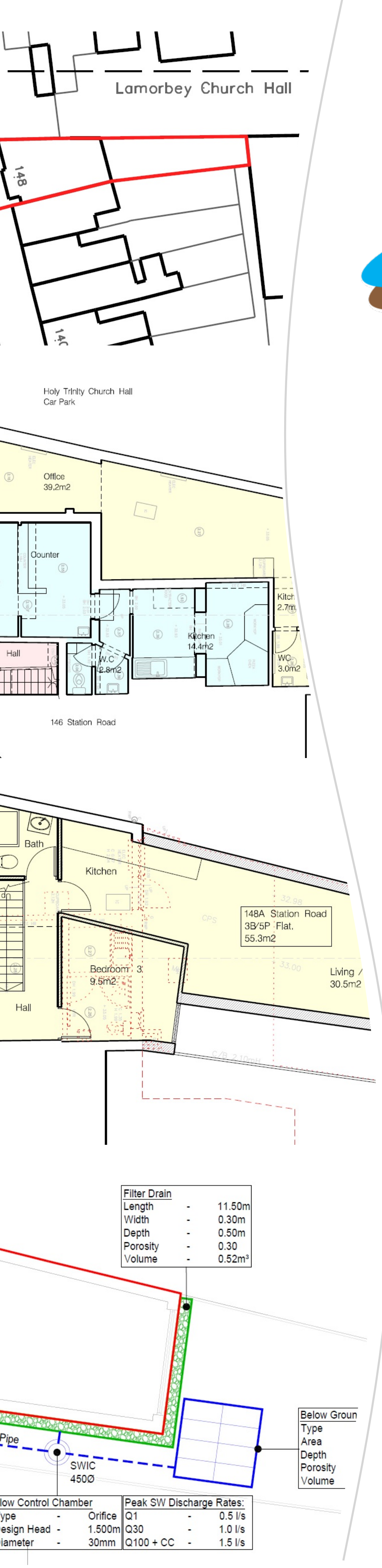

Earth Environmental
& Geotechnical

148 Station Road
Sidcup, Bexley

Flood Risk Statement and Surface Management Report

Revision B
June 2021

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APPENDICES

Report Title:	148 Station Road, Sidcup, Bexley DA15 7AB
Report Reference:	-
Client:	-
Issue Date:	Revision B – 7th June 2021
Drafted By:	Mark Symonds
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1. Introduction

Earth Environmental and Geotechnical Ltd have prepared a Flood Risk Statement and Surface Water Management report, for a new retail and residential development at 148 Station Road, Sidcup, DA15 7AB.

This flood risk statement and surface water management report will assess the current flood risks to the development site, and will demonstrate that the surface water run-off rate and volume for the post development site is managed so it adheres to current regulations, and local authority requirements.

Also, this flood risk assessment and surface water management (SuDS) report has been prepared to the guidance and requirements of the:

- National Planning Policy Framework (NPPF) 2019 Paragraphs 149-150 and 155-165;
- National Planning Practice Guidance (NPPG);
- Principles of Sustainable drainage systems (SuDS) set out by DEFRA (2011);
- Ciria SuDS Manual C753 (2015);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015);
- The London Plan (2016) Policy 5.12 and 5.13;
- New London Plan (2019): Policy G1, SI12 and SI13.
- Greater London Authority: Sustainable Design and Construction Supplementary Planning Guidance – Mayor of London (2014);
- London Borough of Bexley Preferred Approached to Planning Policies (February 2019);
- London Borough of Bexley Strategic Flood Risk Assessment Level-1 (August 2010);
- London Borough of Bexley Local Flood Risk Management Strategy (March 2017).

The Lead Local Flood Authority (LLFA) for London Brough of Bexley (LBB); and Thames Water (TW), need to be satisfied that the design and drainage principles of the proposed development will address the surface water management and risk of flooding; will ensure that the drainage is maintained to prevent flooding; and in turn not to increase the risk of flooding to neighbouring land and property.

This flood risk statement and surface water management report has therefore been prepared to identify and evaluate the various possible sources of flood risk to which the proposed site might be subjected to; to identify any mitigation, protection or compensation measures deemed necessary or feasible; ad to manage the surface water so it sustainable, and does not increase the probability of flooding within, or near the site.

2. National Policies and Water Management Guidance

2.1. National Planning Policy Framework (NPPF) and National Planning Practice Guidance (NPPG)

The NPPF 2019 sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced. This document is used to form this flood risk assessment, with particular attention to Paragraphs 149 to 154 Planning for Climate Change, and Paragraphs 155 to 165 Planning for Flood Risk.

NPPG, Paragraph 030, outlines that the objectives of this FRA is to establish whether a proposed development is likely to be affected by current or future flooding from any source; whether it will increase flood risk elsewhere; whether the measures proposed to deal with these effects and risks are appropriate; whether the evidence for the local planning authority to apply (if necessary) the Sequential Test; and whether the development will be safe and pass the Exception Test, if applicable.

NPPG, Paragraph 051 states that sustainable drainage systems (SuDS) are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible, where they provide opportunities to reduce the causes and impacts of flooding; remove pollutants from urban run-off at source; and to combine water management with green space with benefits for amenity, recreation, and wildlife.

Further to this NPPG, Paragraph 080 states that the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable which (in order) are into the ground (infiltration); to a surface water body; to a surface water sewer, highway drain, or another drainage system; to a combined sewer.

2.2. Flood and Water Management Act

The Flood and Water Management Act takes forward some of the proposals from three previous strategy documents published by the UK Government - Future Water (2008), Making Space for Water (2008) and the UK Government's response to the Sir Michael Pitt's Review of the summer 2007 floods. In doing so it gives the EA a strategic overview role for flood risk, and gives local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

2.3. London Plan (March 2021)

Policy SI 12 states:

A. *Current and expected flood risk from all sources (as defined in paragraph 9.2.12) across London should be managed in a sustainable and cost-effective way in collaboration with the Environment Agency, the Lead Local Flood Authorities, developers and infrastructure providers.*

B. *Development Plans should use the Mayor's Regional Flood Risk Appraisal and their Strategic Flood Risk Assessment as well as Local Flood Risk Management Strategies, where necessary, to identify areas where particular and cumulative flood risk issues exist and develop actions and policy approaches aimed at reducing these risks. Boroughs should cooperate and jointly address cross-boundary flood risk issues including with authorities outside London.*

C. *Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.*

D. *Developments Plans and development proposals should contribute to the delivery of the measures set out in Thames Estuary 2100 Plan. The Mayor will work with the Environment Agency and relevant local planning authorities, including authorities outside London, to safeguard an appropriate location for a new Thames Barrier.*

E. *Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.*

F. Development proposals adjacent to flood defences will be required to protect the integrity of flood defences and allow access for future maintenance and upgrading. Unless exceptional circumstances are demonstrated for not doing so, development proposals should be set back from flood defences to allow for any foreseeable future maintenance and upgrades in a sustainable and cost-effective way.

G. Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat.

Policy SI 13 states:

A. Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed.

B. Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:
   1) rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation)
   2) rainwater infiltration to ground at or close to source
   3) rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens)
   4) rainwater discharge direct to a watercourse (unless not appropriate)
   5) controlled rainwater discharge to a surface water sewer or drain
   6) controlled rainwater discharge to a combined sewer.

C. Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

D. Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation.

2.4. LBB Preferred Approached to Planning Policies

DP36 Flood Risk Management – Preferred detailed policy approach to flood risk management states:

1. *'Development and re-development must be used as an opportunity to reduce flood risk;*

2. *Development is required to provide a Flood Risk Assessment in line with national policy and Bexley's level 1 and 2 Strategic Flood Risk Assessments (SFRAs);*

3. *New developments in riverside locations are required to help reduce flood risk now and into the future. Development should act on the recommendations of the TE2100 Plan;*

4. *All development that is intended to be occupied within the tidal flood risk zone must include an internal safe refuge with a floor level set above the predicted 1 in 200 year plus climate change maximum predicted floor level;*

5. *any development in an identified flood risk zone must provide compensatory capacity to offset the building footprint;*

6. *Within the residual flood risk area where safe escape cannot be facilitated, a dry refuge within each building must be provided;*

7. *Habitable rooms in residential development, within the fluvial flood zones, should be set above the predicted*

1 in 100 year plus climate change peak flood water level;

8. *Within the fluvial flood risk zones development must include safe access and exit, although for development that is not residential an Emergency Plan may provide an acceptable solution;*

9. *Occupied basements are not considered appropriate in Flood Zones 2 and 3; and,*

10. *Development must not increase flood risk on site or off site, and exceedance flows must be considered and appropriately managed'.*

DP37 Sustainable Drainage Systems - Preferred detailed policy approach for sustainable drainage systems states:

1. *'All developments should achieve greenfield runoff rates.*

2. *To minimise flood risk, improve water quality and enhance biodiversity and amenity all development proposals will be required to manage surface water through sustainable drainage systems (SuDS).*

3. *Wherever possible the natural drainage of surface water from new developments into the ground will be preferred. Surface water runoff should be managed as close to its source as possible in line with the following drainage hierarchy:*

    a) *store rainwater for later use;*

    b) *use infiltration techniques, such as porous surfaces;*

    c) *attenuate rainwater in ponds, open water features, tanks, or sealed water features for gradual release;*

    d) *discharge rainwater direct to a watercourse;*

    e) *discharge rainwater to a surface water sewer/drain; and*

    f) *discharge rainwater to the combined sewer'.*

3. Site Setting and Description

3.1. Site Location

The development site located in a Retail / residential area of Sidcup, which is in the London Brough of Bexley, and approximately 100m north of Sidcup Station.

