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# 47A Lower Mortlake Road

# Surface & Foul Water Drainage Strategy


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QUALITY MANAGEMENT

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# SURFACE AND FOUL WATER DRAINAGE STRATEGY

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## 1. ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CIRIA | Construction Industry Research and Information Association |
| DEFRA | Department for Environment, Food and Rural Affairs |
| EA | Environment Agency |
| ha | Hectares |
| LLFA | Lead Local Flooding Authority |
| LPA | Local Planning Authority |
| m | Metres |
| NPPF | National Planning Policy Framework |
| NPPG | National Planning Policy Guidance to the National Planning Policy Framework |
| NTS | Non-statutory Technical Standards |
| LFRA | Local Flood Risk Assessment |
| SuDS | Sustainable Drainage Systems |
| LBRUT | London Borough or Richmond Upon Thames |
| PPG | Planning Practise Guide |
| BGS | British Geological Society |
| TE2100 | Thames Estuary 2100 |
| SPZ | Source Protection Zone |
| CDA | Critical Drainage Area |

# SURFACE AND FOUL WATER DRAINAGE STRATEGY

## APPENDICES

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# SECTION 1
INTRODUCTION

# SURFACE AND FOUL WATER DRAINAGE STRATEGY

## 1. INTRODUCTION

### 1.1. Appointment and Brief

This Surface and Foul Water Drainage Strategy (DS) has been prepared by Constructure Ltd on behalf of Westlake Property Limited for the proposed development at 47a Lower Mortlake Road, Richmond, London, TW9 2LW (hereby referred to as the 'Application Site').

The purpose of this document is to outline the development of the proposed DS, providing sufficient detail to enable both a thorough review of design principles adopted and further refinement of the design as part of the ongoing development of the project.

It aims to demonstrate the foul and surface water management at the Application Site, as follows:

- By providing an analysis of the impact of the proposed development on surrounding foul water infrastructure and identify the constraints present on the site in terms of suitability of conventional gravity drainage; and
- By demonstrating the principles of surface water management in terms of constraints on discharge, permitted discharge rates and required volumes of attenuation (where required), describing how these can be accommodated within the development proposals.

The proposed DS outline below may be subject to further detailed analysis at final design stage, should changes due to Planning requirements be made.

### 1.2. Aims and Objectives

The DS has been prepared with reference to the following requirements:

- The DS must:
  - Ensure that flood risk to the Application Site and surrounding area is not increased over the lifetime of the Proposed Development;
  - Conform with all relevant national and local flood risk polices;
  - Adopt current design standards; and
  - Consider long-term maintenance with respect to practicality, ownership and funding.

- The DS should:
  - Mimic the existing drainage characteristics of the Application Site as far as is practical;

- Look for opportunities to provide a reduction in flood risk to the Application Site and the surrounding area;
- Adhere to current best practice guidance;
- Contribute to the enhanced amenity and aesthetic value of the Application Site; and
- Propose opportunities for biological enhancement and provide habitats for wildlife in urban areas.

## 1.3. Limitations

The purpose of this report is as outlined in Section 1.2, together with those related matters specifically referred to, and it is not intended to be used for any other purposes. The report is for the sole benefit and may only be relied upon by the addressee, to whom we will owe a duty of care. The report and any part of it is confidential to the addressee and should not be disclosed to any third party for any purpose, without the prior written consent of Constructure Ltd as to the form and context of such disclosure. The granting of such consent shall not entitle the third party to place reliance on the report, nor shall it confer any third-party rights pursuant to the Contracts (Rights of Third Parties) Act. The report may not be assigned to any third party.

## 1.4. Reference Information

The following information has been obtained and interrogated as part of this study:

- Lynas Smith Drawing Ref: 15-001-P1 – Location Plan.
- British Geological Society – Geological Maps.
- UK SUDS HR Wallingford – Surface Water Storage Requirements

In addition, the following documents have been consulted:

- Communities and Local Government Document. (Feb 2019). The National Planning Policy Framework;
- Environment Agency. (2016). Flood Risk Assessments: Climate Change Allowances;
- Environment Agency. (2013). Rainfall Runoff Management for Developments;
- Environment Agency. (2019). Flood Risk Assessments: Climate Change Allowances;
- CIRIA. (2015). C753 – The SuDS Manual;
- Secretary of State. (2015). Building Regulations Approved Document H;
- Butler & Davies. (2012). 2nd Ed. Urban Drainage;
- DEFRA / EA Interactive online mapping (magic.defra.gov.uk);
- Department for Environment, Food and Rural Affairs. (2015). Non-Statutory Technical Standards for Sustainable Drainage Systems;
- Department for Environment, Food and Rural Affairs & Environment Agency. (2017). Flood Risk Assessment for Planning Applications;
- London Borough of Richmond upon Thames Design Guide, Design Strategy SPD;
- London Borough of Richmond upon Thames Design Local Development Framework, Core Strategy and Policies for Management of Development; and
- London Borough of Richmond upon Thames Design Local Flood Risk Management Strategy.

# SECTION 2

## PROJECT BACKGROUND

# 2. PROJECT BACKGROUND

## 2.1. Site Location and Existing Land Use

The Application Site is situated off Lower Mortlake Road. Specifically, the site is located close to the junction with Salisbury Road.

The Ordinance Survey (OS) grid reference for the application site is 518381 E, 175449 N and the post code is TW9 2LW.

The site is currently an un-occupied yard that formally was a car wash business site. Where oriented North:-

- The North elevation abuts residential properties 1-3 Avoca Villas with access off Blue Anchor Alley;
- The East elevation abuts a residential dwelling 47 Lower Mortlake Road;
- The South elevation faces onto Lower Mortlake Road; and
- The West elevation faces onto Blue Anchor Alley and beyond this 45 Lower Mortlake Road.

## 2.2. Existing Drainage Infrastructure

The Sewerage Undertaker for the area is Thames Water and review of their asset records (see appendices) suggests the following public infrastructure within close vicinity of the Application Site:

- To the South Elevation:
  - 750 mm diameter foul water sewer flowing West to East along Lower Mortlake Road (Northern side) its depth is not known.
  - 300mm diameter foul water sewer flowing West to East along Lower Mortlake Road (Northern side) its depth is not known.
  - 600 mm diameter surface water sewer flowing West to East along Lower Mortlake Road (Northern side) its depth is not known.
  - 750 mm diameter surface water sewer flowing West to East along Lower Mortlake Road (Southern side) its depth is not known.

The existing Application Site is not known to have any surface water flow restriction or benefit from existing SuDS features.

Similarly, it is assumed that the existing Application Site discharges both foul and surface water to the public sewer network. However, at the time of writing the exact location and condition of the existing connection is unknown as a CCTV survey has not yet been carried out but is likely to form part of the intrusive surveys.

## 2.3. Topography

Currently there is no topographical survey drawing available. However, the site appears to be around 6.5m Above Ordnance Datum and is generally flat with a possible slight fall towards the highway. It is approximately 310m² in area and therefore below the 1.0ha trigger for a full Flood Risk Assessment.

## 2.4. Geology and Hydrogeology

British Geological Survey (BGS) online mapping indicates that the Application Site is situated on a bedrock of London Clay overlain by the Kempton Park Gravel Member. This is a coarse to fine grain superficial deposit.

Due to the London Clay bedrock, the Environment Agency's online groundwater mapping confirms that the site is not located within a Groundwater Source Protection Zone (SPZ). The Kempton Park Gravel Member may contain a perched water table trapped above the Clay and therefore trenches may require pumping out during construction. However, both bedrock and superficial soils are classified as unproductive or secondary undifferentiated aquifers, which are not permeable layers capable of supporting water supplies at a local or strategic level.

Trial pits will confirm at what level this water table may be (see Hydrology below).

## 2.5. Hydrology

From Thames Waters sewer records, there appears to be two foul/combined and two surface water sewers in Lower Mortlake Road. One of the foul sewers is a 30" (750mm) pipe. The other is 12" (300mm). From the writers experience it is likely that the larger of the two is a main trunk sewer and will be relatively deep in comparison to the more local 300mm. It is to this (the 300mm) that the Application Site is likely to connect. Unfortunately, the sewer records do not provide invert or cover levels.

A 24" (600mm) and a 30" (750mm) diameter surface water sewer lie either side of Lower Mortlake Road with the smaller being on the Application Site's side.

It is assumed that surface water currently generated by the Application Site is combined with its foul water and discharges to the foul/combined sewer as was normal practice in London. If this is the case, the separation of surface water for the new development will occur on site and discharge to the 600mm surface water sewer, this is subject to Thames Waters agreement and their capacity check.

The British Geological Survey maps show that Kempton Park Gravels are present may enable infiltration to take place. This is the preferred method of surface water disposal, at source, in the SuDS hierarchal tree.

