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Client: Caroline Nourani
Flood Risk Assessment for the Proposed Development at Land off 1 Elsworthy Road, Camden, London

June 2016

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1 Background and Scope of Appraisal

Flooding is a major issue in the United Kingdom. The impacts can be devastating in terms of the cost of repairs, replacement of damaged property and loss of business. The objectives of the Flood Risk Assessment are therefore to establish the following:

- whether a proposed development is likely to be affected by current or future flooding from any source
- whether the development will increase flood risk elsewhere within the floodplain
- whether the measures proposed to deal with these effects and risks are appropriate
- whether the site will be safe to enable the passing of the Exception Test (where appropriate)

Herrington Consulting has been commissioned by Caroline Nourani to prepare a Flood Risk Assessment (FRA) for the proposed development at **Land off 1 Elsworthy Road, Camden, London, NW3 3DJ**.

This appraisal has been undertaken in accordance with the requirements of the National Planning Policy Framework (March 2012) and the accompanying Planning Practice Guidance Suite. To ensure that due account is taken of industry best practice, it has been carried out in line with the CIRIA Report C624 'Development and flood risk - guidance for the construction industry'.

Reference is also made to the National Planning Practice Guidance Suite (March 2014) that has been published by the Department for Communities and Local Government. The *Flood Risk and Coastal Change* planning practice guidance included within the Suite represents the most contemporary technical guidance on preparing FRAs.

In addition to National Planning Policy, this appraisal has also been undertaken in accordance with the requirements of Policy CPG4 of the Camden Planning Guidance for Basements and Lightwells (2015).

2 Development Description and Planning Context

2.1 Site Location and Existing Development

The site is located at OS coordinates 527377, 184064, off Elsworthy Road in Camden, London. In total the site covers an area of approximately 0.02 hectares and is currently an area of undeveloped brownfield land in the garden of No.1 Elsworthy Terrace. The location of the site in relation to the surrounding area is shown in Figure 2.1.

The site plan included in Appendix A.1 of this report provides more detail in relation to the site location and layout.

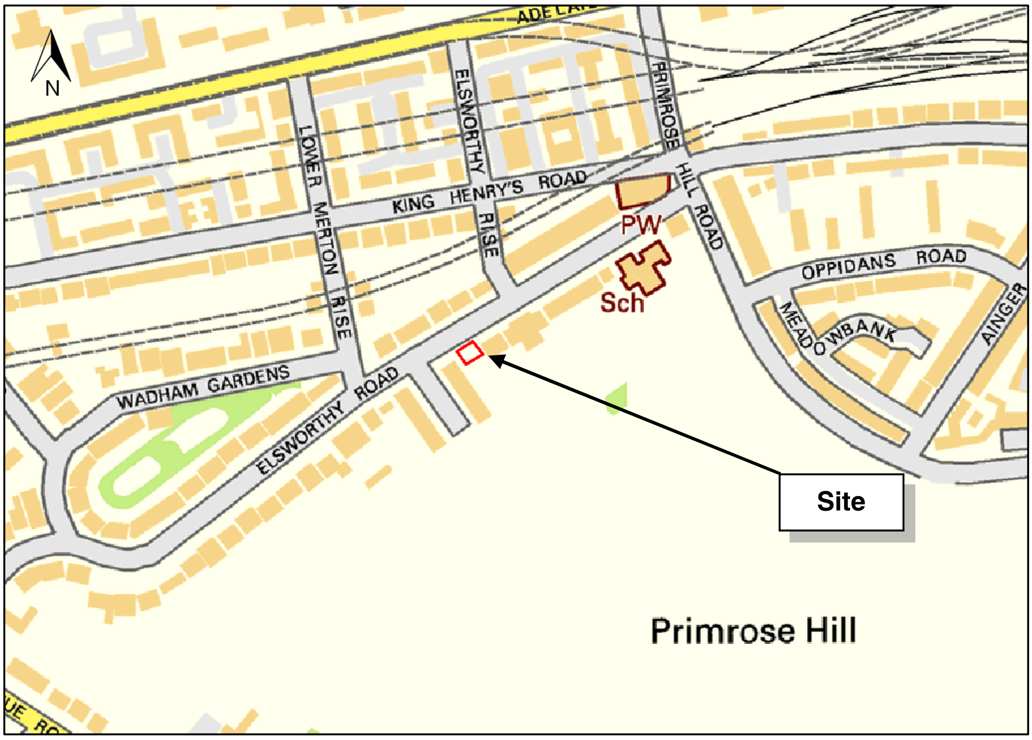


Figure 2.1 – Location map (Contains Ordnance Survey data © Crown copyright and database right 2016)

2.2 Proposed Development

The proposals for development comprise the construction of a single residential dwelling, with the inclusion of a two-storey basement.

Drawings of the proposed scheme are included in Appendix A.1 of this report.

2.3 The Sequential Test

Local Planning Authorities (LPA) are encouraged to take a risk-based approach to proposals for development in areas at risk of flooding through the application of the Sequential Test and the objectives of this test are to steer new development away from high risk areas towards those at lower risk of flooding. However, in some areas where developable land is in short supply there can be an overriding need to build in areas that are at risk of flooding. In such circumstances, the application of the Sequential Test is used to ensure that the lower risk sites are developed before the higher risk ones.

The National Planning Policy Framework (NPPF) requires the Sequential Test to be applied at all stages of the planning process and generally the starting point is the Environment Agency's flood zone maps. These maps and the associated information are intended for guidance, and cannot provide details for individual properties. They do not take into account other considerations such as existing flood defences, alternative flooding mechanisms and detailed site based surveys. They do, however, provide high level information on the type and likelihood of flood risk in any particular area of the country. The flood zones are classified as follows:

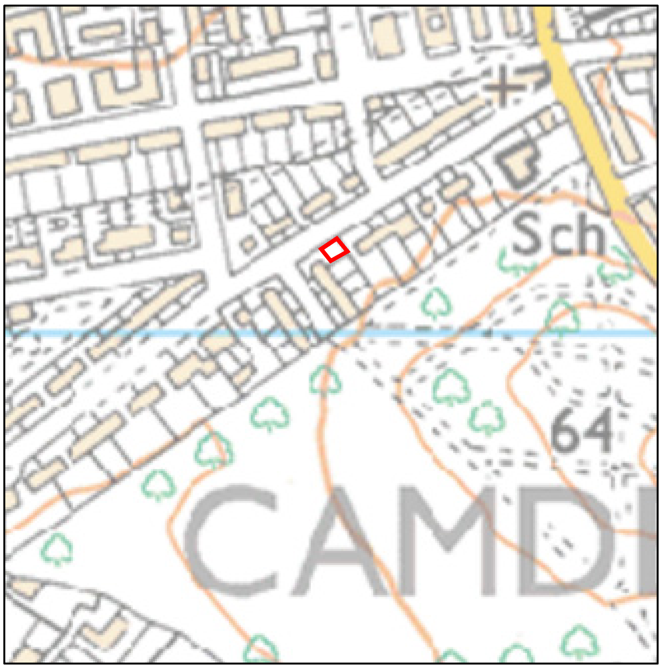
Zone 1 – *Low probability of flooding* – This zone is assessed as having less than a 1 in 1000 annual probability of river or sea flooding in any one year.

Zone 2 – *Medium probability of flooding* – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding or between 1 in 200 and 1 in 1000 annual probability of sea flooding in any one year.

Zone 3a – *High probability of flooding* - This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any one year.

Zone 3b – *The Functional Floodplain* – This zone comprises land where water has to flow or be stored in times of flood and can be defined as land which would flood during an event having an annual probability of 1 in 20 or greater. This zone can also represent areas that are designed to flood in an extreme event as part of a flood alleviation or flood storage scheme.

The location of the site is shown on the Environment Agency's flood zone map in Figure 2.2 and the information provided by this map has been interrogated and summarised in Table 2.1 below.



Key to flood map

Zone 3 - Extent of flooding from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

Zone 2 - Additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year.

Flood defences

Areas benefiting from flood defences

Main rivers

Location of development site

Figure 2.2 – Flood zone map showing the location of the development site (© Environment Agency)

The above mapping shows the development site to be located within Flood Zone 1.

The flood zone mapping and associated information has been summarised in Table 2.2 below.

Flood Zone (percentage of site within zone)		**Source of flooding**	**Benefiting from existing flood defences***
Zone 1	**100%**	N/A	N/A
Zone 2	**0%**		
Zone 3a	**0%**		
Zone 3b	**0%**		
(*) The flood zone maps only recognise defences constructed within the last 5 years			

Table 2.1 – Flood zone classification

In this circumstance it is recognised that the site is located within Flood Zone 1, and therefore is located in the lowest possible flood risk zone. As such, it is concluded that the Sequential Test (if applied) will automatically be passed.

2.4 The Exception Test

In addition to the Sequential Test, it is also necessary to consider the type and nature of the development and whether or not the Exception Test is applicable. The Planning Practice Guidance: *Flood Risk and Coastal Change* defines the type and nature of different development classifications in the context of their flood risk vulnerability. This has been summarised in Table 2.2 below.

Flood Risk Vulnerability Classification	Zone 1	Zone 2	Zone 3a	Zone 3b
Essential infrastructure – Essential transport infrastructure, strategic utility infrastructure, including electricity generating power stations	✓	✓	e	e
High vulnerability – Emergency services, basement dwellings caravans and mobile homes intended for permanent residential use	✓	e	×	×
More vulnerable – Hospitals, residential care homes, buildings used for dwelling houses, halls of residence, pubs, hotels, non-residential uses for health services, nurseries and education	✓	✓	e	×
Less vulnerable – Shops, offices, restaurants, general industry, agriculture, sewerage treatment plants	✓	✓	✓	×
Water compatible development – Flood control infrastructure, sewerage infrastructure, docks, marinas, ship building, water-based recreation etc.	✓	✓	✓	✓

Key :

✓ Development is appropriate

× Development should not be permitted

e Exception Test required

Shaded cell represents the classification of this development

Table 2.2 – Flood risk vulnerability and flood zone compatibility

From Table 2.2 above it can be seen that the development falls into a classification that does not require the Exception Test to be applied. Nonetheless, due to the sites location within a Critical Drainage Area (CDA) (Group3_005), a site-specific flood risk assessment has been prepared to quantify the risk of flooding from all sources, in alignment with the requirements of the NPPF.

The NPPF recognises that a FRA should appraise all forms of flood risk, including; surface water run-off, overland flow and groundwater flooding to ensure that the development is not only safe, but that it does not increase the risk of flooding elsewhere. Consequently, appraising this risk is the primary focus of this report.

3 Definition of Flood Hazard

3.1 Site Specific Information

In addition to the high level flood risk information shown in the Environment Agency (EA) flood zone maps, additional data from detailed studies, topographic site surveys and other information sources is referenced. This section summarises the additional information collected as part of this FRA.

High level information contained within the SFRA – The Camden Borough Council SFRA (2014) contains detailed mapping of flood extents from a wide range of sources. This document has been referenced as part of this site-specific FRA.

Information on localised flooding contained within the SWMP – A Surface Water Management Plan (SWMP) is a study to understand the flood risks that arises from local flooding, which is defined by the Flood and Water Management Act 2010 as flooding from surface run-off, groundwater, and ordinary watercourses. Such a document has been prepared for Camden Borough Council (2013) and has therefore been referenced as part of this site-specific FRA.

Information provided by Thames Water – Thames Water has been consulted as part of the development of this FRA. Their response stated that there have been no incidents of flooding at the development site as a result of surcharging public sewers. Their response is included in Appendix A.2. Thames Water was also consulted with regard to the location of their sewers in the area, this is included in Appendix A.3 for reference.

Site specific topographic surveys – A topographic survey has been undertaken for the site and a copy of this is included in Appendix A.1. From this it can be seen that the level of the site varies between 48.69m and 49.11m Above Ordnance Datum Newlyn (AODN). Land levels fall to the west and north, toward Elsworthy Road.

Geology – Reference to the Geological Survey map shows that the underlying solid geology in the location of the subject site is London Clay Formation. There are no overlying superficial deposits.

Soils – Soil type provides a generic description of the drainage characteristics of soils. This will dictate, for example, the susceptibility of soils to water logging or the capacity of a soil to freely drain to allow infiltration to groundwater. Soil type may only be fully determined after suitable ground investigations, although the mapped soil types (soil association) found beneath the study area may be used as an indicator of permeability and infiltration potential. Reference to the National Soil Resources Institute mapping shows that the general soil type in this location is 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.

Historic flooding – Inspection of the Camden SFRA has revealed that there have been no records of historic flood events from any source at the site. No further information on historic flooding in this area has been provided or revealed through desktop searches.

3.2 Potential Sources of Flooding

The main categories of flooding have been assessed as part of this appraisal. The specific issues relating to each one and its impact on this particular development are discussed below. Table 3.1 at the end of this section summarises the risks associated with each of the flooding sources.

Flooding from Rivers (Fluvial) – The site is not located within an area identified by the Environment Agency's Flood Zone mapping as being at risk of flooding from a main river. Consequently the risk of fluvial flooding from rivers is not considered in further detail.

Flooding from Rivers (Tidal) – There are no tidally influenced watercourses within close proximity of the subject site and therefore the risk of flooding from this source is considered to be negligible. Consequently the risk of tidal flooding from rivers is not considered further within this appraisal.

Flooding from Ordinary or Man-made Watercourses – Natural watercourses that have not been enmained and man-made drainage systems such as irrigation drains, sewers or ditches could potentially cause flooding.

Inspection of the site and surrounding area reveals that there are no non-main rivers or artificial watercourses within close proximity of the site and therefore the risk of flooding from this source is considered to be *low*.

Flooding from the Sea – The site is located a significant distance inland and is elevated well above predicted extreme tide levels. Consequently the risk of flooding from this source is considered to be negligible and therefore the impacts of flooding from the sea are not considered further in this appraisal.

Flooding from Land (overland flow and surface water run-off) – Overland flooding typically occurs in natural valley bottoms as normally dry areas become covered in flowing water and in low spots where water may pond. This flooding mechanism can occur almost anywhere, but is likely to be of particular concern in any topographical low spot, or where the pathway for run-off is restricted by terrain or man-made obstructions.

However, the prediction of flooding from surface water can be difficult, as it is hard to forecast the exact intensity and extent of rainfall of a storm. Under the Flood Risk Regulations 2009, the Environment Agency was therefore tasked with producing and publishing flood maps for surface water.

Maps showing the risk of flooding, and the associated approximate depth and velocity have been produced using information from Lead Local Flood Authorities, such as drainage rates, percentage run-off rates and critical storm durations. The maps pick out natural drainage channels, rivers, low areas within the floodplain and flow paths between buildings. In addition, the maps also consider the influence of buildings, roads and other structures within the floodplain which could obstruct flows, and account for a reduction in rainfall due to drains, sewers and infiltration. They do not, however, take into account individual property threshold heights and assume a single drainage rate for all urban areas.

Consequently, the surface water maps and the associated information are intended for guidance only, and cannot provide details for individual properties. They do, however, provide high level information and indicate areas in which surface water flooding issues should be investigated further. The risk categories are classified as follows:

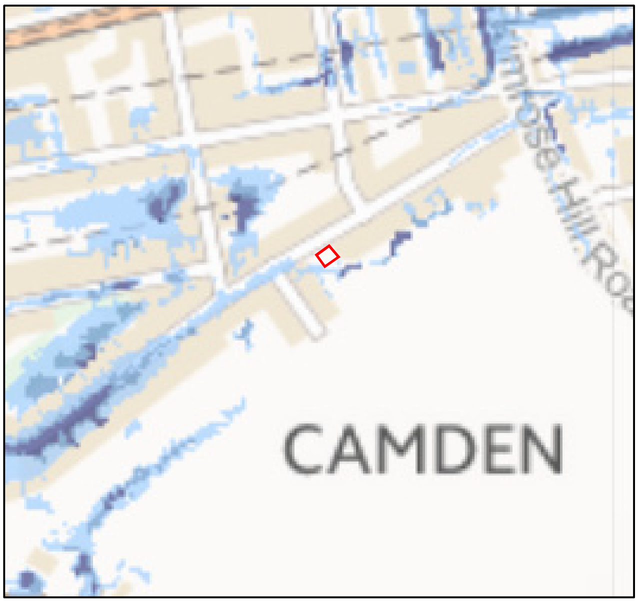
- *Very low probability of flooding* – This zone is assessed as having less than a 1 in 1000 annual probability of surface water flooding.

- *Low probability of flooding* – This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of surface water flooding.

- *Medium probability of flooding* - This zone comprises land assessed as having between a 1 in 30 and 1 in 100 annual probability of surface water flooding.

- *High probability of flooding* – This zone is assessed as having greater than a 1 in 30 annual probability of surface water flooding.

Figure 3.1 below is an extract of the Environment Agency's 'Risk of Flooding from Surface Water' map and identifies the location of the site. This map has been interrogated to assist in this review, helping to identify whether the site is located in an area at specific risk of surface water flooding.



Key to flood map

High – Extent of flooding from surface water that has a 3.3% (1 in 30) or greater chance of happening each year.