As detailed in Appendix A, the development site is bound by a car park for Lamorbey Church Hall, leading onto Hurst Road to the north; a commercial building of No. 2 Hurst Road to the east; an attached retail and residential building of No. 146 Station Road to the south; and Station Road to the west.

The full site address of the site is 148 Station Road, Sidcup, Bexley, London, DA15 7AB, and the co-ordinates of the centre of the site are: Easting: 546240, Northing: 172789.

3.2. Existing Site and Topography

As detailed on the existing floor / site plans Appendix B, the development site currently consists of an existing commercial and residential building, with an office unit, a restaurant residential unit, and entrance to a residential unit at ground floor; and a 2-bedroom residential unit on the first floor.

There is a garden area to the rear of the building (east of site), with Station Road being directly adjacent to the front of the building (west of site)

In terms of topography, the development site is relatively flat, with the levels ranging from approximately 33.23m AOD in the garden area to 32.94m AOD to the west, with the finished floor level of the existing building being 33.05m AOD.

3.3. Proposed Development

The full description of the development site is to be stated by the Architect, with a detailed plan shown in Appendix C. In brief, and in relation to this report, the proposed development is reconfiguring and extend the existing building.

The proposed development is to reconfigure the office and restaurant units at ground floor level (west of building); to expand the ground floor to the rear (towards west of site) to create part of a residential unit (access from first floor); and to create two new residential units at first floor level with access to ground flood and a new terrace area to the rear (east of site);

The western roof areas / falls (adjacent to Station Road) will not change as part of the development.

3.4. Ground Conditions

The ground conditions at the development site can be determined by, and sourced from, the British Geological Survey (BGS) website. The BGS data shows the site to have no superficial deposits with a bedrock-strata consisting of a Harwich Formation (sand and gravel).

The BGS data also shows public record borehole logs, within 250m radius of the development site. As detailed in Appendix C, the borehole logs also show that the ground predominantly consists of sands and gravels with occasional clay.

3.5. Waterbody / Rivers / Canals / Reservoirs

There are no known waterbodies, rivers, canals, or reservoirs near the development site, with the nearest main waterbodies being the River Shuttle approximately 1 km to the north, and the River Cray approximately 2.5km to the southeast of the site.

3.6. On-Site Drainage / Public Sewers

As detailed on the Thames Water asset plan in Appendix E, there are 600mm public foul and surface water sewers within Station Road to the west of the site. There is also a foul water sewer running along the rear of the buildings of Station Road, and passes through the development site, before discharging / connecting to the 600mm foul water sewer.

A full drainage survey of the existing site is yet to take place. However, the site survey identifies that there re exiting rainwater pipes to the front and rear (west and east respectively) of the existing building, where it is assumed that the surface water run-off from the western roof areas discharges directly to the surface water sewer, and the surface water run-off from the eastern roof areas is discharging to an on-site drainage network to the rear of the building.

The western roof and associated rainwater pipe locations will not change as part of the proposed development, and therefore the surface water from the western roof areas will continue to discharge to the surface water sewer at the existing rates.

3.7. Development / Surface Water Management Areas

The overall site boundary area is approximately 220m² / **0.022 ha**.

In terms of the surface water management areas of the site, and as stated above, the western roof and associated rainwater pipe locations will not change as part of the proposed development.

Therefore, the western roof areas of the building will not be included in the surface water management area, with the surface water from the western areas continuing to discharge to the same destination and at the same rate as the pre-development scenario.

The garden area to the eastern areas of the site will also remain as permeable, and therefore will also be excluded from the surface water management area, due to the surface water run-off from the garden discharging off the site at a natural / greenfield rate.

The surface water run-off from the eastern roof areas will be affected / changed as part of the development proposals, and therefore the existing roof, proposed roof, and extended areas will form part of the surface water management calculations, where:

Pre-development surface water run-off area (roof area)	=	70m² / 0.007 ha
Post Development surface water run-off area (roof and extended area)	=	100m² / 0.010 ha

4. Potential Sources of Existing Flooding

The potential sources of exiting flooding for the site, that are to be assessed, are as follows:

4.1. Fluvial Flooding

Fluvial flooding is resulted from watercourses / rivers surcharging and flooding the surrounding areas.

4.2. Pluvial Flooding

'Pluvial' flooding is that which results from rainfall generated overland flow before the run-off enters any watercourse, drain or sewer. It is more often linked to high intensity rainfall events (typically more than 30mm per hour). However, it can also result from lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or has low permeability. This results in overland flow and ponding in depressions in the topography. In urban areas 'pluvial' flows are likely to follow the routes of highways and other surface connectivity to low spots where flooding can occur. In some cases, it can deviate from this route into adjacent developments via dropped kerbs (either for access to driveways or disability access).

4.3. Groundwater Flooding

Groundwater flooding is caused by the emergence of water from sub-surface permeable strata. Fluctuations in the groundwater table can cause flooding should the table rise above the existing ground level. Groundwater flooding events tend to have long durations, lasting days, or weeks.

4.4. Flooding from Drains and Sewers

Flooding from drains and sewers is caused when the capacity of the drains and sewers is exceeded, and will result in flooding from the manholes.

4.5. Canals, Reservoirs and Other Artificial Sources

Flooding from canals, reservoirs and artificial sources is caused when the capacity of the sources is exceeded, or if there is an infrastructure failure.

5. Probability of Flooding from Existing Sources

5.1. Fluvial Flooding

The fluvial flood map (Risk of Flooding from Rivers and Sea) on the EA website (see Figure 1 below) suggests that the all the site lies within Flood Zone 1, which has a **low** probability of flooding

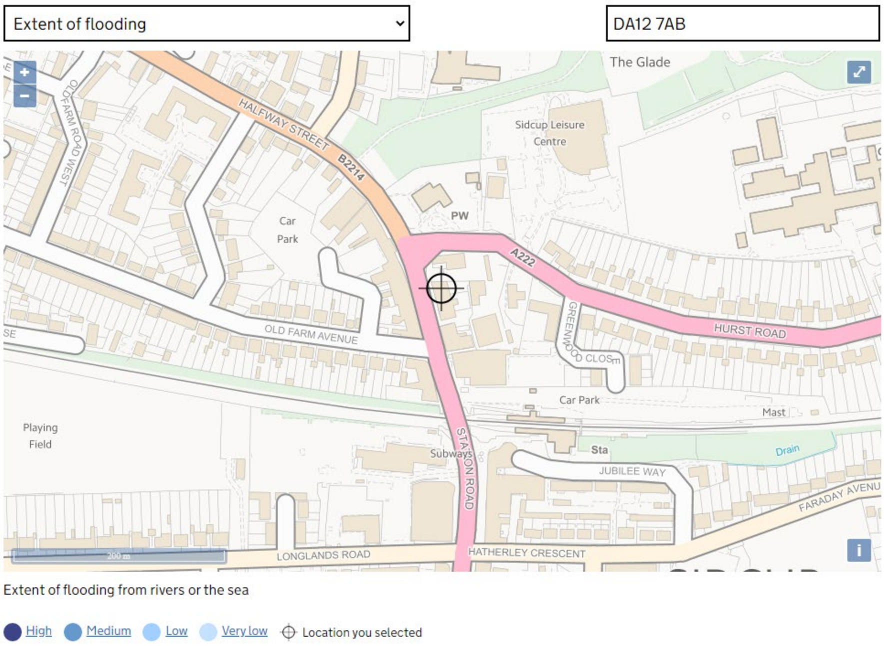


Figure 1 – EA Fluvial Flood Map

5.2. Pluvial / Surface Water Flooding

The pluvial flood map (Risk of Flooding from Surface Water) on the EA website (see Figure 2 below) identifies that all the development areas have a very low probability of pluvial / surface water flooding. Therefore, the probability of pluvial flooding is deemed to be **low**.

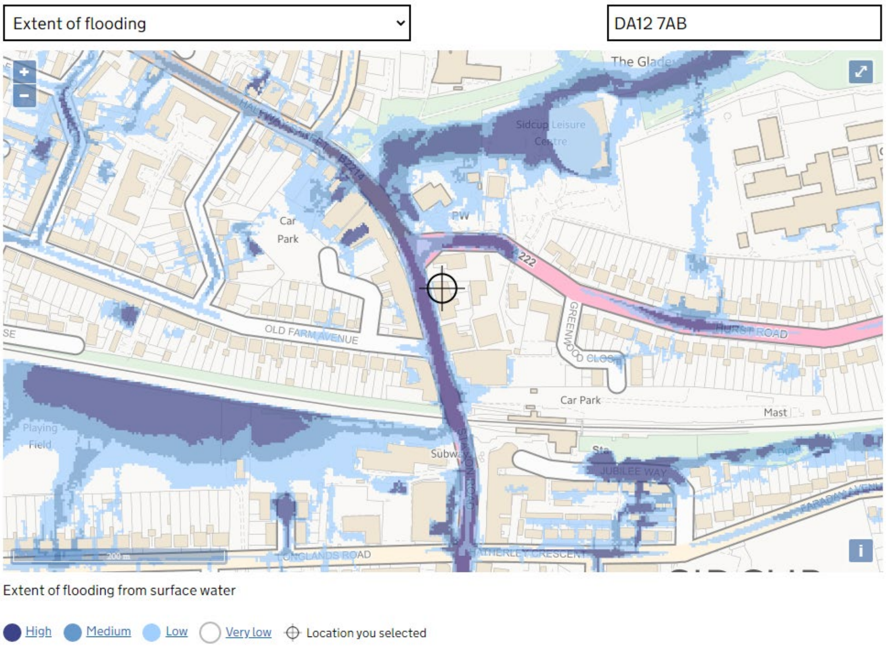


Figure 2 – EA Puvial / Surface Water Flood Map

5.3. Ground Water Flooding

The ground at the development is believed to consist of sands and gravels with occasional clay. The BGS borehole logs show there are water strike at a depth of 0.50m, but this was over a land drain system. The other borehole logs show either no water strikes or strikes to be 4.80m below ground

Therefore, as the ground is deemed to have high infiltration values (sands and gravels), and the no or deep water strikes have only be recorded (with exception of land drain) and there are 1.17m below ground in one location, with other location showing deeper water strikes. It is therefore deemed that the ground water level is relatively low, with the probability of ground water flooding at the development site is also being **low**.