On site infiltration testing should therefore be carried out to provide:

- An insight as to a safe method of excavation should a high perched water table be found;

- And if not, its infiltration capabilities.

For the purposes of this report an estimated figure, $2.5x10^{-5}$ from table 25.1 of the CIRIA C753 manual has been used to provide a guide as to the size of a possible infiltration method most suited to this site. This does not preclude during final design stages other infiltration techniques or methods from being implemented. It is merely to demonstrate what could be achieved.

Clearly, should a better infiltration rate be recorded the size and scope of attenuation devices can be reduced. Conversely, should it be worse, it will need to be increased. It is likely that the requirement of Part H of the Building Regulations may preclude the use of some infiltration techniques.

## Greenfield Runoff Rates

Greenfield runoff rates have been estimated for the site using the Institute of Hydrology Report 124 method, in accordance with the latest Environment Agency Guidance, as summarised below and are included within the appendices of this study:

| CATCHMENT | AREA | 1:1 AEP EVENT | 1:30 AEP EVENT | 1:100 AEP EVENT |
|---|---|---|---|---|
| Total Site | 0.031 Ha | 0.1l/s | 0.1 l/s | 0.2 l/s |

## Peak Existing Runoff Rates

Peak existing runoff rates have been calculated using the Modified Rational Method and obtained from the Causeway Flow simulation model for the 1:1 AEP, 1:30 AEP and 1:100 AEP events respectively with a 20 % and 40 % climate change allowances included to the 1:100 AEP event.

The following design inputs were adopted in accordance with guidance contained within the Flow Design software:

- Storm Duration: 60 Minutes.
- Volumetric Runoff Coefficient (Cv): 0.75
- Routing Coefficient (Cr): 1.30

Findings as summarised below and included within the appendices of this study:

| CATCHMENT | AREA | % IMPERMEABLE | 1:1 AEP EVENT | 1:30 AEP EVENT | 1:100 AEP EVENT | 1:100 AEP + 1.2 CC | 1:100 AEP + 1.4 CC |
|---|---|---|---|---|---|---|---|
| Total Site | 0.031Ha | 100 % | 7.4 l/s | 17.9 l/s | 23.2 l/s | 27.9 l/s | 32.6 l/s |

## 2.6. Proposed Development

The scheme as outlined on the proposed layouts (see appendices) proposes the demolition of the existing single storey garages/lock ups and construction of a new part two, part three storey structure plus basement building delivering a co-living scheme with 16 ca-living units and shared internal and external areas.

The basement has ‘external’ areas that could house infiltration storage providing a relaxation of the Building Regulation requirement of ‘No soakaway within 5.0m of a structure’ is be given. However, this is unlikely and should not be considered as an option.

The flat roofs will incorporate a ‘blue roof’ configuration to enable high level attenuation and thus avoid the need for pumping beneath the basement as would otherwise be necessary. Only the lower areas of sunken gardens and courtyard require pumping.

# SECTION 3

## ANALYSIS OF NATIONAL AND LOCAL POLICY

# 3. ANALYSIS OF NATIONAL AND LOCAL POLICY

## 3.1. National Policy

### National Planning Policy Framework (NPPF)

Communities and Local Government Document. (2019). *The National Planning Policy Framework* requires any Planning Application to demonstrate that the Proposed Development will be safe for the duration of its' design life, taking into account the vulnerability of its' users and without increasing flood risk elsewhere and reducing flood risk overall, where possible.

### Non-Statutory Technical Standards for Sustainable Drainage Systems

Department for Environment, Food and Rural Affairs. (2015). *Non-Statutory Technical Standards for Sustainable Drainage Systems* state that the peak rate of discharge from a redevelopment during the 1:1 year and 1:100 year rainfall events should be as close as reasonably practical to the corresponding greenfield runoff rate, but should never exceed that of the pre-development state.

The standards also recommend that, where reasonably practicable, the runoff volume generated from the 1:100 year, 6 hour rainfall event should be constrained to the corresponding greenfield runoff volume.

### Building Regulations Approved Document H

Secretary of State. (2015). *Building Regulations Approved Document H* establishes a hierarchy for surface water disposal and encourages a SuDS approach. The hierarchy stipulates that surface water runoff which is not collected for re-use must be discharged in the following order of priority:

1. Discharge to ground via infiltration; or, where not reasonably practicable;
2. Discharge to a surface water body (i.e. river, watercourse or the like); or, where not reasonably practicable:
3. Discharge to a surface water sewer, highway drain or other surface water drainage system; or, where not reasonably practicable:
4. Discharge to a combined sewer.

## 3.2. Local Policy

### Lead Local Flood Authority SUDS Policy Statement

The London Borough of Richmond upon Thames, in their role as Lead Local Flood Authority (LLFA), stipulates the required standards for sustainable drainage systems for all major developments within their jurisdiction.

The London Borough of Richmond upon Thames, Local Development Framework, Design Guide and the Flood Risk Management Strategy outlines the following main policies, relevant to the development of the DS, as follows:

- Developments will be expected to incorporate Sustainable Drainage Systems (SuDS) to reduce the risk of surface water flooding, both to the site in question and to the surrounding area;
- Any proposed development must attempt to make use of and work within the constraints of the existing site topography where possible;
- Any SuDS system must consider the effects of climate change and reduce the potential for environmental damage both on and off site;
- Preference should be for the adoption of SuDS systems which enhance public realm, wherever possible;
- Drainage Strategies must assess the hydrology of the site along with landform, geology, drainage and flood risk and incorporate this within the adopted SuDS proposal; and
- Recommendations given within national policy (as outlined above) should be adhered to in full, unless demonstrated to be inappropriate.

## 3.3. Assessing Flood Risk

The Department for Environment, Food and Rural Affairs & Environment Agency (2017). *Flood Risk Assessment for Planning Applications* confirms that detailed flood risk assessment is required where the Application Site is:

- Located in Flood Zone 2 or 3, including minor development and change of use; or
- More than 1 hectare (Ha) in Flood Zone 1; or
- Less than 1 Ha in Flood Zone 1, including change of use in a development type to a more vulnerable class, where the development could be affected by sources of flooding other than by rivers and the sea; or
- In an area within Flood Zone 1 that has critical drainage problems as notified by the Environment Agency.

The Government's online Flood Map for Planning indicates that the Proposed Development is situated within Flood Zone 1. In accordance with Table 1 (Flood Zones) of the NPPF, this classifies the site of having a less than 1:1000 annual probability of river or sea flooding. See appendices.

Table 2 (Flood Risk Vulnerability Classification) of the NPPF classifies the existing commercial yard as 'Less Vulnerable', with a change in proposed use of the site and an introduction of a basement this is classed as 'More Vulnerable'.

Table 3 (Flood Risk Vulnerability and Flood Zone Compatibility) of the NPPF states that More Vulnerable development is compatible within Flood Zone 1 and therefore the Sequential Test is considered to be satisfied and an Exception Test is not required here.

Data as to recorded flood sources other than from a from rivers and the sea have been requested from the LLFA and Environment Agency for completeness. At the time of writing we are yet to receive a formal response from either party.

Finally, the total site area for the Application Site has been determined as 0.031 hectares, falling below the trigger criteria for a formal Flood Risk Assessment.

Therefore, provision of a formal Flood Risk Assessment is not considered to be required for the proposed development and it is felt that flood risk does not represent a constraint to the development of the Site.

## 3.4. Easements and Other Constraints

Utilities records obtained for the site included within the Appendices of this study suggest the presence of several existing utilities on, or within the immediate vicinity, of the Application Site. All of these may benefit from easements and may therefore impact on the future development of the Application Site and DS, during the course of the ongoing design development.

## 3.5. Below Ground Drainage Diversions and Other Constraints

No diversions of publicly owned drainage infrastructure are known to be present at the Application Site at the time of writing.

Similarly, no other notable constraints are envisaged apart from the size of the proposed footprint and the area available for SuDS structures

## 3.6. Opportunities

The redevelopment of the Application Site presents an opportunity to contribute to a reduction in flood risk by reducing the current rate of discharge to the public sewer network and whilst not decreasing the overall volume discharged, the reduced rate proposed will ease the immediate burden on the sewerage network during peak storm events.

The incorporation of attenuation within the Proposed Development should seek to offer a reduction in peak runoff rates in accordance with both the national and local policies described above. Subsequently, a reduction in peak flow rates would result in a lower surface water flood risk downstream of the Proposed Development, with larger reductions providing a greater betterment.

Surface water generated by the Application Site is believed to discharge un-treated directly to the public surface water network. Subsequently the management of surface water in accordance with the requirements of local policy and CIRIA. (2015). *C753 – The SuDS Manual* would result in an increase in the quality of the surface water generated by the Application Site as a result of the Proposed Development.

