage, noise, dust and vibration will invariably arise on any urban construction site. Whilst there may be regulatory controls in place to address these issues there are likely to be various options (some of which may be better than others) for contractors.

## 4.2.2 Simple underpinning

110. Traditional underpinning comprises the construction of a contiguous series of concrete columns beneath the existing foundations. It is executed in a series of gradual steps and relies on the integrity of the supported wall to arch whilst small sections are progressively undermined.
  - The first step is the exposure of the top of the existing foundation, by breaking out the existing ground floor slab along the edge of the foundation that is to be underpinned (see Figure 8). Temporary horizontal propping would be placed at this stage as appropriate.

- The next step is to excavate along the existing foundation in a series of short sections (each typically of length 1m to 1.5m), in a “1,4,2,5,3” repeating pattern that alternates an excavated section with one where the soil under the foundation is left in place (see Figure 9). In the case being considered, each pit would be approximately 2m deep. The excavation is often done by hand. If there is groundwater present, this will need to be controlled in order for the works to progress.
- When a series of short sections under a particular run of wall has been excavated (e.g. all the ‘1s’ but not more than 25% of the length of the wall), concrete is cast under the existing foundation, thus filling the excavated holes to form underpins.
- After the concrete in the first set of underpins has cured, the remaining intermediate sections of soil (which have been left in place between the first underpins) can be gradually excavated piecemeal. Concrete underpins can then be cast into these holes. Together, the series of underpins form a continuous, unreinforced or reinforced, concrete strip footing.
- If the depth of the row of underpins formed is not sufficient, the same process can be repeated, but this time digging and underpinning below the new concrete foundations.
- When the full perimeter of the basement area has been underpinned in this manner, down to the necessary depth, the full excavation of the basement space can proceed (with appropriate temporary supports measures spanning horizontally across the excavation), followed by casting the basement floor slab of the basement and fitting out the basement interior.

### 4.2.3 Piled cut-and-cover

111. The piled cut-and-cover technique can be adopted wherever the ground above the proposed basement is freely accessible, such as basements under gardens or backyards (see Figure 10). First, a series of vertical piles is installed close to each other, in a row along the perimeter line of the proposed basement. The piled wall that is formed in this way should be designed to be strong and rigid enough to be able to support the soil around the basement without excessive ground movement when the basement is dug. When the soil has been excavated from the basement space down to the floor level of the basement, the basement base slab is cast. Within the basement, a secondary internal wall is often installed, leaving a drainage gap between the inner wall and the outer piled wall: any incoming groundwater seepage entering this space can be collected in a sump, and pumped away. Finally, the “lid” or “cover” (that is, the ground floor slab) is installed and the garden can be reinstated. When a single-storey basement is structurally complete, both the ground floor slab and the basement slab act to provide lateral support to the piled wall. In general, the excavation works are at their most vulnerable to ground movements, or even to collapse, during this intermediate stage before the permanent floors and slabs can be installed.
112. Where it is not possible to build traditional underpins due to adverse groundwater conditions but there is space for a piling machine, then a

variation on the piled cut and cover technique can be used. In this case, the piled wall described above is built in-board of the existing foundations within the structure, internal to the existing residence.

## 4.3 Summary of principal issues for consideration

### 4.3.1 Introduction

113. A summary of principal concerns relating to the insertion of new basements is presented below. The range and variety of the listed items illustrate the diverse but interconnected nature of the factors associated with assessing proposals for subterranean development within the borough. Not all the topics come within the remit of the Planning Office, but it is appropriate to discuss all the issues as they inform the wider context of subterranean development.

### 4.3.2 Surface water flow and flooding

114. In designing a basement, a key consideration for the developer is ensuring the basement is not damp or waterlogged, hence solutions will be sought to ensure water is excluded from the basement. This is achieved either through waterproofing the basement, or installing drainage to manage any potential water ingress, or a combination of both.
115. Basement construction may involve permanent (or temporary) diversion of surface water flows around the building and a loss of permeable ground which otherwise would have received and helped to store or remove rainfall from a site. Typically, the ground around a basement will be locally graded so as to direct water away from the basement wall, or drains may be installed to capture any run-off towards the basement. Both these options disturb the surface water regime. This may lead to increases or decreases in surface water reaching the underlying ground (infiltration and groundwater recharge), adjoining land/properties, water-courses and/or sewers, depending upon the route the rainfall and drainage follow as a result of the development. This could lead to areas becoming saturated, in the extreme case even flooded or, alternatively, receiving insufficient water to support the needs of features such as water-courses and vegetation. Altering the volume and location at which infiltration is received by the ground may potentially have knock-on side effects to the way underlying groundwater behaves, both at the site and further afield.

### 4.3.3 Subterranean (groundwater) flow

116. A solitary, isolated basement which intersects the groundwater table is unlikely to affect the groundwater flows in the wider area: the water will simply flow around the obstruction. The effects on water level are likely to be small and less significant than seasonal or other existing variations in the groundwater table.
117. However, locally, changes in groundwater level may occur. Immediately upstream of the development the groundwater level may rise, whilst immediately downstream the groundwater level may decline. The magnitude



- of the change in water level will be dependent on the geology of the aquifer, the size and orientation of the development, and the depth of groundwater in the aquifer. A narrow basement parallel to the direction of groundwater flow will have less of an impact than a wider basement perpendicular to the direction of flow since there is less deflection of the groundwater from its original path. Structures which involve “corralling” shapes, such as an “L” shaped structure with the convex corner in the line of groundwater flow, may result in more pronounced effects.
118. Temporary works such as sheet piling which may be employed in the construction of basements have the potential to affect groundwater flow in the Upper aquifer. Although such structures may be in place for only a short time (and they should be removed once the basement is complete), water levels in the Upper aquifer can respond quite rapidly to interventions.
  119. If the basement is close to sensitive features which rely upon the current groundwater regime, such as a well or a spring feeding a surface water feature, the effect of the groundwater taking a new route may result in reduced (or increased) flow to the well or spring. Similarly, a dormant spring may be reactivated or new springs may be activated when flow has been concentrated, causing groundwater to issue in a different location.
  120. A larger basement (or a series of adjacent, contiguous basements) would have a greater impact on the groundwater flow regime (discussed in Section 4.3.5). The shape of the resulting compound structure in relation to the groundwater flow direction and soil strata should be considered to assess whether any damming or corralling effect could potentially arise (see Figure 11).

#### 4.3.4 Ground and structural movement

121. Underground construction will always – inherently and unavoidably – cause some movement in the surrounding ground. A basement scheme that is poorly designed and/or constructed is likely to cause greater ground movement and have greater potential for damaging adjacent structures and facilities than would a well-designed and well-executed scheme for which ground movements have been minimised and. Basements close to the public highway can also affect both buried services and the road surface. The implications of damage induced by ground movements, including the potential for legal proceedings arising from damage to third-party property and structures, are significant. In practice, any responsible person undertaking a basement project would aim to avoid damaging their own property or neighbouring properties, not least because of the expense of putting it right and of paying compensation for any damage caused to a third party. In practice, this issue is a fundamental and important driver.
122. The foundations for a new basement or basement extension built under an existing structure will be deeper than that building’s original foundations. In clayey soil areas in London, the problem of seasonal ground settlement “shrink” (in dry summers) and ground heave “swell” (in wet winters) is well known (see Figure 12). The most commonly used solution to the problem of subsidence on clay soils is to underpin the affected structure, that is, to deepen its foundations so that the new founding level lies well below the shallow, near-surface clay that is most vulnerable to seasonal shrinking and

swelling. A by-product of adding a basement to an existing structure in clay soils is to accomplish this beneficial deepening. However, in the case of a pair of properties that share a party wall (such as terraced houses), it is appropriate to consider and discuss whether or not deepening the footings of the party wall could perhaps adversely affect the structure on the other side of the wall in a clay soil area. It is a site-specific factor that should be considered when planning, designing and implementing such works. The comments below (Section 4.3.5) about engineering design rigour and design quality apply.

123. Foundation “stiffness” is the engineering term that describes the amount of settlement of a building due to the load from the building. A new basement or a basement extension built under an existing structure will have deeper and hence, usually, stiffer foundations than that building’s original shallow foundations. It is appropriate to consider whether or not stiffening the footings on one side of a party wall may adversely affect the structure that shares the party wall, as there could perhaps be increased potential for differential settlements across the wall if the loading on the foundations were to change significantly in future. This possibility should be considered when planning, designing and implementing basement works at a party wall. Once again, the comments below (Section 4.3.5) about engineering design rigour and quality apply.
124. Where abstraction (dewatering) from an aquifer, as part of the temporary or permanent works, is necessary to maintain dryness in the basement excavation, there is the potential for subsidence. Dewatering lowers the groundwater table, reduces pore water pressures, and increases effective stress. This causes the soil to compress, leading to ground settlement. Dewatering can also induce settlement due to loss of fines, if the groundwater lowering system continually pumps silt and sand sized particles in the discharge water.
125. From a purely ‘depth of basement’ perspective, the risk to adjacent structures generally increases as the depth of the basement increases. If groundwater is also considered, then the risk is higher for a basement formation below the groundwater level. However, it is also of note that a basement formation level close to the boundary between a water bearing granular layer (e.g. River Terrace Deposits) and a relatively impermeable layer (e.g. London Clay) may be more risky than a deeper basement well into the impermeable layer due to the probable method of construction.

### 4.3.5 Other factors

126. **Cumulative effects:** The granting of permission to one applicant for a basement within a particular street often triggers several similar applications from neighbours. The cumulative effect - if any - of several underground developments in a given street could potentially differ from the impact of the initial “pioneer” basement. It is therefore appropriate for developers to consider whether, for example, the layout and proximity of multiple basement schemes is important, especially any adjacent neighbouring schemes.

127. Figure 11 illustrates the principle of groundwater flow around a single basement structure. The diversion of flow paths around the basement structure leads to an increase in groundwater levels upstream, and a similar reduction in groundwater levels downstream
128. The effect of several basements acting cumulatively is illustrated in Figure 11 as Scenarios A, B and C. Scenario B provides a notional example where a one house width gap is always present between adjacent basements. Groundwater flows through the gaps between basement structures and is prevented from passing beneath the houses with new basements. The effects are an increase in groundwater levels upstream of the structures, and a decrease downstream. The disturbance is less than might be expected, however.
129. For hydraulic cut-off structures such as sheet piles, the purpose of which is to form a barrier to groundwater flow, it has been shown<sup>17</sup> that a 90% reduction in the cross-sectional area reduces the rate seepage by only about 60%. In the notional case shown in Figure 11 the space remaining open between buildings, as a proportion of the original flow channel, is approximately 40%. On the basis of the work referenced above it is apparent that the reduction in flow through the gap will be considerably less than the reduction in width of the flow channel. The flow velocity through the narrowed channel will be slightly higher than before, which might conceivably result in piping and subsurface erosion of loose sandy material if this is present, but the greater impact will be to the groundwater levels. The higher flow velocity is due to the increased hydraulic gradient resulting from the rise in water levels upstream, and lowering downstream of the row of basements.
130. The change in water levels is in proportion to the increase in the length of the flow path. In the case of a site measuring 10m in the direction of groundwater flow, the natural difference in groundwater level might be one or two centimetres. Introducing a basement of dimension 10m by 10m will increase the flow path from 10m before to 20m after approximately.
131. Where several basements effectively act as a single barrier to groundwater flow such as Scenario C in Figure 11 the impact will be larger. In this case the water will be forced to follow a longer flow path, with greater energy loss as a consequence, and therefore the changes in groundwater levels upstream and downstream will be greater.
132. The extent to which the cumulative effects of basements may impact groundwater flow and levels is likely to depend on the properties of the aquifer materials. In highly permeable formations groundwater flow can easily be diverted around basements, ultimately leading to a groundwater level increase upstream, less than would be seen for less permeable materials.
133. **Engineering design rigour:** For the development of commercial basement schemes in London, there are well-established and robust engineering processes available, including, for example:
- the quantitative prediction of likely ground movements;

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<sup>17</sup> Powers, J.P., et al, *Construction dewatering and groundwater control: New methods and applications*, 3<sup>rd</sup> Edition, John Wiley & Sons, 2007.

- assessing permissible movements (based on the vulnerability of nearby structures);
  - designing the basement and selecting the construction method to limit the induced ground movements;
  - pre-condition surveys of adjacent buildings;
  - monitoring of movements and other effects during construction, including crack monitoring;
  - establishing contingencies to deal with adverse performance.
134. For commercial basement developments, the Construction (Design & Management) Regulations (2015) (CDM) apply in full. Amongst other things, the CDM regulations impose a duty on commercial clients to ensure that everyone involved in a project is competent and experienced. Under the CDM regulations, however, “domestic” clients have no special duties of care over whom they appoint to undertake works.
135. **Quality of information:** It is often the case for residential developments that ground and structural investigation are seen as expensive options. Developers may decide to gamble on what they may find rather than investigate in advance of works. However this is often a false economy and increases the risk of damage to neighbouring properties. Attempting to design and construct a basement without sufficient quality information relating to the ground, groundwater and existing structures is an open invitation to problems.
136. **Quality of design and workmanship:** Extending downwards beneath an existing building, especially old, masonry-built properties that were not designed to contemporary engineering standards and modern Building Regulations, is a challenging and potentially hazardous undertaking. Although collapses are rare, they do sometimes occur. The work involved in forming a basement under an existing structure is not trivial and it merits input from experienced professional engineers and contractors, including underpinning specialists. Problems are more likely to arise from inexperienced firms who are unfamiliar with the relevant design principles and techniques.
137. **Archaeology:** Most basement schemes involve removal of the shallow strata, (e.g. Made Ground, Alluvium and the River Terrace Gravels) which, in general, have the highest archaeological potential. Most archaeological discoveries in London have been as a result of construction works: subterranean developments therefore represent a means of increasing knowledge and understanding of the archaeology in the borough. Possible planning conditions associated with archaeology restraints are therefore a relevant factor.
138. **Uses of created subterranean space:** The principal potential uses of new underground spaces beneath private residences typically include car parking, leisure (swimming pools and gyms) and increasing the habitable space of the house, although not usually through provision of bedrooms or garden flats. New underground spaces could therefore potentially increase parking facilities within the borough, but may also increase car usage and water consumption, both of which would have adverse effects on sustainability and

- environmental footprint. In general, such developments tend not increase the density of population.
139. **Gardens and trees:** Most basement extensions cover the footprint of the existing building, but some schemes occupy both the house and garden footprint. Where a new basement extends under a garden, trees are likely to be felled. When the garden is reinstated, the lost trees are unlikely to be replaced, or would typically be substituted with smaller species types. It is generally not the position of LB Lambeth to support the loss of trees. (see Para.37)
140. **Environment – waste to landfill and carbon emissions:** The process of extending a property by digging downwards to form a basement will produce a considerably greater volume of spoil and require a greater volume of construction materials (notably concrete, which has a relatively high carbon dioxide emission rating) than would be typical in an above-ground extension to a residential property, such as a loft conversion or conservatory. The excavated material taken from the basement space is likely to include Made Ground and natural soils which will typically be removed from the site by lorry. These materials will typically be disposed of at a suitable landfill site unless measures are taken to treat and re-use elsewhere. As a rough estimate, a basement of 150m<sup>3</sup> (for example 10m length by 5m width by 3m depth) would generate in the order of thirty lorry loads, assuming a lorry is carrying one 6m<sup>3</sup> skip per load. The environmental “footprint” of a basement project is therefore not trivial, and should be viewed in the light of the borough’s environmental and sustainability policies.
141. **Nuisance:** In the context of residential basements, the use of lower energy techniques or quieter equipment can reduce the potential for noise and vibration. Examples include:
- Hand digging using a spade instead of an excavator may be an option for underpin excavation;
  - Using quieter piling plant such as specifically silenced bored piling rigs or push-in sheet piling rigs;
  - Using splitting techniques rather than sawing or hammering techniques when trimming concrete or masonry.
142. Dust can similarly be reduced through the use of lower energy techniques though it can be further reduced by spraying of water or filtering air extraction ducts.
143. In all cases construction practices should be carried out safely.

## 5 Discussion of factors affecting basements in Lambeth

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### 5.1 Surface flow and flooding

#### 5.1.1 Risk

144. Flooding by surface water occurs when the input of water from rainfall or from runoff higher in the catchment exceeds the capacity of the surface drainage system to carry the water away. A proportion of rainwater falling on permeable ground is absorbed by the soil which reduces the amount of water that remains on the surface that potentially contributes to flooding. SuDS (Sustainable urban Drainage Systems) are a means of increasing the proportion of rainfall which infiltrates in this way. Construction of a basement under a garden, on the other hand, will reduce the infiltration capacity of the ground surface. In the case of a basement built under an existing structure, this situation does not arise, as the existing building would already preclude rainwater infiltration into the shallow soil strata.
145. Rainfall which infiltrates beneath the ground surface will initially occupy pore space in the shallow soil, and in the warmer, dryer months of the year this water may be returned to the atmosphere by evaporation or transpiration without travelling any distance. Under wetter conditions, when there is a continuous addition of water at the surface, the percolating moisture penetrates further into the ground and may eventually reach the water table, where it will flow laterally under the influence of the prevailing hydraulic gradient. The soil between the ground surface and the water table thus stores the water temporarily. If the water table is very shallow, or if there is an impermeable layer close to the surface, such as the top of a basement, the storage capacity of the soil is reduced and the ability of the soil to absorb further rainwater is reduced. This causes surface runoff to increase, and the risk of flooding to rise accordingly.

#### 5.1.2 Mitigation

146. The siting of subsurface accommodation in an area already known to be prone to flooding is already subject to control under LB Lambeth development policy EN5, and there is a more general obligation to provide sustainable drainage systems and water management under Policy EN6. Additional guidance on minimising flooding, including through various sustainable urban drainage measures, is provided elsewhere in the Lambeth Local Plan. The design and siting considerations for SuDS are fully described in CIRIA C573.<sup>18</sup>
147. The Royal Borough of Kensington and Chelsea faced criticism when they proposed as a guideline that 50% of the garden area was the maximum that a new basement should occupy. One part of the justification was that any more would adversely impact drainage to groundwater. In his examination of the partial review to the core strategy the Planning Inspector found that the 50%

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<sup>18</sup> Construction Industry Research and Information Association (CIRIA), The SuDS Manual, 2015.

rule was an over-simplification as far as drainage was concerned, but the figure was justified on the grounds that such a limit would mitigate the harm otherwise caused to residents' living conditions or the harm to the character and appearance of the area. In other words, limiting new basements "take" of the garden to 50% would keep the right balance between allowing sustainable development and protecting others and the environment from harm. The Inspector noted that the 50% limit "must be adequately monitored and reviewed in order to have the flexibility to adapt to rapid change, because change has been a feature of basement developments in the Borough over recent years".

148. In LB Islington the Basement Development SPD contains a number Design Indicators which amount to specific stipulations and include:

*DI.1 A basement and/or other structures should cumulatively occupy less than 50% of the original garden/unbuilt upon area, and be smaller in area than the original footprint of the dwelling, whichever the lesser.*

*DI.10 Basement development should be designed to minimise the risk of flooding to a development, ensure the development will not significantly increase the risk of flooding to adjoining properties or to contribute to wider flood risk within the catchment.*

*DI.11 Basement development should be designed to achieve no net increase in surface water runoff as a result of the proposal, and where applicable incorporate sustainable drainage techniques and generous drainage margins.*

149. There is clearly a limit to the extent that a basement should occupy space formerly undeveloped, and 50% is probably a reasonable target figure. Every location is different in hydrological detail, however, and there should be some scope for site-specific criteria to be employed.