5.4. Flooding from Drains and Sewers

The nearest drain / sewers to the development site are in the Station Road to the east of the development. The roads are at a lower level to the proposed site eastern boundary (back of footpath level). and the roads have upstand kerbs which will contain any surface water flooding. Therefore, the probability of flooding is deemed to be **low.**

5.5. Canals, Reservoirs and Other Artificial Sources

There are no canals, reservoirs, or other artificial sources within the vicinity of the site. Therefore, based on this data the probability of flooding from canals, reservoirs or artificial sources for the site is deemed to be **low**

6. Flood Risk and Vulnerability

The NPPG Paragraphs 065 to 067 sets out the flood risk for a site by assessing the flood zones, flood risk vulnerability classification, and flood risk vulnerability and flood zone 'compatibility'.

6.1. Flood Zones

NPPG Paragraph 065, Table 1 indicates that the flood zones are:

Flood Zones	
Flood Zone	**Definition**
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)

The EA flood map data has identified that the development site is in Flood Zone 1, which has a low probability of flooding.

6.2. Flood Risk Vulnerability Classification

NPPG Paragraph 066, Table 2 stated the flood risk vulnerability classifications as:

Flood Risk Vulnerability Classification
Essential Infrastructure Essential transport infrastructure (including mass evacuation routes) which should cross the area at risk; Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; Wind turbines.
Highly Vulnerable Police and ambulance stations; fire stations and command centers; telecommunications installations required to be operational during flooding; Emergency dispersal points; **Basement dwellings**; Caravans, mobile homes and park homes intended for permanent residential use; Installations requiring hazardous substances consent.
More Vulnerable Hospitals; Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels; Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels; Non–residential uses for health services, nurseries and educational establishments; Landfill* and sites used for waste management facilities for hazardous waste; Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable Police, ambulance and fire stations which are not required to be operational during flooding; Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'More Vulnerable' class; and assembly and leisure; Land and buildings used for agriculture and forestry; Waste treatment (except landfill* and hazardous waste facilities); Minerals working and processing (except for sand and gravel working); Water treatment works which do not need to remain operational during times of flood.
Water-Compatible Development Flood control infrastructure; Water transmission infrastructure and pumping stations; Sewage transmission infrastructure and pumping stations; Sand and gravel working; Docks, marinas, and wharves; Navigation facilities.

This development is classed as a 'Highly Vulnerable' as the development is to be used for basement dwellings.

6.3. Flood Risk Vulnerability and Flood Zone 'Compatibility'

NPPG Paragraph 067 Table 3, gives guidance on flood risk vulnerability compared with flood zone, to determine the compatibility.

Flood Risk Vulnerability and Flood Zone 'Compatibility'					
Flood Zones	**Flood Risk Vulnerability Classification**				
	Essential Infrastructure	**Highly Vulnerable**	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	† Exception Test required	X	Exception Test required	✓	✓
Zone 3b*	* Exception Test required	X	X	X	✓*

In accordance with Table 3 of the NPPF if the site is in Flood Zone 1, is classed as 'Highly Vulnerable', the development is appropriate.

7. The Sequential Test and Exception Test

7.1. Sequential and Exception Test Guidance

Paragraph 101 of the NPPG states that: *The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding.*

Paragraph 102 of the NPPG states that: *If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate. For the Exception Test to be passed:*

- *it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and*
- *a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.*

7.2. Sequential and Exception Test Requirement for Development

The development site has passed the sequential and exception test as it is in Flood Zone 1, and in accordance with NPPF guidelines is classed as 'Highly Vulnerable', and therefore is an appropriate development.

8. Surface Water Management Principles

8.1. Run-Off Destination

Surface water run-off is to discharge to one or more of the following in the order of priority shown: Discharge into the ground (infiltration); Discharge to a surface water body; Discharge to a surface water sewer, highway drain or other drain; Discharge to combined sewer.

8.2. The Management Train

A concept fundamental to implementing a successful SuDS scheme is the management train. This is a sequence of SuDS components that serve to reduce run-off rates and volumes and reduce pollution. The hierarchy of techniques that are to be used for the surface water management of the development are: Prevention - Prevention of run-off by good site design and reduction of impermeable areas; Source Control - Dealing with water where and when it falls (e.g. infiltration techniques); Site Control - Management of water in the local area (e.g. swales, detention basins); Regional Control - Management of run-off from sites (e.g. balancing ponds, wetlands).

8.3. Design Principles

The design principles for the surface water management of the development will be to: Ensure that people, property and critical infrastructure are protected from flooding; Ensure that the development does not increase flood risk off site; Ensure that SuDS can be economically maintained for the development.

8.4. Peak Surface Water Flow

The post development surface water drainage system will aim to restrict the surface water to the equivalent greenfield run-off rate (to adhere to LBB preferred policies) with a betterment of the pre-development surface water run-off (including climate change) being the maximum discharge rate for all storm events.

8.5. Flood Risk

The drainage system will be designed so that, unless an area is designed to hold and/or convey water, flooding does not occur on any part of the site for a 1 in 30-year rainfall event.

The drainage system will also be designed so that, unless an area is designed to hold and/or convey water, flooding does not occur during a 1 in 100-year rainfall event in any part of a building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

The design of the site will ensure that flows resulting from rainfall more than a 1 in 100-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

8.6. Pollution

The SuDS design for the development site will ensure that the quality of any receiving water body is not adversely affected and preferably enhanced in accordance with Ciria SuDS Manual C753, Chapter 4.

8.7. Designing for Exceedance

The development site design will be such that when SuDS features fail or are exceeded, exceedance flows do not cause flooding of properties on or off site. This is achieved by completely containing the surface water within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 30-year event. The design of the site ensures that flows from rainfall more than a 1 in 100-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

9. Surface Water Run-Off Destination

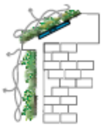
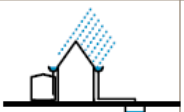
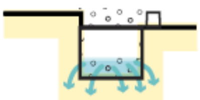
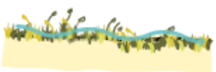
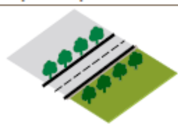
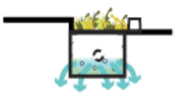
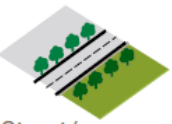
The destination of the surface water run-off from the post development site has been assessed against the prioritisation set by the Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

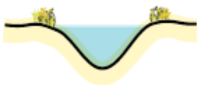
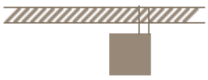
Run-Off Destination	Feasible	Description
Discharge to Ground	No	The BGS data identifies the ground at the site to predominantly consist of sands and gravels. Therefore, based on the ground conditions alone surface water discharge to ground will be feasible. However, Approved Document Part H states that soakaways can not be within 5m of any structure. Given the that the only area for a soakaway is in the garden, which is relatively small, no soakaway / infiltration structure can be installed without being within the 5m perimeter. Therefore, based on the small area of external land, the discharge of surface water to ground is not feasible.
Discharge to Surface Water Body	No	There are no know waterbodies near the development site, and therefore discharge to a waterbody is not a feasible destination.
Discharge to Surface Water Sewer	**Yes**	As there are no suitable areas to discharge the surface water to ground, and there are no water bodies near to the development site, the only alternative is to discharge the surface water to the existing 600mm surface water sewer within Station Road. This will match the surface water discharge destination of the pre-development eastern roof areas.
Discharge to Highway Drain or Other	No	There are no know highway drains or other drains near the development site, and therefore discharge to a highway or other drain is not a feasible destination.
Discharge to Combined Water Sewer	No	There are no know combined sewers near the development site, and therefore discharge to a combined sewer is not a feasible destination.

10. SuDS Feasibility

To reduce the surface water run-off to the greenfield rate, SuDS methods are to be introduced to the post development design.

SuDS methods as per the Sustainable Drainage System (SuDS) hierarchy, and the Non-Statutory Technical Standards for Sustainable Drainage Systems – March 2015, that can be used are detailed below:

	Description	Setting	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	 Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation.	 Building	Water storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	 Open space	Dependant on runoff volumes and soils.
 Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	 Open space	Minimum length 5 metres.
Permeable paving	Paving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into ground below.	 Street/open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens.	 Street/open space	Typically surface area is 5-10% of drained area with storage below.

	Description	Setting	Required area
 Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration.	 Street/open space	Account for width to allow safe maintenancce typically 2-3 metres wide.
 Hardscape storage	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.	 Open space	Could be above or below ground and sized to storage need.
 Pond / Basin	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge.	 Open space	Dependant on runoff volumes and soils.
 Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	 Open space	Typically 5-15% of drainage area to provide good treatment.
 Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	 Open space	Dependant on runoff volumes and soils.