# SECTION 4

## FOUL WATER MANAGEMENT

# 4. FOUL WATER MANAGEMENT

## 4.1. Existing Discharge Rates and Points of Connection

Currently, the Application Site a vacant plot that formerly provided a temporary car wash and a lock up facility.

At the time of writing, the location of the existing point of connection to the public foul water sewer is unknown and it is intended that this will be investigated further as part of ongoing intrusive survey works.

Estimated foul water volume has been determined as **4000 l/day** in accordance with Butler & Davies. (2012). 2nd Ed. *Urban Drainage*, assuming the following:

- Infiltration Factor: 1.10
- Peak Flow Factor: 6
- Per Capita Contribution: 200 l/person/day (or 4000 l/unit/day, whichever is the greater in accordance with recommendations within Sewers for Adoption (7th Ed.).

We do not know what the level of peak foul water flows for the existing premises may have been, as it would have been dependent on the number of cars per day that were valeted, and the number of people formerly employed on site.

## 4.2. Proposed Discharge Rates and Points of Connection

The Proposed Development will provide a total of sixteen co-living units. A population of 1 persons per unit has been assumed as part of this assessment.

Using similar design assumptions, the estimated foul water volume has been determined as the equivalent of **21120 l/day**, corresponding to a peak foul water flow of **0.24 l/s** assuming a 24 hour 'usage'.

Where possible, existing foul water connections will be re-utilised for the Proposed Development and all foul water drainage will be designed and constructed in accordance with the Building Regulations Part H and/or Sewers for Adoption (7th Ed.).

The proposed foul water drainage will require pumping to a shallow on-site termination chamber, prior to discharge via gravity to the public sewer. This will be smaller in size than the surface water systems submersible pump and separate to it. Its discharge rate will be subject to the most efficient impeller/motor combination for the head with the maximum discharge rate limited to 1.0l/s unless the manufacturers are happy that their units can discharge at lower values without causing possible future maintenance issues.

## 4.3. Analysis

The Proposed Development will generate a nett increase in foul water volume and therefore demand to the public foul water sewer network. This can be offset by the controlled volume discharged by the surface water system

Given however the relatively small nature of the increased flow assuming a conventional gravity discharge, it would be unlikely that the public sewer network would not have enough capacity to cater for the Proposed Development. However, this will be discussed with Thames Water at the time of S106 application.

Confirmation as to the capacity of the combined sewer has not been sought from Thames Water at the time of writing. However, it is recommended that a S106 application be made at an early design stage to clarify. It should also be remembered that the increase in foul water waste is easily offset by the decrease in surface water discharge rate due to the flow control device restriction.

# SECTION 5

## SURFACE WATER MANAGEMENT

# 5. SURFACE WATER MANAGEMENT

## 5.1. Proposed Drainage Catchments

Owing to the relatively small area of the Application Site less than 1.0ha, it is proposed to utilise a single drainage catchment in the development of the surface water drainage design.

## 5.2. SuDS Management Train

In accordance with the discharge hierarchy identified in Section 3, surface water generated by the Proposed Development should be discharged to ground via infiltration, where practicable to do so.

Infiltration / percolation testing in accordance with BRE Digest 367 could be undertaken at the application site as part of intrusive site investigation. This test comprises the formation of a trial pit to a depth of 1.00 m below ground level, squaring of the pit sides and subsequent rapid filling with potable water. The fall in water level from 75 % to 25 % effective fill depth is then timed to ascertain an infiltration rate in m/s.

In the case of the Application Site, an infiltration method of disposal is unlikely to be accepted due to the current Building Regulation requirement that a minimum of 5.0m should be maintained between a soakaway and a structure.

Similarly, the presence of a watercourse as a method of disposal is not available and therefore, the Public Combined Sewer to the South of the Application Site is believed the most likely receptive point into which surface water could be discharged.

Subsequently it is proposed that the Application Site will dispose of surface water into this public system, re-utilising existing connections where possible or via new appropriately designed connections. This is subject to seeking appropriate approvals from the sewerage undertaker.

However, the flow will be discharged at a controlled rate and attenuated at roof level, blue roofs and attenuated within the wet well of a small submersible pump, for the sunken areas.

## 5.3. Catchment Contributing Areas

A breakdown of the contributing areas for the proposed surface water drainage system, are as follows:

| CATCHMENT | OPEN SPACE | DEVELOPABLE AREA | %IMPERMEABLE | IMPERMEABLE / DESIGN AREA |
|---|---|---|---|---|
| Total Site | 0.000 Ha | 0.031 Ha | 100.0 % | **0.031 Ha** |

It should be noted that as the Application Site proposes no permeable surfaces owing to the constraints and subsequently no allowance for urban creep has been considered.

## 5.4. Allowance for Climate Change

Table 2 (Peak Rainfall Intensity Allowance in Small and Urban Catchments) of Environment Agency. (2019). Flood Risk Assessments: Climate Change Allowances confirms the climate change allowance of 40% should be adopted for the Application Site, assuming a lifespan of 100 years for residential development as recommended within the NPPF.

## 5.5. Allowable Discharge Rates

In accordance with the national and local policies outlined within Section 3 the Proposed Development should seek to limit the peak flow rate to the greenfield runoff rates, wherever practicable. Where this cannot be achieved, a betterment rate may be considered acceptable.

As has already been confirmed in Section 2, the greenfield runoff rate for the Application Site has been determined as 0.3 l/s for the 1:100 AEP event and it is not considered practicable to limit the discharge rate to such a low value in this instance.

Environment Agency. (2013). *Rainfall Runoff Management for Developments* stipulates that a minimum discharge rate of 5.0 l/s should be adopted to mitigate risks associated with blockage of the flow control device, which could present an unacceptable increase in flood risk.

It should however be noted that, commercially available flow control technologies have since been developed which can better this minimum value, with published minimum flow rates of 0.7 l/s being achievable using vortex-flow systems, for design head values as low as 0.4 m.

Notwithstanding this, a clear balance must be struck between limiting discharge flows, maintaining practicality of construction, minimising ongoing maintenance requirements, and ensuring the scheme remains commercially viable.

Owing to the constraints present at the Application Site due to its small plan area and likely space restrictions, it is considered prudent, from a design perspective, to ensure a constant discharge flow to minimize attenuation volume requirements and mitigate flood risk.

This limits the choice of available flow control devices to that of a float operated system as other types (i.e. vortex systems, throttle pipes, orifice plates etc.) are reliant upon the generation of head pressure to develop the specified peak discharge rates. In simple terms, these systems require a larger volume of water behind the device to activate the peak discharge flows and hence require larger attenuation volumes.

It is therefore proposed to limit the discharge from the Proposed Development to **5.0 l/s**, which is the current minimum published value for a float-operated control device. Again, the volume contained within the wet well of the pumping station is minimal and the flow from the larger blue roof area can be considerably less, but a full design is necessary to obtain the optimum discharge rate for the area and thus volume contained.

Limiting the maximum discharge rate from the Proposed Development to this 5.0l/s would present a reduction in peak discharge rates for the key design events and an overall betterment as shown below. However, this is further improved when considering the lower discharge rates usually generated when introducing blue roofs.

- **84.7 %** during the 1:100 AEP event, including the 40 % allowance for climate change.
- **78.4 %** during the 1:100 AEP event.
- **72.0 %** during the 1:30 AEP event.

## 5.6. Proposed SUDS Features

Due to the constraints imposed on the Proposed Development, the incorporation of above-ground SuDS features offering complementary benefits is not considered feasible, save for the use of a communal water butt to store water for irrigation purposes.

Similarly, owing to the limited area of proposed external works, it is not considered feasible to adopt permeable surfaces at the Proposed Development.

Options available are either or a combination of the two;

- to install a 1.8m dia concrete ring 4.4m deep beneath the basement to form the attenuation tank within the limited area of external works. The attenuation tank will also act as the wet well for a twin pump system the eventual design of which will take into consideration the head and the distance to the termination inspection chamber. It will discharge at a rate of no more than 5.0l/s or;
- To provide some attenuation (10.3m³) at roof level in the form of a Blue Roof and enabling its' discharge to continue under gravity to the Public Sewer, reducing the need for a large wet well (15.0m³).

The required attenuation volume has been determined for a range of storm events in accordance with the requirements of the non-statutory standards for sustainable drainage systems. See appendix D

Estimated attenuation volumes have been calculated in two stages. Firstly, an anticipated range has been determined using the Quick Storage Estimate function of an Industry Standard design package, to inform further rigorous assessment. Secondly, a preliminary model has then been developed using that package to determine a more refined attenuation estimate as summarised in the table below, with calculations given in the appendices.