Medium - Extent of flooding from surface water that has between a 3.3% (1 in 30) and 1% (1 in 100) chance of happening each year.

Low - Extent of flooding from surface water that has between a 1% (1 in 100) and 0.1% (1 in 1000) chance of happening each year.

Location of development site

Figure 3.1 – Surface water flooding map showing the location of the development site (© Environment Agency)

The above mapping shows the development site is located in an area identified as having a 'very low' risk of flooding from surface water. Nevertheless, the Camden SWMP (2013) identifies the site as being located within a CDA (Group3_005). The definition of a CDA is "*a discrete geographic area (usually a hydrological catchment) where multiple or interlinked sources of flood risk cause flooding during a severe rainfall event thereby affecting people, property or local infrastructure*". Given the subject site is located within a CDA, the risk of flooding from surface water sources has been examined in more detail below.

Inspection of the topographical survey for the site identifies that land levels slope toward the north and west. Given that the proposals show no topographical low spots, which would otherwise encourage floodwater to pond, it is considered that flooding through this mechanism is unlikely at this location. Furthermore, if any surface water run-off were to fall on or near the site during a large pluvial event, the run-off would simply be channelled into Elsworthy Road and would flow away to the south-west. In addition, inspection of the Camden SFRA identifies that the site has not been subject to surface water flooding in the past.

Consequently, based on the information outlined above, the site-specific risk of flooding from this source is considered to be *low*.

In addition to the above, the proposals for development shall include drainage provisions to ensure that the post-development run-off does not exceed that of the existing site (refer to Section 6). Consequently, the risk of flooding to the site and surrounding area from this source will not increase as a result of the proposed development.

Flooding from Groundwater – Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year). Where land that is prone to groundwater flooding has been built on, the effect of a flood can be very costly, and because groundwater responds slowly compared with rivers, floods can last for weeks or months. Groundwater flooding generally occurs in rural areas although it can also occur in more urbanised areas where the process known as groundwater rebound can cause localised flooding of basements. This increase in the water table level is occurring as a result of the decrease in groundwater extraction that has taken place since the decline in urban aquifer exploitation by heavy industry.

Detailed mapping on groundwater emergence provided as part of the Defra Groundwater Flood Scoping Study (May 2004), which shows areas where groundwater flooding has occurred in the past and also areas that are potentially vulnerable to groundwater emergence has been referenced as part of this FRA. This shows that no groundwater flooding events were recorded during the very wet periods of 2000/01 or 2002/03 and that the site itself is not located within an area where groundwater emergence is predicted.

Groundwater flooding is most likely to occur in low-lying areas that are underlain by permeable rock (aquifers). The underlying geology in this area is London Clay Formation (with no overlying superficial deposits), which is not typically associated with groundwater flooding. Notwithstanding this, the proposals for development include construction of a basement and therefore the risk of groundwater flooding needs to be considered in more detail.

Inspection of borehole records show selenite crystals in upper deposits along with fissured clays, both of which are potential indicators of groundwater. Inspection of boreholes further along Elsworthy Road indicate groundwater at 3.2m below ground level (congruent with the onset of selenite and fissured clays found in this area). Therefore, it is likely seasonal groundwater levels could rise to around 3m below ground level at this location, although on average levels are significantly lower than this. Consequently, due to the potential for high groundwater in this location, it is recommended that groundwater testing is undertaken to determine the groundwater level at the site.

Regardless of the results of any groundwater testing, it is acknowledged that the proposed basement will need to be appropriately designed to prevent groundwater ingress, in the unlikely and unexpected event that high groundwater levels become elevated.

This type of system could comprise a waterproof membrane (tanked design), or alternatively a drained cavity underground waterproofing system. The latter system enables water to pass through walls and floors into a cavity formed by placing an impermeable membrane to the walls and floor. Drainage channels at floor to wall intersections take the water to a sump where it is pumped out to drainage outlets. Either system will ensure that no internal flooding will occur as a result of groundwater.

Flooding from Sewers – In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and wastewater known as “combined sewers”. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked, or is of inadequate capacity; this will continue until the water drains away. When this happens to combined sewers, there is a high risk of land and property flooding with water contaminated with raw sewage as well as pollution of rivers due to discharge from combined sewer overflows.

Inspection of the Asset Location data provided by Thames Water (Appendix A.3) identifies that the sewers in this area are combined foul and surface water sewers, and consequently there is an inherent risk that these could become surcharged during a heavy rainfall event. Section 5.11 of Policy CPG4 of the Camden Planning Guidance for Basements and Lightwells (2015) requires that “*all basement and other subterranean development is protected from sewer flooding by the installation of a positive pump device.”*

In addition to this, inspection of the Camden SWMP (2013) identifies that the site lies within a CDA (Group3_005), where a pumped device should be installed within the basement development. Consequently, a suitable pumped device should be installed at the proposed development, in conjunction with a non-return valve fitted to the outlet; which will prevent the ingress of water into the basement development in the unlikely event that the positive pump system was to fail.

The site-specific historic sewer records obtained from Thames Water (Appendix A.2) states that there have been no incidents of flooding at the development site as a result of surcharging public sewers. Furthermore, inspection of OS mapping of the wider area has revealed that the land levels in Elsworthy Road slope toward the south-west. Therefore, in the unlikely event that the surrounding sewers were to surcharge, floodwater would simply be retained within the highway, where it would subsequently flow away from the site towards the north.

Taking the above into consideration, and assuming the proposals will include the installation of a positive pump system as required by local policy, it is concluded that the risk of flooding from sewers is *low*.

Flooding from Reservoirs, Canals and other Artificial Sources – Non-natural or artificial sources of flooding can include reservoirs, canals and lakes where water is retained above natural ground level, operational and redundant industrial processes including mining, quarrying and sand and gravel extraction, as they may increase floodwater depths and velocities in adjacent areas. The potential effects of flood risk management infrastructure and other structures also need to be considered. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

Inspection of the Ordnance Survey mapping for the area shows that there are no artificial sources of flooding within close proximity to the site. In addition, the Environment Agency's 'Risk of Flooding from Reservoirs' website shows that the site is not within an area considered to be at risk of flooding from reservoirs (Figure 3.2).

Key to flood map

Maximum extents of flooding from reservoirs

Location of development site

Figure 3.2 – Risk of Flooding from Reservoirs map showing the location of the development site (© Environment Agency)

Summary

The site is located within a Zone 1 (low risk) area and is therefore not exposed to any significant risks from fluvial, coastal or tidal flooding. In addition, the site-specific assessment has shown that the risks from surface water run-off, groundwater flooding, sewer flooding and reservoir flooding are also low. A summary of the overall risk of flooding from each of the main sources is provided in Table 3.1 below.

Source of flooding	Initial level of risk	Appraisal method applied at the initial flood risk assessment stage
Rivers (fluvial)	Low	Environment Agency flood zone map
Rivers (tidal)	Low	Environment Agency flood zone map
Sea/Estuaries	Low	Environment Agency flood zone map
Ordinary and man-made watercourses	Low	Site based appraisal and historical evidence
Overland flow	Low	Site based appraisal, historic records contained within the SFRA and Environment Agency 'Risk of Flooding from Surface Water' flood maps
Groundwater	Low	BGS groundwater flood hazard maps, historic records contained within the SFRA, Defra Groundwater Flood Scoping Study and site-specific geological data
Sewers	Low	Site based appraisal and site-specific Thames Water historic sewer records contained within Appendix A.2
Artificial sources	Low	Site based appraisal and Environment Agency 'Risk of Flooding from Reservoirs' flood map

Table 3.1 – Summary of flood sources and risks

Although the risk of flooding is shown to be low, given the proposed development is located within a CDA (Group3_005), the impact of new development is required to be appraised to ensure that it does not increase the risk of flooding elsewhere.

The remainder of this FRA is therefore focussed on ensuring that surface water run-off from the development will not increase the risk of flooding, both on site and to areas surrounding it.

4 Climate Change

When the impact of climate change is considered it is generally accepted that the standard of protection provided by current defences will reduce with time. The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Over the last few decades there have been numerous studies into the impact of potential changes in the future and there is now an increasing body of scientific evidence which supports the fact that the global climate is changing as a result of human activity. Past, present and future emissions of greenhouse gases are expected to cause significant global climate change during this century.

The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the recent UK flooding could be expected.

These effects will tend to increase the size of flood zones associated with rivers, and the amount of flooding experienced from other inland sources. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels. It will also increase the extent of the area at risk should sea defences fail. Changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events are also predicted.

To ensure that any recommended mitigation measures are sustainable and effective throughout the lifetime of the development, it is necessary to base the appraisal on the extreme flood level that is commensurate with the planning horizon for the proposed development. The NPPF and supporting Planning Practice Guidance Suite state that residential development should be considered for a minimum of 100 years, but that the lifetime of a non-residential development depends on the characteristics of the development. For commercial development, a 60 year design life is assumed. The development that is the subject of this FRA is classified as residential.

4.1 Potential Changes in Climate

Peak Rainfall Intensity

The recommended allowances for increases in peak rainfall intensity were updated in February 2016 and although the allowance is applicable nationally, there is a range of values provided which correspond with the central and upper end percentiles (the 50th and 90th percentile respectively) over three time epochs. The recommended allowances are shown in Table 4.1 below.

Allowance Category (applicable nationwide)	**Total potential change anticipated for each epoch**		
	2015 to 2039	**2040 to 2069**	**2070 to 2115**
Upper End	+10%	+20%	+40%
Central	+5%	+10%	+20%

Table 4.1 – Recommended peak rainfall intensity allowance for small and urban catchments (1961 to 1990 baseline)

The above recommended allowances for climate change should be used as a guideline and can be superseded if local evidence supports the use of other data or allowances.

Additionally, in the instance where flood mitigation measures are not considered necessary at present, but will be required in the future (as a result of changes in climate), a “managed adaptive approach” may be adopted whereby development is designed to allow the incorporation of appropriate mitigation measures in the future.

4.2 Impacts of Climate Change on the Development Site

Whilst the site lies outside of Zone 2 and 3 flood risk areas, changes in the climate can still impact upon flood risk and the effect of the development on flood risk elsewhere. These impacts are primarily linked to the surface water discharge from the site, therefore potential increases in future rainfall need to be taken into account when designing surface water drainage systems.

For a residential development a design life of 100 years is assumed and therefore an increase of 20% in peak rainfall intensity has been used for the outline surface water management strategy (refer to Section 6).

5 Flood Mitigation Measures

The key objectives of flood risk mitigation are:

- to reduce the risk of the development being flooded
- to ensure continued operation and safety during flood events
- to ensure that the flood risk downstream of the site is not increased by increased run-off
- to ensure that the development does not have an adverse impact on flood risk elsewhere

Up to this point in the report the risks to the site have been appraised and the consequences of these risks occurring have been considered. The following section of this report examines ways in which flood risk can be mitigated.

Mitigation Measure	Appropriate?	Comment
Careful location of development within site boundaries	x	Site is located outside of any significant flood risk areas, therefore limited merit in applying a Sequential Approach
Raising floor levels	x	Not considered necessary as site is located outside of fluvial and tidal flood extents and no risk of internal flooding from other sources
Land raising	x	
Flood warning	x	The site is located within an area which is not currently covered by any flood warnings issued by the Environment Agency
Flood resistance & resilience	✓	Recommended for the basement (see Section 5.1)
Alterations/ improvements to channels and hydraulic structures	x	Not required
Flood defences	x	Not required
Compensatory floodplain storage	x	Not required as proposed development is not located within a flood zone, and will not have an adverse impact on flood risk as a result of displaced floodwater
Management of development run-off	✓	See Section 6

Table 5.1 – Appropriateness of mitigation measures

5.1 Flood Resistance and Resilience

During a flood event, floodwater can find its way into properties through a variety of routes including:

- Ingress around closed doorways.
- Ingress through airbricks and up through the ground floor.
- Backflow through overloaded sewers discharging inside the property through ground floor toilets and sinks.
- Seepage through the external walls.
- Seepage through the ground and up through the ground floor.
- Ingress around cable services through external walls.

Since flood management measures only manage the risk of flooding rather than eliminate it completely, flood resilience and resistance measures may need to be incorporated into the design of the buildings. The two possible alternatives are:

Flood Resistance or 'dry proofing', where flood water is prevented from entering the building. For example using flood barriers across doorways and airbricks, or raising floor levels. These measures are considered appropriate for 'more vulnerable' development where recovery from internal flooding is not considered to be practical.

Flood Resilience or 'wet proofing', accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood. Such measures are generally only considered appropriate for some 'less vulnerable' uses and where the use of an existing building is to be changed and it can be demonstrated that no other measure is practicable.

It has, however, been demonstrated as part of this FRA that the risk of flooding to the proposed development is very low and therefore the use of flood resilient or flood resistant construction techniques are not considered to be strictly necessary in this instance.

Nevertheless, adopting a precautious approach, the proposed basement should be sufficiently tanked and the surface water drainage system will require a pumped sump system and non-return valve (fitted on the outfall), which will help to further prevent flooding from the sewer (i.e. under a surcharge event).

6 Surface Water Management Strategy

6.1 Background and Policy

As part of the Government's continuing commitment to protect people and property from flood risk, the Department for Environment, Food and Rural Affairs (Defra) consulted on a proposal to make better use of the planning system to secure sustainable drainage systems (2014).

These changes came into effect from 6 April 2015, and relate to The Floods and Water Management Act 2010 National Standards (Schedule 3 – Paragraph 5) for design, construction, maintenance and operation of Sustainable Drainage Systems (SuDS). These (non-statutory) Technical Standards for SuDS specify criteria to ensure sustainable drainage is included within developments of 10 dwellings or more; or equivalent non-residential, or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010).

These Technical Standards (S1 -14) provide additional detail and requirements not initially covered by the NPPF. However, it is recognised that SuDS should be designed to ensure that the maintenance and operation requirements are economically proportionate.

In this instance, the proposed development is for the construction of a single new residential unit. Consequently, the National Standards will not apply. Nonetheless, reference to the Standards has been made throughout the following sections, in line with best practice.

Further to this, the current requirement of National Policy is that all new developments in areas at risk of flooding should give priority to the use of SuDS. Within this section of the report, reference is therefore made to the new SuDS criteria, ensuring the proposed scheme is compliant with the current planning standards for the lifetime of the development.

In addition to the National Technical Standards Policy 5.13 of the London Plan states developments should incorporate SuDS wherever possible within schemes, unless there is a practical reason for not doing so. Whilst the aspirational objective of the London Plan is to restrict the discharge of surface water run-off from all sites to the greenfield run-off rate, the mandatory requirements for brownfield sites, where SuDS options are available, include a 50% reduction in run-off rates discharged to receiving watercourses or sewers.

Policy 5.13 of the London Plan also states that when implementing SuDS within developments developers should follow the drainage hierarchy, prioritising the discharge of surface water run-off as close to source as possible. The drainage hierarchy is outlined below:

- Store surface water run-off for later use, either internally or externally.
- Use infiltration techniques, such as porous surfaces in non-clay areas to discharge run-off as close to source as possible.
- Attenuate surface water run-off in ponds or open water features for gradual release.
- Attenuate surface water run-off by storing in tanks or sealed water features for gradual release.
- discharge surface water run-off direct to a watercourse
- discharge surface water run-off to a surface water sewer/drain.
- discharge surface water run-off to the combined sewer.

The proposed development must therefore attempt, where possible, to incorporate SuDS features in accordance with the requirements of the London Plan and any other adopted Local Planning Policy pertaining to drainage. Consequently, the potential options for incorporating SuDS and their viability within the proposed scheme is outlined further in the following sections of this report.

6.2 Surface Water Management Overview

The requirements for managing rainfall run-off from developments depends on the pre-developed nature of the site. For undeveloped greenfield sites, the impact of the proposed development will require mitigation to ensure that the run-off from the site replicates the natural drainage characteristics of the pre-developed site.

In the case of brownfield sites, drainage proposals will be measured against the existing performance of the site, although it is preferable for solutions (where practical) to provide run-off characteristics that are similar to greenfield behaviour.

The main characteristics of the site and the proposed development that affect the surface water drainage strategy are summarised in Table 6.1 below.

Site Characteristic	Value
Total area of site	190 m^2
Impermeable area (existing)	**0 m^2**
Impermeable area (proposed)	**100 m^2**
Current site condition	Undeveloped Brownfield site
Greenfield run-off rate	3.7 l/sec/ha (based on IoH Report 124 methodology)
Infiltration coefficient	~ 0.01 m/hr (assumed based on underlying geology and typical soil conditions)
Standard Percentage Run-off (SPR)	50.6%
Current surface water discharge method	No formal drainage
Is there a watercourse within close proximity to site?	No
Is site within groundwater Source Protection Zone?	Yes (Zone 2)

Table 6.1 – Site characteristics affecting rainfall run-off

Synthetic rainfall data has been derived using the variables obtained from the Flood Studies Report (FSR) and the routines within the Micro Drainage Source Control software. The peak surface water flows generated on site for the existing and post-development conditions have been calculated by using the Modified Rational Method. Run-off rates have been calculated for a range of annual return probabilities, including the 100 year return period event with a 20% increase in rainfall intensity to account for future climatic changes.