## 5.2 Subterranean (groundwater) flow

### 5.2.1 Risk

150. Groundwater flooding occurs as a result of the water table in the aquifer rising to the surface, or from water issuing from springs. This tends to occur after long periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is more likely to be at shallow depth. Groundwater flooding tends to last longer than fluvial, pluvial or sewer flooding, because flow is slower in an aquifer than in surface channels or pipes, and water levels recede from a peak more slowly.
151. Section 3 of the SWMP describes the potential groundwater flooding mechanisms and localities that exist in the borough. These are, in summary:
- **On the outcrop of the Claygate Member in the Crystal Palace area:** this unit is water-bearing, the groundwater being perched on the underlying London Clay, and the water table may be close to the surface;
  - **Superficial aquifers along the River Thames and the River Graveney (becomes the Norbury Brook)** where the sand and gravel deposits are in

hydraulic continuity with the rivers (see Figure 13). High groundwater levels in these deposits are likely to be very closely associated with high flows in the rivers (high tides in the case of the Thames), possibly with a time lag, but the fall in groundwater level may be slower than the fall in river levels. The SWMP notes that: “groundwater / surface water interactions will be limited by modifications to the surface water courses e.g. canalisation of River Graveney / Norbury Brook. However, without evidence in the form of groundwater levels, this groundwater flooding mechanism cannot be ruled out.”

- **Within the outcrop area of superficial aquifers not in hydraulic continuity with surface water courses (various locations):** the older river terrace deposits associated with former courses of the Thames and tributaries, mostly on the lower slopes of the central area of the borough, in Brixton and around Clapham Common. The Head deposits in this area may also be water bearing, with perched water originating from a combination of natural rainfall recharge and leaking water mains.
  - **Impermeable (silt and clay) areas downslope of superficial aquifers in the southern half of Lambeth BC:** essentially these are areas along the fringe of water-bearing superficial deposits, where water may seep out along spring lines and pond on the impermeable London Clay.
  - **Artificial ground (various locations)**
152. In areas prone to groundwater flooding the groundwater level will be close to the surface under normal conditions, and at the surface under flood conditions. New basements constructed in such areas will not change that but they may make the flooding more frequent or the floodwater deeper. These areas are shown on Figure 3.5.1 in the SWMP. The introduction of a basement in areas where the groundwater is a little deeper, and there is no current susceptibility to flooding, may cause the groundwater level to rise adjacent to the structure such that that location becomes prone to groundwater flooding.
153. If groundwater in the Upper Aquifer were forced to find an alternative flow route past an underground obstruction, that could cause the groundwater level within the zone encompassed by the new flow route to increase locally upstream of the obstruction, and to fall downstream. If the original groundwater level was close to ground surface (within a few centimetres, the impact of an underground obstruction could be to cause, or to increase, waterlogging of the ground upstream, or drying out of the soil downstream.
154. There are no known springs in the borough currently, but there have been springs in the past (see Section 4.3.2 above). It is conceivable that the introduction of a basement close to the location of a historical spring could cause a resurgence of flow.
155. In Section 4.3.3 the rise of groundwater due to the construction of a basement below groundwater level was introduced. Where there is a groundwater rise in areas of LB Lambeth underlain by Langley Silt, such that previously dry Langley Silt becomes wet, then there is a potential for subsidence.



## 5.2.2 Mitigation

156. The Environment Agency has produced a guidance document on reducing the impact of flooding from groundwater.<sup>19</sup> The current (March 2016) version of the EA document (16 pages) is included in Appendix D.
157. Engineering measures are available for offsetting the impact of an impermeable underground structure by means of gravel blankets or conduits. These effectively replace the lost transmissivity with highly conductive flow channels through which groundwater can flow past the obstruction. There can be a need for maintenance of such features, particularly if pumping is required, although even passive systems may become clogged and require monitoring and servicing.

## 5.3 Slope stability

### 5.3.1 Risk

158. Whatever the ultimate cause of slope instability, one of the triggering factors which can initiate it is human activity. The act of constructing a basement may result in instability affecting both that development and the land surrounding it, for example:
  - Increases in water content due to alteration of drainage may increase pore water pressures and decrease the strength of the soil material;
  - Dewatering for basement construction may cause settlement;
  - Removal of vegetation (including tree felling) results in less water extracted from a slope by plants and more water arriving on the slope because of reduced interception of rainfall, which may initiate movement through adverse changes in the pressure of water within the soil pores;
  - Changes in loading (i.e. loading a slope or cutting into a slope) may cause activation of old slip surfaces; and
  - Excavation in sand and gravel will be at more risk of local instability than clayey deposits particularly where groundwater is present.
159. The risk that instability poses will depend on a number of factors though its magnitude will primarily be influenced by the extent of ground that could be mobilised, what lies downhill of that ground, and what rests on or in the ground that could be mobilised. The risk will be specific to each site.

### 5.3.2 Mitigation

160. As explained in Section 3.5, the maximum stable angle for natural slopes in London Clay is approximately 8 to 10 degrees and for the Claygate Member, the maximum stable angle is approximately 8 degrees whilst for Head it may be as low as a 3 or 4 degrees due to pre-existing failure planes and a high water table. In LB Lambeth, areas where the ground topography is at higher slope angles where these deposits occur (see Figure 6) or where ground

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<sup>19</sup> Environment Agency, *Flooding from groundwater*, Ref. FLHO0911BUGI-E-P, Sept 2011.

has been mapped as instability Class C, D or E (Figure 7), land stability issues should be considered in detail. One further note of localised potential for instability which should be considered in more detail is the presence of running sand recorded by the BGS at the circular alluvial feature shown on Figure 3 to the east of South Lambeth Road.

161. Previous development (including landscaping works and historical features) or nearby road/railway cuttings/tunnels may have also increased the predisposition to land instability in the area, since the soil and the surface topography are no longer in their natural state. These should be treated as triggers for further investigation.
162. Where a retaining structure is constructed to support ground (e.g. an underpin or an embedded wall) overall stability should be considered in addition to local stability of the excavation.

## 5.4 Damage to adjacent structures – geotechnical perspective

### 5.4.1 Introduction

163. This section considers the risks of subterranean development on nearby structures and infrastructure from a geotechnical perspective.
164. In many cases, an adjacent property may directly adjoin another and the two buildings may share a common party wall. In other situations, neighbouring buildings may not share a party wall, but may still lie within the potential zone of influence of the subterranean development works. Structural damage resulting from activities on a neighbouring site may be due to changes caused by a number of effects including ground movements during excavation, heave, foundations at different levels and settlement of the new build due to changes in loading, but the actual nature and extent of the damage will be specific to the affected structure.

### 5.4.2 Risk

165. The following sub-sections describe various situations in which, if they are not successfully avoided by appropriate planning, design and execution of subterranean development works, could potentially cause damage to neighbouring structures. Such damage could include cracking, or perhaps more severe structural damage.

#### **During the works: changes in foundation capacity**

166. The foundations of a structure transfer the load from the building to the ground. In general terms, foundations serve two purposes: to spread the load of the building over a wide area, so that the ground is able to support it without failing; and to reduce the settlement of the ground beneath the building, which might otherwise damage connecting utilities and adjoining structures.
167. The load bearing capacity of a foundation is determined by the mechanical characteristics of the soil, the geometry, size and depth of the foundation, and

the groundwater conditions. Underpinning works require the exposure of the existing foundation, which means that on at least one side of the foundation, the soil between the foundation toe level and the original ground level must be removed. This will cause a temporary reduction in the bearing capacity of the foundation, because the self-weight of the removed soil (the “overburden”) no longer contributes to the bearing capacity of the foundation. The temporary and localised loss of part of the bearing capacity of the building foundations does not mean that the foundations would fail - although this a possibility if the works are not properly planned, designed and constructed.

168. In areas underlain by marginal materials such as Langley Silt the risks are potentially greater, for example, there is a potential for sudden collapse settlement in Langley Silt if the load on this strata is increased above a critical point.

#### **During the works: ground movements**

169. Excavations will always cause some movement in the surrounding ground. A subterranean development that is poorly designed and/or constructed would tend to cause greater ground movement and, hence, have greater potential impact on adjacent structures and infrastructure than would a well-planned, well-designed and well-executed scheme for which ground movements have been minimised and controlled.
170. Where abstraction (dewatering) from an aquifer, as part of the temporary or permanent works, is necessary to maintain dryness in the basement excavation, there is the potential for subsidence. Dewatering lowers the groundwater table, reducing pore water pressures, hence increasing effective stress; this causes the soil to settle. Dewatering can also induce settlement due to loss of fines if the groundwater lowering system continually pumps out silt and sand sized particles in the discharge water.

#### **After the works: change in stiffness of foundations**

171. A new basement or basement extension built under an existing structure will have deeper foundations. These will usually have a different stiffness to the existing foundations. For a pair of adjacent properties (semi-detached or terraced) that directly share a party wall, it is important that both the engineering designer and contractor consider how the deepening of the foundations of the party wall could perhaps affect the structure on the other side of the wall.

#### **After the works: change in depth of the foundations**

172. The new foundations of a subterranean development under an existing structure will be deeper than that building’s original foundations. For structures on London Clay (and to a lesser extent the Lambeth Group), the problem of seasonal ground settlement (in dry summers) and ground heave (in wet winters) is most commonly addressed by deepening foundations so that they extend well below the shallow clay that is most prone to seasonal wetting and drying. Adding a basement to a detached property founded on clayey soil is therefore an attractive way of tackling the problem of subsidence on clay.

173. In the case of a pair of adjacent properties (semi-detached or terraced) that directly share a party wall in a clay soil area, it is important that both the engineering designer and contractor consider how the deepening of the foundations of the party wall could perhaps affect the structure on the other side of the wall.

**After the works: rise in groundwater level**

174. Refer to Section 5.2.2.

### 5.4.3 Mitigation

**Before the works: pre-condition surveys**

175. In practice, it is often difficult to attribute cracks visible in a structure to specific site construction activities unless a detailed survey of the affected structure had been undertaken before the construction works started, and then repeated after the works are complete. Any observed changes in the state of the building can then be causally linked to the works with more confidence and less debate than if no pre-works condition survey had been undertaken. Surveys require the cooperation of the property owner, as entry by surveyors into the property is usually necessary.

**During the works: changes in foundation capacity**

176. A simple method of mitigation used in underpinning works is the use of a “hit and miss” pattern of excavation, in which the length of foundation along which the supporting ground is to be temporarily removed is kept as short and localised as possible (Section 4.2.2 and Figure 9); this process is commonly adopted. The adverse effect of the temporary loss of support is critical in granular soil (sand/gravel). Particular care is therefore required when removing overburden adjacent to footings in such ground.
177. Underpinning of shared party walls is a frequent engineering activity: the technique is widely and successfully used under both large and small structures. The issue of temporary, localised reduction of foundation bearing capacity, or factor of safety, can be mitigated by careful prior planning, by undertaking detailed and relevant design analyses and, perhaps most importantly, by good quality workmanship on site.
178. Particular care is required in areas underlain by marginal materials, for example, in Langley Silt when there is a net increase in load. Mitigation of risk in marginal materials can be achieved through increased expertise in design and execution. In Langley Silt the risk could be mitigated by assessment of the load required to initiate collapse or by founding at depth below this strata.

**During the works: ground movements**

179. Depending on the specific circumstances and method of working on site, ground movements can be controlled and limited by, for example: carrying out the work in gradual, piecemeal steps; using temporary props and struts to support the excavation; using casing when piling and using support from the permanent structure. Generally, ground movements are higher in cases where less care is taken in providing suitable support to the excavation.

180. Where temporary dewatering is permitted, consideration should be given to ground movement (this is likely to be more pronounced where Alluvium is being dewatered) and the effects on neighbouring infrastructure and buildings caused by the change in effective stress. The process of removing the water from the ground should also be considered in terms of how to avoid drawing fines out of granular soils. This could include controlling the rate of pumping, positioning of well points and the use of filters. Where the effects of dewatering have the potential to cause unacceptable damage, alternatives to dewatering should be considered. For example, if dewatering is being employed to allow the construction of underpins then perhaps a piled solution or local grouting could be more appropriate.

**After the works: change in stiffness of foundations**

181. The mitigation of this risk will be site- and project-specific, depending on the structures involved and their geometry and layout.

**After the works: change in depth of the foundations**

182. The mitigation of this potential hazard will be site- and project-specific, depending on the structures involved and their geometry and layout.

**After the works: rise in groundwater level**

183. Refer to Section 5.2.2

## 5.5 Damage to adjacent structures – structural perspective

### 5.5.1 Introduction

184. This section considers the risks of subterranean development on nearby structures from a structural perspective.

### 5.5.2 Risks

185. Basement construction will always cause some movement in the surrounding ground. The area affected could be a distance away equal to four times the depth of excavation, with the impact diminishing with distance from the excavation<sup>20</sup>. It is these ground movements which result in structural damage.
186. Thus in a residential street with houses close together there will always be a risk of some damage to the adjacent buildings; the ground movements can cause cracking of the internal and external finishes, affecting the appearance of the adjacent building and can in the worst instance affect its safety and stability (causing partial collapse or structural damage). In practice structural damage is rare, and damage is usually limited to minor cracking which is more a matter of appearance and can be more readily repaired. The pattern of damage or cracking will be a function of the buildings fabric and style.

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<sup>20</sup> Gaba, A.R. et al., *Embedded retaining walls – guidance for economic design*, CIRIA Report C580, London, 2003.

187. The precise level of movement can be fairly well predicted but the degree of cracking and damage can only be estimated and requires engineering judgement; it is not something which can ever be fully codified.
188. Most of the movements will occur during the works, but in clay soils some movement can occur for several years after completion of the works.

### 5.5.3 Mitigation

189. Movements are mainly caused by (a) loss of ground during installation of the new basement retaining wall (b) bowing/flexing of the wall during basement excavation and (c) settlement due to temporary dewatering and/or load redistribution/transfer. Therefore movement depends as much on the method of the construction and workmanship (how the wall is installed, how well it is installed and how well it is propped during excavation) as the design (how stiff the wall is). It is possible to reduce the risk of damage to adjacent buildings by spending more money on the design and construction of the basement (e.g. with a different type of wall installation method or by using a stiffer wall with props or by jacking), but it is not possible to completely eliminate movements.

#### **How much damage is acceptable?**

190. The council will have to decide how much harm/damage and disruption to an adjacent building it considers to be acceptable. Different councils have taken different views on this. It is a balance between the monetary cost of the works and the disruption caused to neighbours. Typically the additional costs (to reduce movements) will be much higher than the costs of making good decorations or localised repair; but of course it is difficult to put a value on the disruption to neighbours.
191. In the box below a classification system put forward by Burland<sup>21</sup> is presented which is often used to classify levels of damage and ease of repair. It is of course important to ensure that permanent visible distortion to the neighbour's property is avoided (even following repairs).

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<sup>21</sup> Burland, J.B. et al., *Building response to tunnelling: Case studies from construction of the Jubilee Line Extension, London. Volume 1: Projects and methods*, CIRIA Special Publication 200, London, 2001, pp. 23-43.

*Classification of visible damage to walls with particular reference to ease of repair of plaster and brickwork or masonry*

Category of damage	Normal degree of severity	Description of typical damage (ease of repair is in bold type) <i>Note: Crack width is only one factor in assessing category of damage and should not be used on its own as a direct measure of it.</i>
0	Negligible	Hairline cracks less than about 0.1 mm wide
1	Very slight	<b>Fine cracks that are easily treated during normal decoration.</b> Damage generally restricted to internal wall finishes. Close inspection may reveal some cracks in external brickwork or masonry. Typical crack widths up to 1 mm
2	Slight	<b>Cracks easily filled. Redecoration probably required. Recurrent cracks can be masked by suitable linings.</b> Cracks may be visible externally and <b>some repointing may be required to ensure weather-tightness.</b> Doors and windows may stick slightly. Typical crack widths up to 5 mm.
3	Moderate	<b>The cracks require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.</b> Doors and windows sticking. Service pipes may fracture. Weather-tightness often impaired. Typical crack widths are 5–15 mm or several > 3 mm.
4	Severe	<b>Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows.</b> Windows and door frames distorted, floor sloping noticeably <sup>1</sup> . Walls leaning <sup>1</sup> or bulging noticeably, some loss of bearing in beams. Service pipes disrupted. Typical crack widths are 15–25 mm, but also depends on the number of cracks.
5	Very severe	<b>This requires a major repair job involving partial or complete rebuilding.</b> Beams lose bearing, walls lean badly and require shoring. Windows broken with distortion. Danger of instability. Typical crack widths are greater than 25 mm, but depends on the number of cracks.

<sup>1</sup> **Note:** Local deviation of slope, from the horizontal or vertical, of more than 1/100 will normally be clearly visible. Overall deviations in excess of 1/150 are undesirable.

192. Table 2 below looks at the susceptibility of different building construction types to damage from adjacent basement excavation. The “Acceptable Category of Damage” is based solely on ease of repair / illustrative crack width: thus, where there is a greater risk of permanent (that is, difficult to repair) visual (or other) damage these cases would merit tighter controls on the levels of ground movement than cases where the damage may be easily repaired.
193. The categorisation does not consider disruption or distress which may be caused to neighbours, which may legitimately be disproportionate to the ease of repair of the damage; therefore, if there is concern about disruption to neighbours then it could be argued that the “Acceptable Category of Damage” should be limited to no more than ‘1 - very slight’.

**Are there any cases where basements should be avoided?**

194. There are unlikely to be any cases where a basement excavation would be technically impossible; it is more a question of whether there are some cases that warrant more control (and therefore expense) to reduce the risk of damage. Additional control could include both measures to reduce the level of movement and also checks by a suitably qualified independent engineer of the detailed proposals. Examples might be the cases in Table 2 below where there is a MEDIUM to HIGH risk of damage, and also listed buildings (see Figure 14).