The preliminary model is based upon a single attenuation tank, with discharge from the structure limited to 5.0 l/s via a pump to the existing combined sewer in Lower Mortlake Road. The rising main should discharge to a termination inspection chamber enabling a gravity to outfall to the sewer, as required by the Water Authority.

Following a storage estimate exercise, a minimum volume of 15.0 $m^3$ will be required in order to provide the maximum achievable betterment of 84.7% during the 1:100 AEP event plus a 40% allowance for climate change, as outlined above. However, as the method of attenuation will be in the form of the wet well due to the limitations of available area the wet well can be reduced in volume due to the constant discharge brought about by the pump(s) to 5.0m² and the additional storage from the blue roofs (10.0m³).

It should also be understood that the during the peak storm event the neighbourhood might be experiencing is unlikely to be at the same time as the pump automated system reaches the start

level within the pumping station, together with the slower and delayed discharge from the blue roofs. As such the peak flow in the receiving sewer may have already passed or not yet occurred.

As there is minimal change in impermeable area, there would be little increase in discharge volumes as a result of the 1:100 AEP 6-hour event and therefore this has not been considered further.

| STORM EVENT | CONTRIBUTING AREA | MAXIMUM DISCHARGE | ATTENUATION VOL (RANGE) | ATTENUATION VOL (OPTIMISED) |
|---|---|---|---|---|
| 1:1 AEP | 0.031 Ha | 5.0 l/s | 1.0 – 3.0 $m^3$ | 2.0$m^3$ |
| 1:30 AEP | 0.031 Ha | 5.0 l/s | 6.0 – 11.0 $m^3$ | 7.0$m^3$ |
| 1:100 AEP | 0.031 Ha | 5.0 l/s | 9.0 – 16.0 $m^3$ | 11.0$m^3$ |
| 1:100 AEP + 20% CC | 0.031 Ha | 5.0 l/s | 12.0 – 20.0 $m^3$ | 13.0$m^3$ |
| 1:100 AEP + 40% CC | 0.031 Ha | 5.0 l/s | 15.0 – 25.0 $m^3$ | 15.0$m^3$ |

With the above in consideration, the Proposed Development would therefore contribute to a reduction in flood risk associated with the exceedance of the public surface water sewer network in the vicinity of the Application Site. But it would provide a significant reduction in peak runoff rates and avoid an increase in the total runoff volume.

## 5.7. Water Quality

The Proposed Development would utilise existing connections to the public surface water sewers in the immediate vicinity of the site, wherever possible.

As there is a significant change of use of the Proposed Development this would greatly reduce former pollutant loading and subsequently the vulnerability of the existing surface water sewer is considered to be high with likely hydrocarbon levels.

## 5.8. Ownership and Maintenance

To ensure the long-term performance of the proposed DS, the on-site drainage system will be owned and maintained by the site operator or a maintenance company (MC) in accordance with the indicative schedule below:

| ELEMENT / DRAINAGE COMPONENT | OWNERSHIP / ADOPTION | MAINTENANCE REQUIREMENTS |
|---|---|---|
| Pumping stations | Site Operator / MC | To be monitored electronically and be on a maintenance regime with a professional service team.<br><br>**Inspection and service annually**. |
| Blue Roofs | Site Operator / MC | To be inspected by supplier or suppliers agents to determine the condition of the lining material with respect to leaks.<br><br>**Inspect annually**<br><br>To inspect flow control device and overflow intake for blockages and debris<br><br>**Inspect six months or prior to Autumn leaf drop and again in the spring** |
| Rain Water Pipes | Site Operator / MC | Clearance of leaves / debris from guttering and hopper inlets. Rodding points provided to clear blockages via conventional rodding methods.<br><br>**Inspection annually and before / after extreme storm events.** |
| Soil Vent Piles / “Stub Stacks” | Site Operator / MC | Rodding points to be provided to clear blockages via conventional rodding methods.<br><br>**Inspection annually**. |
| Gullies (Internal & External) | Site Operator / MC | To be monitored for silt build-up and cleaned as required. Where provided, ensure air traps are primed and sealed to prevent smells.<br><br>**Inspection quarterly.** |

| | | |
|---|---|---|
| Surface Water Drainage Channels | Site Operator / MC | To be monitored and cleaned via jetting when any debris / silt reduces the cross-sectional area by 25% or more. Inspection to include both the channel and silt trap / gulley outlets.<br><br>**Inspection annually and before / after extreme storm events**. |
| Below Ground Pipework Generally | Site Operator / MC | To be inspected for reduction in cross-sectional area (i.e due to blockage, silt or debris build-up, root ingress etc) general condition of materials, pipe displacement and the like.<br><br>**Inspection annually and where appropriate before / after extreme storm events**. |
| Manholes / Inspection Chambers Generally | Site Operator / MC | To be inspected for debris and integrity of chambers and covers generally.<br><br>**Inspection annually and where appropriate before / after extreme storm events.** |