The feasibility of the above SuDS methods for the post developed site are summarised in the table below:

SuDS Method	Feasible Use	Description
Green Roofs	**Potential**	There is potential to have soft landscaping areas at the terrace at first floor of the extended building. The soft landscaping will reduce the surface water run-off from the terrace area, add biodiversity to the development, and also act as pollutant control. Note that the extent of soft landscaping / green roof is to be confirmed at detailed design stage, and will not be taken into consideration within the surface water management calculations.
Rainwater Harvesting	**Yes**	Rainwater harvesting for water re-use has not been considered for the development due to the cost of a dual pipe network. However, water butts could be installed in the garden areas to be used for irrigation.
Soakaway	No	As stated in Section 9, the BGS data identifies the ground at the site to predominantly consist of sands and gravels. Therefore, based on the ground conditions alone the use

		of soakaways will be feasible. However, Approved Document Part H states that soakaways cannot be within 5m of any structure. Given the that the only area for a soakaway is in the garden, which is relatively small, no soakaway / infiltration structure can be installed without being within the 5m perimeter. Therefore, based on the small area of external land, soakaways are not feasible.
Filter Strips	**Yes**	A filter rain can be installed along the wall line to the rear of the extended building, and will take the surface water run-off (via rainwater pipe) from the extended and reformed roof areas. The filter drain will not discharge the surface water to ground (due to close proximity to building), but will convey the surface water to the main drainage network, reduce the surface water run-off rate, and act as a pollutant control
Permeable Paving / Surfacing	No	There are no external surfing where permeable paving can be installed. Therefore, the use of this SuDS method is not feasible
Bioretention Area / Swales / Ponds / Basins	No	All external soft landscape areas are relatively small and are to be used for as private garden areas. Therefore, as there are no areas for these SuDS methods, they are no feasible
Underground Storage	**Yes**	The surface water run-off from the development site will discharge off the site at a reduced rate. As the surface water run-off has been reduced, there will be a requirement for underground storage. This will prevent flooding for storm events up to the 1 in 30-year; and to suitable sized so that the volume of water during the 1 in 100-year storm event is kept a minimum at surface level, where it can be contained on site.

11. Development Greenfield Run-Off Rate and Volumes

To minimise the surface water run-off from the new development areas of the site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rate and volumes.

11.1. Greenfield Run-Off Rate

The Flood Estimation Handbook (FEH) is often used for the calculation of the greenfield run-off rate, however, relevant documents state that to calculate the greenfield run-off rates on small catchments less than 25km², the IH 124 QBAR equation (and the equation for the instantaneous time to peak for the unit hydrograph approach) is to be used. The IH method is based on the Flood Studies Report (FSR) approach and is developed for use on catchments less than 25km². It yields the Mean Annual Maximum Flood (QBAR). This reference also recommends the use Ciria C753 Table 24.2 to generate Growth Factors. These are used to convert QBAR to different return periods for different regions in the UK.

The input variables to establish QBAR are:

Return Period (years)	Results based on a range of return periods and the specified RP;
Area	Catchment Area (ha) which is adjusted to km2 for use in the equation;
SAAR	Average annual rainfall in mm (1941-1970) from FSR figure II.3.1;
Soil	Procedure Volume 3. Soil classes 1 to 5 have Soil Index values of 0.15, 0.3, 0.4, 0.45 and 0.5 respectively;
Urban	Proportion of area urbanised expressed as a decimal;
Region Number	Region number of the catchment based on FSR Figure I.2.4.

QBAR(l/s)

The output variables to establish QBAR are calculated using the following formula (equation yields m³/s):

QBAR = $0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

The IH 124 Variables (taken from FSR) that are specific to this site are as follows:

Area	=	50.00 ha (required area for calculation)
SAAR	=	600
Soil	=	0.300
Urban Factor	=	0.75
Region Number	=	6

The calculations in Appendix F, show the rate for 50.00ha is 282.8 l/s, but is to be reduced to reflect the surface water catchment area (0.010 ha) of the development site. Therefore, the QBAR (greenfield run-off) for development area has been calculated to be:

QBAR = **0.06 l/s (5.65 l/s/ha)**

Ciria C753 Table 24.2 identifies the growth factors for each of the storm events, based on the known QBAR figure. The growth factors from the table vary depending on the site location. In this case hydrometric area (Region Number) is 6.

Based on the figures shown in the table, the growth factors, and the existing greenfield run-off rates for each of the storm events for the development areas of the site are as follows:

Storm Event	QBAR	Growth Factor (C753 Table 24.2)	Greenfield Run-off Rate
Q_1	0.06 l/s	0.85	**0.1 l/s**
Q_{30}	0.06 l/s	2.40	**0.2 l/s**
Q_{100}	0.06 l/s	3.19	**0.2 l/s**

11.2. Greenfield Run-Off Volume

The greenfield run-off volume for the 100-year, 6-hour storm event has also been calculated in the MicroDrainage software using the data from the Flood Estimation Handbook (FEH), with the results shown in Appendix F.

The FEH data and variables used to calculate the greenfield run-off volume at the development site locations are as follows:

Site Location = GB 546300 172900 TQ 46300 72900

C (1km) = -0.023

D1 (1km) = 0.307

D2(1km) = 0.368

D3 (1km) = 0.368

E (1km) = 0.313

F (1km) = 2.594

Areal Reduction Factor = 1.000

Area = 61.500 ha

SAAR = 627

CWI = 91.860

SPR Host = 16.280

URBTEXT = 0.50

Based on these variables, and the calculation results provided by the WinDes computer software (Appendix F), the greenfield run-off volume for the overall catchment area at the site location is:

$Q_{100\ (6\text{-Hour})}$ = 15,567.750m³

This figure is for the catchment area of 61.500 ha, and is to be reduced to reflect the surface water catchment area of the development site which is 0.010 ha. Therefore, the greenfield run-off volume for the development site area has been calculated to be:

$Q_{100\ (6\text{-Hour})}$ = **2.53m³ (253.13m³/ha)**

12. Pre-Development Surface Water Run-Off Rates and Volume

The pre-development surface water run-off rates and volumes are to be calculated, so that the post development rates, and volume are a betterment.

The calculations to determine the pre-development surface water run-off rates and volume are based on the pre-development surface water run-off area of 0.007 ha (eastern roof areas only), and the data given by the Flood Estimation Handbook (FEH).

The pre-development surface water run-off rates and volume have also been simulated in the MicroDrainage software (Appendix G), where the variables used (FEH data) to calculate the surface water run-off rates and volumes are as follows:

Pre-Development Area	=	0.007 ha
Site Location	=	GB 546300 172900 TQ 46300 72900
C (1km)	=	-0.023
D1 (1km)	=	0.307
D2(1km)	=	0.368
D3 (1km)	=	0.368
E (1km)	=	0.313
F (1km)	=	2.594

Based on the above variables and computer software results, the pre-development surface water run-off rates will be as follows:

Q_1	=	1.0 l/s (15-minute storm duration*)
Q_{30}	=	3.6 l/s (15-minute storm duration*)
Q_{100}	=	5.3 l/s (15-minute storm duration*)

*The critical storm duration for each of the return period is 15 minutes.

Based on the above variables for the surface water run-off from the pre-development impermeable area, it has been calculated that the pre-development surface water discharge volume for the pre-development site (at 6-hour storm events) are as follows:

Q_{100}	=	4.26m^3 (360-minute storm duration)

13. Below Ground Drainage Networks and Surface Water Management Calculations

13.1. Climate Change

The NPPF makes it a planning requirement to account for climate change in the proposed design. The recommended allowances are taken from the Environment Agency guidance (Table 2) summarised in Table 4 below.

Applies across all of England	**Total change anticipated for the 2020's**	**Total change anticipated for the 2050's**	**Total change anticipated for the 2080's**
Upper End	10%	20%	**40%**
Central	5%	10%	20%

The baseline year is 1961 to 1990. It is anticipated the life span of the proposed retail and residential building will be approximately 80 years, and therefore will fall at least into the 2080's and will have rainfall intensity increase of 40%.

This increase in rainfall is to be taken into consideration for the surface water management of the proposed development site (100-year event), to ensure that the probability of flooding remains low.

13.2. Surface Water Network Calculations

The FEH data and variables used to calculate the required below ground attenuation network and attenuation volumes at the development site are as follows:

SW Catchment Area	=	0.010 ha
Site Location	=	GB 546300 172900 TQ 46300 72900
C (1km)	=	-0.023
D1 (1km)	=	0.307
D2(1km)	=	0.368
D3 (1km)	=	0.368
E (1km)	=	0.313
F (1km)	=	2.594
Time of Entry	=	5 minutes

13.3. Surface Water Drainage Networks

As shown on the below ground drainage layout drawing in Appendix H, the surface water drainage network will consist of 450mm diameter inspection chambers; 150mm a diameters pipes; a filter drain system; a flow control chamber; and a below ground attenuation tank in the formed of cellular units.

The surface water run-off from the reconfigured and extended roof areas will discharge to the network via rainwater pipes and filter drain system, and the surface water run-off from the lightwell area will be pumped to the main drainage network. The surface water within the network will be restricted by the flow control chamber, with the surcharged water being attenuated within the cellular units. The proposed surface water network is to flow along the rear of the new building before discharging under the building and into the existing 600mm surface water sewer in Station Road (either direct connection or via existing lateral drain).

13.4. Surface Water Run-Off Rate

For the surface water run-off from the entire development site to be at the greenfield run-off rate, the surface water run-off rate for post development site is to be restricted by a flow control to 0.1 l/s for the 1 in 1-year storm event; 0.2 l/s for the 1 in 30-year storm event, and 0.2 l/s for the 1 in 100-year storm event including 40% rainfall intensity increase (climate change).