Table 2 – Susceptibility of residential building construction types to damage from adjacent basement excavation

Construction types	Discussion	Risk of permanent visual (or other) damage	Acceptable Category of Damage (see Note 1)
Exposed loadbearing brickwork C18-19, with normal wide pointing	Generally built with weak lime mortar enabling ground movements to be accommodated by small opening/closing of all the joints. Have often suffered significant movements in the past due to typically shallow foundations.	LOW - can accommodate relatively large levels of distortion with little or no visible damage. Large distortions would need to occur before they were permanently visible.	1 - Very slight in terms of ease of repair 2- Slight (lower end of)
Finely pointed loadbearing brick or stonework, C18-19	Opening of the joints is harder to invisibly repair. Have often suffered significant movements in the past due to typically shallow foundations.	MEDIUM	1 - Very slight
Loadbearing brickwork which has been rendered and painted, C18-19	Cracks in render can easily be filled and painted over. Again, have often suffered significant movements in the past due to typically shallow foundations.	LOW – can usually be invisibly repaired. Large distortions would need to occur before they were permanently visible.  However, render was often used to hide poor quality brickwork, which would then be more susceptible to damage. It can still be invisibly repaired but there is a greater risk of movements and cracks being concentrated in 1 location due to existing defects, in which case the risk of permanent visual damage might increase to MEDIUM.	1 - Very slight to 2 - Slight
Exposed brickwork C20-21	Generally built with strong cement mortar; movements will tend to get concentrated in a single crack which can be filled, but always remains visible as a larger joint or as a crack through the bricks themselves	HIGH – not only will movements tend to be concentrated at one location, but also distortion is more likely to be visible against the existing straight lines of mortar (compared to C18-19 which are more likely to be distorted already).	1 - Very slight

Table 2 – Susceptibility of residential building construction types to damage from adjacent basement excavation (continued)

Construction types	Discussion	Risk of permanent visual (or other) damage	Acceptable Burland damage category (see Note 1)
Terrace, any age	Houses share party walls. A basement under one house will require the party wall foundation to be deepened, leaving the adjacent house with foundations at different depths and therefore potentially more susceptible to both seasonal and excavation related ground movements (especially on clay soils).	HIGH	1 - Very slight
C18-19 containing features such as cantilever stone stairs and delicate plasterwork; these buildings may also be listed	These features are sensitive to damage from small movements.	MEDIUM	1 - Very slight
Buildings in extremely poor condition	A building which is in very poor condition may (depending on the nature of the problems) be on the point of collapse, such that even a very small movement might lead to structural damage or alternatively loss of fragile finishes.	HIGH (unless the building/finishes as appropriate is stabilised before the works)	1 - Very slight

Note 1: Assuming that Council considers some disruption to the neighbours to be acceptable, that is, assuming that cracking and redecoration is acceptable.

## 6 Sufficiency of existing policies

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### 6.1 Policy Q11 – building alterations and extensions

195. Policy Q11 of the Council’s draft Local Plan requires proposals for the alteration or extension of buildings (including conversions) to be well designed and built to a high standard. This Policy is supported by a Supplementary Planning Document (SPD) which provides guidance for those preparing to alter or extend their properties. Policy Q11 “is supportive, in principle, of the provision of new basement accommodation below existing buildings.”
196. Paragraphs (i) and (j) of the Policy are specifically concerned with basements; however, except for sub-paragraph (i)(iii) restricting development below gardens which might introduce a need for irrigation, there is no ground-related content. The SPD, in the section on basements, deals exclusively with aspects of basements which might affect the appearance of the completed works.

### 6.2 Policy EN5 – flood risk

197. Flooding is a risk which has been much studied and for which there is a substantial hierarchy of national, regional and local policy and legislation (see Table 3).

Table 3 – Flooding policy and legislation

Study	Summary
<b>Lambeth Preliminary Flood Risk Assessment (PFRA) 2011</b>	PFRA provides a high level summary of significant flood risk from all sources through collection of information on past (historic) and future (potential) floods. Driven by the Flood Risk Regulations.
<b>Lambeth Strategic Flood Risk Assessment (SFRA) 2013</b>	Focuses on risk from the River Thames and River Graveney.* Provides an overview of flood risk issues in Lambeth and analyses specific locations where development is proposed in areas at risk from flooding. Driven by the NPPF.
<b>Lambeth Surface Water Management Plan (SWMP) 2011 and Appendix C2 Intermediate Assessment of Groundwater Flooding Potential March 2011</b>	Cover areas deemed at high risk from flooding. They use historical information and pluvial modelling. These identify the areas of significant surface water and groundwater risk, options to address the risk and an Action Plan for taking these options forward. Following the Pitt Review.
<b>Lambeth Flood Risk Management Strategy (LFRMS) October 2014</b>	Outlines priorities for flood risk management in the borough and provides a delivery plan to manage the risk. Builds on the outcomes of the Lambeth Surface Water Management Plan (SWMP) and Preliminary Flood Risk Assessment. Driven by the Flood and Water Management Act (2010).

\* Contains the statements (para 17.1): “*The London Borough of Lambeth has a presumption against the location of any new basements in their borough* and as such these would not be permitted in any areas at risk of flooding. This would include the excavation of basements under existing dwellings”, (para 17.2): “NPPF does not permit basement dwellings to be located within Flood Zone 3a. *The London Borough of Lambeth has a presumption against the location of any new basements in their borough* and as such these would not be permitted in any areas at risk of flooding. This would include the excavation of basements under existing dwellings.” We understand that the italicised part of these statements is incorrect, however.

198. The key documents in terms of planning policy are the LFRMS and the Local Plan. The strategy objectives in the LFRMS, of which the one most directly relevant to residential basement development is “Delivering sustainable and proportionate mitigation for existing and future communities”, are to be delivered by “Ensuring planning avoids inappropriate development and has a positive or nil effect on flood risk”. The LFRMS states that this will be achieved by “Enforcing flood risk and sustainable water management policies from the Local Plan”.

199. Policy EN5 requires that a Flood Risk Assessment (FRA) is prepared for all proposed development within Flood Zones 2, 3a and 3b, which are defined in relation to flooding risk from main rivers and the sea (in Lambeth this means the Thames and the Graveney) “or where the development may be subject to other sources of flooding”. The flood risk posed by the development and to the development are both to be considered. Guidance on the scope and methodology for preparing an FRA (Site-Specific Flood Risk Assessment: CHECKLIST) is provided on the NPPF website under “Guidance”.
200. Flood Zone maps appear no longer to be included with the SFRA (at one time they were in Appendix A of that document) but these maps are available on the Environment Agency website which is referenced in the LFRMS document in relation to Fluvial and Tidal Flood Risk. For areas susceptible to groundwater flooding, the LFRMS refers to the Lambeth SWMP. Both documents present a map (Figure 3 and Figure 3.5.1 in the respective documents) showing historic groundwater flooding incidents in the borough and “increased potential for elevated groundwater”. Both documents describe the mechanisms for groundwater flooding, principally in terms of the local geological conditions, and identify particular areas in the borough where these conditions are particularly evident.

### 6.3 Conclusions

201. Under existing policies EN5 and Q11, it appears that residential basement developments in LB Lambeth are not subject to particular restrictions or special requirements in relation to geological, hydrogeological or other ground-related circumstances or risks. The number of basement developments in Lambeth has increased over the last few years and it is likely that this trend will continue as more people look to extend their existing homes as upsizing to larger homes in London becomes increasingly unaffordable. Also, the geology and other ground-related conditions in Lambeth are not dissimilar to those in other London boroughs which have adopted policies specifically aimed at controlling basement development.
202. In relation to a planning application for a basement development, the planning authority (Council) must address only the issues which can be considered under planning legislation, which are known as ‘material considerations’. The courts ultimately decide what a material consideration is, but local planning authorities have a great deal of leeway to decide what considerations are relevant. Accordingly, we understand that the local development plan and associated Planning Policy Guidance Notes may be drafted so as to incorporate matters which the authority considers to be a legitimate planning consideration.
203. As the existing policy in Lambeth apparently does not deal adequately with basements in terms of ground-related risks and there are indeed such risks present within the borough, it seems that there is a need for changes to the planning policy context. The requirement is that new residential basements should not unduly impact upon drainage, flooding, groundwater conditions, land stability, structural stability and condition of other buildings. Inasmuch as there is currently no requirement for applicants to consider these matters in their proposals, what is needed is a revision to policy which introduces such a

requirement. Also necessary is clear direction on the scope of the assessment required.

204. We are led to conclude that a Basement Impact Assessment (BIA) approach is needed, under which all applicants for planning permission for a residential basement would be required to undertake a structured assessment of their proposed development in relation to the physiographic conditions at their site, and to submit the results of their assessment as part of their application. The next section (Section 7) outlines an approach to BIA production which could be implemented in LB Lambeth.
205. The requirement for a BIA could be specified in a Supplementary Planning Document, as it is in LB Camden.

## 7 Information required with applications

### 7.1 Context

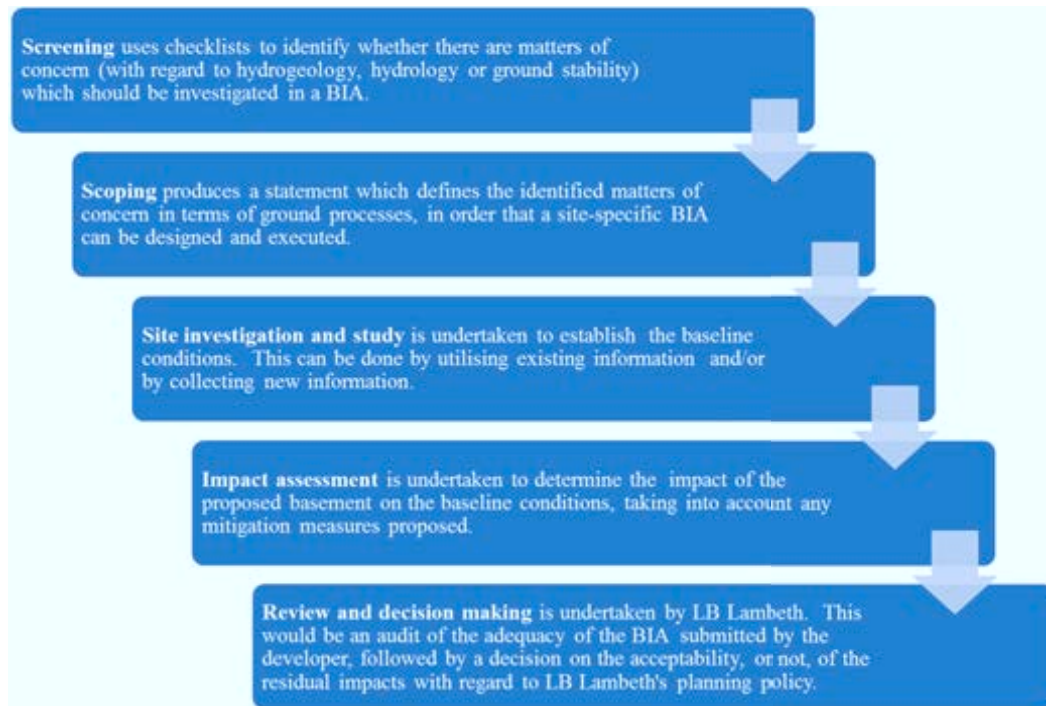
206. LB Lambeth requires such works (as basement extensions) to be well designed and built to a high standard, as stated in the “Building Alterations & Extensions” Supplementary Planning Document. At present the policies contain little detail about what information the Council expects to be submitted at planning stage to demonstrate that this requirement has been complied with.
207. Given the technical nature of the issues associated with basement developments and the level of concern commonly caused by proposals to add or extend residential basements, there is a strong case for policies to be more specific with regard both to information required and the process which applicants should follow in preparing their submission.
208. The council will need to decide how much design is required to be undertaken before planning is granted; typically the time and cost to develop the design and construction methodology to a sufficient level to accurately predict the damage would be high and take time. In theory it would be possible for the council to simply impose a limit on ground movements or at least degree of predicted damage as part of the planning conditions, but in practice these might be difficult for the council to enforce at a later stage. There would be a strong temptation for the builder to reduce the costs and take more risks and simply make good any damage caused afterward. There is therefore a good argument for ensuring that a reasonable amount of design work is done before planning is granted, to demonstrate how the damage to adjacent buildings will be limited. This would also help allay neighbour’s concerns.
209. An example of a policy framework aimed at basement developers is available in the London Borough of Camden. Development Policy DP27 states that LB Camden “*will require an assessment of the scheme’s impact on drainage, flooding, groundwater conditions and structural stability, where appropriate.*” The Council “*will only permit [basement and other underground development that] does not cause harm to the built and natural environment and local amenity and does not result in flooding or ground instability*”. LB Camden “*will require developers to demonstrate by methodologies appropriate to the site that schemes*”
- a. *maintain the structural stability of the building and neighbouring properties;*
  - b. *avoid adversely affecting drainage and run-off or causing other damage to the water environment;*
  - c. *avoid cumulative impacts upon structural stability or the water environment in the local area”*

DP27 is supported in LB Camden by a supplementary planning guidance document CPG 4 “Basements and lightwells”, which prescribes a “Basement Impact Assessment” (BIA) approach to preparing an application for a development which includes a basement, or an extension to a basement.

210. The geology and topography in LB Lambeth is comparable to that found in Camden, so there is good reason for the approach to basement developments to have some similarities also.

## 7.2 The Basement Impact Assessment approach

211. The BIA process includes the stages shown in the BIA Stages flow chart below.



212. The BIA methodology is derived from the Environmental Impact Assessment (EIA) model which is a well-established and widely-utilised process of identifying, predicting, evaluating and mitigating relevant environmental effects of development proposals prior to decisions being taken. The requirement for a BIA has been policy in LB Camden since 2011 and there is a wide level of acceptance in the community and among developers.
213. The following sections outline the methodology for specifying and undertaking a BIA, as in use in LB Camden. The first four stages of the BIA process are those that would be expected to be undertaken by the developer. The scoping stage defines in further detail the matters to be investigated as part of the BIA process. This then leads to the site investigation and finally the impact assessment.

### 7.2.1 Screening

214. The first stage in assessing the impact of a proposed basement development is to recognise what issues are relevant to the proposed site. Screening is the process of determining whether or not a BIA is required for a particular project. All basement proposals are subjected to the screening stage of a BIA to identify the relevant matters of concern with regard to the proposed



development. A number of steps are involved in screening and the process proceeds through these steps until a decision is made on whether or not impact assessment is required with regard to different matters. If a decision can be made at an early stage that specific matters are not applicable to a given project, then the process can stop and the later steps will not be required for the non-applicable matters.

### 7.2.2 Scoping

215. The scoping stage requires the developer to identify the potential impacts for each of the matters of concern identified in the screening stage. To undertake the scoping stage of the BIA process, a developer needs to have some information on the specific project as well as the site. The type of information required at this stage is the same as the list for screening except that at the scoping stage more detailed information is needed. This may involve some preliminary data collection and field work.

### 7.2.3 Site investigation and study

216. The third stage in a BIA, after screening and scoping, is site investigation. The scope developed in the previous scoping stage outlines the matters of concern in relation to the site. Using this scope, a site investigation can be designed specific to the site and to the particular development proposed.
217. The BIA site investigation is usually wider than that of a typical “site investigation”, which is primarily concerned with soil and groundwater conditions, and which usually takes place within the site boundary. The degree of investigation varies depending upon the matters of concern identified in the screening and scoping stages, and is therefore dependent on the location of the proposed basement within the borough, its size and setting in relation to the existing development on the site and its relationship to adjacent properties including their basements and nearby features of importance.
218. The BIA site investigation comprises several stages including:
- desk study, including site walkover;
  - field investigation, including intrusive investigation;
  - monitoring;
  - reporting;
  - interpretation.
219. The data and information collected in the site investigation is analysed and interpreted by the developer or his specialist adviser/consultant, to provide baseline data which, in the next stage of the BIA, can be used in order to make an assessment the potential impacts identified through the scoping exercise.
220. The assessment should also make allowance for existing works that are post-planning but yet to be executed.

## 7.2.4 Impact assessment

221. A BIA describes the impacts of the project on the environment by comparing the present situation (the baseline) with the situation as it would be with the basement in place; that is, after construction.
222. The BIA should describe, quantify, and then aggregate the effects of the development on those attributes or features of the geological, hydrogeological and hydrological environment which have been identified (in the Scoping stage) as being potentially affected; i.e. assess cumulative effects.
223. A damage assessment with reference to the Burland categories would form part of the impact assessment.
224. Attributes applicable to the conditions in LB Lambeth are listed below:
  - Surface (hydrological) flow
    - Rate of runoff
    - Loss of permeable area
    - Direction of overland flow
    - Stream hydrograph
    - Soil moisture
    - Frequency of surface flooding
    - Sediment transport (erosion and siltation)
  - Subsurface (groundwater) flow
    - Groundwater levels
    - Direction of flow
    - Range of seasonal fluctuation in groundwater levels
    - Spring hydrographs
    - Soil moisture
    - Water quality
  - Slope stability
    - Slope angle
    - Moisture content
    - Porewater pressure
    - Stiffness
    - Compressibility
    - Bearing capacity (strength)
    - Atterberg limits
225. If the consequences are not acceptable, mitigation should be incorporated into the proposed scheme and the changes in attributes re-evaluated and the new net consequences determined. Any mitigation measures incorporated into the proposed scheme should be described in the BIA report with details of how they reduce and/or alter the impact of the proposed basement on the surrounding environment.

226. For example, an applicant proposing a basement will carry out Stages 1 to 3 (Screening to Site Investigation) but find out in Stage 4 (Impact Assessment) that the predicted level of risk to neighbouring buildings will exceed the permitted Burland category. In that case, the applicant would incorporate mitigation into the proposed scheme so as to bring the residual risk down to the acceptable level. If all stage of the BIA are completed before the proposal is discussed with the Council then the mitigation measures should already be incorporated.

### 7.2.5 Reporting

227. A comprehensive non- technical summary document of the BIA should be included with the BIA report so that it can be understood by those with limited technical knowledge and conclusions about the BIA can be drawn.

### 7.2.6 Audit

228. The final stage in the BIA process would be the review by LB Lambeth of the results. The Council would not undertake technical evaluation of submissions (although in some more complex cases this could be necessary), but would use an audit approach to check the adequacy of a BIA. Thus the submission would be audited against the criteria for a BIA which would have been set out by the Council in an SPD or elsewhere.

## 7.3 Basement construction plans

229. A further control option for Council may be to employ the use of a Section 106 agreement to require a Basement Construction Plan. The focus of such plans as presently specified by, for example, the London Borough of Richmond upon Thames (Construction Management Statement), is on the temporary condition but many of the concerns which should be addressed during construction are similar to those arising from the completed project.
230. Basement Construction Plans may not be an alternative to a properly written BIA, which should address the construction stage as well as the completed of a project, but as a separate document it may be more appropriate for larger basements, more complex basements, difficult ground conditions or basements involving listed buildings.
231. In terms of the structural and geotechnical aspects of the development, such a plan would set out in detail how the basement contractor intends to construct the basement and include:
- Discussion and justification for significant changes made post planning;
  - Detailed method statements;
  - Identification of site specific structural and geotechnical risks, and discussion on how these have been or will be mitigated;
  - Detailed monitoring and proactive contingency plans, and discussion of how ground movements will be limited to ensure that previously agreed levels of damage are not exceeded;

- Evidence showing that they understand the particular characteristics of the site (e.g. party wall footings, structural condition, groundwater conditions);
  - Discussion of how they intend to minimise the impact of the development on the neighbours;
  - Clear evidence of previous experience by the basement contractor and designers on similar projects in similar ground conditions;
  - Appropriate calculations for Building Control for temporary and permanent conditions;
  - Provision for a suitably qualified and experienced engineer from a recognised relevant professional body to supervise the works; and
  - Measures to ensure the ongoing maintenance and upkeep of the basement.
232. The basement construction plan should be reviewed by an independent, suitably qualified and experienced engineer.