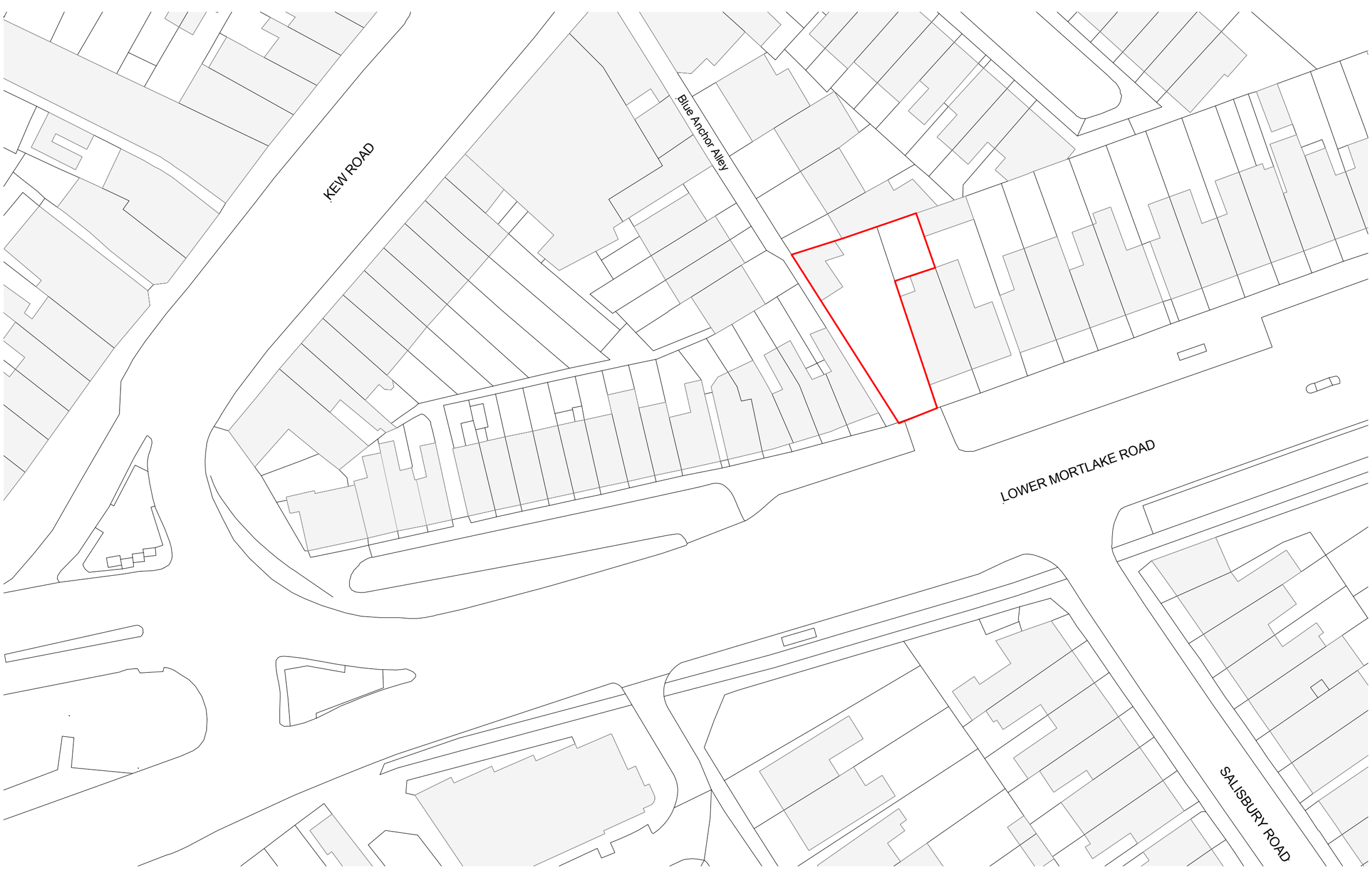
# SECTION 6
CONCLUSIONS

## 6. CONCLUSIONS

- The development proposals comprise a new part two part three story plus basement co-living scheme delivering sixteen units plus shared internal and external spaces..
- It is assumed that both surface and foul water sewer currently generated by the site is discharged to the public sewer network in Lower Mortlake Road as discussed in 2.2. The number of connections is likely to be one of both foul and surface water. However, the location and condition of the existing connection to the public sewer is not at present known at the time of writing.
- Due to the proximity of the foundations and adjacent structures, the incorporation of soakaways or other infiltration devices is not considered to be practical.
- The peak greenfield runoff rate at the site has been determined as being well below the minimum practicable discharge rates for commercially available flow restriction devices. A discharge limit of 5.0 l/s has been adopted as the minimum. To limit discharge to less than this value would result in an unacceptable increase in flood risk associated with surcharge of the limited area available for the wet well and the vast increase in volume needed to achieve Greenfield rates. Consequently, it is not considered practicable to limit discharge from the development to the greenfield runoff rate in accordance with SuDS Policy 14.
- The discharge from the site post-development will be limited to a maximum rate of 5.0 l/s during all events up to and including the 1:100 AEP event including a 40% allowance for climate change. This would provide a significant betterment to the existing condition without introducing an additional source of flood risk.
- To achieve the above limitations of discharge, a 5.0$m^3$ of wet well attenuation will be provided under the proposed sunken garden, pumping to a termination inspection chamber prior to out falling, by gravity, to the Public sewerage system.
- A blue roof is to be provided to attenuate 10.0$m^3$ a larger portion of the volume required enabling discharge by gravity reducing the size of wet well for a submersible pumping station. It will not eliminate it, as it will serve the sunken areas and for the purposes should the flow control on the roofs becomes blocked and the overflow is operable.
- A separate and smaller pumping station will be located under the washroom/plant area for the foul waste ensuring the minimum 24hr storage capacity. Prior to discharging by gravity as shown
- The development proposals will increase the peak foul water flows from the site. However, given the relatively small flow rates in either instance, it would be unlikely that the public sewer network would not have sufficient capacity to cater for the Proposed Development. Clarification has not been sought from Thames Water at the time of writing.
- The development proposals will contribute to a reduction in flood risk associated with the exceedance of the public surface water sewer network in the vicinity of the site by providing a significant reduction in both peak discharge rates and reducing volume during peak storm intensities.
- The proposed Drainage Strategy has been prepared to be robust and to demonstrate that it is possible to drain the site in a sustainable manner in keeping with local policy requirements without increasing flood risk to or from the Proposed Development. It should be noted that this strategy presents one possible solution to demonstrate that the Proposed Development can be sustainably drained and should not be interpreted as the definitive solution.

# APPENDIX A

EXISTING SITE PLAN




Lynas Smith, Studio 21, Monohaus, 143 Mare Street, London, E83FW
020 8985 0492
www.lynas-smith.com

| Rev. | Description | Date | By |
|---|---|---|---|
| P 1 | Issued for Planning | 22.10.19 | CK |

18/10/2019 14:22:12



Status: Planning
Drawn: CK
Checked: ML

Project No: 1904
Last Issued: 22.10.19

47a Lower Mortlake Road

# Existing Site Plan

1 : 500@A3

N

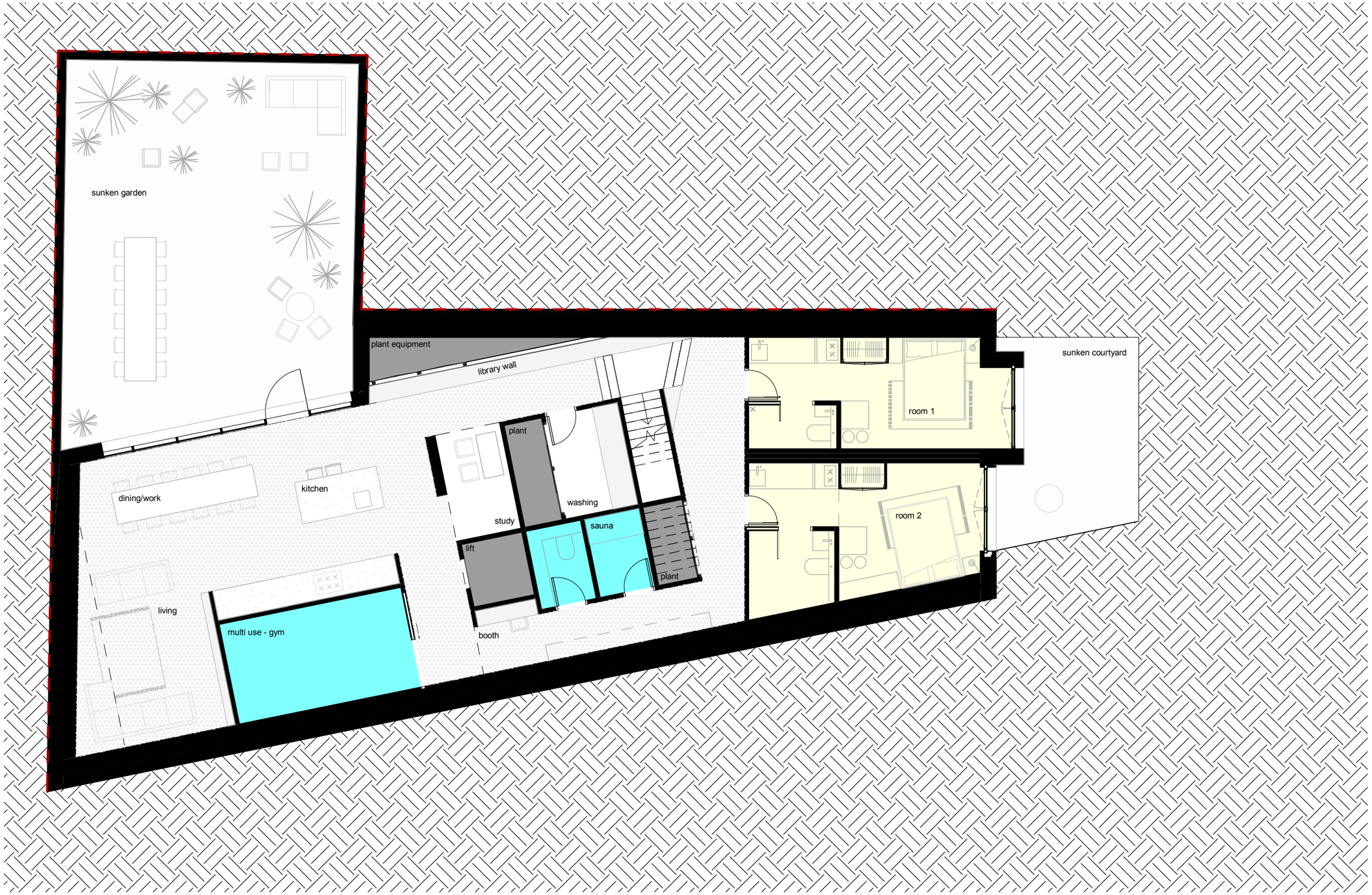
LYNAS SMITH

1904- LS-01-010_ P1

# APPENDIX B

PROPOSED SITE PLANS

Lynas Smith, Studio 21, Monohaus, 143 Mare Street, London, E83FW




020 8985 0492

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0 1 5 10 M

| Rev. | Description | Date | By |
|---|---|---|---|
| P1 | Issued for Planning | 22.10.19 | CK |

18/10/2019 14:17:11



Status: Planning
Drawn: CK
Checked: ML

Project No: 1904
Last Issued: 22.10.19

47a Lower Mortlake Road

# Lower Ground Floor Plan

1 : 100@A3

LYNAS SMITH

1904- LS-15-099_ P1


Lynas Smith, Studio 21, Monohaus, 143 Mare Street, London, E83FW
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| Rev. | Description | Date | By |
|---|---|---|---|
| P 1 | Issued for Planning | 22.10.19 | CK |

18/10/2019 14:28:48



Status: Planning
Drawn: CK
Checked: ML

Project No: 1904
Last Issued: 22.10.19

47a Lower Mortlake Road

# Ground Floor Plan

1 : 100@A3

LYNAS SMITH

1904- LS-15-100_ P1


Lynas Smith, Studio 21, Monohaus, 143 Mare Street, London, E83FW
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| Rev. | Description | Date | By |
|---|---|---|---|
| P1 | Issued for Planning | 22.10.19 | CK |