For the surface water run-off from the entire development site to be a betterment of the pre-development rates, the surface water run-off from the post development site is to be restricted by a flow control to at least 1.0 l/s for the 1 in 1-year storm event; 3.6 l/s for the 1 in 30-year storm event; and 5.3 l/s for the 1 in 100-year storm event including 40% rainfall intensity increase / climate change.

An assessment of the suitable flow control opening, and subsequent surface water discharge needs to assessed, where Ciria document C753 – The SuDS Manual states that: *'the flow controls / orifice design should be designed so that it has simplicity on operation, and has resistance to clogging, blocking or mechanical failure'.*

The flow control (hydro-brake) therefore is to be a suitable diameter where the surface water run-off discharge form the development area of the site is as close to the greenfield rates as possible, is at least a betterment of the pre-development 1 in 1-year run-off rate, and will be a size where the likelihood of blockage and subsequent flooding is reduced.

For this development, and based on the guidance, the suitable / minimum size of the flow control opening is deemed to be 30mm. As shown in the output calculation from the MicroDrainage computer software in Appendix **I**, if the orifice opening is set at 30mm, the maximum surface water run-off rates for each storm event will be as follows:

Strom	**-**	**Rate**	**-**	**Critical Storm Event**
Q_1	**-**	**0.5 l/s**	-	30-minute winter storm duration
Q_{30}	**-**	**1.0 l/s**	-	30-minute winter storm duration
Q_{100}	**-**	**1.6 l/s**	-	30-minute winter storm duration

A summary of the post development surface water run-off rates compared to the greenfield and pre-development rates are as follows:

Greenfield Rate to Post Development Rate

Strom	**-**	**Greenfield**	**-**	**Post Dev**	**-**	**Difference**
Q_1	-	0.1 l/s	-	0.5 l/s	-	5.0 x Greenfield
Q_{30}	-	0.2 l/s	-	1.0 l/s	-	5.0 x Greenfield
Q_{100}	-	0.2 l/s	-	1.6 l/s	-	8.0 x Greenfield

Pre-Development Rate to Post Development Rate

Strom	**-**	**Pre-Dev**	**-**	**Post Dev**	**-**	**Difference**
Q_1	-	1.0 l/s	-	0.5 l/s	-	0.50 x Pre-Development / 50% Betterment
Q_{30}	-	3.6 l/s	-	1.0 l/s	-	0.28 x Pre-Development / 72% Betterment
Q_{100}	-	5.3 l/s	-	1.6 l/s	-	0.30 x Pre-Development / 70% Betterment

The surface water run-off rates are greater than the equivalent greenfield rates. Greenfield rates cannot be achieved due the rates being too low for a flow control to suitably restrict, without having a too small opening that will increase the risk of block and subsequent flooding. However, the surface water run-off rates are between a 50% to 72% betterment of the pre-development surface water run-off rates. Therefore, the restricted rates will reduce the probability of flooding to the Thames water surface water sewer system, which is deemed to be acceptable.

13.5. Surface Water Run-Off Volume

The surface water run-off volumes for the post development site have also been calculated for 1 in 100-Year the 6-hour duration (Inc. 40% RII), within the MicroDrainage computer software in Appendix I, where:

$Q_{100\ (6\text{-hour})}$ - **9.50m³**

A summary of the post development surface water run-off volume compared to the greenfield and pre-development volumes are as follows:

Greenfield Volume to Post Development Volume

Strom	-	Greenfield	-	Post Dev	-	Difference
Q_{100}	-	2.53m³	-	9.50m³	-	3.75 x Greenfield

Pre-Development Volume to Post Development Volume

Strom	-	Pre-Dev	-	Post Dev	-	Difference
Q_{100}	-	4.26m³	-	9.50m³	-	2.23 x Greenfield

The surface water run-off volume for the 100-year, 6-hour storm event is a greater than the greenfield and pre-development run-off volume for the same storm event. However, the surface water run-off rates are between a 50% to 72% betterment of the pre-development surface water run-off rates. Therefore, the restricted volume discharge off the site at reduced rate for most system events, and will reduce the probability of flooding to the Thames water surface water sewer system, which is deemed to be acceptable.

13.6. Surface Water Attenuation Calculations

As the positively drained areas of the post development site are being restricted, there will be a requirement for below ground attenuation to prevent flooding. Ciria SuDS Manual 2015, Paragraph 10.2.4 where it states that: *'Exceedance flows (i.e. flows more than those for which the system is designed) should be managed safely in above-ground space such that risks to people and property are acceptable'.*

The surface water attenuation for the development site will be within the below ground attenuation tank (comprising of cellular units), filter drain and pipe network. As detailed in the MicroDrainage calculations (Appendix I) and surface water management layout (Appendix H), the attenuation volumes for each of the SuDS methods re as follows:

Cellular Units

Area	-	4.00m²
Depth	-	0.80m
Porosity	-	0.95
Volume	-	**3.05m³**

Infiltration Trench (Filter Drain)

Length	-	11.50m
Width	-	0.30m
Depth	-	0.50m
Porosity	-	0.030
Volume	-	**0.52m³**

The MicroDrainage calculations (Appendix I) show that with these SuDs methods and volumes, no flooding will occur for all storms up to and including the 1 in 100-year event + 40% climate change.

14. Maintenance Requirements

Details of the maintenance required, and the parties to carry out the maintenance of all drainage aspects, to ensure that the SuDS methods are working affectively, and subsequently reducing the risk of flooding on the site are as follows:

The management and maintenance of the surface water drainage networks and SuDS features will be by contractors appointed by the owners / residents of the new residential / retail units, where payments of the works will form part of the property deeds and / or rental agreements, and will be carried out as follows:

14.1. Surface Water Drainage Network

The required maintenance for the drainage network will be as follows:

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from manholes (where may cause risk performance)	Monthly
Where rainfall into network from above, check surface or filter for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year
Remove sediment from pipework by jetting.	Annually or as required
Repair/check all inlets, outlets, and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

14.2. Flow Control and Attenuation Tank

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from flow control chamber and attenuation tank (where may cause risk performance)	Monthly
Where rainfall into flow control chamber and attenuation tank from above, check surface or filter for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year
Remove sediment from upstream surface water network by jetting.	Annually or as required
Repair/check all inlets, outlets, and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

14.3. Filter Drain

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from catchment of areas near filter drain (where may cause risk performance)	Monthly
Where rainfall infiltration into filter drain, check surface for blockage or silt, algae, or other matter by jetting	As required, but at least twice a year

14.4. Linked and Further Maintenance and Maintenance Activities

The maintenance of the drainage network and SuDS features are to be linked with the wider site maintenance for the new residential landscaped / garden areas.

A log of all maintenance activities is to be kept and made available to the local planning authority (LPA) and / or the Lead Local Flood Authority (LLFA) on request.

15. Surface Water Design Exceedance

In the event of an extreme storm event (greater than 100-year + 40% climate change), or poor maintenance of the pipework potentially flooding of the drainage network could occur. Surface water will be contained within the garden area due the garden being flat.

The flood volume will also less than the pre-development scenario, due to additional attenuation volumes within the ground. Therefore, due to the new SuDS methods, the flood risk to land or properties within or outside the development would not increase even in an extreme (greater than 1% AEP + 40% cc) storm event.

16. Pollution Prevention

Also, as shown on drawing 609-DR-100, and described in this report, the surface water run-off within the development site will be from roof and lightwell areas only.

The roof areas will have very little pollutants, and the surface water run-off discharging through a filter drain system. The filter drain will act as a pollutant control, and therefore there will be a betterment of water quality from the post development site.

17. Development Management and Construction Phase

All existing drainage within the site, is to be maintained during the construction of the new buildings and external hard standing areas. The flow control and attenuation tank are to be the first parts of the drainage network to be built. This will ensure that the surface water discharge from any phase of the network will be discharged to ground.

18. Conclusion / Summary

18.1. Existing Flood Probability

All potential sources of flooding to the development site have assessed, and it is deemed that the probability of flooding from all existing sources is **low**. In accordance with NPPF, the site is less and more vulnerable, but as it is in Flood Zone 1 it is appropriate for development with no requirement for a sequential or exception test.

18.2. SuDS Principles

All feasible SuDS methods, and surface water discharge destination have been assessed, with the feasible SuDS methods being; a filter drain system; flow control and attenuation tank, and the surface water destination being to a Thames Water 600mm surface water sewer within Station Road (which replicates the pre-development surface water discharge destination).

18.3. Peak Flow Control

The surface water run-off rates are greater than the equivalent greenfield rates. Greenfield rates cannot be achieved due the rates being too low for a flow control to suitably restrict, without having a too small opening that will increase the risk of block and subsequent flooding. However, the surface water run-off rates are between a 50% to 72% betterment of the pre-development surface water run-off rates. Therefore, the restricted rates will reduce the probability of flooding to the Thames water surface water sewer system, which is deemed to be acceptable.

18.4. Volume Control

The surface water run-off volume for the 100-year, 6-hour storm event is a greater than the greenfield and pre-development run-off volume for the same storm event. However, the surface water run-off rates are between a 50% to 72% betterment of the pre-development surface water run-off rates. Therefore, the restricted volume discharge off the site at reduced rate for most system events, and will reduce the probability of flooding to the Thames water surface water sewer system, which is deemed to be acceptable.

18.5. Flood Risk within the Development

The drainage network and below ground attenuation tank has been suitably sized so that no flooding occurs within the network during the 1 in 1-year; 1 in 30-year; and 1 in 100-year storm event + 40% climate change.