These values are summarised in Table 6.2 for a range of return periods. The critical storm duration is shown in brackets.

Return period (years)	Peak run-off (l/sec)	
	Existing site	Developed site
1	Undeveloped	1.7 (15 mins)
30	Undeveloped	4.0 (15 mins)
100	Undeveloped	5.2 (15 mins)
100 + 20%	Undeveloped	6.4 (15 mins)

Table 6.2 – Summary of peak run-off

The total volume of water discharged from the site from the 100 year 6 hour event (including for a 20% increase for climate change) is summarised in Table 6.3 below for both the existing and proposed site conditions.

Site condition	Total volume discharged
Existing site	0 m^3
Proposed development (before mitigation)	7.6 m^3

Table 6.3 – Total volume discharged from the 100 yr+20%cc 6 hour event

Reference to Tables 6.2 and 6.3 shows that the peak discharge rate and discharge volume will be increased by the proposed development. Consequently, as outlined by the NPPF and Policy CPG4 of the Camden Planning Guidance for Basements and Lightwells (2015) , it will be necessary to provide mitigation to ensure the rate of run-off discharged from the site is not increased as a result of the proposed development.

Consequently, the potential for incorporating a sustainable drainage system within the proposed development will be considered in order to assess the practicality of better replicating greenfield behaviour, in accordance with local planning policy, the London Plan and S3 and S5 of the National Technical Standards for SuDS.

The general surface water management requirement for all new development is to ensure that the peak discharge rate and the discharge volume of surface water run-off does not exceed that of the existing site. Additionally, surface water run-off up to the 100 year return period event should preferably be contained within the site at designated temporary storage locations unless it can be shown to have no material impact in terms of nuisance or damage, or increase river flows during periods of river flooding (Preliminary rainfall run-off management for developments - EA/DEFRA W5-074/A).

At this stage a detailed surface water drainage design has not been undertaken, however, it is necessary for this assessment to demonstrate that the surface water from the proposed development can be discharged safely and sustainably. The following calculations have therefore been undertaken to demonstrate that this is achievable. The proposed method of managing the surface water discharged from the site, and the associated constraints, is described below.

6.3 Existing Drainage

Given the undeveloped nature of the site, it is assumed that there is no formal drainage onsite and that surface water run-off from the pre-developed site discharges informally. Any surface water not intercepted by the local drainage network will flow overland, following the natural contours of the land, towards the surrounding topographical low spots. This water eventually discharges into the adjacent road, where it is subsequently intercepted by the local highway drainage system.

Thames Water has provided the results of an asset location search for the site (Figure 6.1 below).

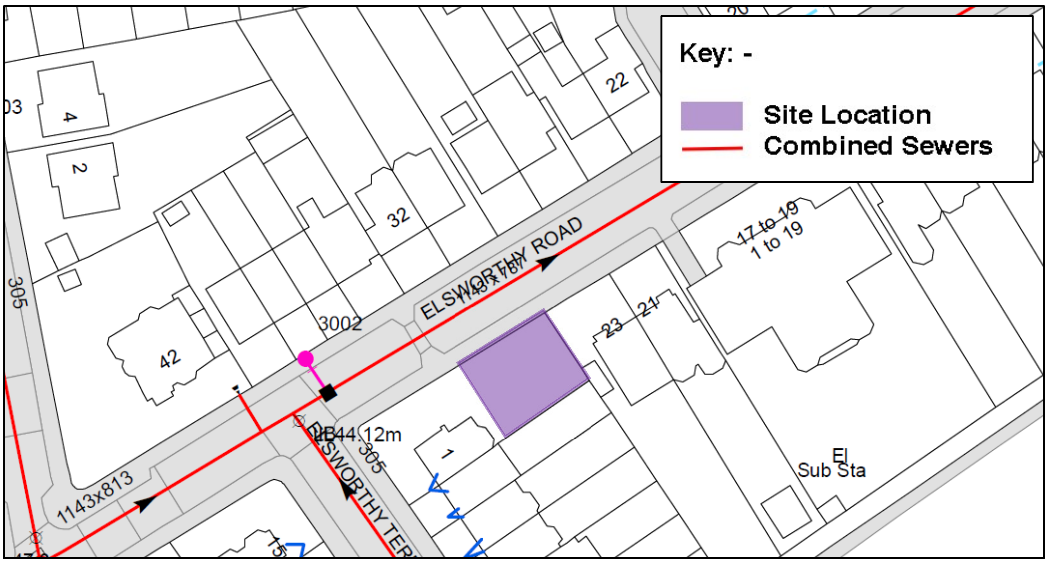


Figure 6.1 – Extract from Thames Water Asset Location Mapping for the area around Elsworthy Road.

The above mapping identifies the nearest public sewer to the site is a large combined sewer (dimensions 1143mm x 813mm), located within Elsworthy Road. Given the location of this existing sewer, it is probable that any surface water run-off intercepted by the highway drainage in this area is likely to be discharged directly into this existing sewer system.

Further investigation may be required at the detailed design stage to confirm the exact layout of the existing underground drainage network and the potential to utilise any pre-existing or new connections to the public sewer system. For the purpose of this surface water management strategy, it has been assumed there are no existing connections to the existing combined sewer. Consequently, any discharge to the public sewer system will have to be via a new *direct* connection.

6.4 Opportunities to Discharge Surface Water Run-Off

For any given development, the National Standards in relation to SuDS state that the preferred option for discharging surface water run-off from the site is to **infiltrate** water into the ground as this deals with the water at source, and serves to replenish groundwater. If this is not viable (due to a high water table, local impermeable soils, contamination issues including source protection zones etc.), then the next option of preference is for the run-off to be discharged into a **watercourse**. Only if neither of these options is possible should the water be conducted into the **public sewer** system.

Infiltration – Whilst site-specific ground investigations have not been carried out at this stage in the development process, the Standard Percentage Run-off (SPR) value has been established for this site from the Flood Estimation Handbook (FEH) database. This parameter is used to indicate the percentage of rainfall which becomes direct response run-off to a watercourse. A higher run-off percentage means that less rainfall is infiltrated into the soil, indicating lower permeability soil.

The SPR for this site is 50.6%, suggesting that the soils have relatively poor permeability. This is supported by the geology and soil characteristics for this area, which show the site to be located on Clays, Silts and Sand from the London Clay Formation. It is therefore considered that the percolation rate of the soils in this area are likely to be insufficient for traditional infiltration techniques to be utilised. Nevertheless, this may need to be confirmed via site-specific soakage tests at the detailed design stage.

Consequently, it has been assumed on this basis that infiltration will not be a suitable method for discharging surface water run-off from the site, although the use of permeable paving may still be appropriate.

Discharge to Watercourses – There are no watercourses within close proximity of the site to permit a direct connection. Consequently, there is no opportunity to utilise a direct connection to an existing watercourse as a means of managing surface water run-off from the proposed development.

Discharge to Public Surface Water Sewer & Existing Connections – The undeveloped site is not currently believed to have an existing connection to any neighbouring public sewer. Whilst utilising a new connection into the surface water sewer would be the most convenient option for discharging surface water, it is the least preferential in the hierarchy of discharge options.

It is therefore likely that any discharge into this system will be required to be restricted and attenuated accordingly, in line with the requirements of Thames Water and, where possible, the National Technical Standards; which state that for previously developed sites the peak rate of run-off must be as close as reasonably practical to the greenfield run-off rate.

6.5 Foul Drainage

With regard to foul drainage, it is likely that the proposed development will require a new connection to discharge foul waste into the public combined sewer within Elsworthy Road. At the detailed design stage, it will be necessary to confirm that there is adequate capacity within this sewer to accommodate any additional foul waste from the new residential unit.

6.6 Constraints and Further Considerations

Infiltration testing may be required at the detailed design stage to refine the outline designs put forward as part of this surface water management strategy. It may also be necessary to confirm the depth below the ground level of the groundwater table. At this 'strategic' stage the surface water management strategy has been based upon an assumed infiltration rate of 0.01 m/hr, which whilst insufficient for the use of traditional soakaways is still appropriate for the use of permeable paving.

The site is shown by the Environment Agency's groundwater Source Protection Zone maps to be located within an area where infiltration is restricted. Whilst this does not preclude the use of infiltration, in order for water to be discharged to the ground, it must be demonstrated that an unsaturated zone will be available between the discharge point and the groundwater table at all times of the year. If this is not possible then infiltration will not be considered appropriate.

Figure 6.2 below shows the site in relation to the surrounding Source Protection Zones outlined by the Environment Agency.

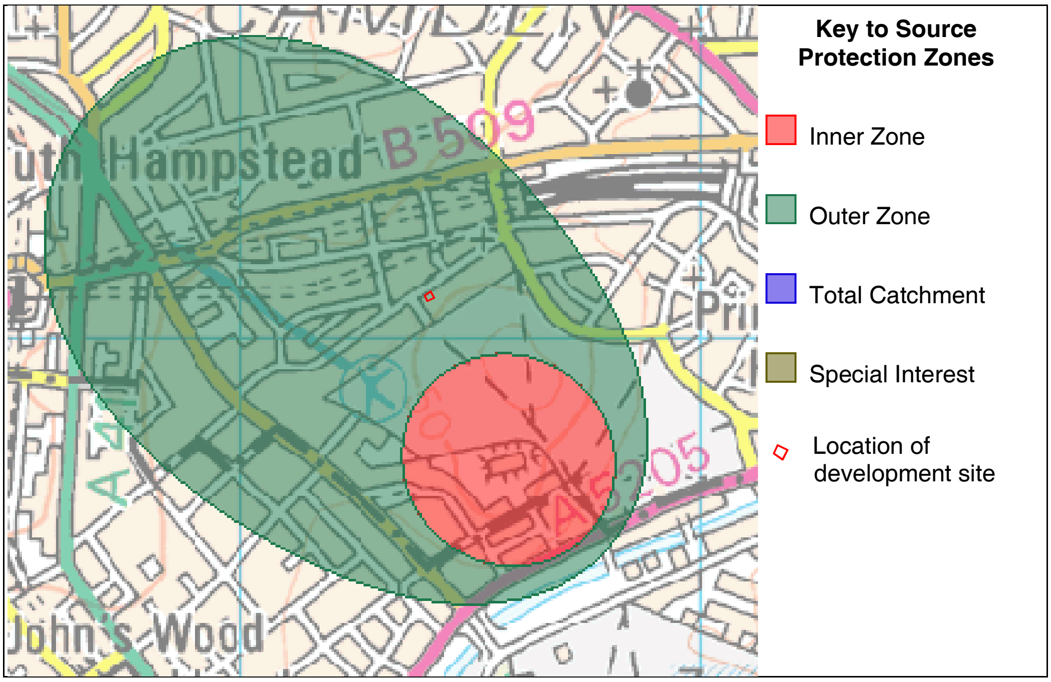


Figure 6.2 – Groundwater map showing the Environment Agency's Source Protection Zones (Contains Ordnance Survey data © Crown copyright and database right 2016)

In this circumstance ground conditions are unlikely to be suitable for any infiltration SuDS other than permeable paving. Groundwater levels at the site could be within 3m of the surface, and therefore the required unsaturated zone may not be available.

Inspection of the site and scheme layout shows that, whilst there are opportunities for the inclusion of Sustainable Drainage Systems (SuDS), there is very little open space in which to incorporate SuDS features that require significant areas of land such as, large ponds, wetland areas and detention basins etc. The SuDS options are discussed in more detail in the following section.

6.7 Sustainable Drainage Systems (SuDS)

Appropriately designed SuDS can be utilised such that they not only attenuate run-off but also provide a level of improvement to the quality of the water passed on to watercourses or into the groundwater table. This is known as source control and is a fundamental part of the SuDS philosophy. The London Plan highlights the importance of using SuDS in new developments wherever possible in Policy 4C.8:

> *"Boroughs should seek to ensure that surface water run-off is managed as close to its source as possible. The use of SuDS should be promoted for developments unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases the developer should seek to manage as much run-off as possible on site and explore sustainable methods of managing the remainder as close as possible to the site."*

A range of typical SuDS components that can be used to improve the environmental impact of a development is listed in Table 6.4 below along with the relative benefits of each feature and the appropriateness for the subject site.

SuDS Feature	Environ-mental benefits	Water quality improve ment	Suitability for low permeability soils (k<10-6)	Ground-water recharge	Suitable for small/ confined sites?	Site-specific restrictions	Appropriate for subject site?
Wetlands	✓	✓	✓	x	x	Insufficient space	No
Retention ponds	✓	✓	✓	x	x	Insufficient space	No
Detention basins	✓	✓	✓	x	x	Insufficient space	No
Infiltration basins	✓	✓	x	✓	x	Insufficient space and Infiltration	No
Soakaways	x	✓	x	✓	✓	Insufficient Infiltration	No
Underground storage	x	x	✓	x	✓	None	Yes
Swales	✓	✓	✓	✓	x	Insufficient space	No
Filter strips	✓	✓	✓	✓	x	Insufficient space	No
Rainwater harvesting	x	✓	✓	✓	✓	None	Yes
Permeable paving	x	✓	✓	✓	✓	None	Yes
Water butts	✓	x	✓	x	✓	None	Yes
Green roofs	✓	✓	✓	x	✓	None	Yes

Table 6.4 – Suitability of SuDS

From Table 6.4 it can be seen that there are a number of SuDS elements that are potentially suitable for this site. However, at this stage in the planning process, it is envisaged that a combination of a green roof, underground storage and permeable paving will be used to discharge the surface water run-off, via a connection to the public sewer system.

6.8 Proposed Surface Water Management Strategy (SWMS)

A detailed surface water drainage design has not currently been undertaken, however, it is necessary for this assessment to demonstrate that the surface water from the proposed development can be discharged safely and sustainably. The objective of the SWMS is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate and discharge volume to that of the existing site. For brownfield sites the aspiration is to replicate the surface water run-off characteristics of a greenfield site wherever reasonably practicable, (in line with Technical Standard S3).

The SWMS for each of the different elements of the scheme is set out below along with the calculations that have been undertaken to demonstrate how the overall objectives have been achieved. This does not represent a detailed surface water drainage design, it is simply an assessment to demonstrate that the objectives and requirements of the NPPF can be met at the planning stage.

Permeable Paving

For the paths and any other hardstanding areas, it is possible to incorporate permeable paving. Provided that this is laid onto a minimum of a 0.2m thick open-graded sub-base, this will provide sufficient storage for the run-off before discharging via infiltration such that the 100 year+20%cc event can be fully discharged. This is based upon an infiltration rate of 0.01 m/hr.

A summary of the Micro Drainage analysis for permeable paving is shown in Table 6.5 below.

Parameter	Value
Area draining to permeable paving	~ 10m^2
Critical storm duration	240 minutes
Half drain time	287 minutes
Required sub-base depth	0.2m

Table 6.5 – Summary of Micro Drainage analysis for the permeable paving (100 yr+20%cc)

It is recognised that if the infiltration rates determined through site specific infiltration testing are confirmed to be lower than expected, it may still be possible to incorporate permeable paving into the scheme by increasing the depth of the sub-base accordingly; to account for the additional time required to discharge run-off into the ground.

However, if infiltration is found to be negligible, the sub-base could simply be used as additional storage, which would be connected to the overall surface water drainage system. The surface water from this storage would subsequently be discharged into the public sewer at a restricted rate.

For the purpose of the rest of this assessment, the additional attenuation provided by run-off filtering through permeable paving has *not* been taken into account. This provides a worst case scenario in order to provide the maximum storage volume required for all surface water run-off discharged from the site.

Green Roof

The development proposals incorporate a green roof across the majority of the roof area, totalling around 80m^2 (Figure 6.3 below). Assuming a 100mm sub-base across the entire green roof area, this will provide approximately 1.4m^2 of storage for surface water run-off within the green roof.

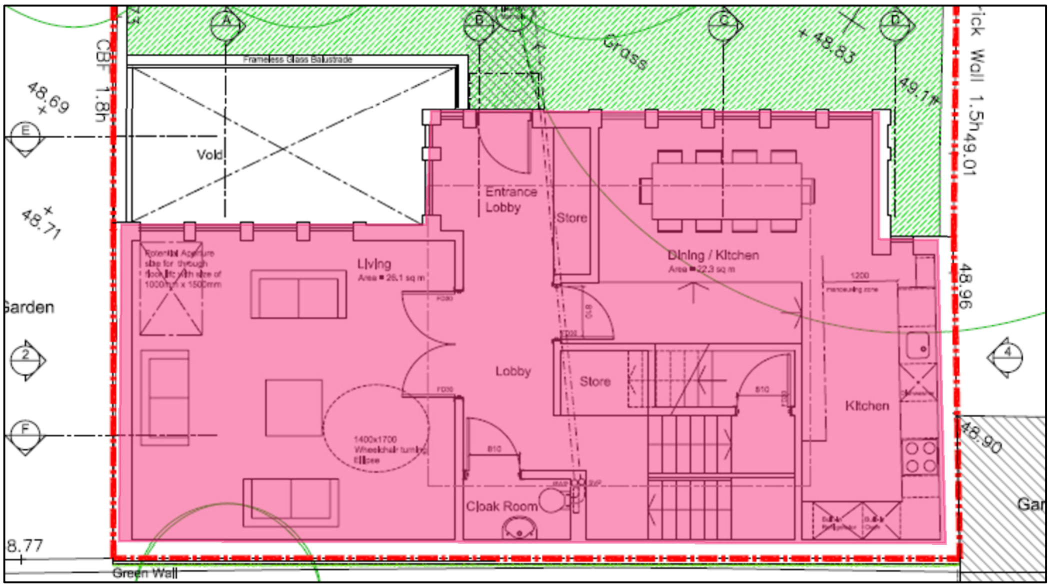


Figure 6.3 – Approximate extent of proposed green roof (pink)

As part of the detailed design for the green roof it will also be necessary to provide adequate drainage at the base of the green roof to avoid stagnation. In this case it is envisaged that surface water run-off discharging from the green roof will pass into a traditional piped drainage system.