18/10/2019 17:16:17



Status: Planning
Drawn: CK
Checked: ML

Project No: 1904
Last Issued: 22.10.19

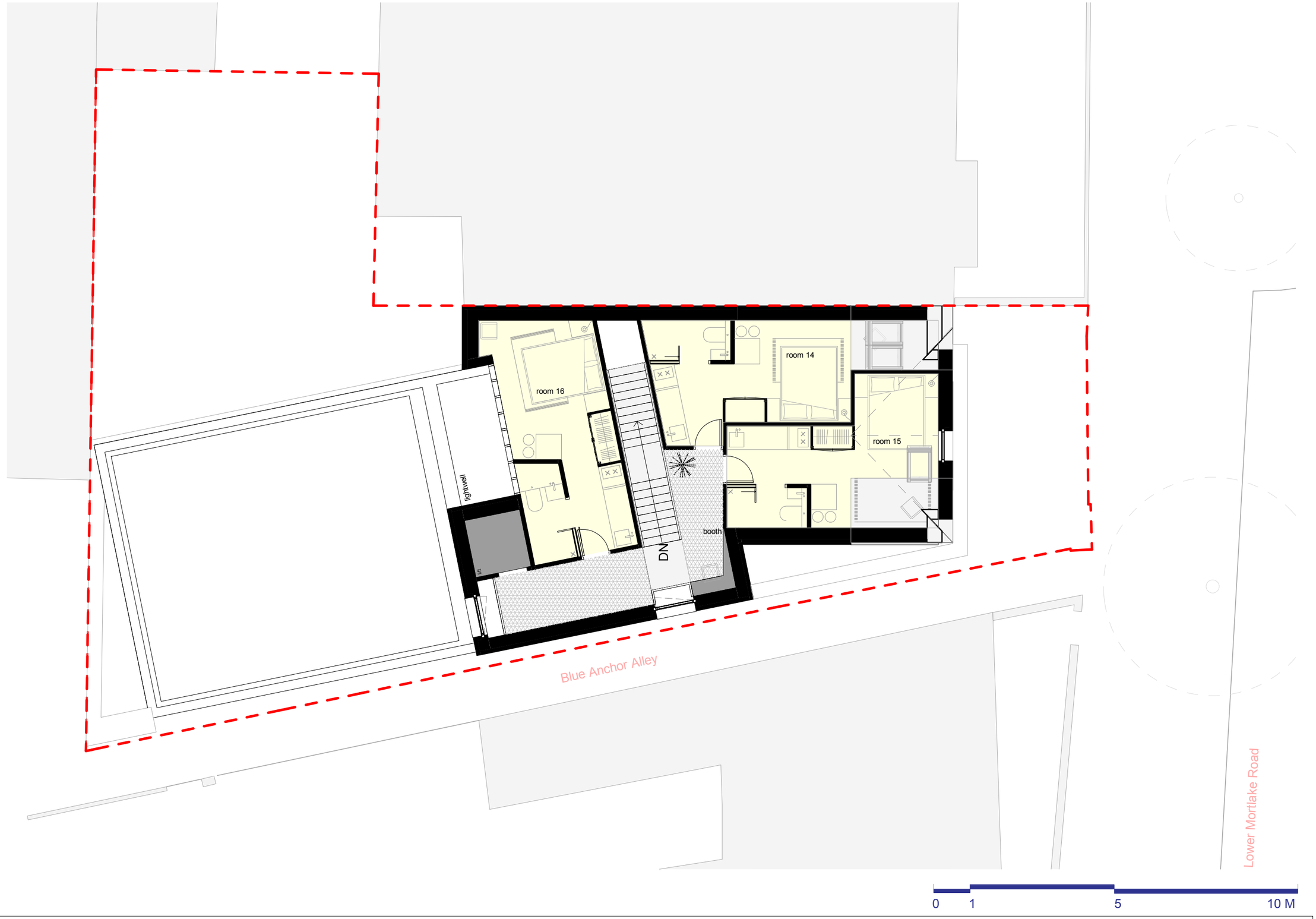
47a Lower Mortlake Road

# First Floor Plan

1 : 100@A3

LYNAS SMITH

1904- LS-15-101_ P1

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| Rev. | Description | Date | By |
|---|---|---|---|
| P1 | Issued for Planning | 22.10.19 | CK |

18/10/2019 17:16:33



Status: Planning
Drawn: CK
Checked: ML

Project No: 1904
Last Issued: 22.10.19

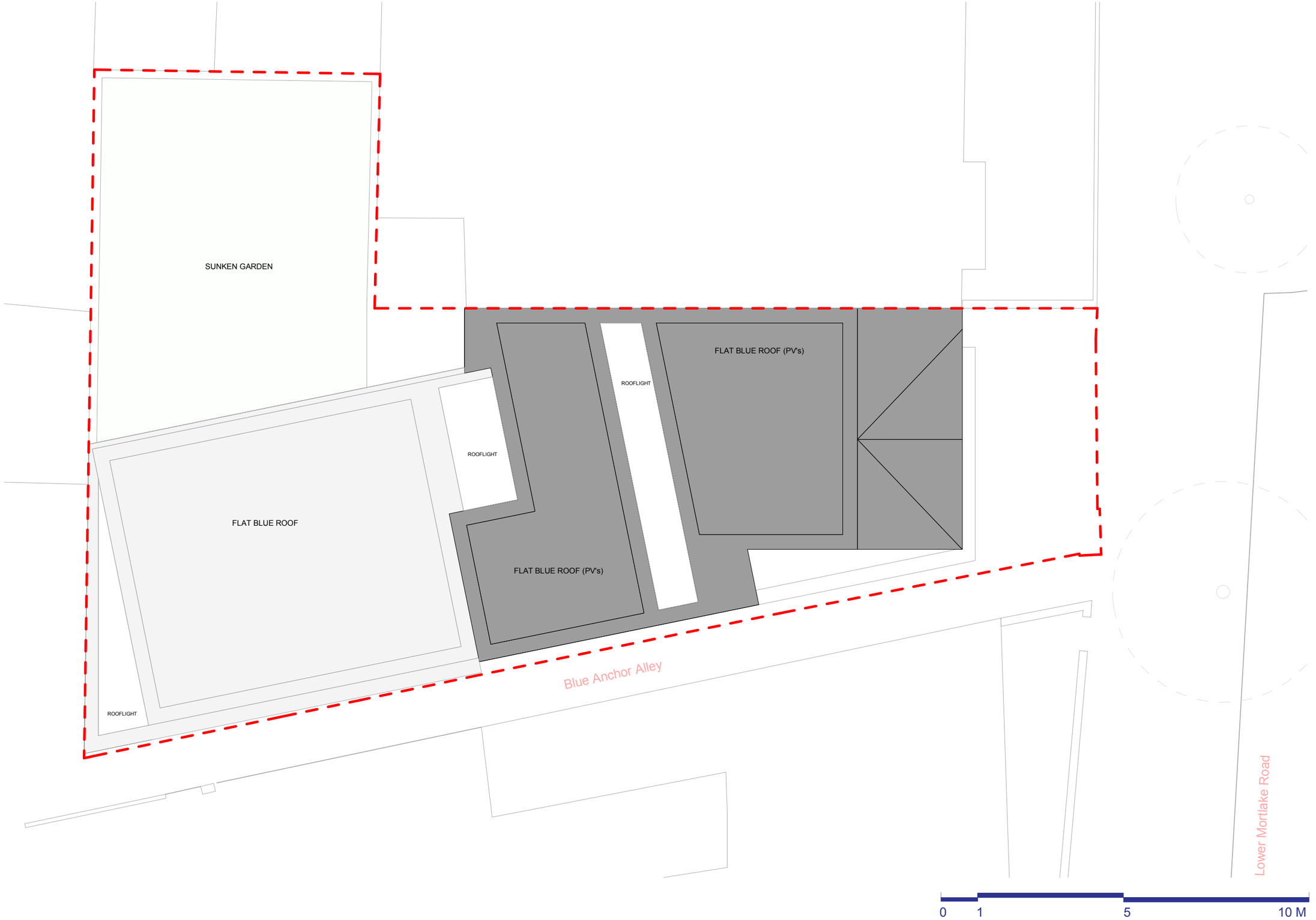
47a Lower Mortlake Road

# Second Floor Plan

1 : 100@A3

LYNAS SMITH

1904- LS-15-102_ P1

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| Rev. | Description | Date | By |
|---|---|---|---|
| P 1 | Issued for Planning | 22.10.19 | CK |

18/10/2019 14:30:32



Original drawing is A3. Do not scale from this drawing.