18.6. Management and Maintenance

The management and maintenance of the surface water drainage networks and SuDS features will be by contractors appointed by the owners / residents of the new residential / retail units, where payments of the works will form part of the property deeds and / or rental agreements,

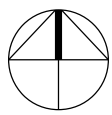
18.7. Exceedance Event

In the event of an extreme storm event (greater than 100-year + 40% climate change), or poor maintenance of the pipework potentially flooding of the drainage network could occur. Surface water will be contained within the garden area due the garden being flat. The flood volume will also less than the pre-development scenario, due to additional attenuation volumes within the ground. Therefore, due to the new SuDS methods, the flood risk to land or properties within or outside the development would not increase even in an extreme (greater than 1% AEP + 40% cc) storm event.

18.8. Water Quality

Surface water run-off within the development site will be from roof and lightwell areas only. The roof areas will have very little pollutants, and the surface water run-off discharging through a filter drain system. The filter drain will act as a pollutant control, and therefore there will be a betterment of water quality from the post development site.

Appendix A
Site Location Plan



NORTH

SCALE

0 20 40 60 80 100ft

0 10 20 30m

PROJECT

148 STATION ROAD, LONDON, DA15 7AB

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PROUN

ARCHITECTS • DESIGNERS • PLANNERS

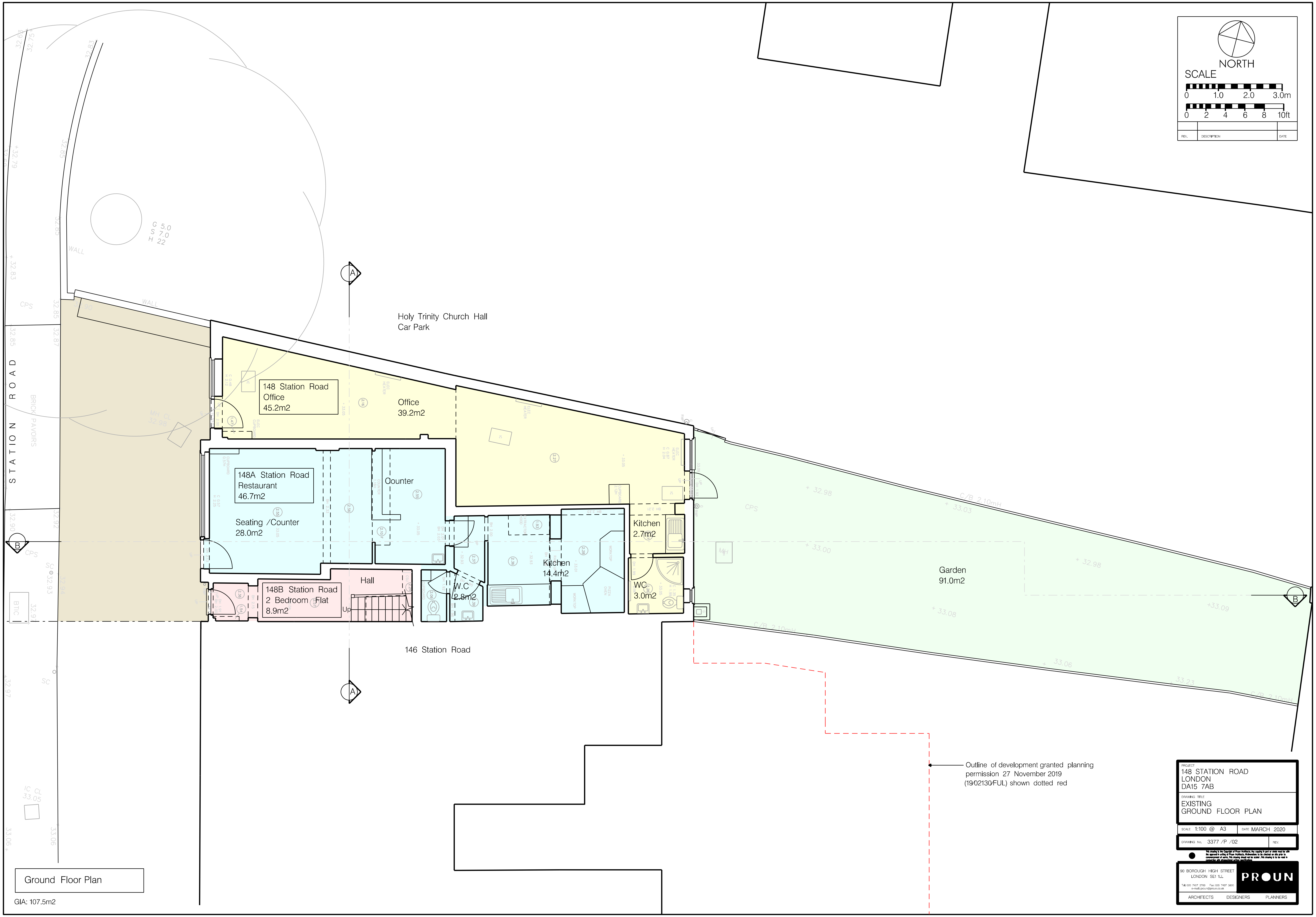
DRAWING TITLE

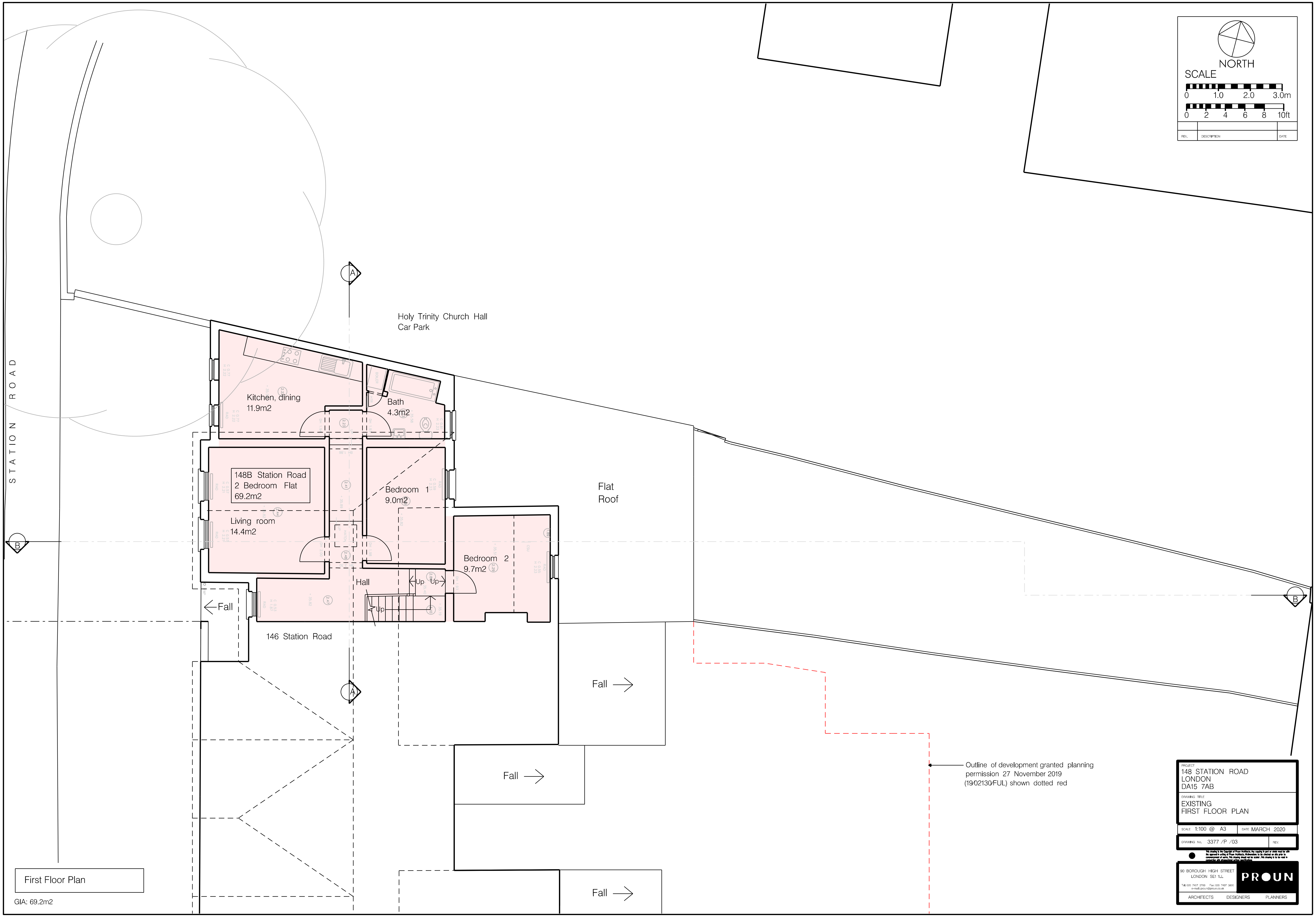
LOCATION PLAN

SCALE 1:1250 @ A4	DATE : MARCH 2020	DRAWING No. 3377 / L / 01	REV.