Cellular Storage

Whilst the use of a green roof and permeable paving will provide a reasonable amount of storage for the surface water run-off discharged from the site, it will still be necessary to restrict the rate at which surface water is discharged into the public sewer system, in accordance with the requirements of the sewerage undertaker (Thames Water).

Ideally, surface water run-off discharged from the site to the public sewer should be restricted to the greenfield run-off rate, however, in order to minimise the risk of flooding through a failure in the local drainage system (i.e. as a result of blockage), a discharge rate of 5.0 l/s is typically used. In this instance it is likely that a rate of 5.0 l/s will likely be acceptable on this basis.

The surface water run-off from the roof of the proposed building can be discharged to the public sewer at an attenuated rate, via a cellular storage system and orifice plate flow control device. These calculations do not take into consideration any additional storage which may be provided within the proposed permeable paving, or green roof.

Parameter	**Value**
SuDS Type	Cellular Storage
Area draining to attenuation system	0.01 ha
Assumed infiltration	None
Flow control device	Orifice plate
Maximum allowable rate of discharge	5.0 l/sec
Peak discharge for 100yr+cc	4.6 l/sec
Critical storm duration	15 minutes
Half drain time	2 minutes
Required storage	2.0m^2 x 0.5m (deep)

Table 6.6 – Summary of Micro Drainage analysis for the cellular storage (100 yr+20%cc)

The information contained within the table above suggests approximately 1.5m^3 of storage would potentially be required to be accommodated on site. Figure 6.4 (below) is an indicative drainage plan, showing how cellular storage crates can be incorporated into the scheme proposals. The proposed system has been designed to discharge via an orifice plate flow control device to the sewer system, limiting to the discharge rate to 5.0 l/s.

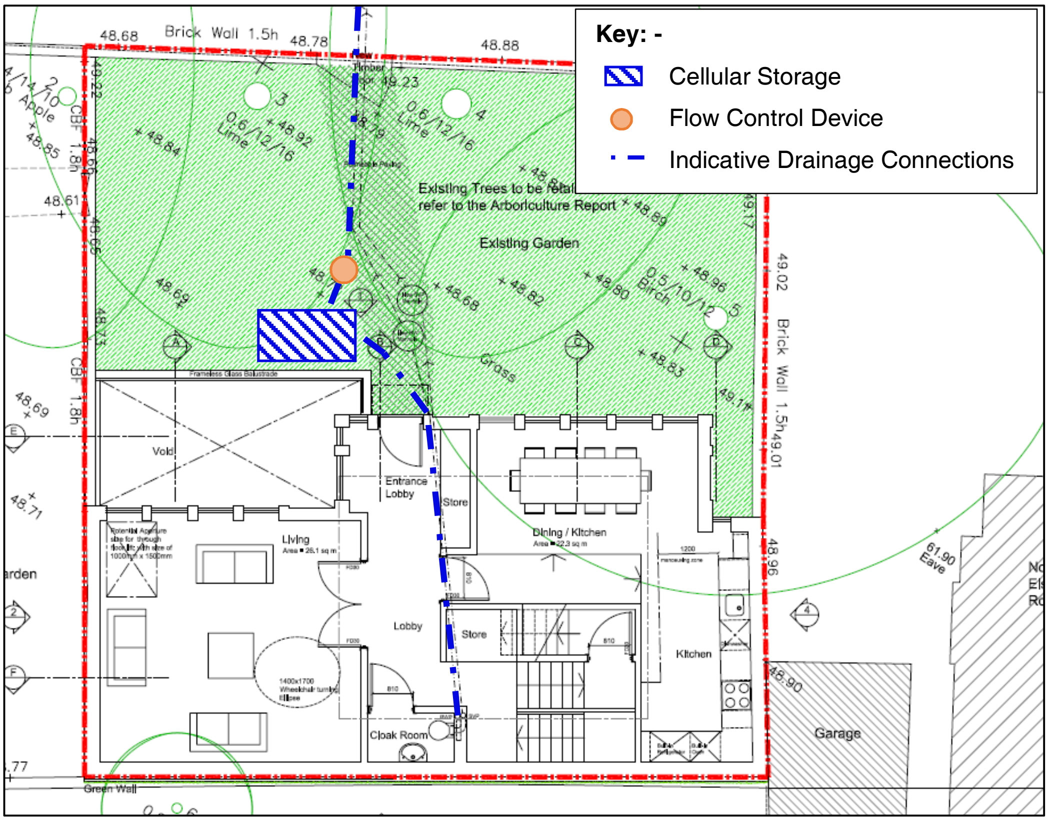


Figure 6.4 – Indicative drainage layout and location of cellular storage and flow control device (not to scale)

6.9 Additional Opportunities for SuDS

If at the detailed design stage, capacity checks and discussions with Thames Water result in an imposed limit on the rate of discharge from the site to the public sewer, it may be necessary to further reduce the rate of discharge from the site. This can be achieved by utilising additional SuDS options which could be explored further, some of which are outlined below:

Rainwater Harvesters – Based on the proposed scheme there is potential to incorporate a rainwater harvesting system. Utilising rainwater harvesting would not only provide some additional storage for storm water, but would also help to reduce the developments reliance on potable water supplies. If rainwater harvesting is proposed, analysis of the potential demand and yield, as well as the cost effectiveness of utilising such a system, should be examined at the detailed design stage. At this stage the surface water management strategy simply outlines the potential possibility of incorporating rainwater harvesting within the scheme.

Rain Gardens – For small areas of isolated hardstanding such as garden paths and sheds, it may be possible to discharge run-off to dedicated areas of landscaped rain gardens. These rain gardens could be profiled to allow run-off to pond and infiltrate into a thin soil substrate of permeable sand or gravel. In turn this would reduce the volume of run-off from these areas discharged directly to the public sewer system if minimal infiltration is discovered at the detailed design stage.

Water Butts – Given the nature of the development there is some scope for the incorporation of water butts within the proposed scheme. Typical sizes and dimensions of water butts are outlined below.

Typical House Water Butt Options	Dimensions of a typical house water butt	Volume of storage provided (litres)
Type 1 (wall mounted – Small)	1.22m high x 0.46m x 0.23m	100
Type 2 (Standard house water butt)	0.9m high x 0.68m diameter	210
Type 3 (Large house water butt)	126m high x 124m x 80m	510
Type 4 (Column tank – Very large)	2.23m high x 1.28m diameter	2000

Table 6.7 - Estimated storage capacity of available water butts

6.10 Management and Maintenance

In order for any surface water drainage system to operate as originally designed, it is necessary to ensure that it is adequately maintained throughout its lifetime. For commercial development this is generally taken as 60 years and residential 100 years is assumed. Therefore over the lifetime of a development there is a strong possibility that the system could either fail or its performance be reduced if it is not correctly maintained. This is even more important when SuDS form a part of the surface water management system, as these require a more onerous maintenance regime than a typical piped network.

The key requirement of any management regime is routine inspection and maintenance and therefore at the stage when the development is taken forward to the detailed design stage an 'owners manual' will need to be prepared. This will include:

- A description of the drainage scheme,
- A location plan showing all of the SuDS features and equipment such as flow control devices etc.
- Maintenance requirements for each element
- An explanation of the consequences of not carrying out the specified maintenance

For the SuDS features recommended by this assessment, the most obvious maintenance tasks will be the cleaning of the permeable paving and green roof as well as the de-silting of underground storage areas. For the latter, it is important to ensure that the design must recognise the need for this operation and thus incorporate silt traps and easy access for emptying.

At this point in time there are no formal arrangements for SuDS to be adopted; however, for developments such as this that rely to some extent on the ongoing inspection and maintenance of the SuDS features, it will be necessary to ensure that measures are in place.

As the site is relatively small, one option could be to task the individual residents with the maintenance responsibilities for the property and any associated drainage features. However, measures will need to be put in place to ensure occupants are made aware of maintenance schedules.

6.11 Residual Risk

For development located outside of identified flood risk areas there is also a requirement to assess the impact of an exceedance rainfall event or the failure of the surface water drainage system.

The mitigation measures discussed previously within this section of the report will significantly reduce the risk of the development being affected by flooding from surface water run-off and reduce the risk of flooding to areas outside the boundaries of the site; however, they do not completely remove the risk. The impact of a residual risk event has therefore been assessed in this part of the FRA.

A sensitivity assessment based on a 40% increase in rainfall intensity has been undertaken. Even under this exceedance scenario, the proposed cellular storage system will have sufficient capacity to accommodate surface water run-off from the entire proposed development.

6.12 Summary of Surface Water Management Strategy

The overarching objective of a SWMS is to identify a sustainable surface water drainage system that reduces the peak rate and volume of run-off from the site to a value that is less than would be experienced with the existing site condition. This helps to reduce the amount of surface water discharged from the site and passed onto systems further downstream and thus in doing so helps to reduce the risk of flooding.

The development strategy recommends that the development utilises infiltration as much as is reasonably possible, which is in line with the hierarchical approach promoted by current best practice.

The strategy that has been identified at this early stage in the development design process achieves the objective of reducing peak discharge rates to the limiting discharge rate through the combined use of a green roof, permeable paving and a cellular storage system.

The proposals assume that the entire developed site will discharge surface water run-off at an attenuated rate to the neighbouring combined sewer system, with surface water discharge rates restricted through the use of an orifice plate flow control device.

Before progressing the proposed strategy further, it is suggested that site-specific ground investigations be undertaken in order to quantify the available infiltration, the groundwater level and the level of contamination that may be present in the soils. The results of such investigations will help to establish whether or not infiltration would be a more appropriate (and sustainable) solution for managing surface water run-off from the development as opposed to a new connection into the public sewer system.

Other potential opportunities to incorporate SuDS measures within the scheme have been explored, including the use of, rainwater harvesting, water butts and rain gardens. These options could be used to provide additional storage onsite, thereby reducing the required capacity within the proposed cellular crate system. Further detailed site investigations may be required at the detailed design stage to confirm which are the most suitable for incorporation into the scheme.

The above calculations are indicative only and whilst they do not comprise a detailed drainage scheme, they do at this stage demonstrate that the proposed strategy for managing surface water run-off is achievable.

7 Conclusions

The key aims and objectives for a development that is to be sustainable in terms of flood risk are summarised in the following bullet points:

- the development should not be at a significant risk of flooding, and should not be susceptible to damage due to flooding
- the development should not be exposed to flood risk such that the health, safety and welfare of the users of the development, or the population elsewhere, is threatened
- normal operation of the development should not be susceptible to disruption as a result of flooding and safe access to and from the development should be possible during flood events
- the development should not increase flood risk elsewhere
- the development should not prevent safe maintenance of watercourses or maintenance and operation of flood defences by the Environment Agency
- the development should not be associated with an onerous or difficult operation and maintenance regime to manage flood risk; the responsibility for any operation and maintenance required should be clearly defined
- the development should not lead to degradation of the environment
- the development should meet all of the above criteria for its entire lifetime, including consideration of the potential effects of climate change

In determining whether the proposals for development at Elsworthy Road are sustainable in terms of flood risk and are compliant with the NPPF and its Planning Practice Guidance, all of the above have been taken into consideration as part of this FRA.

From Table 2.2 it can be seen that the proposed development is situated within a Zone 1 flood risk area and is a development type that is classified as being ‘more vulnerable’. For such a combination of risk and vulnerability, the NPPF does not require either the Sequential Test or the Exception Test to be applied.

Notwithstanding this, due to the developments location within a CDA (Group3_005), it has been necessary to examine the impact of all sources of flood risk on the development, which has been the focus of this site-specific FRA.

Inspection of Table 3.1 identifies that all sources of flooding have been appraised and, following the detailed inspection of the Camden SFRA, SWMP and site-specific parameters, the risk of flooding from all sources is considered to be low. However, given the proposed development is located within a CDA (Group3_005), the impact of new development with regard to surface water run-off is required to be appraised further, to ensure that it does not increase the risk of flooding elsewhere.

Detailed analysis has therefore been undertaken to quantify the impact under an extreme rainfall event (i.e. an event with a 1 in 100 year return period, including an allowance for climate change) and the results demonstrate that without appropriate mitigation measures in place, the surface water run-off discharged from the proposed development could be increased when compared to the existing site.

Therefore, additional SuDS measures have been investigated to demonstrate how the peak discharge rate from the site can be reduced. The preferred solution that has been identified comprises the use of a green roof, permeable paving and a cellular storage system, which discharges to the public sewer via a flow control device, thus limiting the peak discharge rate from the new development to less than 5.0 l/s.

In summary, it can be concluded that with the inclusion of the aforementioned SuDS measures the risk of flooding will be significantly reduced at the site, and furthermore, could help to minimise the risk to the adjacent properties.

It is therefore evident from the findings of this appraisal that a sustainable drainage solution is achievable and that the development meets the requirements of the NPPF.

8 Recommendations

The findings of this report conclude that the development will not increase flood risk at the site, or elsewhere. There are, however, a number of mitigation measures and recommendations that are required to reduce the risk to the development and other areas within the floodplain.

- It is recommended that groundwater testing is undertaken to determine the groundwater level at the site. It may also be necessary to undertake site-specific investigations at the detailed design stage in order to quantify the available infiltration and the level of contamination that may be present in the soils.

- The proposed basement will need to be sufficiently tanked and a suitable pump device and non-return valve be installed.

- The surface water management strategy for the development will need to be developed to a detailed design stage and this will need to take into account the requirements set out in Section 6.

- The use of appropriate SuDS techniques as discussed in Section 6.7 should be considered for incorporation into the scheme design. For this development the use of a green roof in conjunction with permeable paving and cellular storage system is recommended.

With the above mitigation measures incorporated into the design of the development the proposals will meet the requirements of the NPPF and its Planning Practice Guidance and will therefore be acceptable and sustainable in terms of flood risk.