Status: Planning
Drawn: CK
Checked: ML

Project No: 1904
Last Issued: 22.10.19

47a Lower Mortlake Road

# Roof Plan

1 : 100@A3

LYNAS SMITH

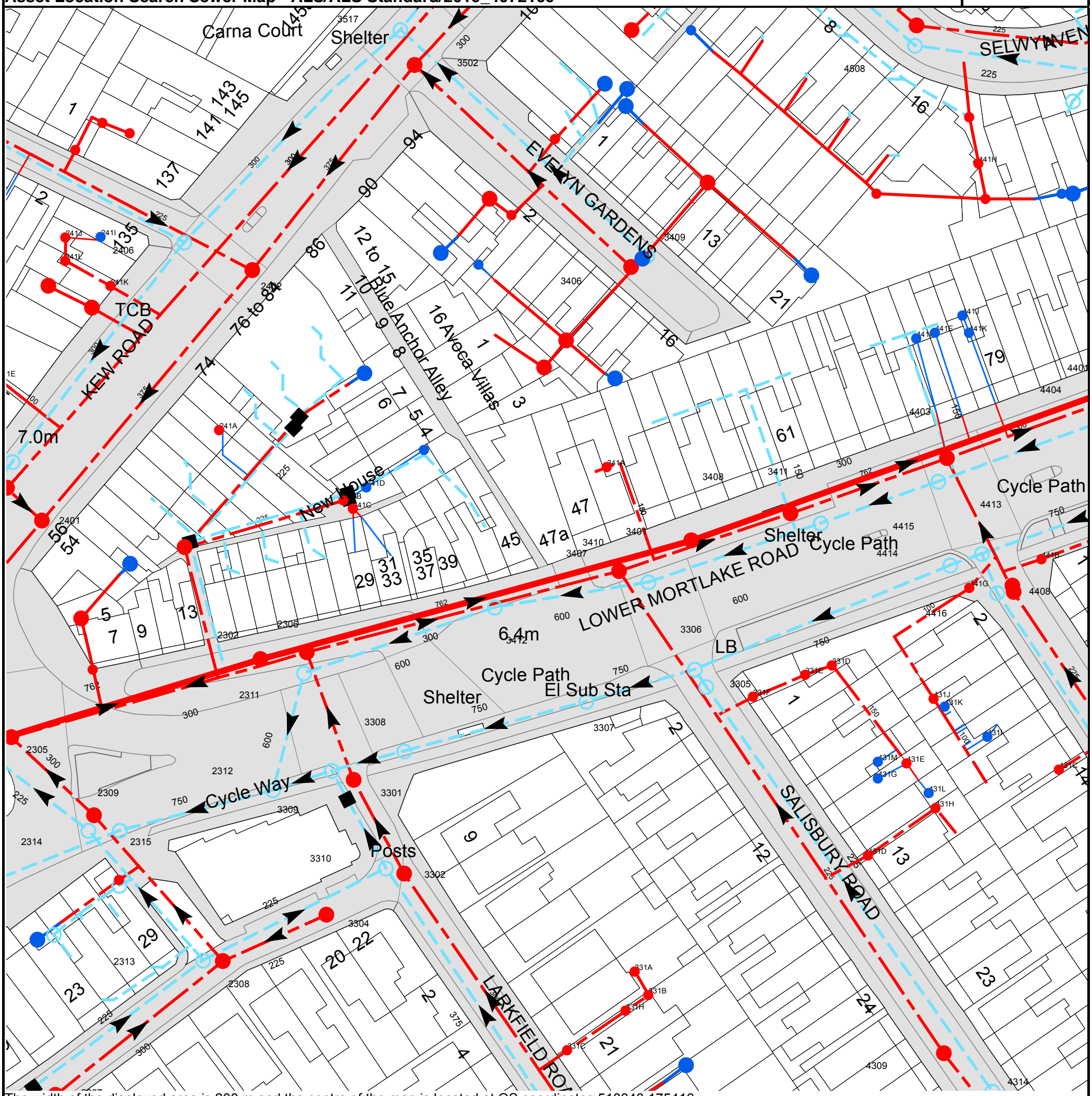
1904- LS-15-103_ P1

# APPENDIX C

THAMES WATER

ASSET PLANS

**Asset Location Search Sewer Map - ALS/ALS Standard/2019_4072169**




The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 518343,175416

**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 |
|---|---|---|
| 44XV | n/a | n/a |
| 4408 | 6.27 | 2.34 |
| 441B | n/a | n/a |
| 431C | n/a | n/a |
| 44XS | n/a | n/a |
| 44WZ | n/a | n/a |
| 44WX | n/a | n/a |
| 44WR | n/a | n/a |
| 34ZS | n/a | n/a |
| 35YV | n/a | n/a |
| 3406 | 6.92 | 4.36 |
| 35YR | n/a | n/a |
| 34ZV | n/a | n/a |
| 3409 | 6.88 | 5.61 |
| 35XR | n/a | n/a |
| 34ZQ | n/a | n/a |
| 34ZP | n/a | n/a |
| 44XT | n/a | n/a |
| 4508 | 6.9 | 5.24 |
| 4501 | 6.92 | 3.98 |
| 441F | n/a | n/a |
| 441E | n/a | n/a |
| 441J | n/a | n/a |
| 441K | n/a | n/a |
| 44XR | n/a | n/a |
| 441H | n/a | n/a |
| 3407 | 6.62 | 2.28 |
| 331A | n/a | n/a |
| 3410 | 6.64 | 3.63 |
| 331B | n/a | n/a |
| 3401 | n/a | -3.52 |
| 3306 | 6.61 | 3.21 |
| 3305 | 6.58 | 4.22 |
| 331F | n/a | n/a |
| 3408 | n/a | n/a |
| 331E | n/a | n/a |
| 3411 | 6.51 | 3.65 |
| 331D | n/a | n/a |
| 431D | n/a | n/a |
| 431G | n/a | n/a |
| 431M | n/a | n/a |
| 431E | n/a | n/a |
| 431L | n/a | n/a |
| 431J | n/a | n/a |
| 431H | n/a | n/a |
| 4413 | 6.38 | 3.65 |
| 431K | n/a | n/a |
| 4403 | n/a | n/a |
| 4414 | 6.42 | 3.35 |
| 441G | n/a | n/a |
| 4415 | 6.34 | 3.35 |
| 431I | 6.63 | 5.99 |
| 4416 | 6.22 | 4 |
| 4314 | 6.96 | 5.19 |
| 33ZW | n/a | n/a |
| 4309 | 6.94 | 4.48 |
| 331H | n/a | n/a |
| 2402 | 6.92 | 1.21 |
| 34YY | n/a | n/a |
| 241L | n/a | n/a |
| 34YS | n/a | n/a |
| 2406 | 6.98 | 3.63 |
| 241J | n/a | n/a |
| 241I | n/a | n/a |
| 34YP | n/a | n/a |
| 34YQ | n/a | n/a |
| 24YZ | n/a | n/a |
| 34XX | n/a | n/a |
| 24ZR | n/a | n/a |
| 24ZQ | n/a | n/a |
| 35YW | n/a | n/a |
| 3502 | 6.75 | 1.4 |
| 3517 | 6.75 | 3.7 |
| 3307 | 6.55 | 3.15 |
| 2311 | 6.18 | 3.62 |
| 23ZX | n/a | n/a |
| 2302 | n/a | -3.45 |
| 2306 | 6.15 | 2.61 |
| 24YV | n/a | n/a |
| 3412 | 6.48 | 3.62 |
| 24YX | n/a | n/a |
| 24YR | n/a | n/a |
| 2401 | 6.76 | .86 |
| 341C | n/a | n/a |
| 341B | n/a | n/a |
| 2407 | n/a | n/a |
| 341D | n/a | n/a |
| 341A | n/a | n/a |
| 2405 | n/a | n/a |
| 34WZ | n/a | n/a |
| 241A | n/a | n/a |

| Manhole Reference | Manhole Cover Level | Manhole Invert Level |
|---|---|---|
| 34YW | n/a | n/a |
| 34XQ | n/a | n/a |
| 34ZX | n/a | n/a |
| 34ZW | n/a | n/a |
| 24ZT | n/a | n/a |
| 24ZV | n/a | n/a |
| 241K | n/a | n/a |
| 331C | n/a | n/a |
| 2308 | 6.57 | 4.78 |
| 2313 | 6.58 | 4.64 |
| 23XW | n/a | n/a |
| 23YS | n/a | n/a |
| 3304 | 6.5 | 4.16 |
| 23YP | n/a | n/a |
| 23XT | n/a | n/a |
| 3302 | 6.53 | 4.46 |
| 3310 | n/a | n/a |
| 2315 | 6.61 | 2.98 |
| 2314 | 6.51 | 4.37 |
| 2309 | 6.58 | 4.47 |
| 2312 | 6.62 | 3.06 |
| 3301 | 6.39 | 4.22 |
| 3309 | 6.4 | 3.09 |
| 3308 | 6.43 | 3.12 |
| 2305 | 6.88 | 2.37 |