## Figures

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Figure 1 Location map

Figure 2 Relief map

Figure 3 Geological map

Figure 4 Superficial geology thickness map

Figure 5 Aquifer designation of geological units

Figure 6 Slope angle map

Figure 7 Slope instability hazard map

Figure 8 Typical underpinning construction sequence

Figure 9 Typical underpinning sequence pattern

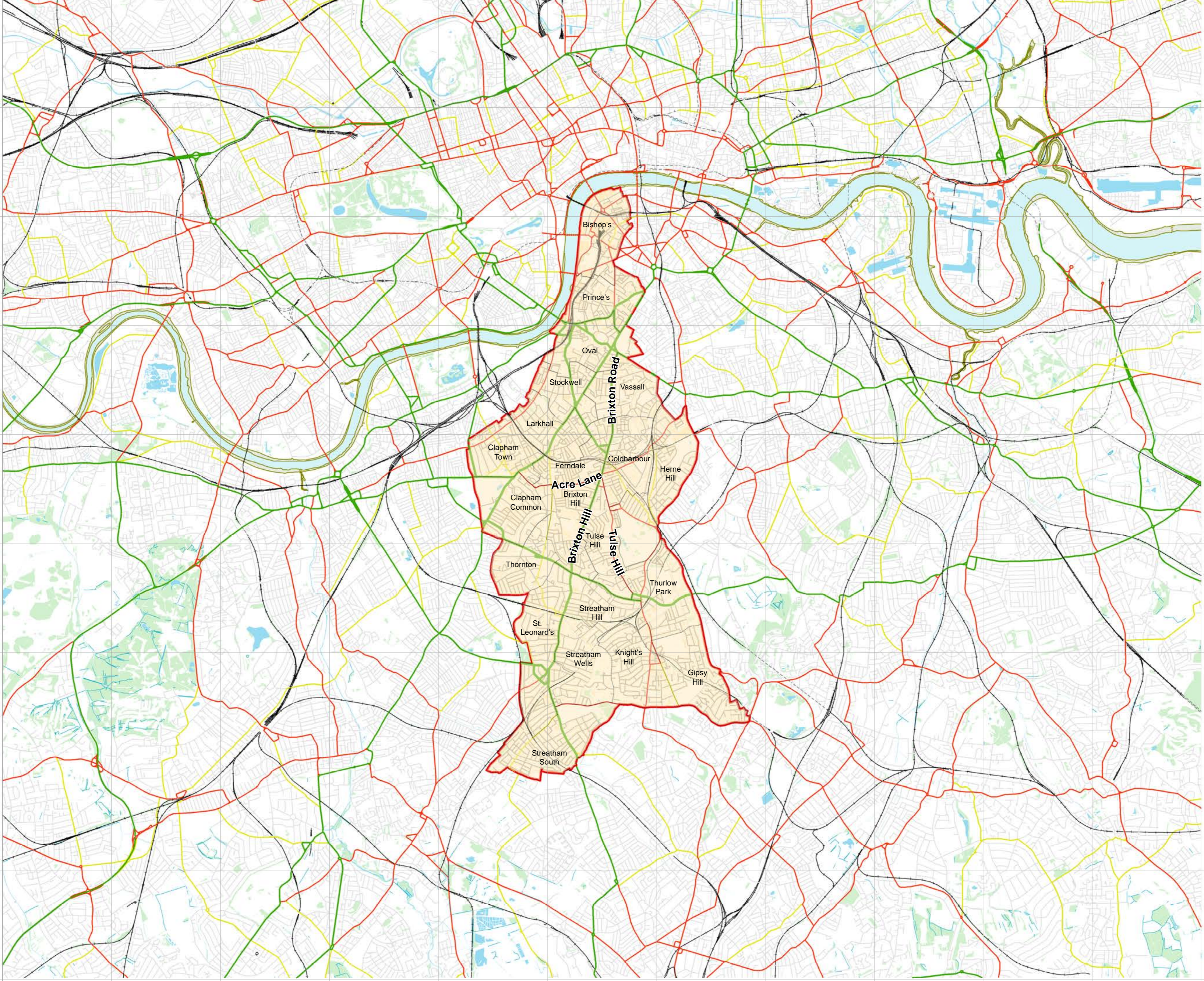
Figure 10 Typical “cut and cover” construction sequence used for garden basements

Figure 11 Schematic groundwater flow around basements

Figure 12 Shrink swell hazard map

Figure 13 Lost rivers

Figure 14 Listed buildings



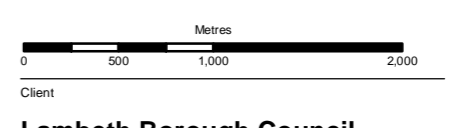
**Legend**

- Lambeth Borough
- Motorway
- Primary Road - Dual Carriageway
- A Road
- B Road
- Local Street
- Railway Track
- Surface Water Feature
- Woodland
- Lambeth Wards

PI	07-03-16	ET	JL	DW
Issue	Date	By	Chkd	Appd

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**Lambeth Borough Council**

Job Title  
**Lambeth Residential Basement Study**

**Figure 1 - Lambeth Borough Location Map**

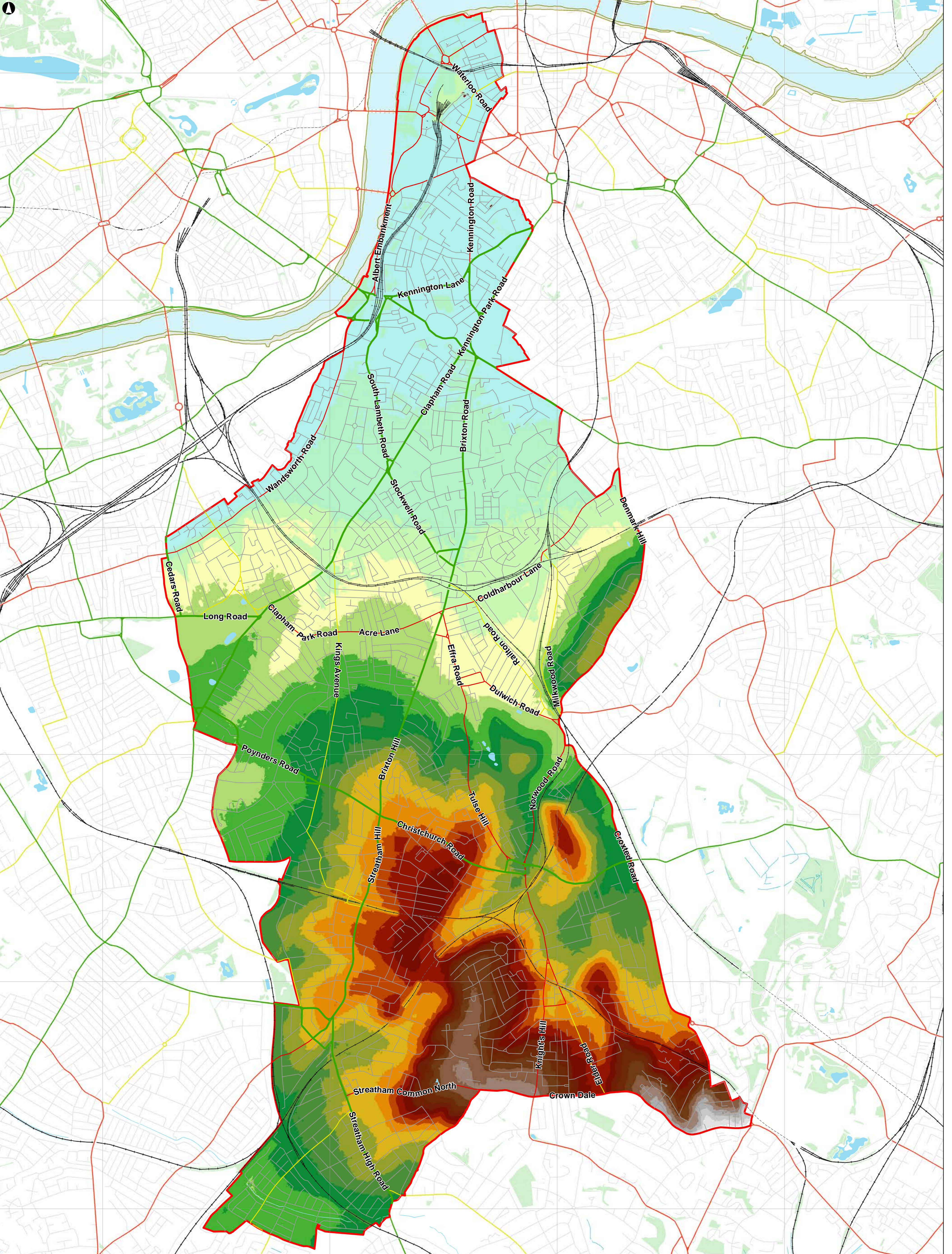
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**247871-00**

Drawing Status  
**Draft**

Issue  
**001**

**P1**



**Legend**

Lambeth Borough	Railway Track
Motorway	Surface Water Feature
Primary Road - Dual Carriageway	Woodland
A Road	
B Road	
Local Street	

**Elevation (mOD)**

0 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	66 - 70	71 - 75	76 - 80	81 - 85	86 - 90	91 - 95	96 - 100	101 - 105	106 - 110	111 - 115
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P1	07-03-16	ET	JL	DW
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Client: **Lambeth Borough Council**

Job Title: **Lambeth Residential Basement Study**

Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing No: **001**

Drawing Status: **Draft**

**Figure 2 - Lambeth Borough Relief Map**

Scale at A1: **1:15,000**

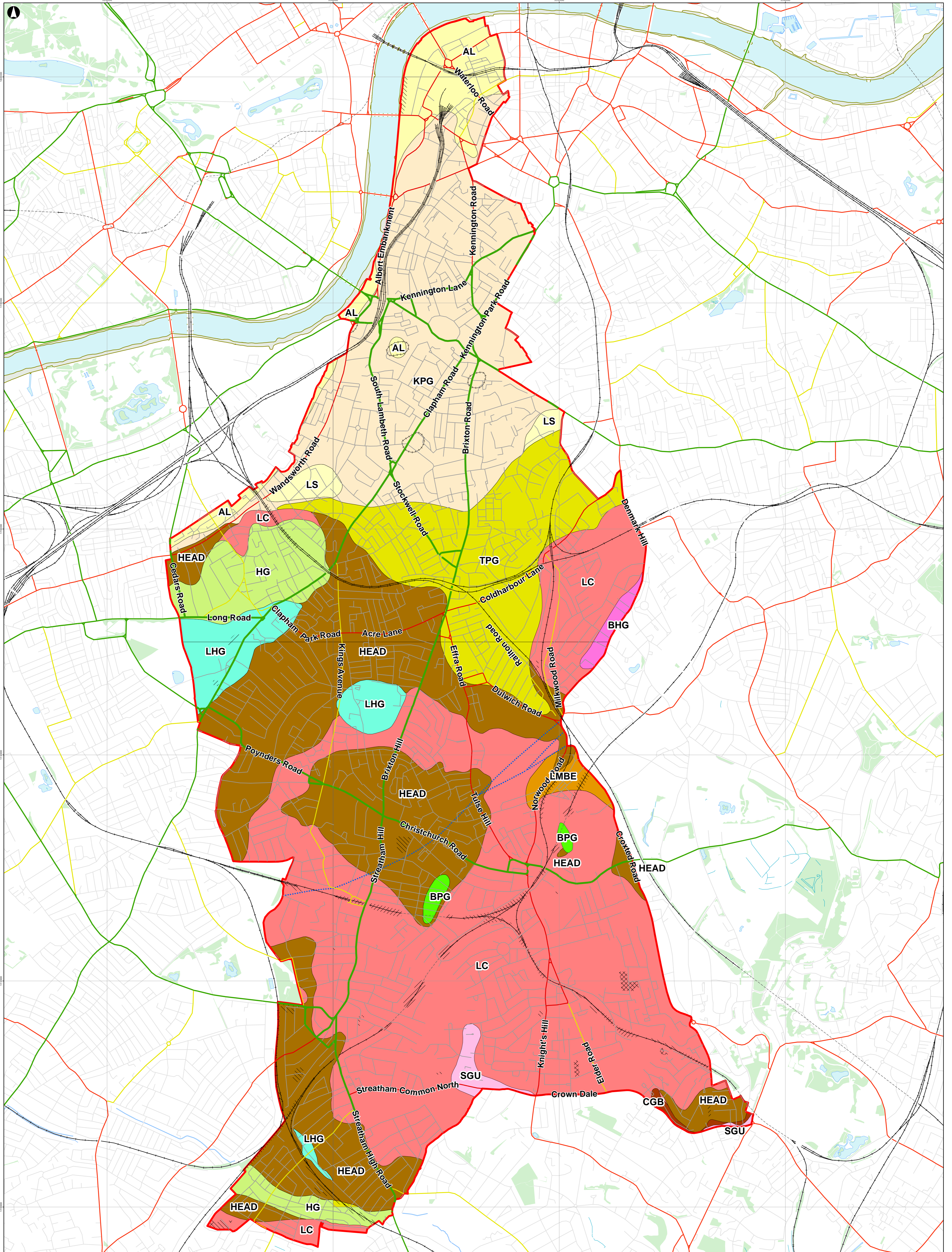
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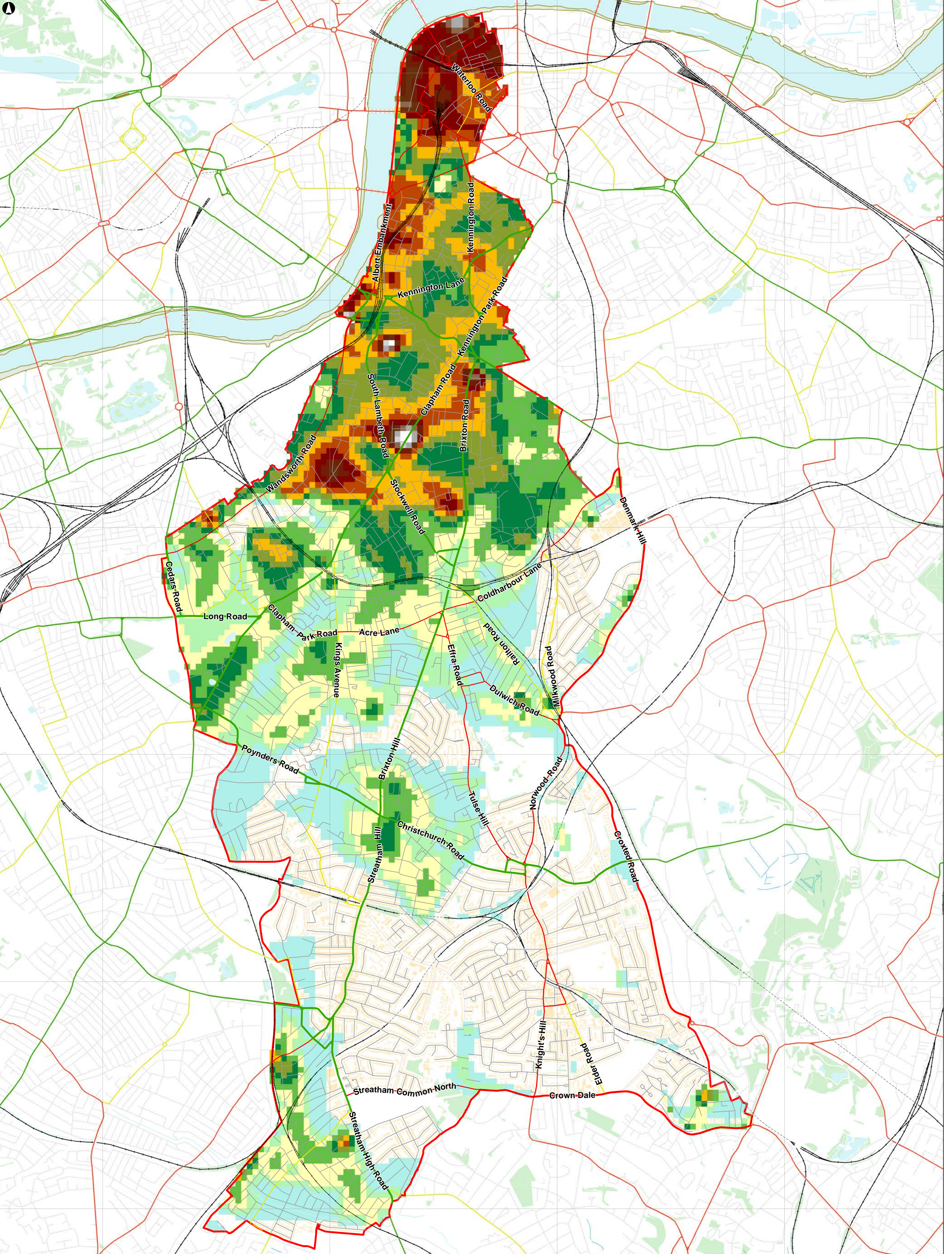




<b>Legend</b> <b>Artificial Geology</b> Made Ground (Artificial Deposit) Made Ground Worked Ground Infilled Ground Filled Hollow		<b>Superficial Geology</b> Alluvium (AL) Boyn Hill Gravel (BHG) Black Park Gravel (BPG) Hackney Gravel (HG) Head		Kempton Park Gravel (KPG) Langley Silt (LS) Lynch Hill Gravel (LHG) Sand Gravel Unknown Age (SGU) Taplow Gravel (TG)		<b>Solid Geology</b> Claygate Member (CGB) London Clay (LC) Lambeth Group (LMBE) Fault (Inferred)		Lambeth Borough Motorway Primary Road - Dual Carriageway A Road B Road Local Road		Railway Track Surface Water Feature Woodland	
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Geological boundaries based on 1:10,000 scale BGS mapping.  
 Linear features based on 1:50,000 scale BGS mapping.