9 Appendices

Appendix A.1 – Drawings

Appendix A.2 – Thames Water Historic Sewer Flooding Record

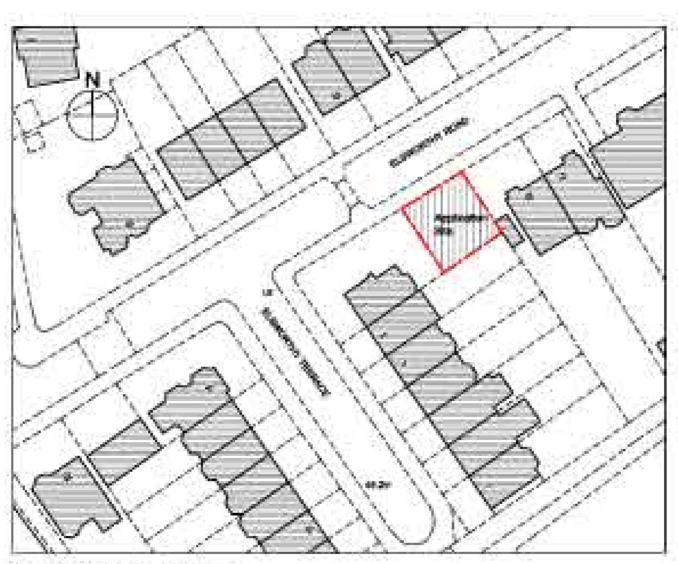
Appendix A.3 – Thames Water Asset Location Data

Appendix A.4 – Surface Water Management Calculations

Appendix A.1 – Drawings

1 Street Elevation with Proposed Scheme (North)

0 1 5m



Location Plan
scale 1:1250

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	NOV 15	Revised Elevations Design
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

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E postbox@koandpartners.co.uk

Project: **Land to the rear of 1 Elsworthy Terrace, London NW3 3DR** FOR APPLICATION

STREET ELEVATION WITH PROPOSED SCHEME

433-A-001

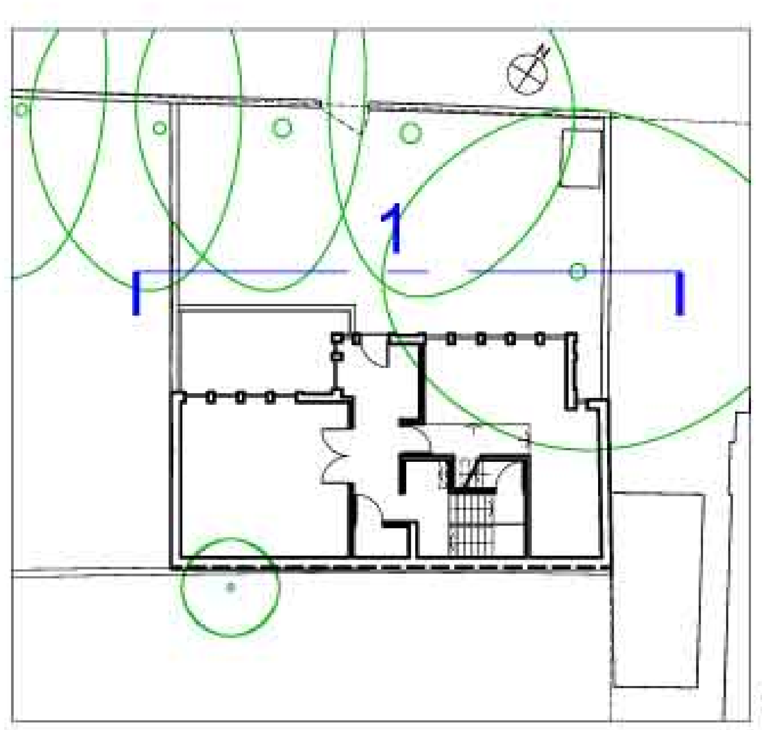
Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: **Nourani**

1 Proposed Front Elevation 1 (North)



KEY

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR | FOR APPLICATION

PROPOSED FRONT ELEVATION 1

433-A-002

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: **Nourani**

1 Proposed Section E

0 1 5m

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	SEP 15	Add window details
B	NOV 15	Revised Elevations Design
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3601
E postbox@koandpartners.co.uk

Project: **Land to the rear of 1 Elsworthy Terrace, London NW3 3DR**

FOR APPLICATION

PROPOSED SECTION E

433-A-003

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: **Nourani**

Sample of Green Roof

Sample of Permeable Paving

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	NOV 15	Revised Elevations Design
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED ROOF FLOOR PLAN

433-A-004

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: Nourani

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	SEP 15	Add window details
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR16	Issue for planning

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR | FOR APPLICATION

PROPOSED GROUND FLOOR PLAN

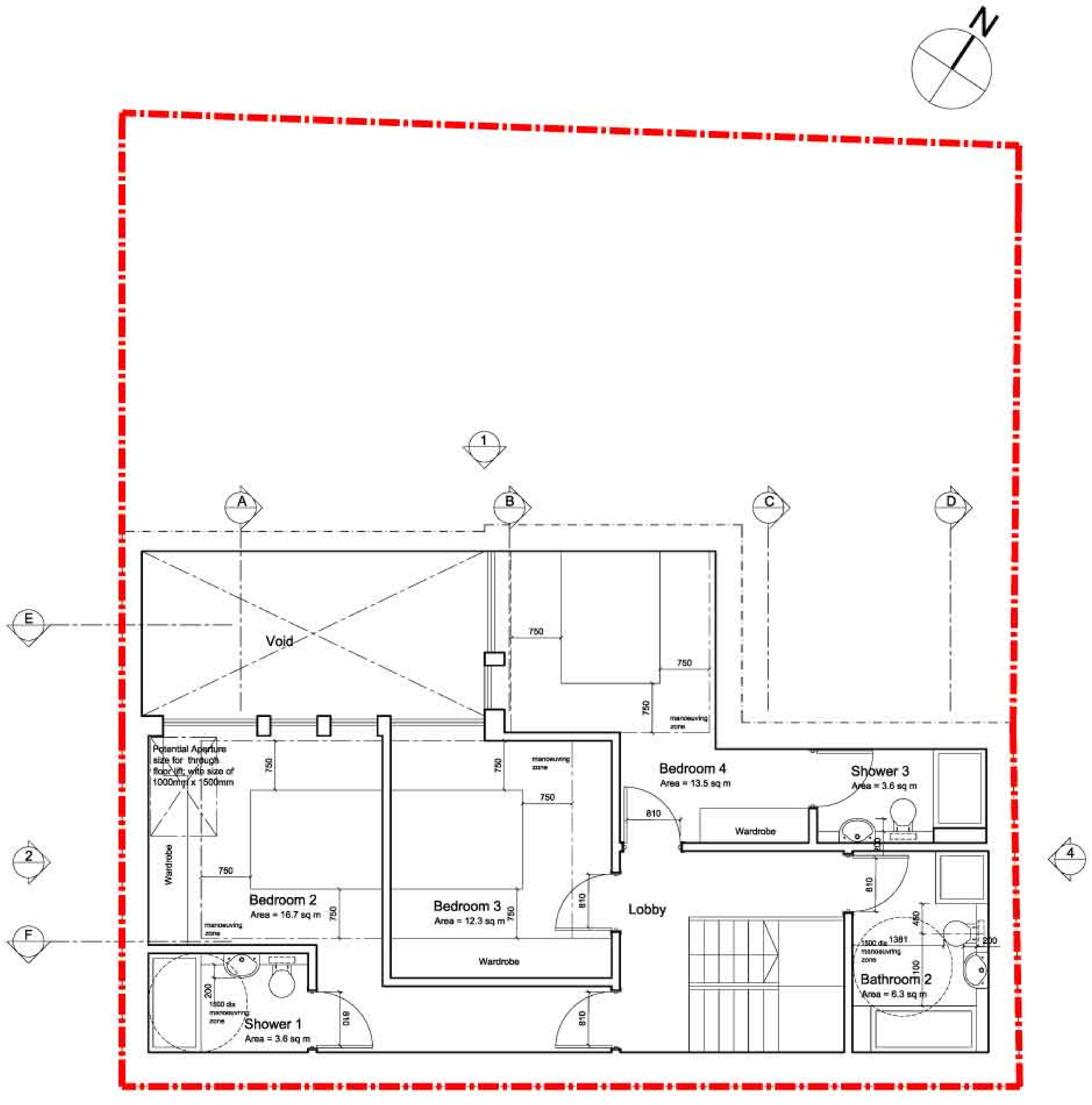
433-A-005

Date: ARP 2016

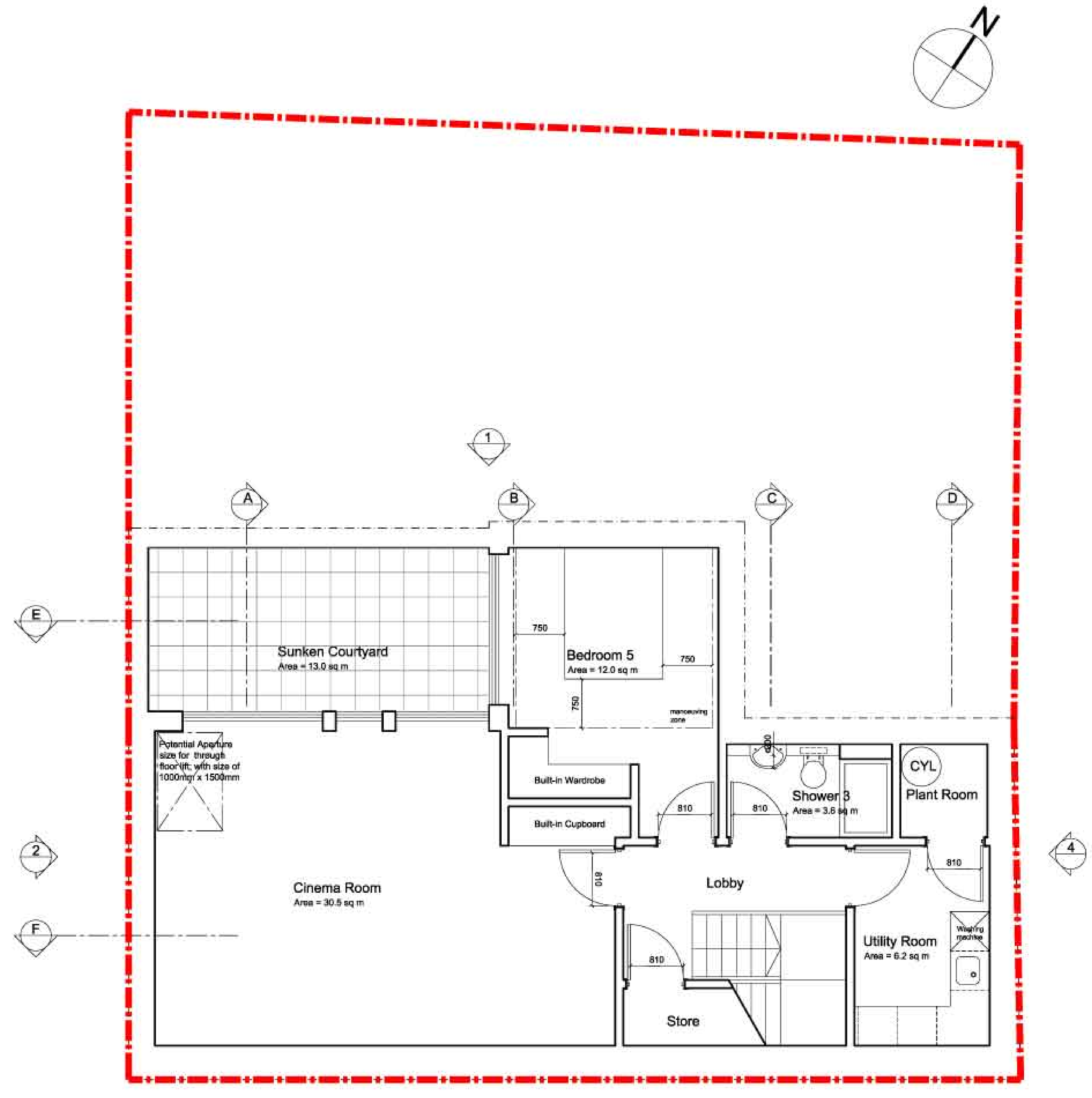
Revision: E

Scale: 1:50@A1

Client: Nourani



1 Proposed Basement 1 Plan
Area = 70.2 sq m



2 Proposed Basement 2 Plan
Area = 70.2 sq m

0 1 5m

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	SEP 15	Add window details
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED BASEMENT 1 AND 2 PLANS

433-A-006

Date: APR 2015

Revision: E

Scale: 1:50@A1

Client: Nourani

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	SEP 15	Add window details
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED FIRST FLOOR PLAN

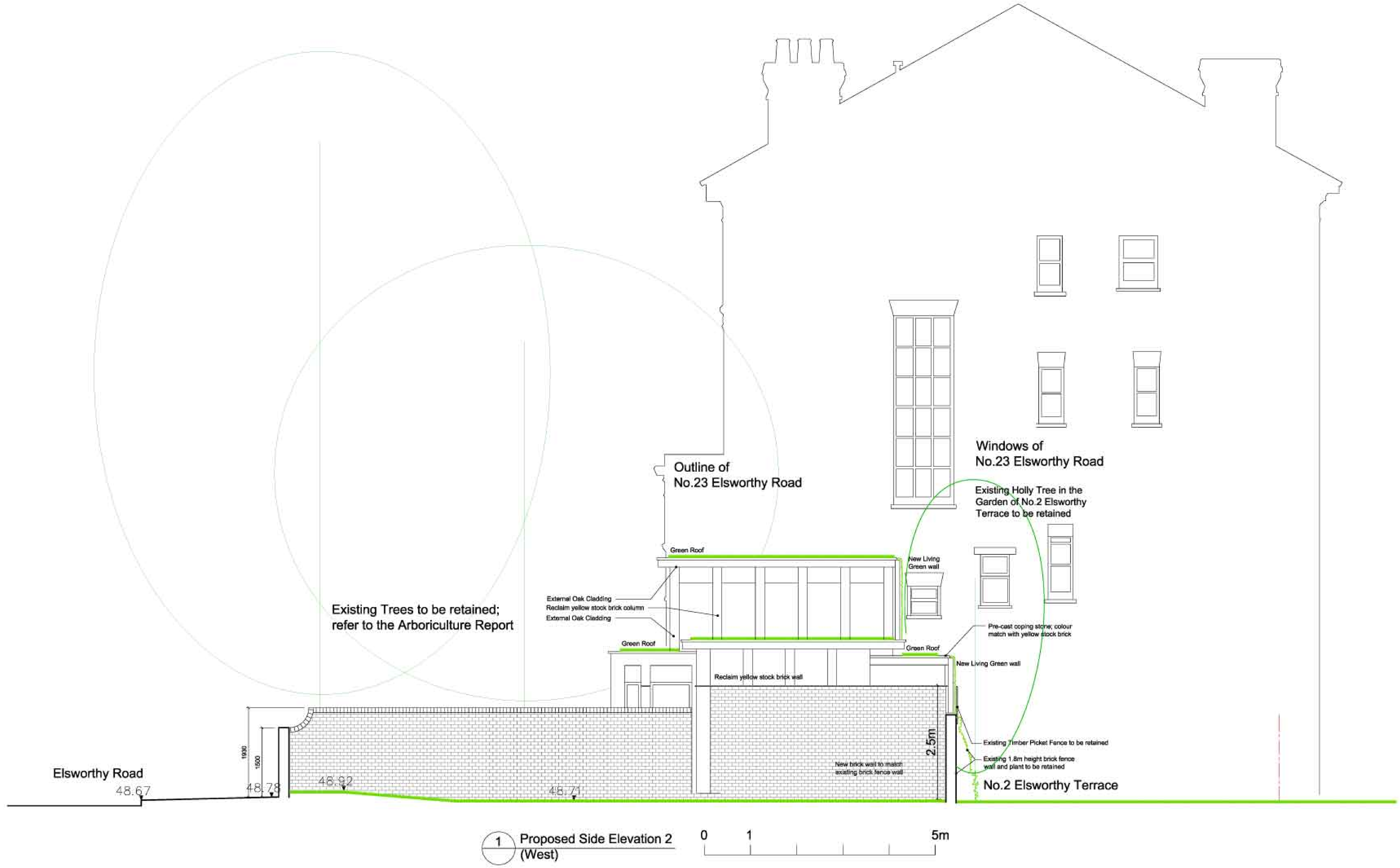
433-A-007

Date: APR 2016

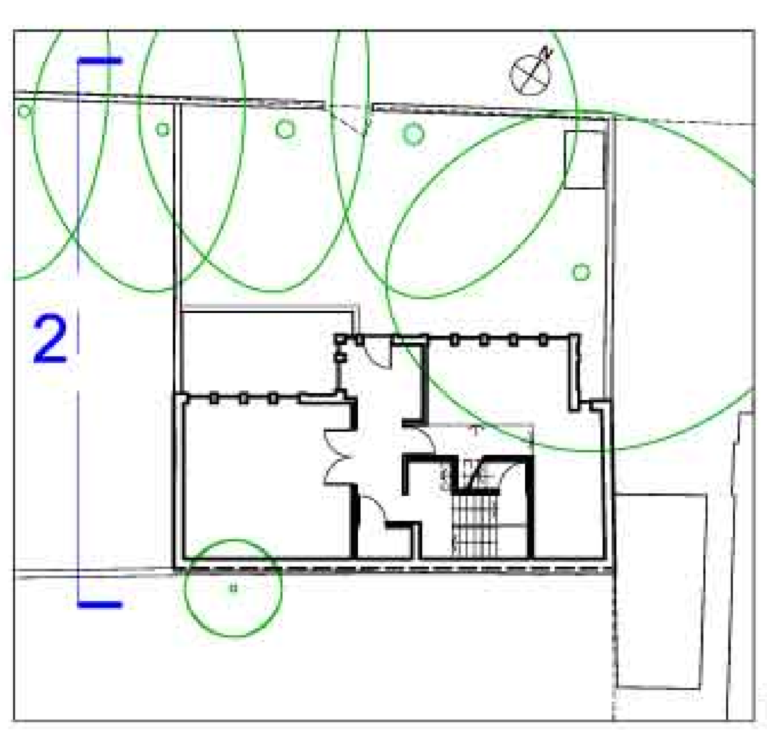
Revision: E

Scale: 1:50@A1

Client: Nourani



1 Proposed Side Elevation 2 (West)



KEY

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
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E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR | FOR APPLICATION