# 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

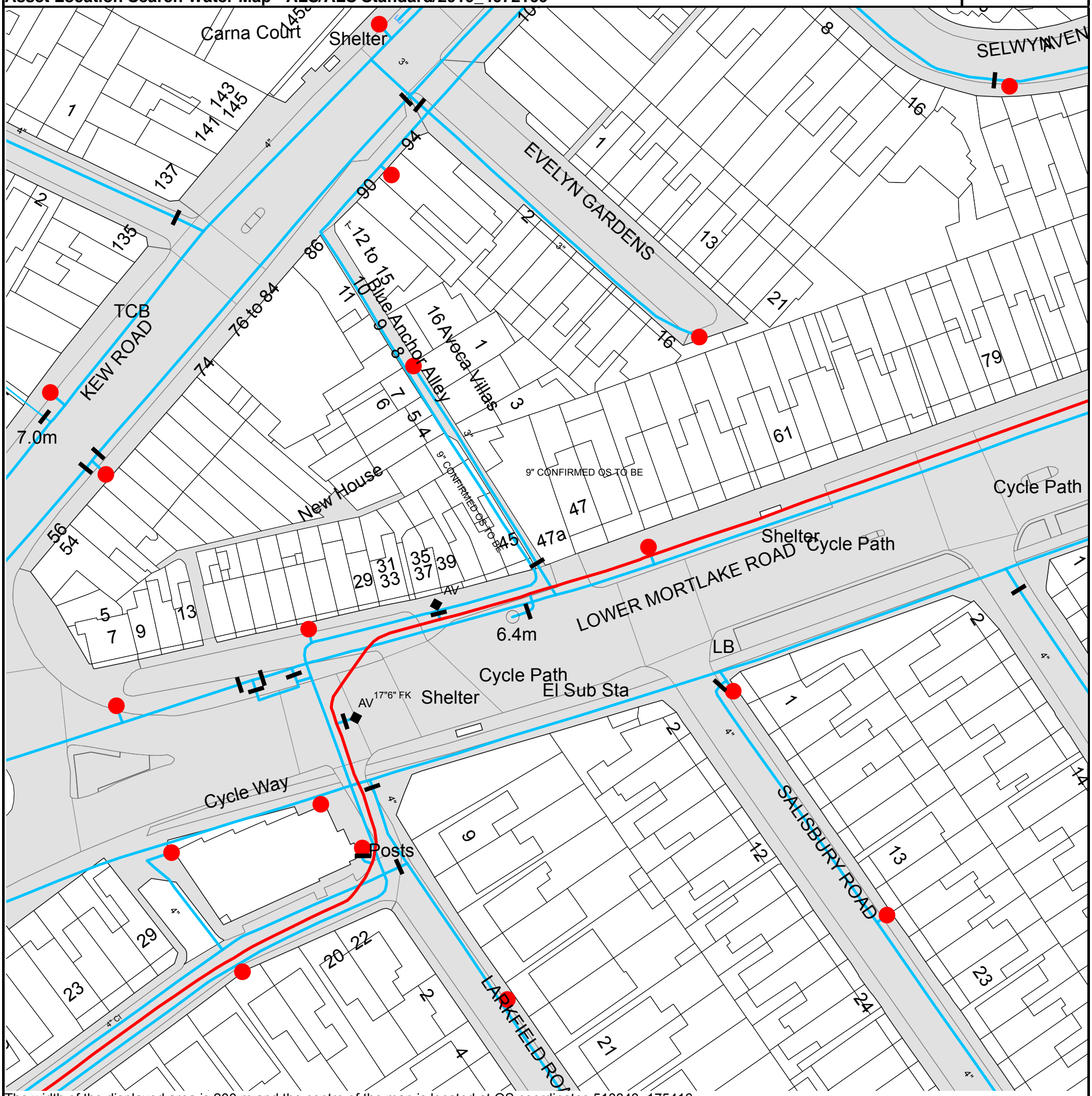
Proposed

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/2019_4072169**




The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 518343, 175416.

# 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.

## 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

| 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') |

## 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.

# APPENDIX D

SURFACE WATER CALCULATIONS

# EXISTING SITE CONDITION

## Design Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FSR | Maximum Time of Concentration (mins) | 30.00 |
| Return Period (years) | 1 | Maximum Rainfall (mm/hr) | 50.0 |
| Additional Flow (%) | 0 | Minimum Velocity (m/s) | 1.00 |
| FSR Region | England and Wales | Connection Type | Level Soffits |
| M5-60 (mm) | 20.000 | Minimum Backdrop Height (m) | 0.200 |
| Ratio-R | 0.400 | Preferred Cover Depth (m) | 1.200 |
| CV | 0.750 | Include Intermediate Ground | ✓ |
| Time of Entry (mins) | 2.00 | Enforce best practice design rules | ✓ |

## Nodes

| Name | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Width (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|---|
| ic1 | 0.020 | 2.00 | 16.160 | 600 | 440 | 568869.272 | 182379.460 | 0.560 |
| ic2 | 0.019 | 2.00 | 16.000 | 1200 | | 568877.428 | 182363.662 | 0.550 |
| Sewer | | | 15.620 | | | 568880.003 | 182358.418 | 1.270 |
| Depth/Area 1 | | | | | | 568877.345 | 182363.993 | |

## Links

| Name | US Node | DS Node | Length (m) | ks (mm) / n | US IL (m) | DS IL (m) | Fall (m) | Slope (1:X) | Dia (mm) | T of C (mins) | Rain (mm/hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | ic1 | ic2 | 17.779 | 0.600 | 15.600 | 15.450 | 0.150 | 118.5 | 150 | 2.32 | 50.0 |
| 1.001 | ic2 | Sewer | 5.842 | 0.600 | 15.450 | 14.350 | 1.100 | 5.3 | 150 | 2.34 | 50.0 |

| Name | Vel (m/s) | Cap (l/s) | Flow (l/s) | US Depth (m) | DS Depth (m) | Σ Area (ha) | Σ Add Inflow (l/s) | Pro Depth (mm) | Pro Velocity (m/s) |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 0.922 | 16.3 | 2.7 | 0.410 | 0.400 | 0.020 | 0.0 | 41 | 0.684 |
| 1.001 | 4.402 | 77.8 | 5.3 | 0.400 | 1.120 | 0.039 | 0.0 | 27 | 2.539 |

## Simulation Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FSR | Drain Down Time (mins) | 240 |
| FSR Region | England and Wales | Additional Storage (m³/ha) | 20.0 |
| M5-60 (mm) | 20.000 | Check Discharge Rate(s) | ✓ |
| Ratio-R | 0.400 | 1 year (l/s) | 0.0 |
| Summer CV | 0.750 | 30 year (l/s) | 0.1 |
| Winter CV | 0.840 | 100 year (l/s) | 0.2 |
| Analysis Speed | Normal | Check Discharge Volume | ✓ |
| Skip Steady State | x | 100 year +40% 360 minute (m³) | 8 |

### Storm Durations

| 15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440 |
|---|---|---|---|---|---|---|---|---|---|---|---|

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 100 | 20 | 0 | 0 |
| 100 | 40 | 0 | 0 |

## Pre-development Discharge Rate

| | | | |
|---|---|---|---|
| Site Makeup | Greenfield | Growth Factor 30 years | 2.40 |
| Greenfield Method | IH124 | Growth Factor 100 years | 3.19 |
| Positively Drained Area (ha) | 0.031 | Betterment (%) | 0 |
| SAAR (mm) | 599 | QBar | 0.0 |
| Soil Index | 2 | Q 1 year (l/s) | 0.0 |
| SPR | 0.30 | Q 30 year (l/s) | 0.1 |
| Region | 6 | Q 100 year (l/s) | 0.2 |
| Growth Factor 1 year | 0.85 | | |

## Pre-development Discharge Volume

| | | | |
|---|---|---|---|
| Site Makeup | Greenfield | Return Period (years) | 100 |
| Greenfield Method | FSR/FEH | Climate Change (%) | 40 |
| Positively Drained Area (ha) | 0.031 | Storm Duration (mins) | 360 |
| Soil Index | 2 | Betterment (%) | 0 |
| SPR | 0.30 | PR | 0.280 |
| CWI | 90.222 | Runoff Volume ($m^3$) | 8 |

**Results for 1 year Critical Storm Duration. Lowest mass balance: 100.00%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute summer | ic1 | 9 | 15.653 | 0.053 | 3.8 | 0.0518 | 0.0000 | OK |
| 15 minute summer | ic2 | 9 | 15.482 | 0.032 | 7.4 | 0.0587 | 0.0000 | OK |
| 15 minute summer | Sewer Depth/Area 1 | 9 | 14.381 | 0.031 | 7.4 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute summer | ic1 | 1.000 | ic2 | 3.8 | 0.925 | 0.233 | 0.0740 | |
| 15 minute summer | ic2 | 1.001 | Sewer | 7.4 | 2.732 | 0.095 | 0.0158 | 2.3 |