<b>ARUP</b> <small>13 Finsbury Street          London EC2A 3BB          Tel: +44 20 7586 1031 Fax: +44 20 7586 3824          www.arup.com</small>	Client: <b>Lambeth Borough Council</b> Job Title: <b>Lambeth Residential          Basement Study</b>	Scale at A1: <b>1:15,000</b> Job No: <b>247871-00</b> Drawing No: <b>001</b>	<b>Figure 3 - Lambeth Borough          Geological Map</b> Scale at A1: <b>1:15,000</b> Job No: <b>247871-00</b> Drawing Status: <b>Draft</b> Issue: <b>P1</b>
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- Legend**
- Lambeth Borough
  - Motorway
  - Primary Road - Dual Carriageway
  - A Road
  - B Road
  - Local Street

Superficial Thickness (m)	
1 - 2	12 - 13
2 - 3	13 - 14
3 - 4	14 - 15
4 - 5	15 - 16
5 - 6	11 - 12
6 - 7	
7 - 8	
8 - 9	
9 - 10	
10 - 11	

PI	07-03-16	ET	JL	DW
Issue	Date	By	Chkd	Appd

**ARUP**

13 Finsbury Street  
London EC2A 3DF  
Tel: +44 20 7766 1331 Fax: +44 20 7580 3824  
www.arup.com

Client: **Lambeth Borough Council**

Job Title: **Lambeth Residential Basement Study**

Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing Status: **Draft**

Issue: **001**

**Figure 4 - Superficial Geology Thickness Map**

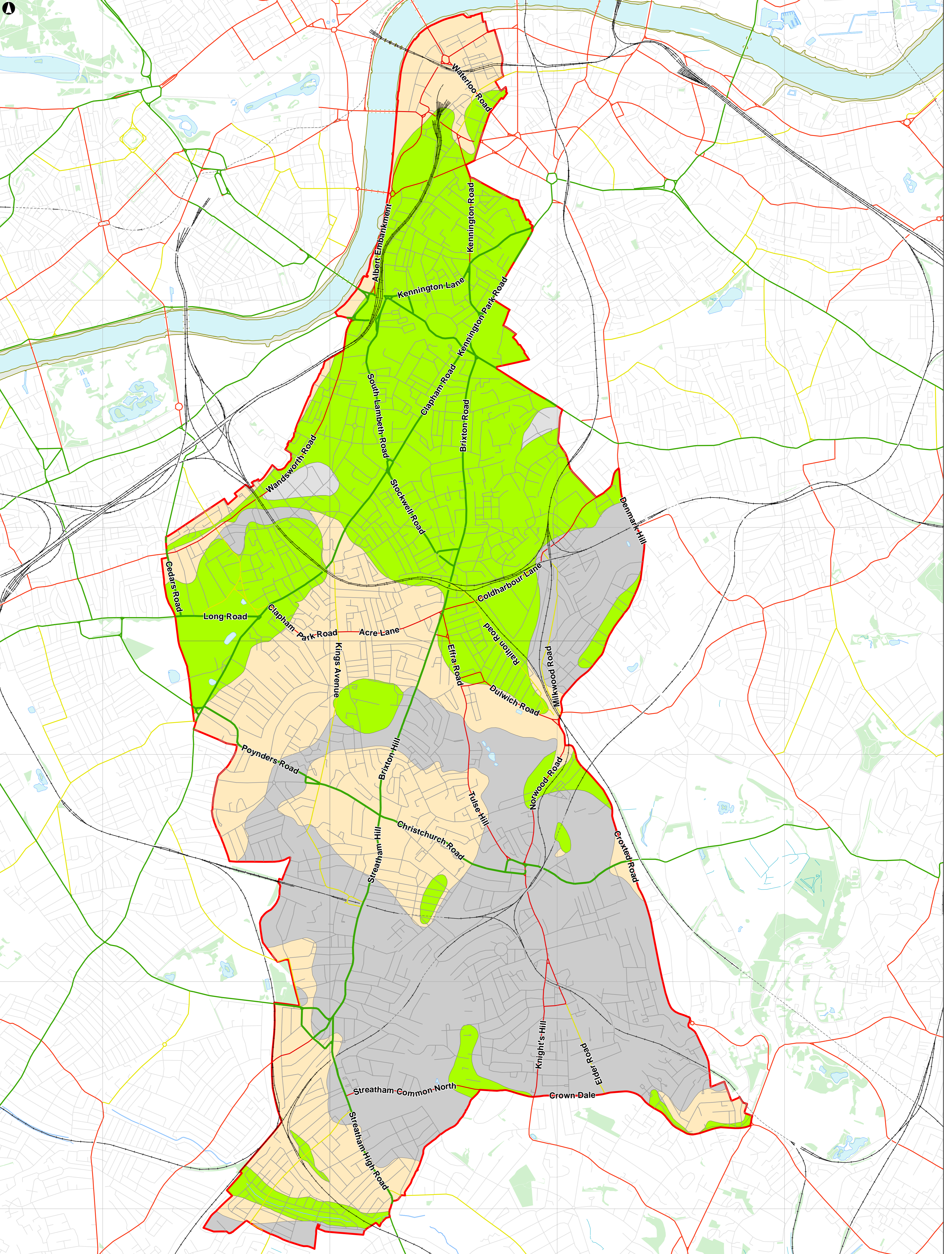
Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing Status: **Draft**

Issue: **001**

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**Legend**

- Lambeth Borough
- Motorway
- Primary Road - Dual Carriageway
- A Road
- B Road
- Local Road
- Railway Track
- Woodland
- Surface Water Feature

**Aquifer Designation**

- Principal
- Secondary A
- Secondary B
- Secondary (undifferentiated)
- Unknown (lakes+landslip)
- Unproductive

Geological boundaries based on 1:10,000 scale BGS mapping  
 Aquifer classifications based on Environment Agency Groundwater Protection Policy

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Client: **Lambeth Borough Council**

Job Title: **Lambeth Residential Basement Study**

Scale at A1: **1:15,000**

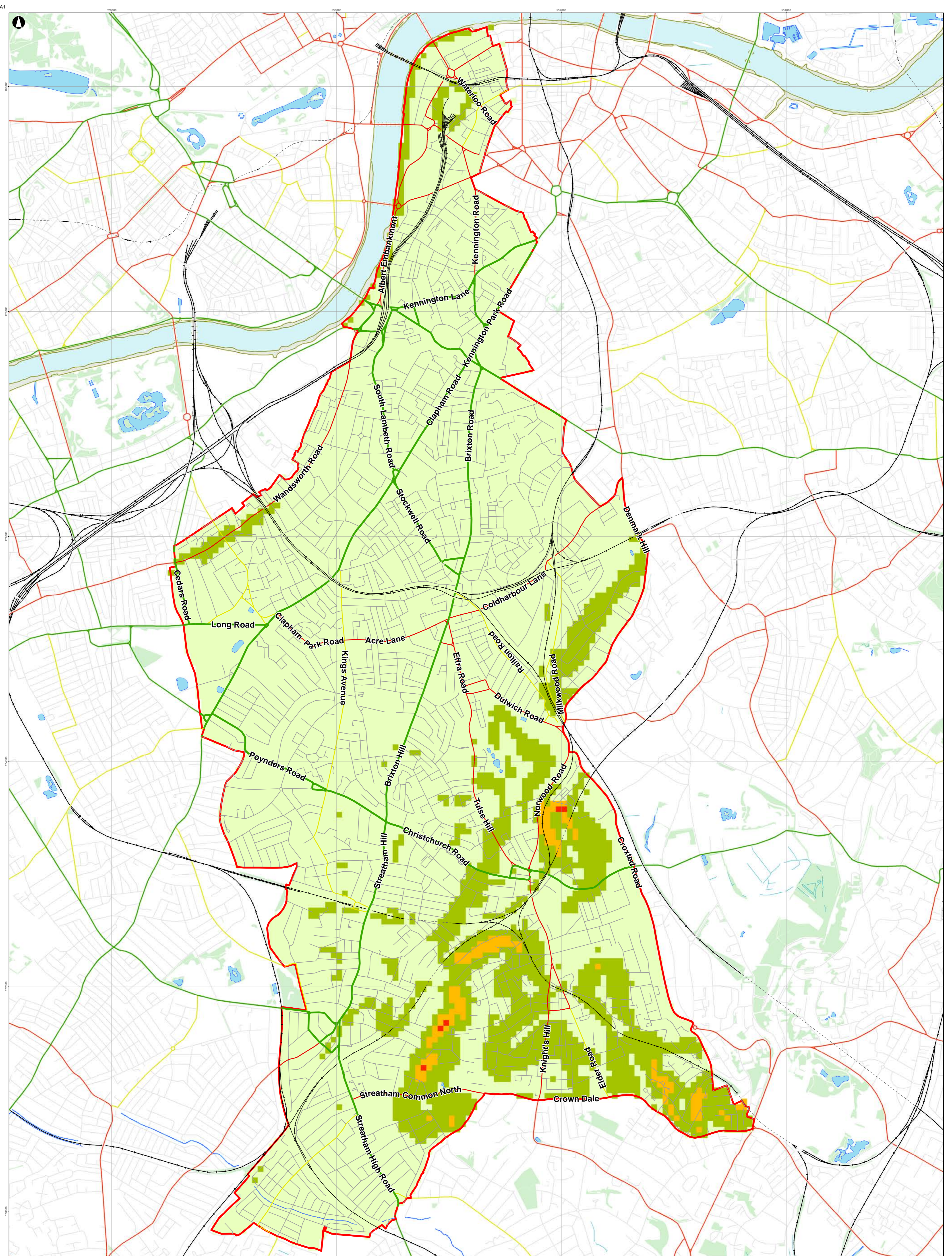
Job No: **247871-00**

Drawing No: **001**

Drawing Status: **Draft**

Issue: **P1**

**Figure 5 - Aquifer Designation of Geological Units**



**Legend**

- Lambeth Borough
- Motorway
- Primary Road - Dual Carriageway
- A Road
- B Road
- Local Street
- Railway Track
- Surface Water Feature
- Woodland

**Ground Surface Slope Angle (degrees)**

- 0 - 3
- 3 - 7
- 7 - 10
- >10

PI	07-03-16	ET	JL	DW
Issue	Date	By	Chkd	Appd

**ARUP**

13 Finsbury Street  
London EC2A 3DF  
Tel: +44 20 7766 1331 Fax: +44 20 7580 3824  
www.arup.com

Client: **Lambeth Borough Council**

Job Title: **Lambeth Residential Basement Study**

Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing Status: **Draft**

Issue: **001**

**Figure 6 - Lambeth Borough Slope Angle Map**

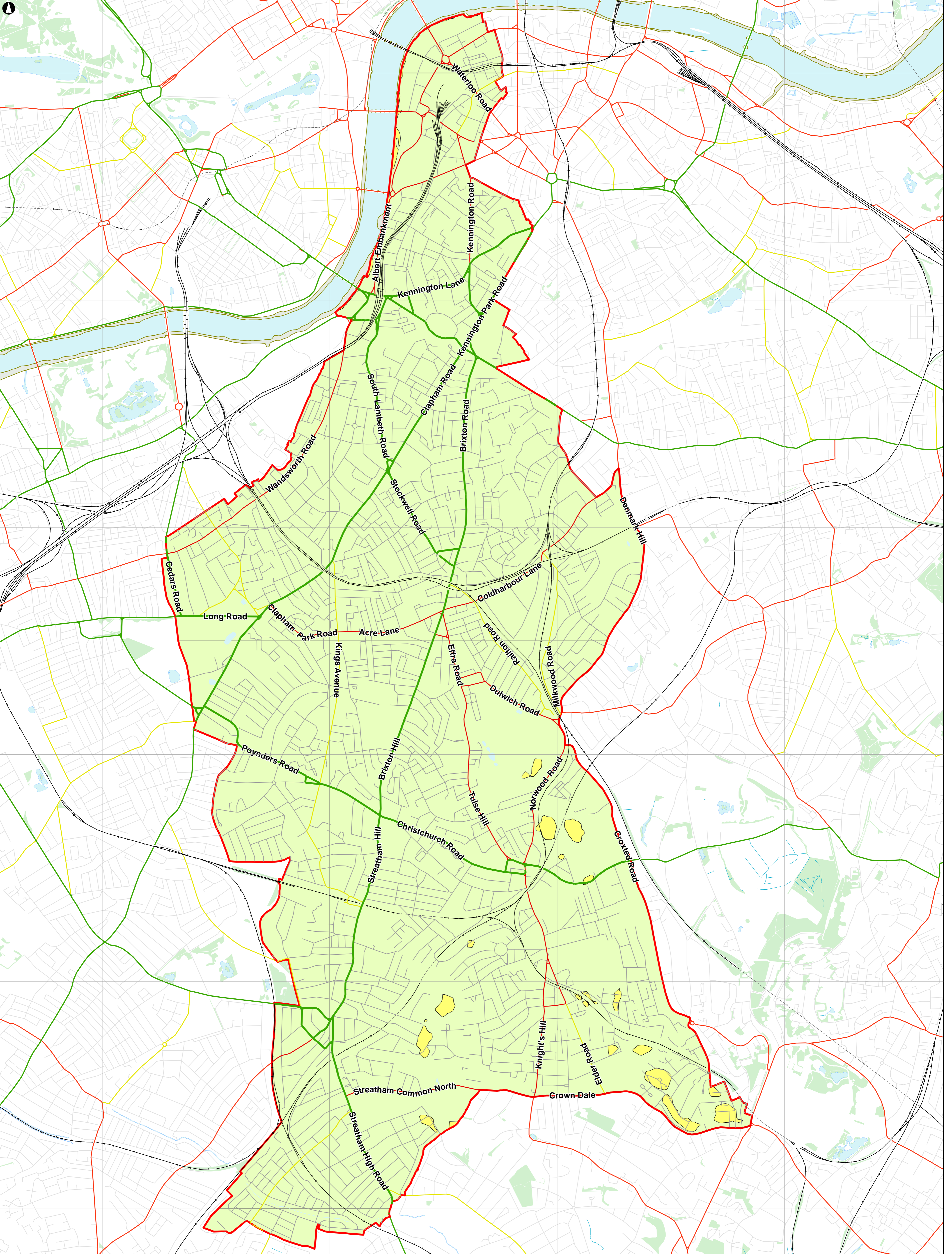
Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing Status: **Draft**

Issue: **001**

Derived from 1:10,000 and 1:50,000 scale. BGS Digital Data under Licence 2016/029 ©NERC  
Contains OS data ©Crown copyright/Open Map 2016  
Slope angles calculated using 1:50,000 scale OS topographic data



**Legend**

- Lambeth Borough
- Motorway
- Primary Road - Dual Carriageway
- A Road
- B Road
- Local Street
- Railway Track
- Woodland
- Surface Water Feature

**Slope Instability Hazard Rating**

- B - Slope instability problems are not likely to occur
- C - Slope instability problems may be present or anticipated
- D - Slope instability problems are present or have occurred in the past
- E - Slope instability problems almost certainly present and may be active

Refer to Appendix C for full details of the Geosure classification index

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ARUP

13 Fenny Street  
London W14 8EP  
Tel: +44 20 7586 1331 Fax: +44 20 7586 3824  
www.arup.com

Client  
**Lambeth Borough Council**

Job Title  
**Lambeth Residential  
Basement Study**

**Figure 7 - Slope Instability  
Hazard Map**

Scale at A1  
**1:15,000**

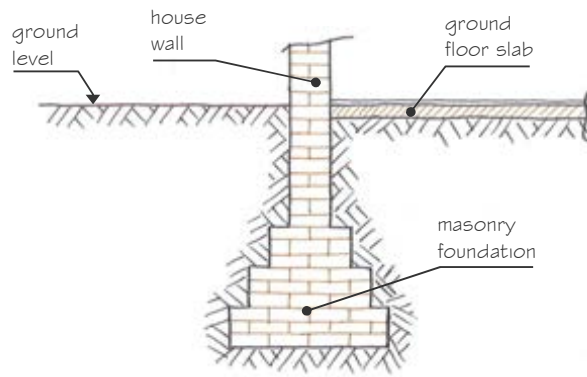
Job No  
**247871-00**

Drawing Status  
**Draft**

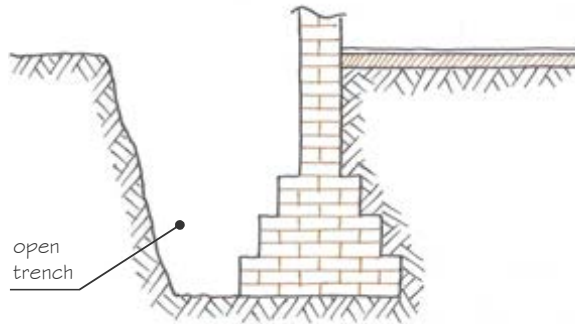
Drawing No  
**001**

Issue  
**P1**

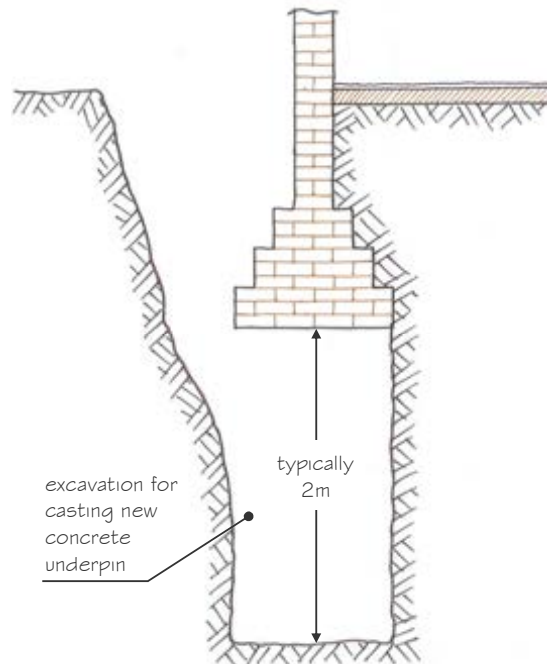
Stage 0: original foundation, typical of houses



Stage 1: exposure of original foundation by digging a short trench along a section of the wall to be underpinned



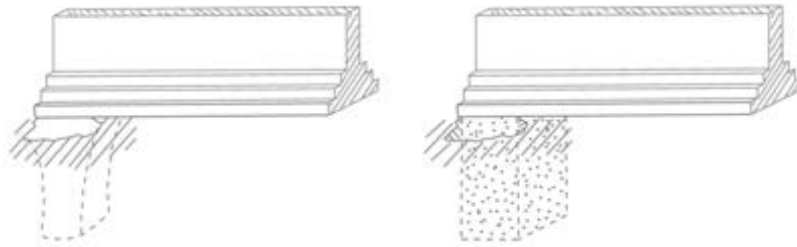
Stage 2: excavation of pit to form underpin: (see Fig. 9 for details)



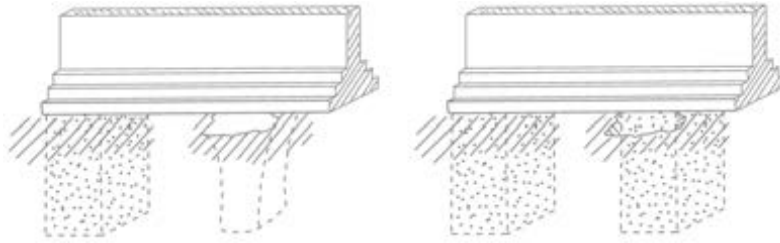
Indicative, schematic sketches only.  
Actual dimensions are likely to vary.  
Not to scale.