PROPOSED SIDE ELEVATION

433-A-008

Date: APR 2016

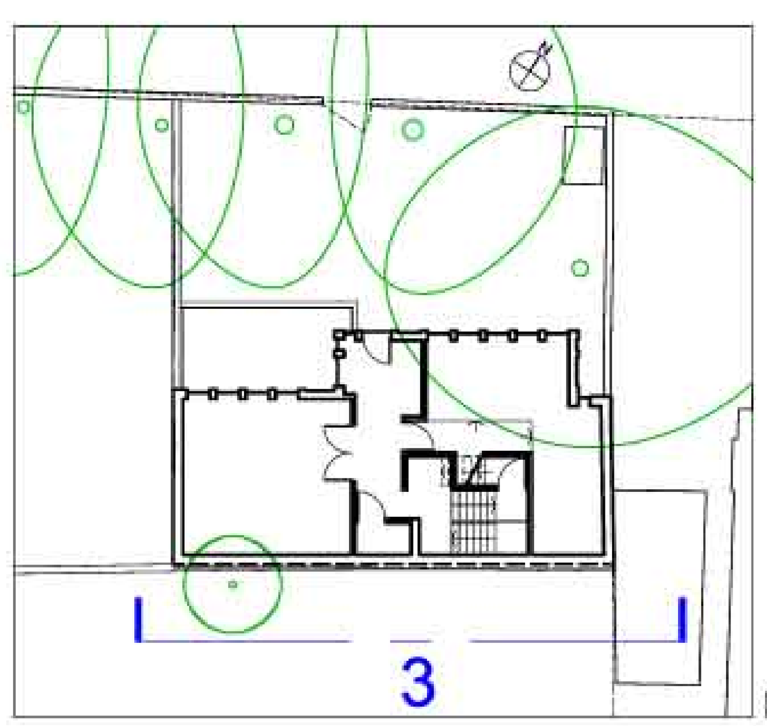
Revision: E

Scale: 1:50@A1

Client: Nourani

1 Proposed Rear Elevation 2 (South)

0 1 5m



KEY

Sample of Green Wall

Sample of Green Wall

Sample of Green Wall

Sample of Green Roof

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to Rear Elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX

T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR | FOR APPLICATION

PROPOSED REAR ELEVATION

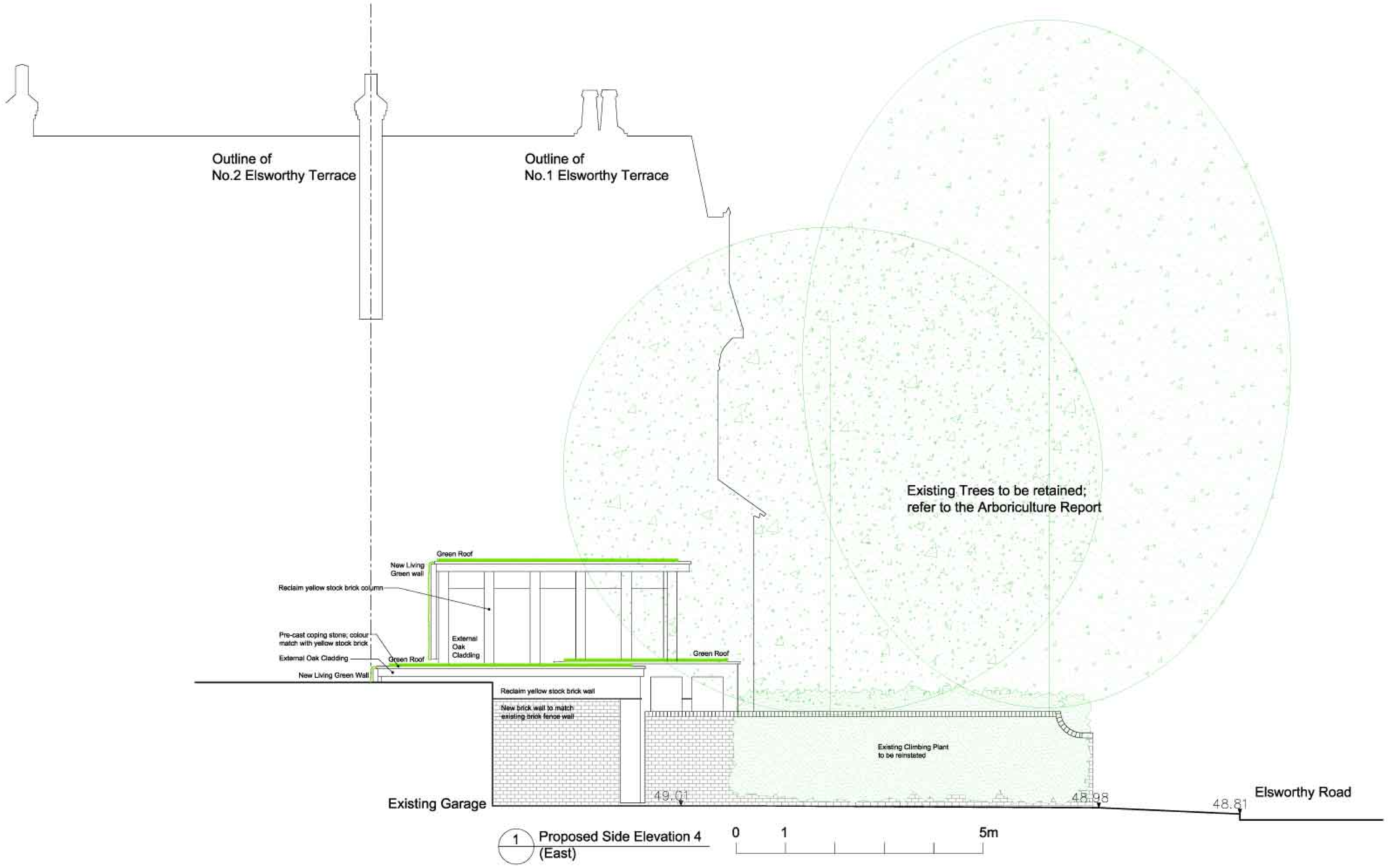
433-A-009

Date: APR 2016

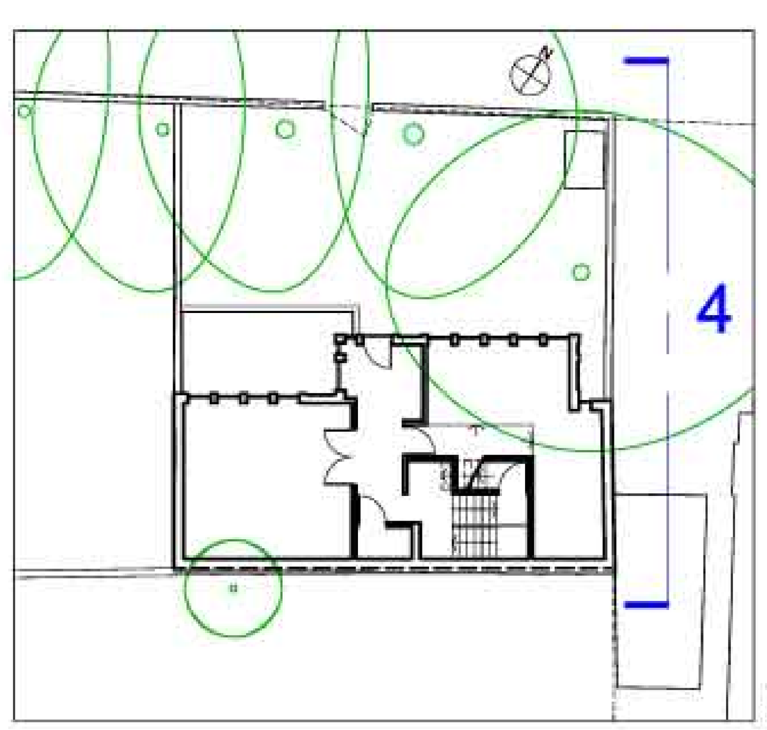
Revision: E

Scale: 1:50@A1

Client: Nourani



1 Proposed Side Elevation 4
(East)



KEY

GENERAL NOTES

All dimensions are in millimetres

REVISION		
A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

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E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED SIDE ELEVATION

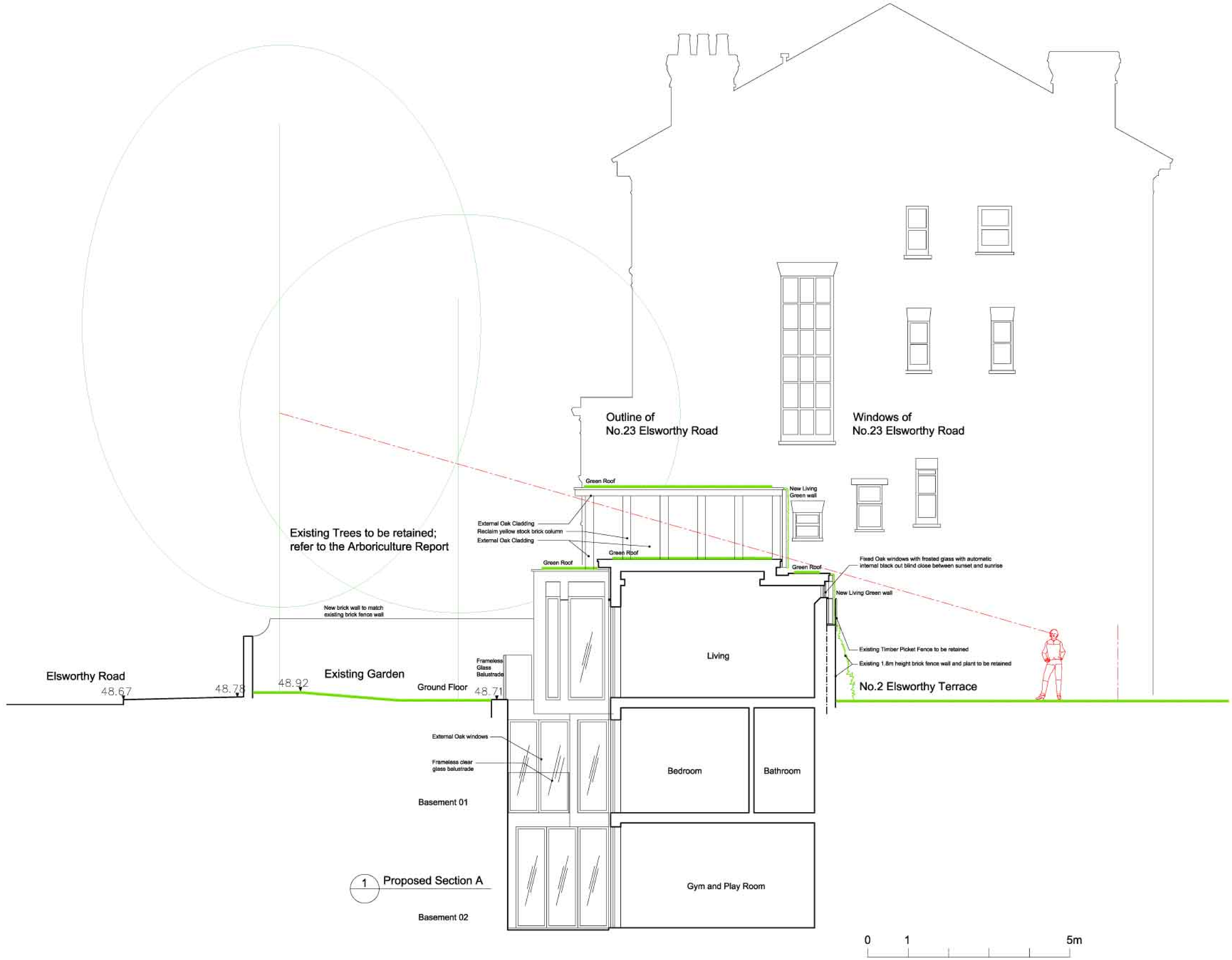
433-A-010

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: Nourani



GENERAL NOTES

All dimensions are in millimetres

REVISION

A	SEP 15	Add window details
B	OCT 15	Add details and annotations
C	OCT 15	Add details and annotations
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
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T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED SIDE ELEVATION

433-A-011

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: Nourani

1 Proposed Section B

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED SECTION B

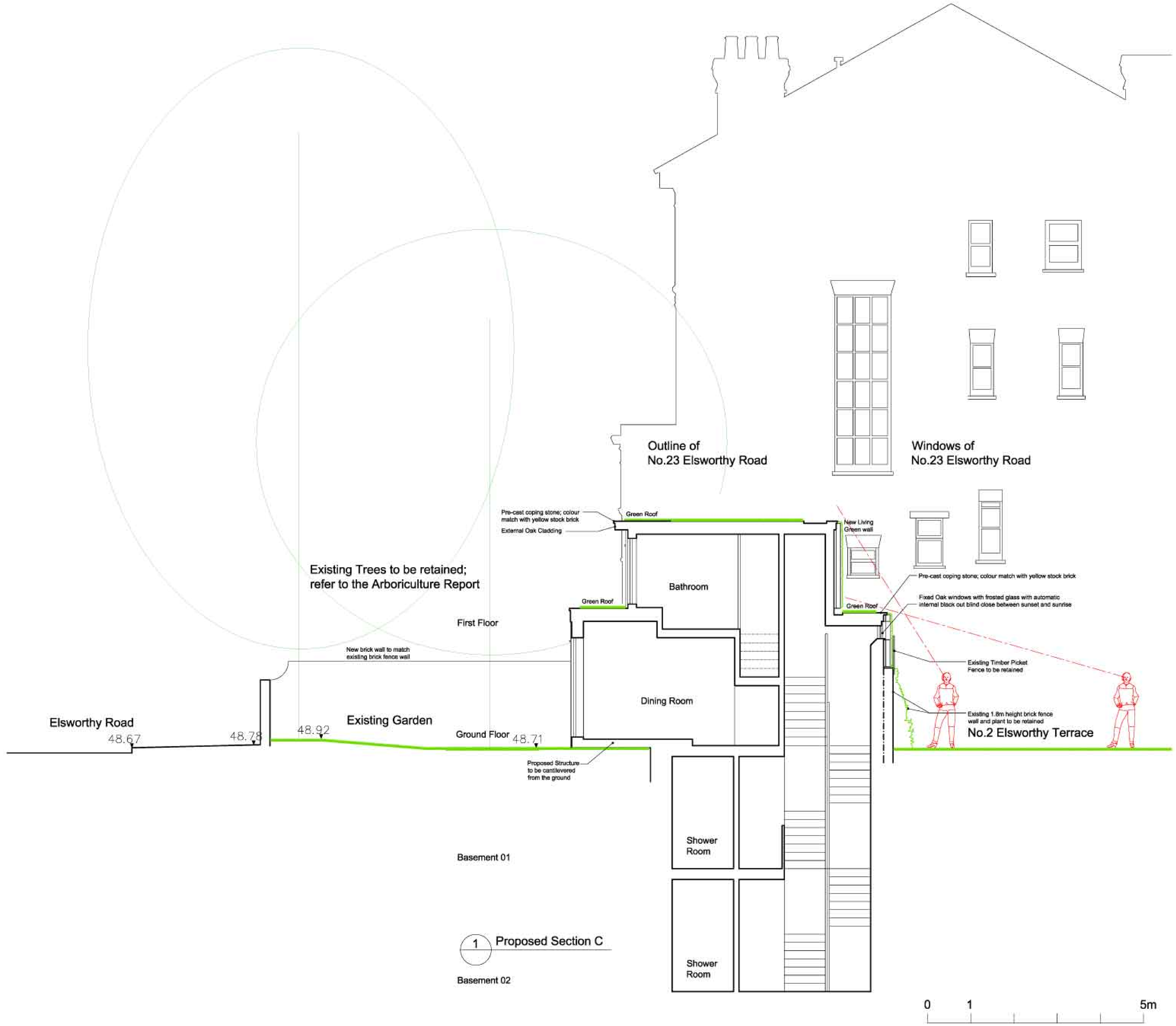
433-A-012

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: Nourani



1 Proposed Section C

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR | FOR APPLICATION

PROPOSED SECTION C

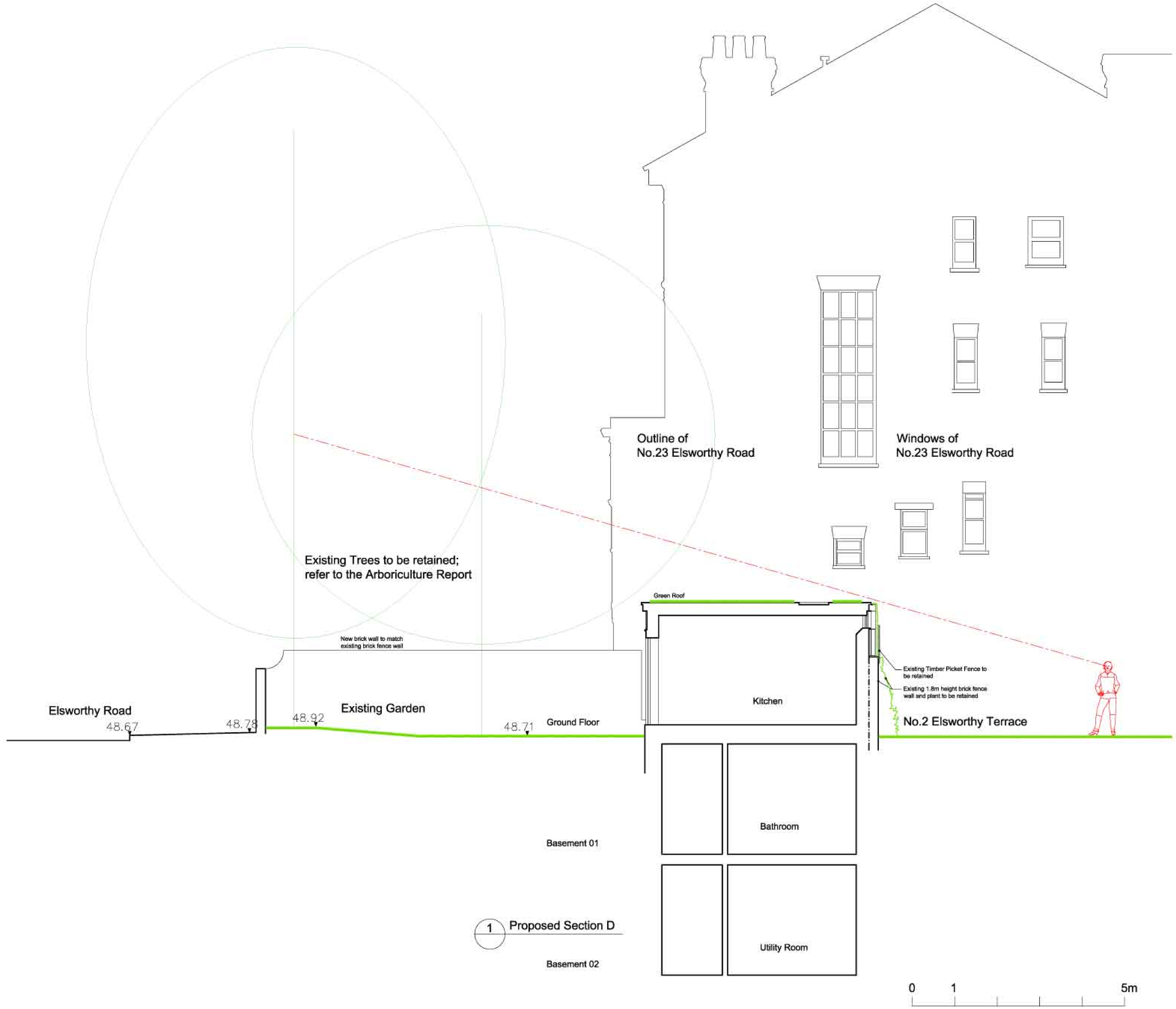
433-A-013

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: Nourani



1 Proposed Section D

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: **Land to the rear of 1 Elsworthy Terrace, London NW3 3DR** FOR APPLICATION