Appendix B

Existing Site Plans


NORTH
SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft
STATION ROAD
Holy Trinity Church Hall
Car Park
148 Station Road
Office
45.2m2
Office
39.2m2
148A Station Road
Restaurant
46.7m2
Counter
Seating /Counter
28.0m2
148B Station Road
2 Bedroom Flat
8.9m2
Hall
Up
W.C
2.8m2
Kitchen
14.4m2
Kitchen
2.7m2
WC
3.0m2
Garden
91.0m2
146 Station Road
Outline of development granted planning
permission 27 November 2019
(19/02130/FUL) shown dotted red
148 STATION ROAD
LONDON
DA15 7AB
EXISTING
GROUND FLOOR PLAN
1:100 @ A3
MARCH 2020
3377 /P /02
90 BOROUGH HIGH STREET
LONDON SE1 1LL
PROUN
ARCHITECTS DESIGNERS PLANNERS
Ground Floor Plan
GIA: 107.5m2


NORTH
SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft
REV. DESCRIPTION DATE
Holy Trinity Church Hall
Car Park
STATION ROAD
Kitchen, dining
11.9m2
Bath
4.3m2
148B Station Road
2 Bedroom Flat
69.2m2
Living room
14.4m2
Bedroom 1
9.0m2
Bedroom 2
9.7m2
Hall
Up
Up
Up
Fall
Flat
Roof
146 Station Road
Fall
Fall
Fall
A
A
B
B
Outline of development granted planning
permission 27 November 2019
(19/02130/FUL) shown dotted red
PROJECT
148 STATION ROAD
LONDON
DA15 7AB
DRAWING TITLE
EXISTING
FIRST FLOOR PLAN
SCALE 1:100 @ A3
DATE MARCH 2020
DRAWING No. 3377 /P /03
REV.
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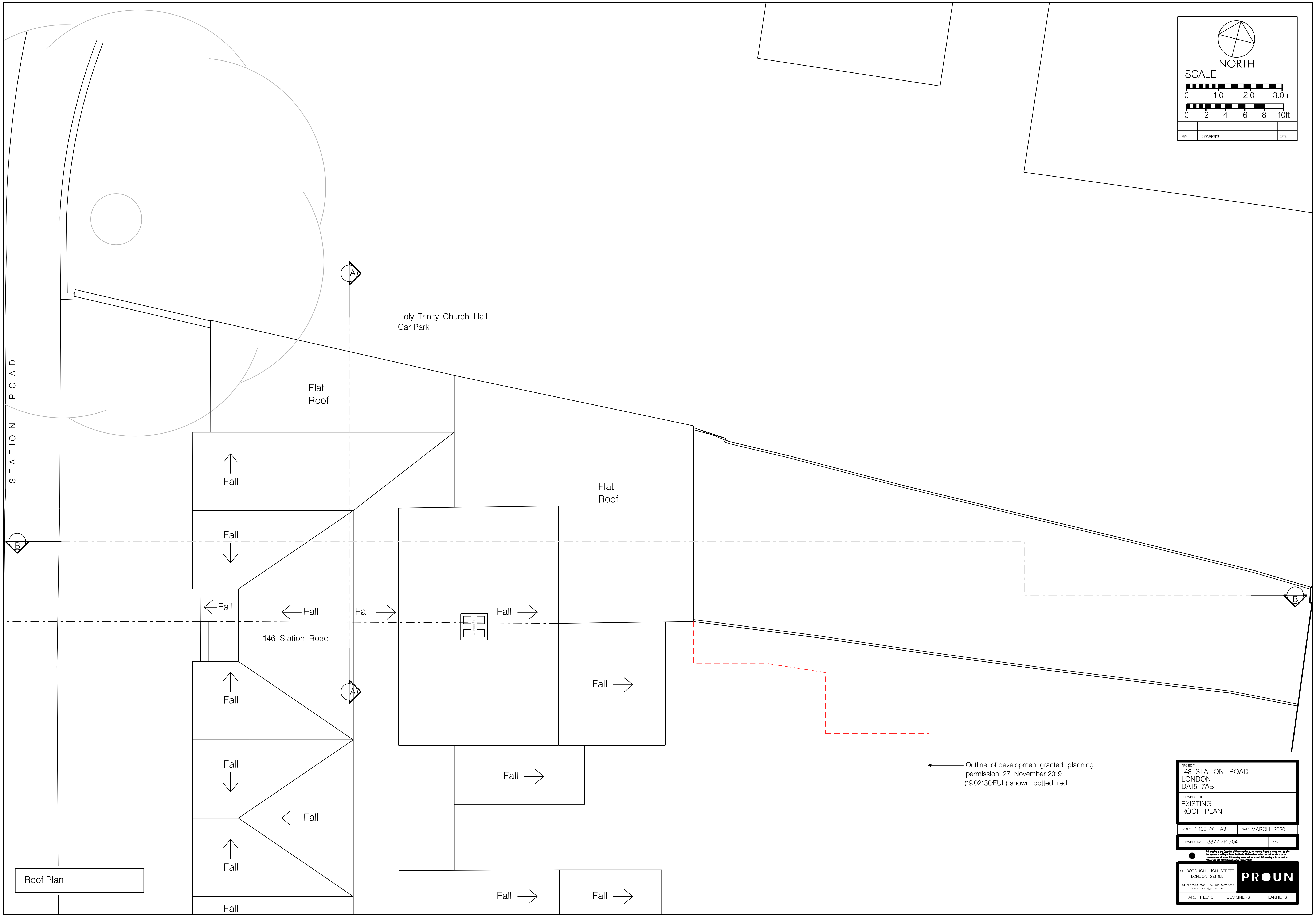
e-mail: proun@proun.co.uk
PROUN
ARCHITECTS DESIGNERS PLANNERS
First Floor Plan
GIA: 69.2m2


NORTH
SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft
REV. DESCRIPTION DATE
Holy Trinity Church Hall
Car Park
STATION ROAD
A
B
Flat
Roof
Flat
Roof
Fall
Fall
Fall
Fall
Fall
Fall
146 Station Road
Fall
Fall
Fall
Fall
Fall
Fall
Fall
Fall
Fall
Fall
Outline of development granted planning
permission 27 November 2019
(19/02130/FUL) shown dotted red
Roof Plan
PROJECT
148 STATION ROAD
LONDON
DA15 7AB
DRAWING TITLE
EXISTING
ROOF PLAN
SCALE 1:100 @ A3
DATE MARCH 2020
DRAWING No. 3377 /P /04
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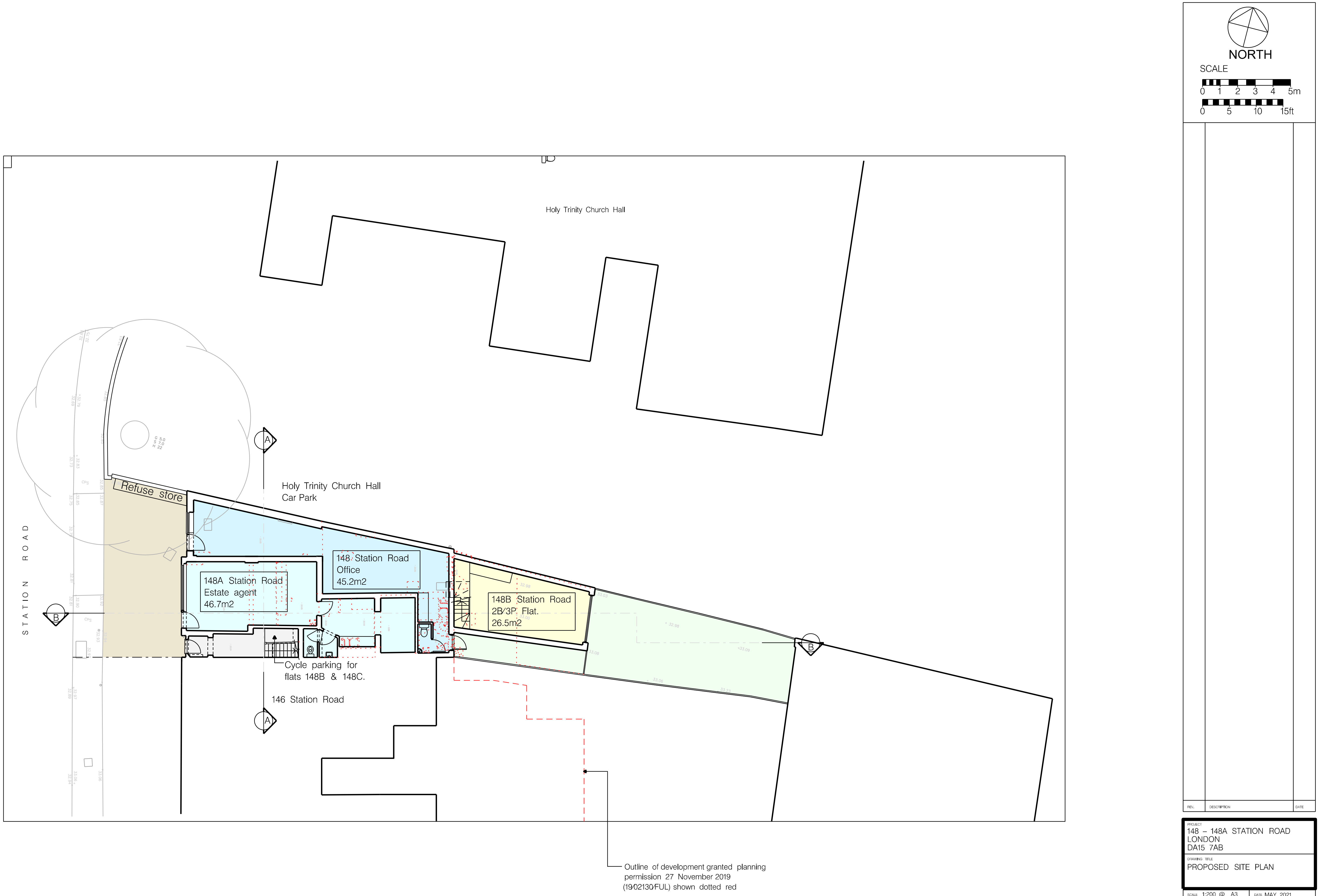
Appendix C

Proposed Site Plans



REV.	DESCRIPTION	DATE

PROJECT
148 – 148A STATION ROAD
LONDON
DA15 7AB

DRAWING TITLE
PROPOSED SITE PLAN

SCALE 1:200 @ A3 | DATE MAY 2021

DRAWING No. 3377 /P /21 | REV.