## Lambeth Residential Basement Study Typical underpinning construction sequence

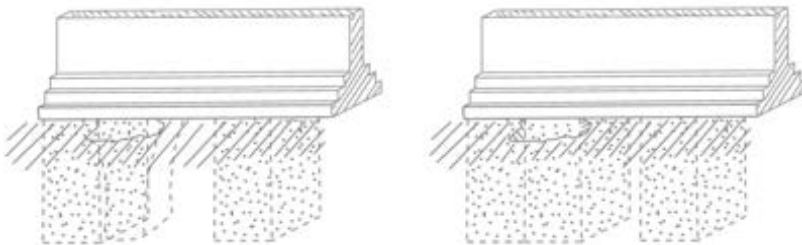
Stage 2a: excavation and concreting of first pin (#1) in 1,4,2,5,3 sequence



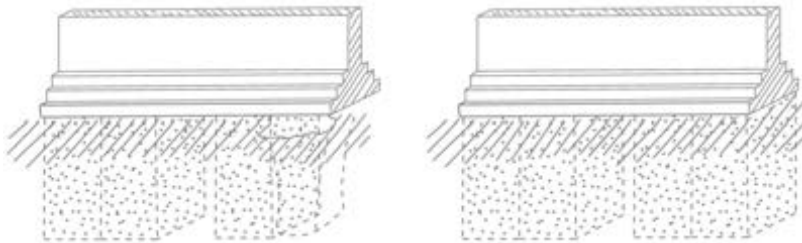
Stage 2b: excavation and concreting of second pin (#4) in 1,4,2,5,3 sequence



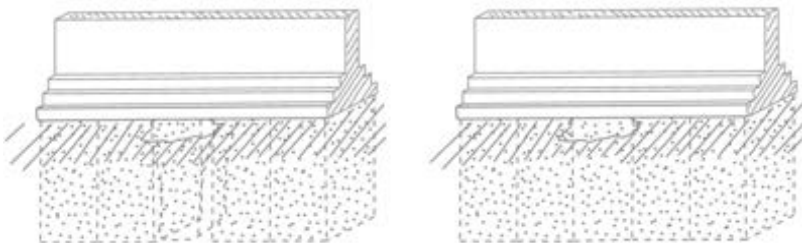
Stage 2c: excavation and concreting of third pin (#2) in 1,4,2,5,3 sequence



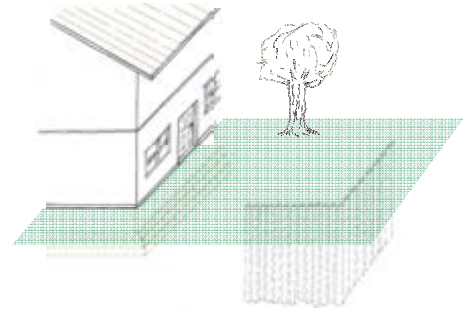
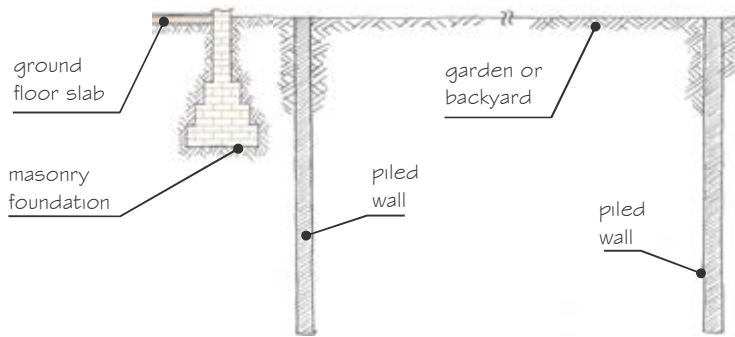
Stage 2d: excavation and concreting of fourth pin (#5) in 1,4,2,5,3 sequence



Stage 2e: excavation and concreting of sixth pin (#3) in 1,4,2,5,3 sequence

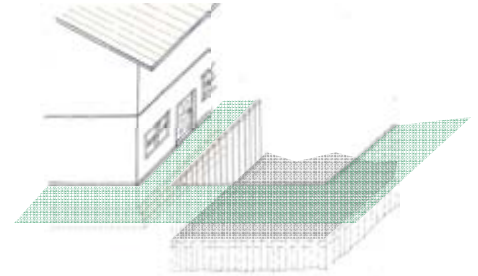
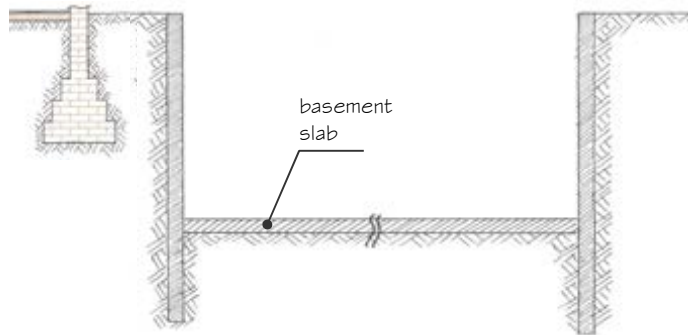


Stage 1: installation of piled walls

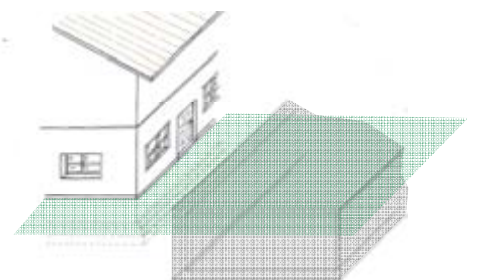
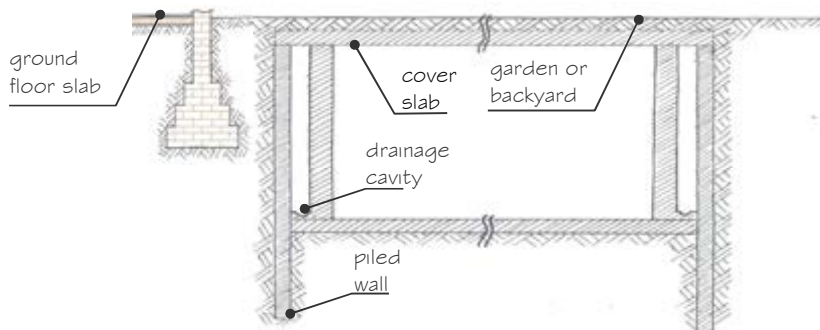


Stage 2: excavation and construction of basement slab

**Note:** temporary propping support is essential, but is not shown in sketches for clarity



Stage 3: construction of basement walls and cover, before reinstating garden



Indicative, schematic sketches only.  
Actual dimensions are likely to vary.  
Not to scale.

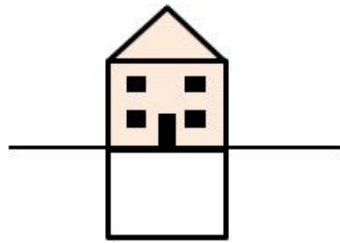
**Lambeth Residential Basement Study**

Typical “cut and cover” construction sequence used for garden basements

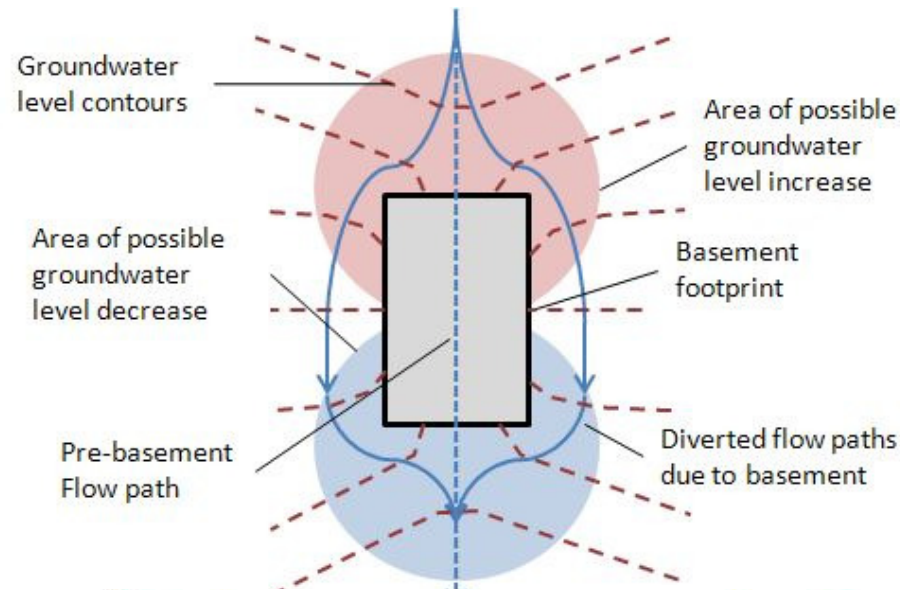


**Scenario**

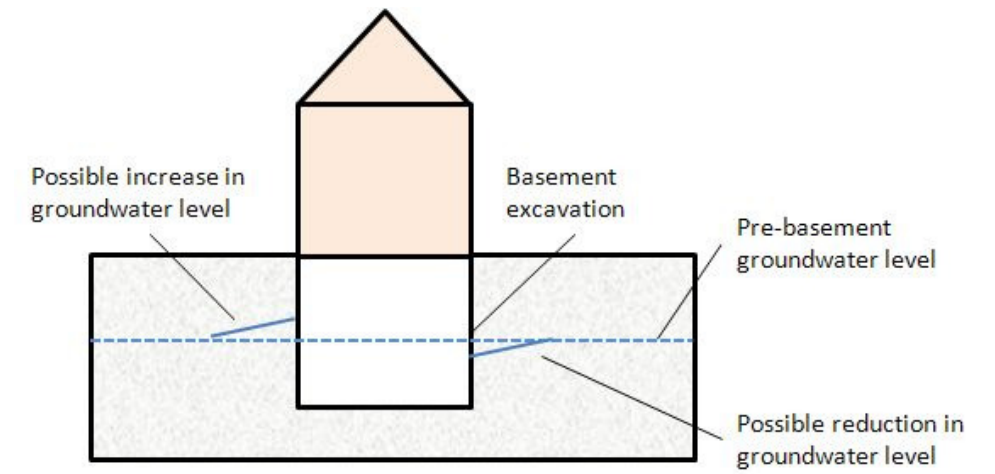
**A**



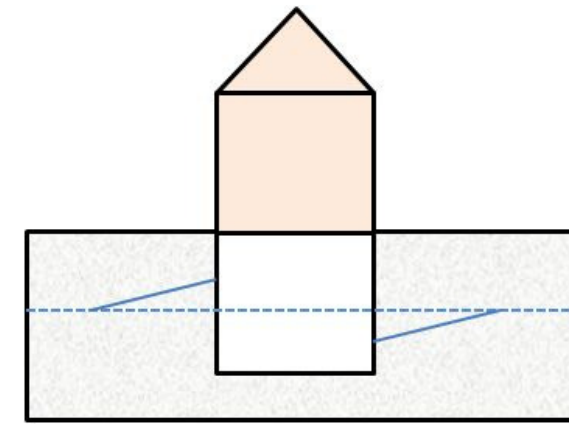
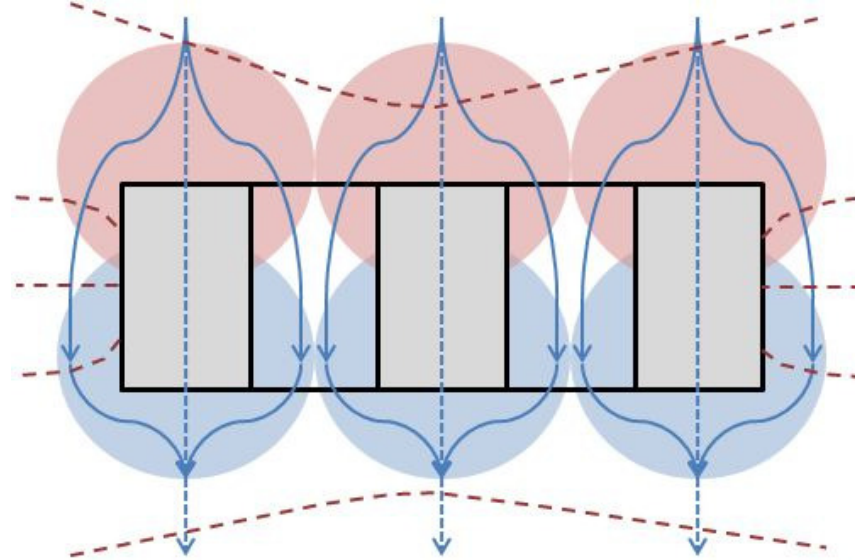
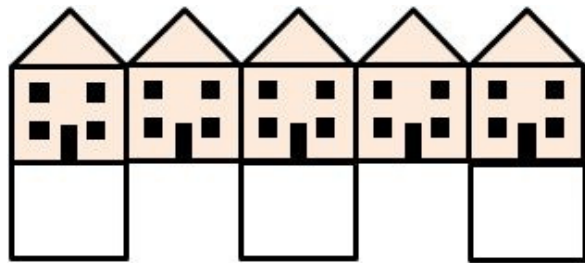
**Plan**



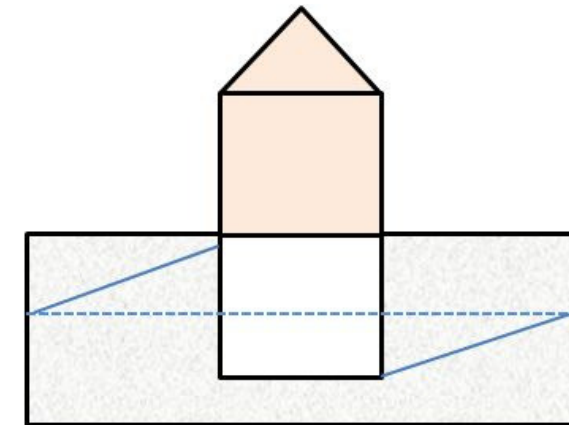
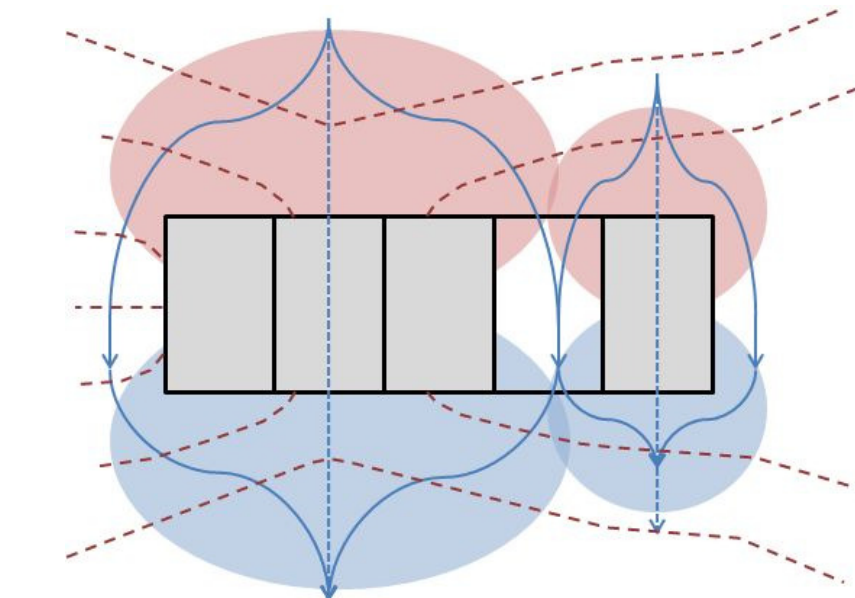
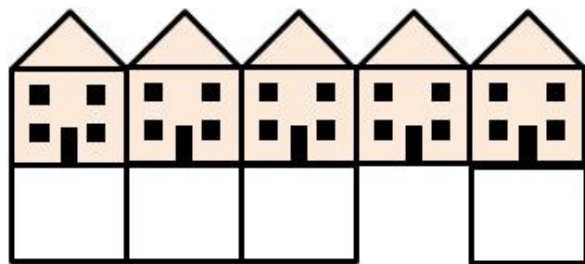
**Section**



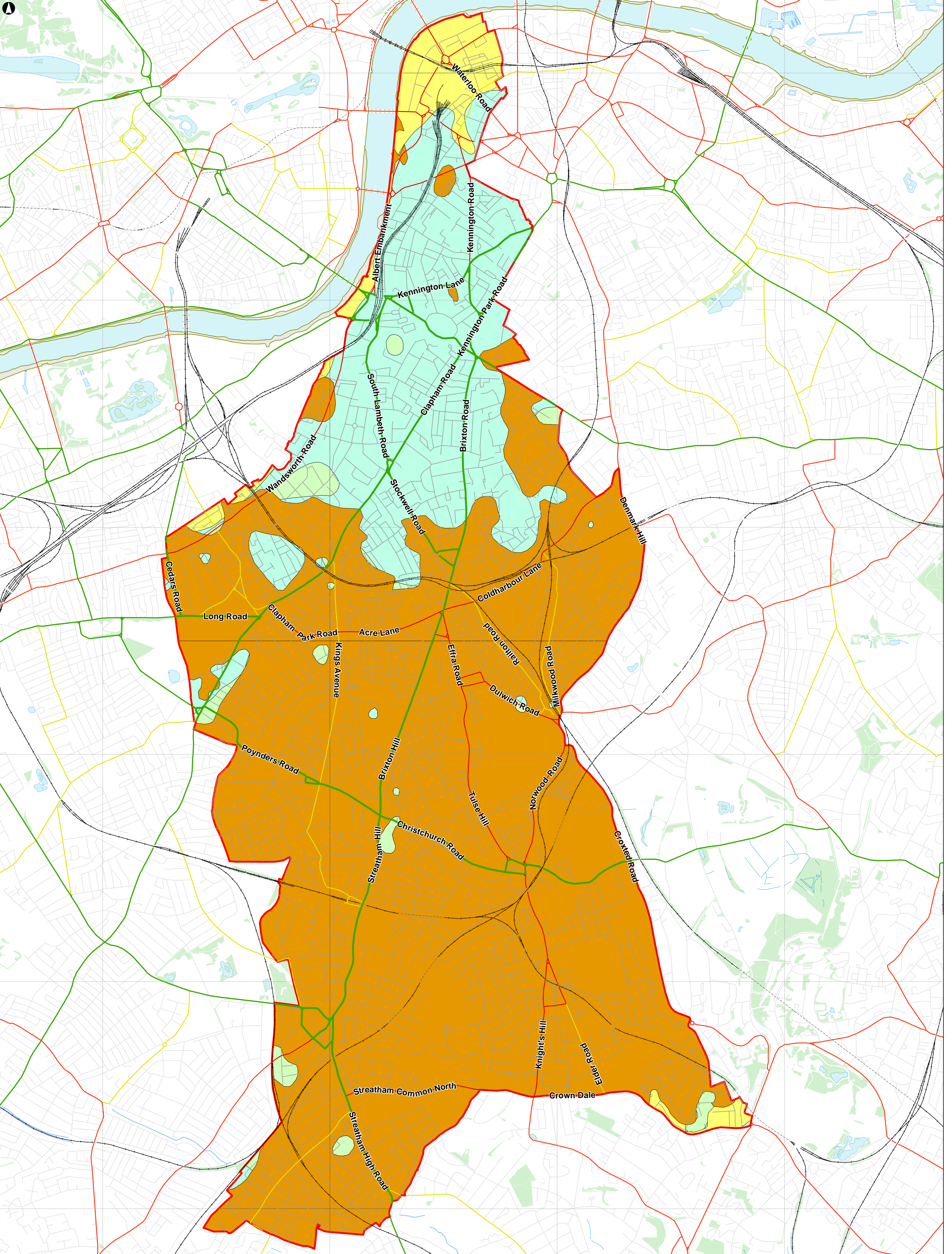
**B**



**C**



**Lambeth Residential Basement Study**  
Schematic groundwater flow around basements



**Legend**

- Lambeth Borough
- Motorway
- Primary Road - Dual Carriageway
- A Road
- B Road
- Local Street
- Railway Track
- Surface Water Feature
- Woodland