PROPOSED SECTION D

433-A-014

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: **Nourani**

1 Proposed Section F

GENERAL NOTES

All dimensions are in millimetres

REVISION

A	OCT 15	Add details and annotations
B	OCT 15	Add details and annotations
C	JAN 16	Revised Elevations Design
D	FEB 16	Add Green Wall to the rear elevation (South)
E	APR 16	Issue for application

Ko and Partners
72A Disraeli Road
London SW15 2DX
T 020 8785 3501
E postbox@koandpartners.co.uk

Project: Land to the rear of 1 Elsworthy Terrace, London NW3 3DR

FOR APPLICATION

PROPOSED SECTION F

433-A-015

Date: APR 2016

Revision: E

Scale: 1:50@A1

Client: Nourani

Appendix A.2 – Thames Water Historic Sewer Flooding Record

Sewer Flooding
History Enquiry

Herrington Consulting Limited

Elham Valley Road

Search address supplied	Land to the rear of 1 Elsworthy Terrace 1 Elsworthy Terrace London NW3 3DR
Your reference	1289/KT
Our reference	SFH/SFH Standard/2016_3327180
Received date	**13 May 2016**
Search date	**13 May 2016**

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Sewer Flooding
History Enquiry

Search address supplied: Land to the rear of 1 Elsworthy Terrace,1,Elsworthy Terrace,London,NW3 3DR

This search is recommended to check for any sewer flooding in a specific address or area

TWUL, trading as Property Searches, are responsible in respect of the following:-

(i) any negligent or incorrect entry in the records searched;

(ii) any negligent or incorrect interpretation of the records searched;

(iii) and any negligent or incorrect recording of that interpretation in the search report

(iv) compensation payments

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Sewer Flooding

History Enquiry

History of Sewer Flooding

Is the requested address or area at risk of flooding due to overloaded public sewers?

The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers.

For your guidance:

- A sewer is "overloaded" when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Flooding as a result of temporary problems such as blockages, siltation, collapses and equipment or operational failures are excluded.
- "Internal flooding" from public sewers is defined as flooding, which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.
- "At Risk" properties are those that the water company is required to include in the Regulatory Register that is presented annually to the Director General of Water Services. These are defined as properties that have suffered, or are likely to suffer, internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Company's reporting procedure.
- Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the At Risk Register.
- Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the Company.
- Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991.
- It should be noted that flooding can occur from private sewers and drains which are not the responsibility of the Company. This report excludes flooding from private sewers and drains and the Company makes no comment upon this matter.
- For further information please contact Thames Water on Tel: 0800 316 9800 or website www.thameswater.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Appendix A.3 – Thames Water Asset Location Data

Asset Location
Search

Herrington Consulting Limited
Barham Business Park
Unit 6Elham Valley Road
CANTERBURY
CT4 6DQ

Search address supplied	Land to the rear of 1 Elsworthy Terrace 1 Elsworthy Terrace London NW3 3DR
Your reference	1289/KT
Our reference	ALS/ALS Standard/2016_3327179
Search date	13 May 2016

You are now able to order your Asset Location Search requests online by visiting
www.thameswater-propertysearches.co.uk

searchcode

Asset Location Search

Search address supplied: Land to the rear of 1 Elsworthy Terrace, 1, Elsworthy Terrace, London, NW3 3DR

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer

Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

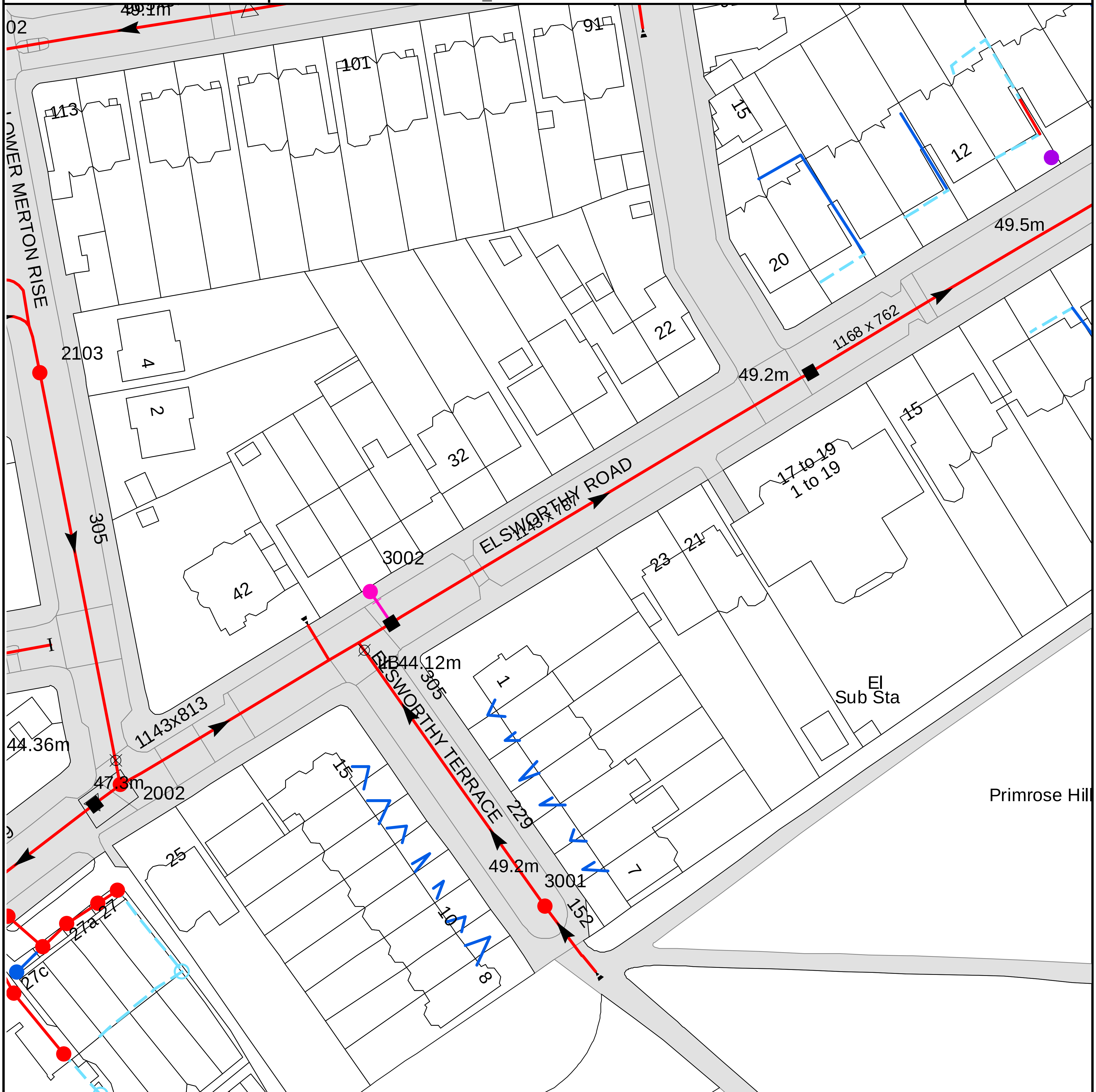
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2016_3327179



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 527370,184075

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
2103	n/a	n/a
411A	n/a	n/a
29BH	n/a	n/a
29BI	n/a	n/a
29BA	n/a	n/a
39AD	n/a	n/a
20AI	n/a	n/a
20BB	n/a	n/a
20BC	n/a	n/a
3001	49.54	46.77
20BA	n/a	n/a
20AJ	n/a	n/a
2002	47.08	44.03
3002	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

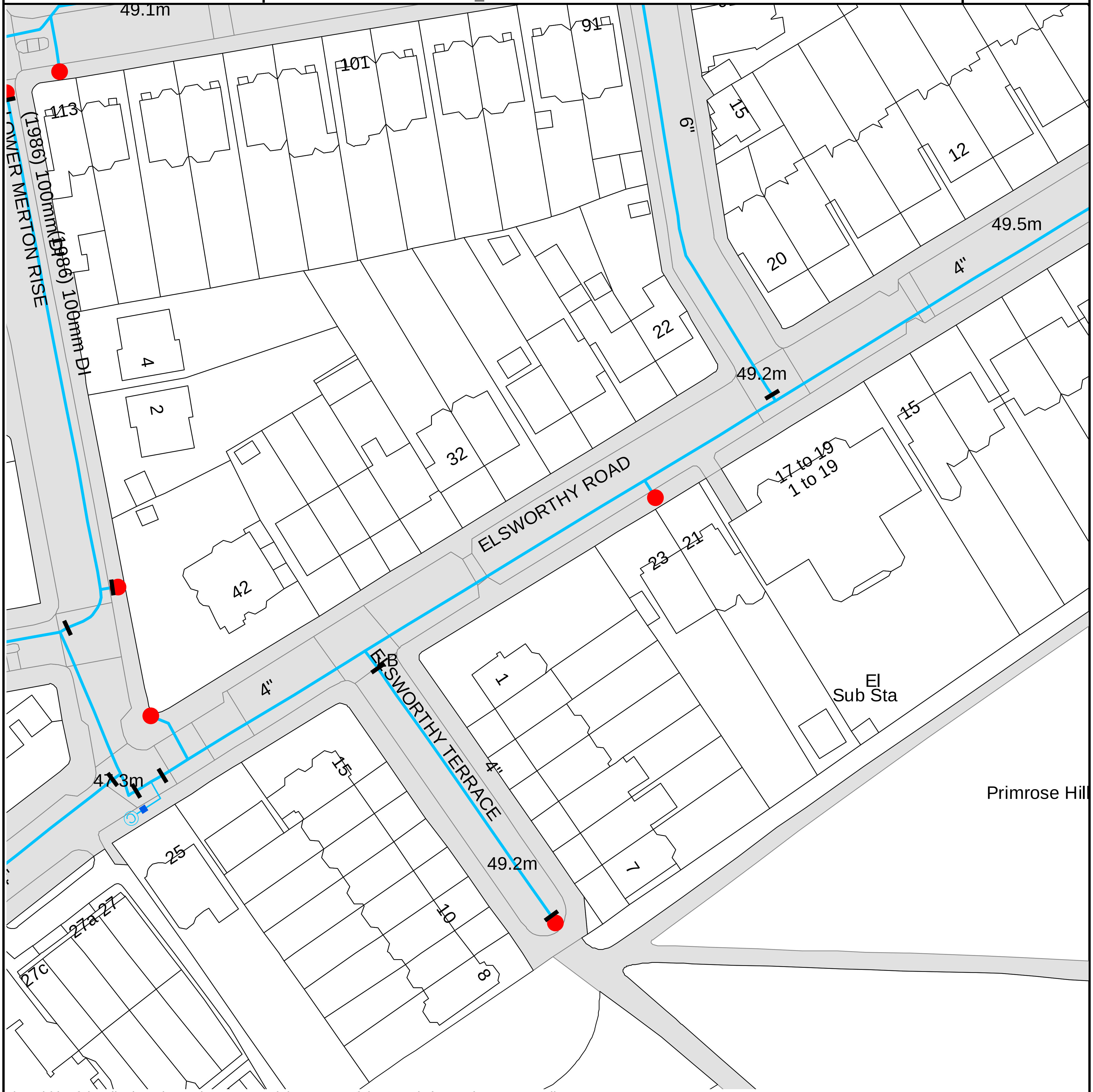
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2016_3327179



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 527370, 184075.

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4" — **Distribution Main:** The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16" — **Trunk Main:** A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY — **Supply Main:** A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE — **Fire Main:** Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED — **Metered Pipe:** A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to him at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	BACS Payment	Telephone Banking	Cheque
Call **0845 070 9148** quoting your invoice number starting CBA or ADS.	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

Appendix A.4 – Surface Water Management Calculations

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	8.063	0.063	6.4	0.1	O K
30 min Summer	8.059	0.059	5.3	0.1	O K
60 min Summer	8.047	0.047	3.8	0.1	O K
120 min Summer	8.037	0.037	2.4	0.0	O K
180 min Summer	8.032	0.032	1.8	0.0	O K
240 min Summer	8.030	0.030	1.4	0.0	O K
360 min Summer	8.021	0.021	1.0	0.0	O K
480 min Summer	8.017	0.017	0.8	0.0	O K
600 min Summer	8.014	0.014	0.7	0.0	O K
720 min Summer	8.012	0.012	0.6	0.0	O K
960 min Summer	8.010	0.010	0.5	0.0	O K
1440 min Summer	8.007	0.007	0.4	0.0	O K
2160 min Summer	8.006	0.006	0.3	0.0	O K
2880 min Summer	8.004	0.004	0.2	0.0	O K
4320 min Summer	8.004	0.004	0.2	0.0	O K
5760 min Summer	8.003	0.003	0.1	0.0	O K
7200 min Summer	8.003	0.003	0.1	0.0	O K
8640 min Summer	8.003	0.003	0.1	0.0	O K
10080 min Summer	8.003	0.003	0.1	0.0	O K
15 min Winter	8.062	0.062	6.2	0.1	O K
30 min Winter	8.054	0.054	4.7	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.825	0.0	2.4	9
30 min Summer	83.210	0.0	3.1	17
60 min Summer	51.094	0.0	3.8	32
120 min Summer	30.291	0.0	4.6	62
180 min Summer	22.019	0.0	4.9	94
240 min Summer	17.461	0.0	5.3	122
360 min Summer	12.592	0.0	5.6	182
480 min Summer	9.977	0.0	6.0	244
600 min Summer	8.324	0.0	6.1	302
720 min Summer	7.175	0.0	6.1	366
960 min Summer	5.673	0.0	6.4	488
1440 min Summer	4.069	0.0	6.7	730
2160 min Summer	2.914	0.0	7.0	544
2880 min Summer	2.297	0.0	7.5	664
4320 min Summer	1.641	0.0	8.1	1536
5760 min Summer	1.292	0.0	8.0	4832
7200 min Summer	1.073	0.0	8.0	4832
8640 min Summer	0.921	0.0	8.1	6104
10080 min Summer	0.810	0.0	7.7	5960
15 min Winter	128.825	0.0	2.7	9
30 min Winter	83.210	0.0	3.5	17

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	8.041	0.041	2.9	0.0	O K
120 min Winter	8.033	0.033	1.8	0.0	O K
180 min Winter	8.027	0.027	1.3	0.0	O K
240 min Winter	8.022	0.022	1.1	0.0	O K
360 min Winter	8.016	0.016	0.8	0.0	O K
480 min Winter	8.013	0.013	0.6	0.0	O K
600 min Winter	8.011	0.011	0.5	0.0	O K
720 min Winter	8.009	0.009	0.4	0.0	O K
960 min Winter	8.007	0.007	0.4	0.0	O K
1440 min Winter	8.006	0.006	0.3	0.0	O K
2160 min Winter	8.004	0.004	0.2	0.0	O K
2880 min Winter	8.004	0.004	0.2	0.0	O K
4320 min Winter	8.004	0.004	0.2	0.0	O K
5760 min Winter	8.004	0.004	0.2	0.0	O K
7200 min Winter	8.003	0.003	0.1	0.0	O K
8640 min Winter	8.003	0.003	0.1	0.0	O K
10080 min Winter	8.003	0.003	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	51.094	0.0	4.3	34
120 min Winter	30.291	0.0	5.1	62
180 min Winter	22.019	0.0	5.6	94
240 min Winter	17.461	0.0	5.9	122
360 min Winter	12.592	0.0	6.3	182
480 min Winter	9.977	0.0	6.7	246
600 min Winter	8.324	0.0	6.9	298
720 min Winter	7.175	0.0	7.3	350
960 min Winter	5.673	0.0	7.2	480
1440 min Winter	4.069	0.0	7.7	724
2160 min Winter	2.914	0.0	7.8	700
2880 min Winter	2.297	0.0	8.5	276
4320 min Winter	1.641	0.0	8.7	956
5760 min Winter	1.292	0.0	8.6	656
7200 min Winter	1.073	0.0	7.9	1240
8640 min Winter	0.921	0.0	8.3	6640
10080 min Winter	0.810	0.0	8.7	7200

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.010

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.010

Model Details

Storage is Online Cover Level (m) 10.000

Pipe Structure

Diameter (m)	1.000	Length (m)	5.000
Slope (1:X)	10.000	Invert Level (m)	8.000

Pipe Outflow Control

Diameter (m)	1.000	Entry Loss Coefficient	0.500
Slope (1:X)	10.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	8.000
Manning's n	0.015		

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 287 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	9.870	0.070	0.0	0.2	Flood Risk
30 min Summer	9.894	0.094	0.0	0.3	Flood Risk
60 min Summer	9.915	0.115	0.0	0.3	Flood Risk
120 min Summer	9.931	0.131	0.0	0.4	Flood Risk
180 min Summer	9.935	0.135	0.0	0.4	Flood Risk
240 min Summer	9.935	0.135	0.0	0.4	Flood Risk
360 min Summer	9.933	0.133	0.0	0.4	Flood Risk
480 min Summer	9.930	0.130	0.0	0.4	Flood Risk
600 min Summer	9.927	0.127	0.0	0.3	Flood Risk
720 min Summer	9.923	0.123	0.0	0.3	Flood Risk
960 min Summer	9.914	0.114	0.0	0.3	Flood Risk
1440 min Summer	9.897	0.097	0.0	0.3	Flood Risk
2160 min Summer	9.874	0.074	0.0	0.2	Flood Risk
2880 min Summer	9.858	0.058	0.0	0.2	Flood Risk
4320 min Summer	9.843	0.043	0.0	0.1	Flood Risk
5760 min Summer	9.836	0.036	0.0	0.1	Flood Risk
7200 min Summer	9.830	0.030	0.0	0.1	Flood Risk
8640 min Summer	9.827	0.027	0.0	0.1	Flood Risk
10080 min Summer	9.824	0.024	0.0	0.1	Flood Risk
15 min Winter	9.881	0.081	0.0	0.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	128.825	0.0	18
30 min Summer	83.210	0.0	33
60 min Summer	51.094	0.0	62
120 min Summer	30.291	0.0	122
180 min Summer	22.019	0.0	180
240 min Summer	17.461	0.0	226
360 min Summer	12.592	0.0	282
480 min Summer	9.977	0.0	344
600 min Summer	8.324	0.0	410
720 min Summer	7.175	0.0	478
960 min Summer	5.673	0.0	614
1440 min Summer	4.069	0.0	878
2160 min Summer	2.914	0.0	1236
2880 min Summer	2.297	0.0	1584
4320 min Summer	1.641	0.0	2288
5760 min Summer	1.292	0.0	3000
7200 min Summer	1.073	0.0	3744
8640 min Summer	0.921	0.0	4416
10080 min Summer	0.810	0.0	5144
15 min Winter	128.825	0.0	18

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	9.907	0.107	0.0	0.3	Flood Risk
60 min Winter	9.931	0.131	0.0	0.4	Flood Risk
120 min Winter	9.950	0.150	0.0	0.4	Flood Risk
180 min Winter	9.956	0.156	0.0	0.4	Flood Risk
240 min Winter	9.957	0.157	0.0	0.4	Flood Risk
360 min Winter	9.953	0.153	0.0	0.4	Flood Risk
480 min Winter	9.948	0.148	0.0	0.4	Flood Risk
600 min Winter	9.943	0.143	0.0	0.4	Flood Risk
720 min Winter	9.937	0.137	0.0	0.4	Flood Risk
960 min Winter	9.923	0.123	0.0	0.3	Flood Risk
1440 min Winter	9.897	0.097	0.0	0.3	Flood Risk
2160 min Winter	9.865	0.065	0.0	0.2	Flood Risk
2880 min Winter	9.848	0.048	0.0	0.1	Flood Risk
4320 min Winter	9.835	0.035	0.0	0.1	Flood Risk
5760 min Winter	9.828	0.028	0.0	0.1	Flood Risk
7200 min Winter	9.823	0.023	0.0	0.1	Flood Risk
8640 min Winter	9.820	0.020	0.0	0.1	Flood Risk
10080 min Winter	9.818	0.018	0.0	0.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	83.210	0.0	33
60 min Winter	51.094	0.0	62
120 min Winter	30.291	0.0	120
180 min Winter	22.019	0.0	176
240 min Winter	17.461	0.0	232
360 min Winter	12.592	0.0	328
480 min Winter	9.977	0.0	372
600 min Winter	8.324	0.0	448
720 min Winter	7.175	0.0	522
960 min Winter	5.673	0.0	666
1440 min Winter	4.069	0.0	938
2160 min Winter	2.914	0.0	1280
2880 min Winter	2.297	0.0	1584
4320 min Winter	1.641	0.0	2332
5760 min Winter	1.292	0.0	3048
7200 min Winter	1.073	0.0	3752
8640 min Winter	0.921	0.0	4416
10080 min Winter	0.810	0.0	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.001

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.001

Model Details

Storage is Online Cover Level (m) 10.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.01000	Width (m)	3.0
Membrane Percolation (mm/hr)	1000	Length (m)	3.0
Max Percolation (l/s)	2.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	9.800	Cap Volume Depth (m)	0.000

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 2 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.342	0.342	0.0	4.5	4.5	0.7	O K
30 min Summer	9.299	0.299	0.0	4.2	4.2	0.6	O K
60 min Summer	9.198	0.198	0.0	3.3	3.3	0.4	O K
120 min Summer	9.111	0.111	0.0	2.3	2.3	0.2	O K
180 min Summer	9.082	0.082	0.0	1.7	1.7	0.2	O K
240 min Summer	9.071	0.071	0.0	1.4	1.4	0.1	O K
360 min Summer	9.058	0.058	0.0	1.0	1.0	0.1	O K
480 min Summer	9.051	0.051	0.0	0.8	0.8	0.1	O K
600 min Summer	9.045	0.045	0.0	0.7	0.7	0.1	O K
720 min Summer	9.041	0.041	0.0	0.6	0.6	0.1	O K
960 min Summer	9.035	0.035	0.0	0.5	0.5	0.1	O K
1440 min Summer	9.030	0.030	0.0	0.3	0.3	0.1	O K
2160 min Summer	9.026	0.026	0.0	0.2	0.2	0.0	O K
2880 min Summer	9.023	0.023	0.0	0.2	0.2	0.0	O K
4320 min Summer	9.019	0.019	0.0	0.1	0.1	0.0	O K
5760 min Summer	9.017	0.017	0.0	0.1	0.1	0.0	O K
7200 min Summer	9.015	0.015	0.0	0.1	0.1	0.0	O K
8640 min Summer	9.014	0.014	0.0	0.1	0.1	0.0	O K
10080 min Summer	9.014	0.014	0.0	0.1	0.1	0.0	O K
15 min Winter	9.359	0.359	0.0	4.6	4.6	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.825	0.0	2.4	11
30 min Summer	83.210	0.0	3.1	19
60 min Summer	51.094	0.0	3.8	34
120 min Summer	30.291	0.0	4.5	64
180 min Summer	22.019	0.0	5.0	94
240 min Summer	17.461	0.0	5.2	124
360 min Summer	12.592	0.0	5.7	182
480 min Summer	9.977	0.0	6.0	244
600 min Summer	8.324	0.0	6.2	302
720 min Summer	7.175	0.0	6.5	360
960 min Summer	5.673	0.0	6.8	488
1440 min Summer	4.069	0.0	7.3	736
2160 min Summer	2.914	0.0	7.9	1088
2880 min Summer	2.297	0.0	8.3	1440
4320 min Summer	1.641	0.0	8.9	2156
5760 min Summer	1.292	0.0	9.3	2920
7200 min Summer	1.073	0.0	9.7	3616
8640 min Summer	0.921	0.0	9.9	4384
10080 min Summer	0.810	0.0	10.2	5064
15 min Winter	128.825	0.0	2.7	11

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.273	0.273	0.0	3.9	3.9	0.5	O K
60 min Winter	9.154	0.154	0.0	2.8	2.8	0.3	O K
120 min Winter	9.083	0.083	0.0	1.8	1.8	0.2	O K
180 min Winter	9.068	0.068	0.0	1.3	1.3	0.1	O K
240 min Winter	9.058	0.058	0.0	1.0	1.0	0.1	O K
360 min Winter	9.048	0.048	0.0	0.7	0.7	0.1	O K
480 min Winter	9.041	0.041	0.0	0.6	0.6	0.1	O K
600 min Winter	9.036	0.036	0.0	0.5	0.5	0.1	O K
720 min Winter	9.034	0.034	0.0	0.4	0.4	0.1	O K
960 min Winter	9.031	0.031	0.0	0.3	0.3	0.1	O K
1440 min Winter	9.026	0.026	0.0	0.2	0.2	0.0	O K
2160 min Winter	9.022	0.022	0.0	0.2	0.2	0.0	O K
2880 min Winter	9.019	0.019	0.0	0.1	0.1	0.0	O K
4320 min Winter	9.016	0.016	0.0	0.1	0.1	0.0	O K
5760 min Winter	9.014	0.014	0.0	0.1	0.1	0.0	O K
7200 min Winter	9.013	0.013	0.0	0.1	0.1	0.0	O K
8640 min Winter	9.012	0.012	0.0	0.1	0.1	0.0	O K
10080 min Winter	9.011	0.011	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	83.210	0.0	3.5	19
60 min Winter	51.094	0.0	4.3	34
120 min Winter	30.291	0.0	5.1	62
180 min Winter	22.019	0.0	5.5	92
240 min Winter	17.461	0.0	5.9	126
360 min Winter	12.592	0.0	6.3	182
480 min Winter	9.977	0.0	6.7	240
600 min Winter	8.324	0.0	7.0	306
720 min Winter	7.175	0.0	7.2	358
960 min Winter	5.673	0.0	7.6	478
1440 min Winter	4.069	0.0	8.2	726
2160 min Winter	2.914	0.0	8.8	1064
2880 min Winter	2.297	0.0	9.3	1420
4320 min Winter	1.641	0.0	9.9	2096
5760 min Winter	1.292	0.0	10.4	2864
7200 min Winter	1.073	0.0	10.8	3584
8640 min Winter	0.921	0.0	11.1	4240
10080 min Winter	0.810	0.0	11.4	4968

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.010

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.010

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.96
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m^2)**	**Inf. Area (m^2)**	**Depth (m)**	**Area (m^2)**	**Inf. Area (m^2)**
0.000	2.0	2.0	0.501	0.0	4.8
0.500	2.0	4.8			

Orifice Outflow Control

Diameter (m) 0.062 Discharge Coefficient 0.600 Invert Level (m) 9.000

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 2 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	9.420	0.420	0.0	5.0	5.0	0.8	O K
30 min Summer	9.372	0.372	0.0	4.7	4.7	0.7	O K
60 min Summer	9.249	0.249	0.0	3.7	3.7	0.5	O K
120 min Summer	9.138	0.138	0.0	2.6	2.6	0.3	O K
180 min Summer	9.094	0.094	0.0	2.0	2.0	0.2	O K
240 min Summer	9.079	0.079	0.0	1.6	1.6	0.2	O K
360 min Summer	9.064	0.064	0.0	1.2	1.2	0.1	O K
480 min Summer	9.056	0.056	0.0	1.0	1.0	0.1	O K
600 min Summer	9.050	0.050	0.0	0.8	0.8	0.1	O K
720 min Summer	9.045	0.045	0.0	0.7	0.7	0.1	O K
960 min Summer	9.038	0.038	0.0	0.5	0.5	0.1	O K
1440 min Summer	9.032	0.032	0.0	0.4	0.4	0.1	O K
2160 min Summer	9.028	0.028	0.0	0.3	0.3	0.1	O K
2880 min Summer	9.025	0.025	0.0	0.2	0.2	0.0	O K
4320 min Summer	9.021	0.021	0.0	0.2	0.2	0.0	O K
5760 min Summer	9.019	0.019	0.0	0.1	0.1	0.0	O K
7200 min Summer	9.017	0.017	0.0	0.1	0.1	0.0	O K
8640 min Summer	9.015	0.015	0.0	0.1	0.1	0.0	O K
10080 min Summer	9.015	0.015	0.0	0.1	0.1	0.0	O K
15 min Winter	9.448	0.448	0.0	5.2	5.2	0.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.296	0.0	2.8	11
30 min Summer	97.078	0.0	3.6	19
60 min Summer	59.609	0.0	4.5	34
120 min Summer	35.340	0.0	5.3	64
180 min Summer	25.689	0.0	5.8	94
240 min Summer	20.371	0.0	6.1	124
360 min Summer	14.691	0.0	6.6	184
480 min Summer	11.640	0.0	7.0	244
600 min Summer	9.711	0.0	7.3	306
720 min Summer	8.371	0.0	7.5	366
960 min Summer	6.618	0.0	7.9	488
1440 min Summer	4.747	0.0	8.5	734
2160 min Summer	3.399	0.0	9.2	1100
2880 min Summer	2.680	0.0	9.6	1464
4320 min Summer	1.915	0.0	10.3	2204
5760 min Summer	1.507	0.0	10.9	2920
7200 min Summer	1.251	0.0	11.3	3616
8640 min Summer	1.075	0.0	11.6	4320
10080 min Summer	0.945	0.0	11.9	4952
15 min Winter	150.296	0.0	3.2	12

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	9.343	0.343	0.0	4.5	4.5	0.7	O K
60 min Winter	9.195	0.195	0.0	3.2	3.2	0.4	O K
120 min Winter	9.096	0.096	0.0	2.0	2.0	0.2	O K
180 min Winter	9.075	0.075	0.0	1.5	1.5	0.1	O K
240 min Winter	9.064	0.064	0.0	1.2	1.2	0.1	O K
360 min Winter	9.053	0.053	0.0	0.9	0.9	0.1	O K
480 min Winter	9.045	0.045	0.0	0.7	0.7	0.1	O K
600 min Winter	9.040	0.040	0.0	0.6	0.6	0.1	O K
720 min Winter	9.036	0.036	0.0	0.5	0.5	0.1	O K
960 min Winter	9.033	0.033	0.0	0.4	0.4	0.1	O K
1440 min Winter	9.028	0.028	0.0	0.3	0.3	0.1	O K
2160 min Winter	9.023	0.023	0.0	0.2	0.2	0.0	O K
2880 min Winter	9.021	0.021	0.0	0.2	0.2	0.0	O K
4320 min Winter	9.018	0.018	0.0	0.1	0.1	0.0	O K
5760 min Winter	9.015	0.015	0.0	0.1	0.1	0.0	O K
7200 min Winter	9.014	0.014	0.0	0.1	0.1	0.0	O K
8640 min Winter	9.013	0.013	0.0	0.1	0.1	0.0	O K
10080 min Winter	9.012	0.012	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	97.078	0.0	4.1	19
60 min Winter	59.609	0.0	5.0	34
120 min Winter	35.340	0.0	5.9	64
180 min Winter	25.689	0.0	6.5	94
240 min Winter	20.371	0.0	6.8	122
360 min Winter	14.691	0.0	7.4	180
480 min Winter	11.640	0.0	7.8	248
600 min Winter	9.711	0.0	8.2	306
720 min Winter	8.371	0.0	8.4	366
960 min Winter	6.618	0.0	8.9	492
1440 min Winter	4.747	0.0	9.6	732
2160 min Winter	3.399	0.0	10.3	1072
2880 min Winter	2.680	0.0	10.8	1432
4320 min Winter	1.915	0.0	11.6	2168
5760 min Winter	1.507	0.0	12.2	2808
7200 min Winter	1.251	0.0	12.6	3520
8640 min Winter	1.075	0.0	13.0	4232
10080 min Winter	0.945	0.0	13.3	4992

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.437	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.010

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.010

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 9.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.96
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	2.0	2.0	0.501	0.0	4.8
0.500	2.0	4.8			

Orifice Outflow Control

Diameter (m) 0.062 Discharge Coefficient 0.600 Invert Level (m) 9.000