**Shrink Swell Hazard Rating**

- A - Ground conditions predominantly non-plastic
- B - Ground conditions predominantly low-plasticity
- C - Ground conditions predominantly medium-plasticity
- D - Ground conditions predominantly high-plasticity
- E - Ground conditions predominantly very high-plasticity

Refer to Appendix C for full details of the Geosure classification index

PI	07-03-16	ET	JL	DW
Issue	Date	By	Chkd	Appd

**ARUP**

13 Finsbury Street  
London EC2A 3BE  
Tel: +44 20 7586 1331 Fax: +44 20 7586 3824  
www.arup.com

Client: **Lambeth Borough Council**

Job Title: **Lambeth Residential Basement Study**

Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing No: **001**

Drawing Status: **Draft**

**Figure 12 - Shrink Swell Hazard Map**

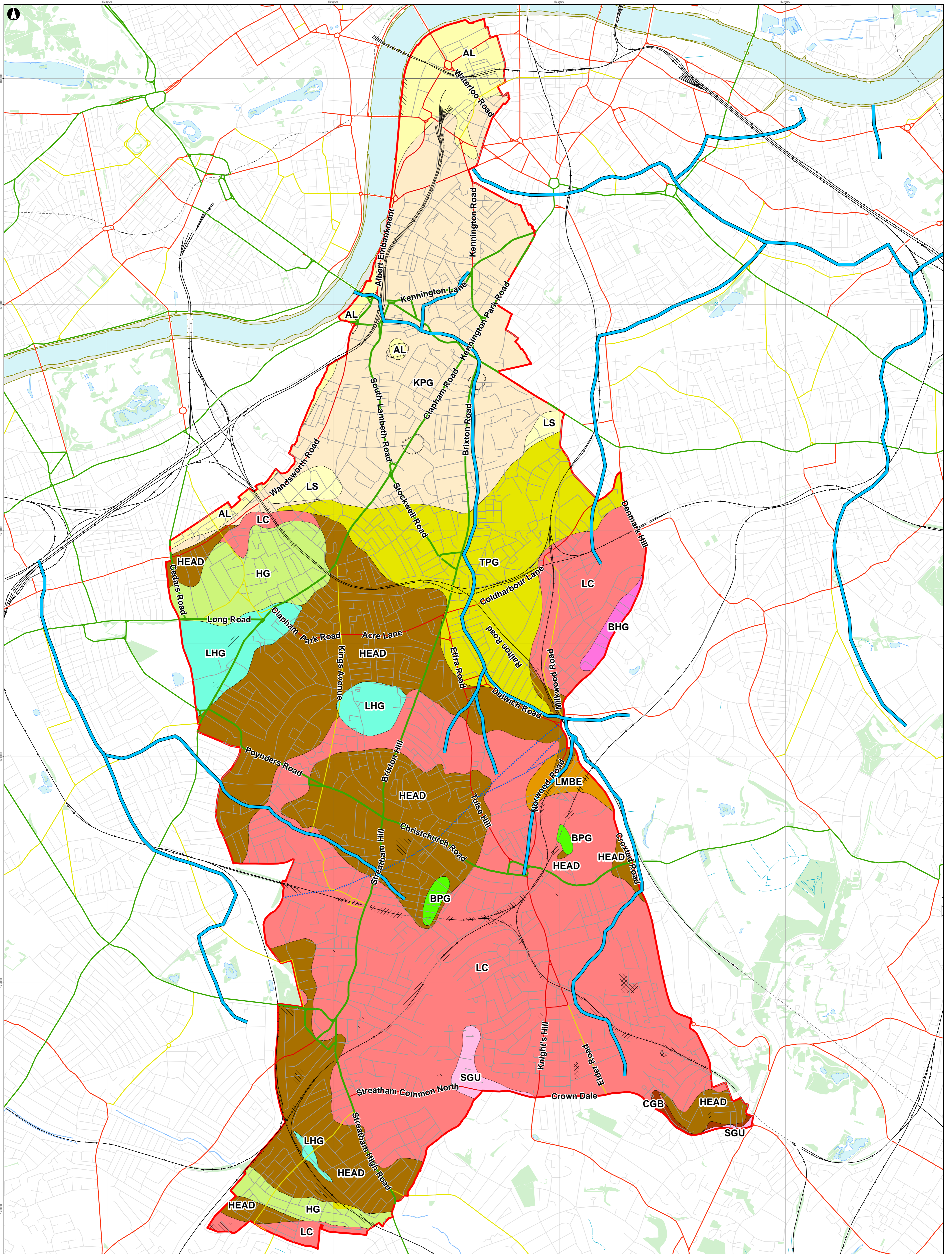
Scale at A1: **1:15,000**

Job No: **247871-00**

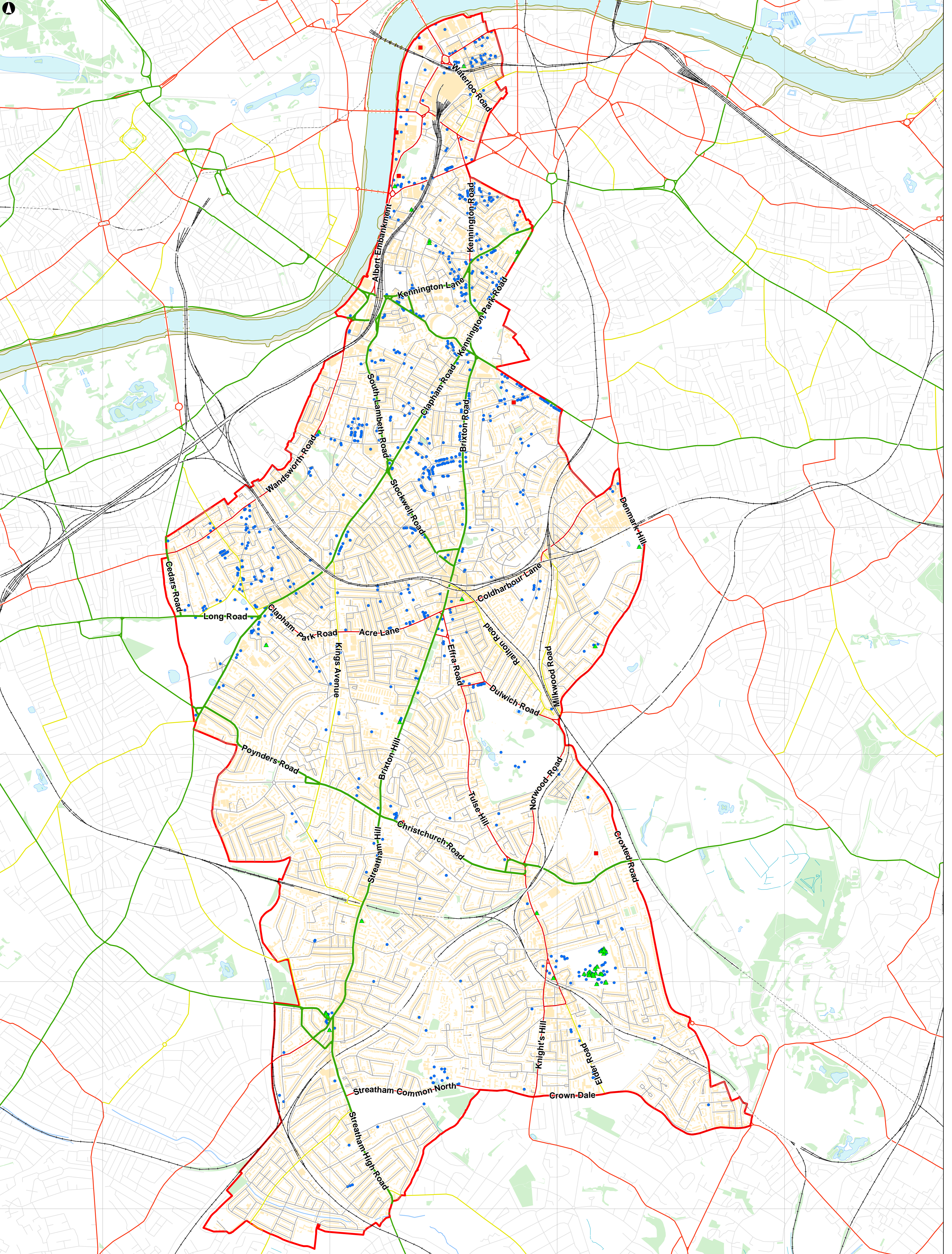
Drawing No: **001**

Drawing Status: **Draft**

Issue: **P1**



<b>Legend</b> Lost Rivers (Barton) <b>Artificial Geology</b> Made Ground (Artificial Deposit) Made Ground Worked Ground Infilled Ground		<b>Superficial Geology</b> Alluvium (AL) Boyn Hill Gravel (BHG) Black Park Gravel (BPG) Hackney Gravel (HG) Head		Kempton Park Gravel (KPG) Langley Silt (LS) Lynch Hill Gravel (LHG) Sand Gravel Unknown Age (SGU) Taplow Gravel (TG)		<b>Bedrock Geology</b> Filled Hollow Claygate Member (CGB) London Clay (LC) Lambeth Group (LMBE) Fault (Inferred)		Lambeth Borough Motorway Primary Road - Dual Carriageway A Road B Road Local Road		Railway Track Surface Water Feature Woodland		Geological boundaries based on 1:10,000 scale BGS mapping. Linear features based on 1:50,000 scale BGS mapping. Position of lost rivers is indicative only and the thickness of the lines are not to scale for the features. Derived from 1:10,000 and 1:50,000 scale BGS Digital Data under Licence 2016/029 ©NERC. Contains OS data ©Crown copyright Open Map 2016.		<table border="1"> <tr> <td>PI</td> <td>07-03-16</td> <td>ET</td> <td>JL</td> <td>DW</td> </tr> <tr> <td>Issue</td> <td>Date</td> <td>By</td> <td>Chk'd</td> <td>App'd</td> </tr> </table>		PI	07-03-16	ET	JL	DW	Issue	Date	By	Chk'd	App'd	Scale at A1 <b>1:15,000</b> Drawing Status <b>Draft</b> Drawing No <b>247871-00</b> Issue <b>001</b>		<b>Figure 13 - Lost Rivers In Lambeth Borough</b> Lambeth Borough Council <b>Lambeth Residential Basement Study</b> ARUP 13 Fitzroy Street, London, W1T 4BQ, UK Tel: +44 20 7580 1331 Fax: +44 20 7580 3824 www.arup.com	
PI	07-03-16	ET	JL	DW																									
Issue	Date	By	Chk'd	App'd																									



**Legend**

- Lambeth Borough
- Motorway
- Primary Road - Dual Carriageway
- A Road
- B Road
- Local Street
- Railway Track
- Surface Water Feature
- Woodland

**Listed Buildings**

- Grade I
- Grade II

**Heritage at Risk Listed Buildings**

- ▲ Heritage at Risk Listed Buildings

PI	07-03-16	ET	JL	DW
Issue	Date	By	Chkd	Appd

Client: **Lambeth Borough Council**

Job Title: **Lambeth Residential Basement Study**

Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing No: **001**

Drawing Status: **Draft**

Issue: **P1**

**Figure 14 - Lambeth Borough Listed Buildings**

Scale at A1: **1:15,000**

Job No: **247871-00**

Drawing No: **001**

Drawing Status: **Draft**

Issue: **P1**

## **Appendix A**

### **Project Brief**



## LAMBETH RESIDENTIAL BASEMENT STUDY

### BRIEF TO CONSULTANTS

JANUARY 2016

#### 1. Overview

This brief invites suitably qualified and experienced consultants to submit a tender for a two month contract to prepare a basements study for the London Borough of Lambeth. A first initial draft of the study will be required by early March 2016.

#### 2. Introduction

The council is currently undertaking an immediate partial review of the Lambeth Local Plan, which was adopted in September 2015. As part of this review, the council is revisiting the existing residential basement and flood policies within it to determine if the current approach to basements is adequate or if it needs strengthening.

In Lambeth, the number of basement developments has increased over the last few years and it is considered likely that this trend will continue as more people look to extend their existing homes as upsizing to larger homes in London becomes increasingly unaffordable.

Basements, when properly constructed, are a useful way to extend a home. However, concerns have been raised about the potential impacts of such development on the hydrological and geological environment of Lambeth as well as the impacts on the structural stability of buildings (particularly historic buildings) and whether there are areas which may be more susceptible to instability and localised flooding. Construction resulting from basement development can also cause noise, vibration, dust and traffic implications to local residents.

The council therefore wishes to obtain further evidence to establish what policy approach to basement development is appropriate.

#### 3. Background & Purpose of the Study

The Lambeth Local Plan was adopted in September 2015. Policies Q11 and EN5 relate to the design of basements and lightwells and flood risk. The council considers that there are two appropriate ways in which these existing policies could be strengthened. The first is an immediate approach which would result in the preparation of a supplementary planning document which elaborates on the existing Lambeth Local Plan Policy. A supplementary planning document could be produced in approximately one year.

The second option is that the existing policies Q11 and EN5 could be looked at again as part of the Local Plan Review. The Local Plan Review will inevitably take a minimum of three years meaning that in the interim the council would have to rely on its current policies for basement development.

To inform the new supplementary planning document or new policy, the council wishes to commission a basements study to consider the potential risks associated with residential basement development in relation to the differing hydrological and geological characteristics across Lambeth and the proposed planning policy response to this.

#### **4. Scope**

The study will include a desktop analysis of the hydrological and geophysical character of Lambeth. This should review existing data held by Lambeth, identify any gaps and obtain missing data, to provide an up-to-date picture of the varied existing geological and hydrological conditions in Lambeth including: Topography, Geological conditions (clay, gravel, old river channels etc) and Hydrological and hydro-geological conditions (surface water, shallow and deep aquifers).

The study will consider whether these differing characteristics across Lambeth will increase risk of flooding and land instability and as such require a differing approach to basement development. It should indicate:

- whether there are specific geographical areas or types/ages of buildings (especially on listed buildings) in Lambeth where the risks are such that basement development may be inappropriate;
- whether certain forms of basement development may be appropriate in different areas, including any circumstances in which the building of more than one storey of basement may increase risks;
- whether the cumulative impacts of multiple basement developments may increase risk and what these risks are;
- the potential impact that basement development beneath a garden may have upon rainwater runoff and surface water flooding;
- the potential impact of basement development upon perched water, groundwater flows and upon the aquifer, including at times of storm events;
- the measures necessary to mitigate the possible impact of basement construction (e.g permeable soil layer above a garden basement extension and how much of the area underneath a garden should be left undeveloped to allow free flow of ground water and retention of an effective soakaway);
- the measures necessary to mitigate the risk of surface water flooding of the basement to neighbouring dwellings.

It will be potentially important to comment from your experience about construction techniques and methods that have the potential to reduce the nuisance from noise, dust and vibration cause by the construction of basement extensions.

The study should identify what hydrological, geological and other technical information applicants should be required to submit with planning applications.

#### **5. Sources of Information**

- [Lambeth Local Plan September 2015](#)
- [Lambeth Building Alterations & Extensions SPD 2015](#)

- [Lambeth Strategic Flood Risk Assessment 2013](#)
- [Lambeth Preliminary Flood Risk Assessment 2011](#)
- [Lambeth Surface Water Management Plan 2011](#)
- [Lambeth Surface Water Management Plan C2 \(Groundwater\) 2011](#)
- [Lambeth Planning applications database](#)
- Lambeth Historic Flood Records 1911-1956 (limited)
- Lambeth Building Control records

## 6. Project Management and Timetable

The study will be managed by the Planning Strategy and Policy section of the Planning and Development Department.

The selected consultants shall attend an inception meeting to initiate the study, agree the methodology and discuss the content of the draft report in the week following the award of commission.

The proposed timetable for the project is:

Milestone	Date
Invitation to tender	11 Jan 2016
Tender closing date	25 Jan 2016
Confirmation of appointed consultant	w/e 29 Jan 2016
Inception meeting with consultants	w/e 29 Jan 2016
Project update meeting	w/c 22 Feb 2016
Working draft of report submitted	Early March 2015
Final report signed off by council	w/e 18 March 2015

## 7. Price

Consultants will be asked to submit their estimates on a fixed cost basis.

The appointed consultants will be paid in instalments: 2/3 on receipt of the draft report and 1/3 on acceptance of the final report to the satisfaction of the client.

## 8. Key outputs and reporting

The results of this study will be used to provide evidence in support of either the preparation of a supplementary planning document or will be used to inform a new basements policy in the review of the Lambeth Local Plan.



The methodology to be used will be agreed in advance with the council.

The consultant should make clear what information the council will be expected to provide, but it will be necessary for the appointed consultant to carry out their own primary research or use alternative sources of information. Information sources and methodology should be set out clearly in the tender bid.

The draft report should contain all the key findings and information necessary to provide a sound evidence base to inform the council's review of the Lambeth Local Plan or preparation of a supplementary planning document.

The final report will contain an executive summary, with all supporting survey information and assumptions referenced. The report must be in a clear format and must be written in 'plain English' and provide a non-technical summary.

One bound copy and one unbound copy of the final report will be required along with an electronic version in Microsoft Word.

It is anticipated that a short presentation of the key findings will be necessary on the production of the draft and final reports.

Any maps produced must be in Arc GIS/ArcMap.

Any datasets which are not spatially referenced (i.e. not on GIS) should be made available in Excel format.

## **9. Evaluation**

Tenders must include the following:

- response to the brief including resources available and agreement to commit to deliver the report/s within the timescale;
- proposed programme and methodology;
- CVs of all proposed consultancy team members;
- evidence of relevant previous experience;
- breakdown of costs by team member, time per task and total team time and if applicable, which elements of the brief will be attributed to which consultant or employee;
- confirmation that the project will be delivered on a fixed price costing (please indicate whether VAT is shown in your final fee);
- details of any aspects of the work that will be handled by subcontractors, and details of subcontractors and their relevant experience;
- the level of information/input expected to be provided by Lambeth Council; and

- the declaration of any potential conflicts of interest.

The appointment will be based on value for money taking into account cost, experience, methodology and quality.

#### 10. Submitting Proposals

Proposals should be sent to the Lambeth Planning Strategy and Policy team: [EMarriott-Brittan@lambeth.gov.uk](mailto:EMarriott-Brittan@lambeth.gov.uk) or to the postal address set out below:

Lambeth Planning  
1st Floor, Phoenix House  
10 Wandsworth Road  
London SW8 2LL

Submissions must be received by **5pm Monday 25 January 2016**. Proposals received after this date and time will not be considered.

If you have any queries please contact Emily Marriott-Brittan: [EMarriott-Brittan@lambeth.gov.uk](mailto:EMarriott-Brittan@lambeth.gov.uk) or 020 7926 0109.

Answers to enquiries may be distributed to all those tendering.

## **Appendix B**

### **Glossary**

**Alluvium:** Sediments deposited by flowing rivers.

**Aquiclude:** A low- permeability unit that forms either the upper or lower boundary of a ground-water flow system.

**Aquifer:** Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

**Aquitard:** A low-permeability unit that can store ground water and also transmit it slowly from one aquifer to another.

**Basement:** All works that are subterranean, or constructed wholly or partly under the natural ground level.

**Confined Aquifer:** An aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

**Confining Layer:** A body of material of low hydraulic conductivity that is stratigraphically adjacent to one or more aquifers.

**Dewatering:** Lowering of the water table by abstraction of groundwater (i.e. pumping), typically to prevent excavation below the water table from flooding.

**Discharge:** The volume of water flowing in a stream or through an aquifer past a specific point in a given period of time.

**Catchment basin/ drainage basin:** The land area from which surface runoff drains into a stream system.

**GIS:** A geographic information system (GIS), geographical information system, or geospatial information system is any system that captures, stores, analyses, manages, and presents data that are linked to location.

**Groundwater:** The water contained in interconnected pores located below the water-table in an unconfined aquifer or located in a confined aquifer.

**Hydraulic conductivity:** A coefficient of proportionality describing the rate at which water can move through a permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity.

**Hydraulic gradient:** The change in total head with a change in distance in a given direction. The direction is that which yields a maximum rate of decrease in head.

**Hydrogeology:** The study of the interrelationships of geologic materials and processes with water, especially ground water.

**Hydrology:** The study of the occurrence, distribution and chemistry of all water of the earth.

**Measurement:** a method of determining quantity, capacity, or dimension

**Monitoring:** to test or sample, especially on a regular or ongoing basis

**Perched aquifer:** A region in the unsaturated zone where the soil may be locally saturated because it overlies a low-permeability unit.

**Permeability:** See Hydraulic Conductivity.

**Piezometer:** A non-pumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface. A piezometer generally has a short well screen through which water can enter.

**Polar coordinates:** The means by which the position of a point in a two-dimensional plane is described; based upon the radial distance from the origin to the given point and the angle between a horizontal line passing through the origin and a line extending from the origin to the given point.

**Porosity:** The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment.

**Runoff:** The total amount of water flowing in a stream. It includes overland flow, return flow, interflow and baseflow.

**Sedimentary rock:** A rock formed from sediments through a process known as diagenesis or formed by chemical precipitation in water.

**Soil:** In the geotechnical engineering context the term “soils” means geological strata (except rock) as well as the familiar horticultural or agricultural material.

**Sediment:** An assemblage of individual mineral grains that were deposited by some geologic agent such as water, wind, ice or gravity.

**Surcharge pressure:** An overloaded main sewer will come under pressure created by water flows from areas upstream in the sewer system, causing the effect of water backing up out of manholes and gully gratings onto the streets and also out of toilets, sinks and baths directly into buildings.

**Surface water:** Water found in ponds, lakes, inland seas, streams and rivers.

**Unconfined aquifer:** An aquifer in which there are no confining beds between the zone of saturation and the surface. There will be a water table in an unconfined aquifer. Water-table aquifer is a synonym.

**Unsaturated zone:** The zone between the land surface and the water table. It includes the root zone, intermediate zone and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched ground water, may exist in the unsaturated zone. Also called the zone of aeration and vadose zone.

**Water table:** The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric. It can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.

## **Appendix C**

### **BGS Geosure Classifications**

CLASS	COLLAPSIBLE DEPOSITS	RUNNING SAND	COMPRESSIBLE DEPOSITS	SLOPE INSTABILITY (LANDSLIDES)	SOLUBLE ROCKS (DISSOLUTION)	SHRINK SWELL
A	Deposits with potential to collapse when loaded and saturated are believed not to be present	Running sand conditions are not thought to occur whatever the position of the water table. No identified constraints on land use due to running conditions.	Compressible strata are not thought to occur.	Slope instability problems are not thought to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered	Soluble rocks are present within the ground. Very few dissolution features are likely to be present. Potential for difficult ground conditions or localised subsidence are at a level where they need not be considered.	Ground conditions predominantly non-plastic.
B	Deposits with potential to collapse when loaded and saturated are unlikely to be present	Running sand conditions are unlikely. No identified constraints on land use due to running conditions unless water table rises rapidly.	Compressibility and uneven settlement problems are not likely to be significant on the site for most land uses.	Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered.	Soluble rocks are present within the ground. Few dissolution features are likely to be present. Potential for difficult ground conditions or localised subsidence are at a level where they need not be considered except in exceptional circumstances.	Ground conditions predominantly low plasticity.
C	Deposits with potential to collapse when loaded and saturated are possibly present in places.	Running sand conditions may be present. Constraints may apply to land uses involving excavation or the addition or removal of water.	Compressibility and uneven settlement potential may be present. Land use should consider specifically the compressibility and variability of the site.	Slope instability problems may be present or anticipated. Site investigation should consider specifically the slope stability of the site.	Soluble rocks are present within the ground. Some dissolution features may be present. Potential for difficult ground conditions are at a level where they may be considered, localised subsidence need not be considered except in exceptional circumstances.	Ground conditions predominantly medium plasticity.
D	Deposits with potential to collapse when loaded and saturated are probably present in places	Running sand conditions are probably present. Constraints may apply to land uses involving excavation or the addition or removal of water.	Compressibility and uneven settlement hazards are probably present. Land use should consider specifically the compressibility and variability of the site.	Slope instability problems are probably present or have occurred in the past. Land use should consider specifically the stability of the site.	Soluble rocks are present within the ground. Many dissolution features may be present. Potential for difficult ground conditions are at a level where they should be considered. Potential for subsidence is at a level where it may need to be considered.	Ground conditions predominantly high plasticity.
E	Deposits with potential to collapse when loaded and saturated are present	Running sand conditions are almost certainly present. Constraints will apply to land uses involving excavation or the addition or removal of water.	Highly compressible strata present. Significant constraint on land use depending on thickness.	Slope instability problems almost certainly present and may be active. Significant constraint on land use.	Soluble rocks are present within the ground. Numerous dissolution features may be present. Potential for difficult ground conditions should be investigated. Potential for localised subsidence is at a level where it should be considered.	Ground conditions predominantly very high plasticity.

## Appendix D

Environment Agency "Flooding  
from Groundwater"





# Flooding from groundwater

Practical advice to help you reduce  
the impact of flooding from groundwater



We are the Environment Agency. It's our job to make people aware of flooding from rivers and the sea, provide flood warning services and build and maintain flood defences. In some areas we can also provide flood warning services for flooding from groundwater.

This leaflet contains useful information to help you reduce the effects of flooding on you and your property.

If you live in an area that could be affected by flooding from groundwater then this guide is for you. It contains useful information to help you reduce the impact of groundwater flooding on your property

The LGA welcomes the advice provided in this information leaflet

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\* Calls to 03 numbers cost no more than a national rate call to an 01 or 02 number and must count towards any inclusive minutes in the same way as 01 and 02 calls. These rules apply to calls from any type of line including mobile, BT, other fixed line or payphone.

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# Flooding from groundwater

Floods can happen anywhere and at anytime.

The most common sources of flooding are:

- river flooding.
- coastal flooding.
- surface water flooding.
- reservoir flooding.
- flooding from groundwater.

This leaflet is about flooding from groundwater. For more information about other forms of flooding, please visit our website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)).

Flooding from groundwater can happen when the level of water within the rock or soil that makes up the land surface (known as the water table) rises. The level of the water table changes with the seasons due to variations in long term rainfall and water abstraction.

When the water table rises and reaches ground level, water starts to emerge on the surface and flooding can happen.

There are some key features of flooding from groundwater:

- Flooding will usually occur days or even weeks after heavy or prolonged rainfall.
- Flooding may occur for a long time, often lasting several weeks.
- The water doesn't always appear where you would expect it to (i.e. valley bottoms). It may also emerge on hillsides.
- Water may rise up through floors rather than coming in through doors.

Flooding from groundwater is most common in areas where the underlying bed rock is chalk, but it can also happen in locations with sand and gravel in the river valleys.

If you live in an area that could be affected by flooding from groundwater then this guide is for you. It contains useful information to help you reduce the impact of groundwater flooding to your property.

# Are you at risk?

Mapping the risk of flooding from groundwater is complex and is currently not possible.

Lead Local Flood Authorities (LLFAs) have powers to carry out risk management activities associated with flooding from groundwater. Your LLFA is either the unitary authority or the county council for your area. LLFAs work with other organisations, including the Environment Agency, to manage this risk. If you would like further information about flooding from groundwater you should contact your Lead Local Flood Authority.

There are no flood risk maps for groundwater. If you want to find out if your property could be at risk of flooding from groundwater or may have flooded in the past you should contact your Lead Local Flood Authority. If they do not have any information on flooding from groundwater in your area you may find it helpful to contact one of the following:

- your local Environment Agency office.
- your parish or town council.
- the Highways Authority.
- any flood wardens or Flood Action Groups in your area.

If you are still unsure whether your home is at risk you may wish to carry out a flood risk assessment. To do this, you will need to contact a professional such as a consulting engineer or chartered surveyor.

## Your flood warning service

The Environment Agency is responsible for providing warnings for flooding from rivers and the sea. In some areas we also provide messages about flooding from groundwater.

Our free service can send you messages by phone, email, text message or fax when a flood is expected in your area.

Floodline can also give you practical flooding advice and a Quickdial number to help you easily access information on flooding in your area.

To find out if the service is available in your area, call Floodline on 0845 988 1188 or visit our website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)).

# Know your flood codes



## FLOOD ALERT

### What it means

Flooding is possible.  
Be prepared.

### What to do:

- Be prepared to act on your flood plan.
- Prepare a flood kit of essential items.
- Check pumps and any other flood protection equipment you may have.
- Keep an eye on local water levels and weather conditions. Visit the Environment Agency website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)) for flooding information.



## FLOOD WARNING

### What it means

Flooding is expected.  
Immediate action required

### What to do:

- Protect yourself, your family and help others.
- Move family, pets and valuables to a safe place.
- Keep a flood kit ready.
- If you have a pump, make sure it is working.
- Keep an eye on local water levels and weather conditions. Visit the Environment Agency website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)) for flooding information.

You need to be aware of flooding and keep an eye on the water levels and weather in your area. You can find information on our website or by listening to local news and weather forecasts.

# Preparing for flooding

Start preparing today before a flood happens.  
Use this checklist as your flood plan.

1. **Know who to contact and how.**
  - Agree where you will go and how to contact each other
  - Check with your council if pets are allowed at evacuation centres
  - Keep a list of all your important contacts to hand.
2. **Think about what you can move now.**
  - Don't wait for a flood. Move items of personal value such as photo albums, family films and treasured mementos to a safe place.
3. **Think about what you would want to move to safety during a flood.**
  - pets
  - cars
  - furniture
  - electrical equipment
  - garden pot plants and furniture
  - what else? .....
  - .....

Think about who you could ask for help and who you could offer to help – particularly vulnerable neighbours or relatives – in the event of a flood.



4. **Check your insurance cover.**
  - Check your buildings and contents insurance policy.
  - Confirm you are covered for flooding.
  - Find out if the policy replaces new for old, and if it has a limit on repairs.
  - Don't underestimate the value of your contents.
5. **Know how to turn off your gas, electricity and water mains supplies.**
  - Ask your supplier how to do this.
  - Mark taps or switches with stickers to help you remember.
6. **Prepare a flood kit of essential items and keep it handy.**
  - Copies of your home insurance documents.
  - A torch with spare batteries.
  - A wind-up or battery radio.
  - Warm, waterproof clothing and blankets.
  - A first aid kit and prescription medication.
  - Bottled water and non-perishable foods.
  - Baby food and baby care items.

You can get more information about preparing for flooding in our *'What to do before, during and after a flood'* leaflet on our website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)). You can also find more information and a template for creating your own flood plan on our website.

# Protecting your property

Flooding from groundwater can affect ground floors, cellars, basements and garages.

## Preventing water from entering your property

Many traditional methods of flood protection, such as sandbags, may not be effective against flooding from groundwater. This is because water can come up through the floor and remain high for a long time. Instead, you may need to consider pumping water to protect your property.

The most effective way to keep groundwater out of your property is to use a drainage or pump system to divert the water away from your home or business. However, in some cases there may be too much water and even pumping may not be effective.

Pumps work best when the inlet is installed in a sump (a low point into which water can drain). Pumping is likely to be required over many days, weeks or months.

Pumps can be electric or petrol/diesel driven. Electric pumps may be the most convenient but remember there is a chance of power cuts during a

flood. You may need to consider a back up generator. Care must be taken if a mains powered electric pump is used during a flood. You should contact a qualified electrician for further advice.

Petrol or diesel pumps are possible alternatives but can be noisier and will require refuelling. This can be a problem as flooding from groundwater can often last for many weeks or even months. Position the generator outside in the open air as generators produce carbon monoxide fumes which can kill.

You will also need to consider where you will pump water to. Pumping from one place to another may cause flooding elsewhere. You must not pump water into the public foul sewer. Only pump out water when flood levels outside your property start to be lower than inside. This reduces the risk of structural damage. It may also be worth you contacting a structural engineer before pumping very deep water from basements.



When thinking about where you will pump water to you should contact:

- your local Environment Agency office if you are thinking about pumping water into main rivers or boreholes.
- your local authority if you are thinking about pumping water into ditches, watercourses or piped watercourses.
- the water company if you are thinking about pumping water into public surface water sewers or foul sewers.
- the Highways Authority if you are thinking about pumping water into a highway drain.

A good quality pump should last around 10 years. However, this depends on how often it is used and the acidity and dirtiness of the water.

- Regularly check and test your pump.
- Remove and thoroughly clean the pump at least once a year. Disconnect the pump from the power source before you handle or clean it.



# Reducing damage to your property

Floors, lower parts of walls and openings such as airbricks are the most vulnerable parts of the property.

There are steps you can take to reduce the damage flood water causes if it does enter your property.

## Floors

A replacement floor constructed to a high standard with reinforced concrete and with a continuous damp proof membrane can be an effective solution where groundwater pressures are low. Particular care must be taken where the floor and the walls join as water can penetrate through this point.

## Suspended floors

Suspended floors create a void beneath the floor which will flood before water rises to enter the house. They may be constructed of timber or concrete. Flooding beneath wooden floors will often cause the timber to rot and specialist advice should be sought before carrying out this work.

## Raising floor levels

If headroom is available, you could investigate raising the floor level. This can be done by either laying a new

reinforced concrete floor directly onto the existing floor or by creating a new suspended floor.

It is important to remember that water exerts considerable pressure. A 300mm depth (1 foot) of water pressure will lift a 125mm thick (5 inch) concrete slab. It's this pressure that makes groundwater flooding difficult to prevent.

## Basements

Basements are particularly prone to flooding and remedial measures are often difficult to implement. There are a range of 'tanking' materials available but these are best applied on the outside walls. This is often impractical and it is sometimes necessary to construct an inner wall to achieve a satisfactory result. Specialist advice is strongly recommended. Sealing the walls can lead to an increase in water pressure which may cause structural damage.

You can get more information about flood protection equipment in our

Prepare your property for flooding leaflet on our website ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)).

## Foul drainage

Foul sewage is the waste from sinks, baths and toilets. Foul sewage often backs up and causes problems during groundwater flooding. Foul sewerage systems fall into two categories.

### 1. Main drainage systems

Any problems with main drainage systems should be reported to the water company or housing association who operates them. If you need further help or advice you can also contact the economic regulator of the water and sewerage industry, Ofwat ([www.ofwat.gov.uk](http://www.ofwat.gov.uk)).

If you have a continuing problem with sewage flooding which the relevant authorities are unable to solve, a range of non-return valves are available which may be able to help. You can get guidance on these from the Construction Industry Research Information Association (CIRIA).

### 2. Septic tanks and cess pits

Septic tanks are private systems which trap solids and then discharge semi-treated fluid to soakaways or land drains. These systems frequently have problems when groundwater levels rise and it may be necessary to hire portable facilities.

Adding a pump to the outlet side of the tank may help keep your system operational and pump the sewage to high ground above the groundwater table. You must contact the Environment Agency if you want to do this as you will need a 'consent to discharge'. The design of pumped sewerage systems is quite complex and you should always seek specialist advice.

Cess pits are sealed tanks which store five or six week's worth of waste. If these are well built, they should not be a problem. Rising groundwater will test the integrity of the structure and small leaks may occur which will quickly fill the tank.

**WARNING:** it is tempting to call a tanker to empty a septic tank or cess pit when the toilet will not flush. However, if the tank has not been installed with a sufficient concrete surround then there is a risk it could float the tank or it will quickly fill with groundwater.

# During a flood

## In an emergency follow these simple steps to help you stay safe:

- Check on other people in your household to make sure they are safe.
- If the flood water hasn't reached you, move your car to higher ground.
- Gather essential items and put them upstairs or in a high place.
- Fill jugs and saucepans with clean water.
- Turn off gas, electricity and water supplies if safe to do so. DO NOT touch sources of electricity when standing in flood water. If you have an electric pump running you will need to leave your electricity supply on.
- Put plugs in sinks and baths to stop water entering your home. Weigh them down with a sandbag or plastic bag filled with garden soil. This is only a short-term solution. You may need to consider a longer-term solution such as non-return valves, as groundwater can be high for months.

- Keep listening to local radio updates or call Floodline on 0845 988 1188.

## Stay safe. Always listen to the advice of the emergency services and evacuate when told to do so.

- If evacuated, you will be taken to an evacuation centre run by your local council. Free food and bedding is provided and most will let you bring your pets.
- Bring spare clothing, essential medication, pet food and baby care items if you have an infant.

You can get more information about what to do during flooding in our *'What to do before, during and after a flood'* leaflet from our website.

# After a flood

## Cleaning up after a flood

- Flood water can contain sewage and chemicals. Always wear waterproof clothing, gloves, wellington boots and a face mask.
- Make sure that your electrics and central heating are checked by qualified engineers before switching them back on.
- Clean and disinfect your property using ordinary household products.
- Use a normal garden hose to wash down surfaces.
- If you are drying your property naturally, keep windows and doors open as much as possible. If using dehumidifiers, close all windows and doors.

## Insurance

- Ask your insurance company how long it will be before the loss adjuster visits.
- Photograph or film your damaged property.
- Keep copies of letters, emails and receipts as well as making a note of all phone calls.
- Flood repairs can take weeks or months to complete. Ask your insurance company if they will provide temporary accommodation.
- If you don't have insurance, your local council should be able to provide you with information on hardship grants and charities.

You can get more information about preparing for flooding in our '*What to do before, during and after a flood*' leaflet from our website.

# For more information

These organisations have advice, information  
and services to help you after a flood.

## National Flood Forum

[www.floodforum.org.uk](http://www.floodforum.org.uk)

01299 403055

## Citizens Advice Bureau

[www.adviceguide.org.uk](http://www.adviceguide.org.uk)

See local telephone directory

## The Financial Ombudsman Service

[www.financial-ombudsman.org.uk](http://www.financial-ombudsman.org.uk)

0300 123 9 123

## Construction Industry Research and Information Association (CIRIA)

[www.ciria.org/flooding](http://www.ciria.org/flooding)

020 7549 3300

## The Construction Centre

[www.theconstructioncentre.co.uk](http://www.theconstructioncentre.co.uk)

01926 865825

## Health Protection Agency

[www.hpa.org.uk](http://www.hpa.org.uk)

01235 822 603/742

## The British Damage Management Association (BDMA)

[www.bdma.org.uk](http://www.bdma.org.uk)

07000 843 236



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**incident hotline 0800 80 70 60** (24hrs)

**floodline 0845 988 1188**



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