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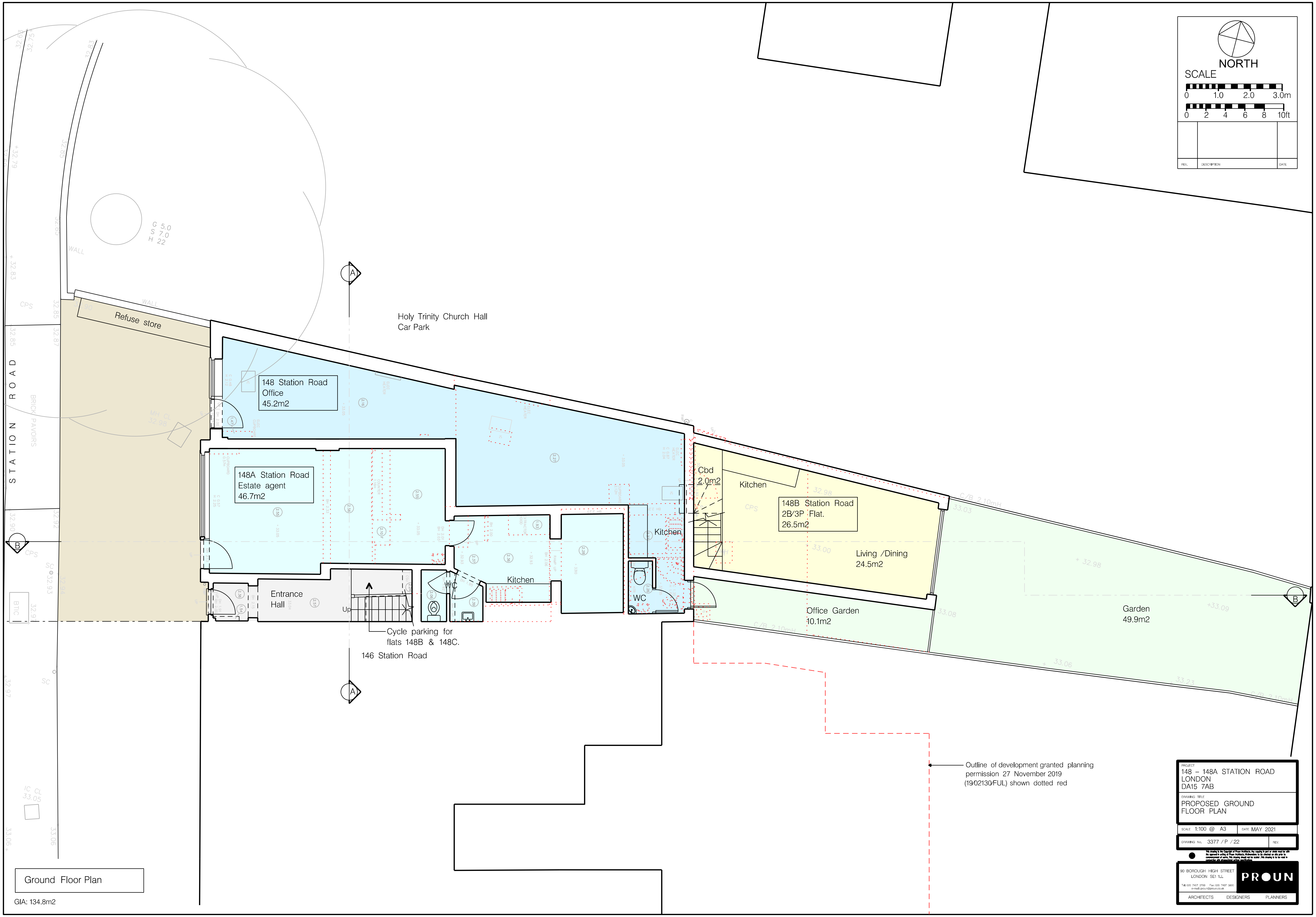
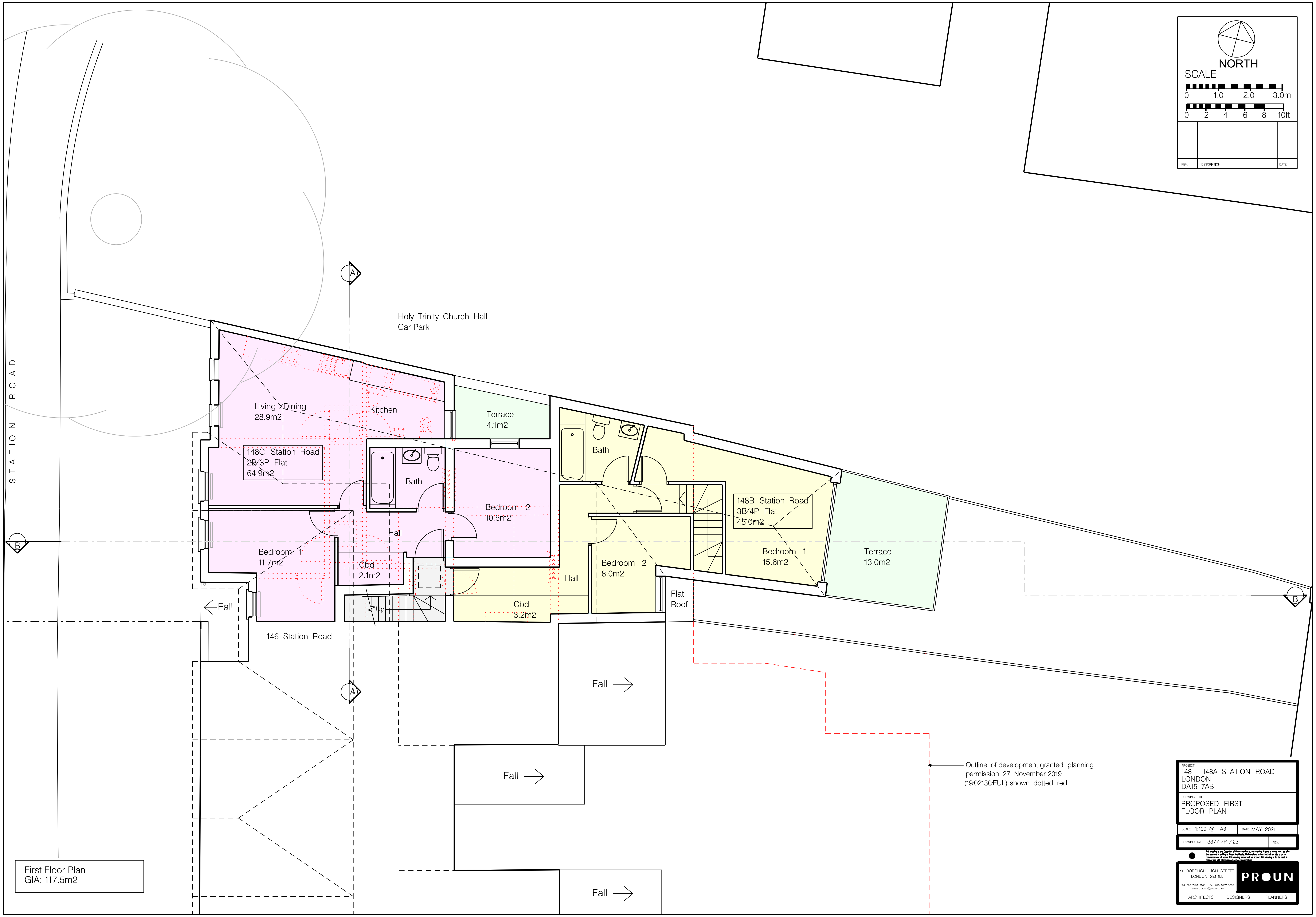

NORTH
SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft
Holy Trinity Church Hall
Car Park
Refuse store
STATION ROAD
148 Station Road
Office
45.2m2
148A Station Road
Estate agent
46.7m2
Kitchen
WC
Entrance
Hall
Up
Cycle parking for
flats 148B & 148C.
146 Station Road
Cbd
2.0m2
Kitchen
148B Station Road
2B/3P Flat.
26.5m2
Living /Dining
24.5m2
Office Garden
10.1m2
Garden
49.9m2
Outline of development granted planning
permission 27 November 2019
(19/02130/FUL) shown dotted red
Ground Floor Plan
GIA: 134.8m2
148 – 148A STATION ROAD
LONDON
DA15 7AB
PROPOSED GROUND
FLOOR PLAN
1:100 @ A3
MAY 2021
3377 / P / 22
90 BOROUGH HIGH STREET
LONDON SE1 1LL
PROUN
ARCHITECTS DESIGNERS PLANNERS



PROJECT
148 – 148A STATION ROAD
LONDON
DA15 7AB

DRAWING TITLE
PROPOSED FIRST
FLOOR PLAN

SCALE 1:100 @ A3 | DATE MAY 2021

DRAWING No. 3377 /P / 23 | REV.

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LONDON SE1 1LL
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e-mail: proun@proun.co.uk
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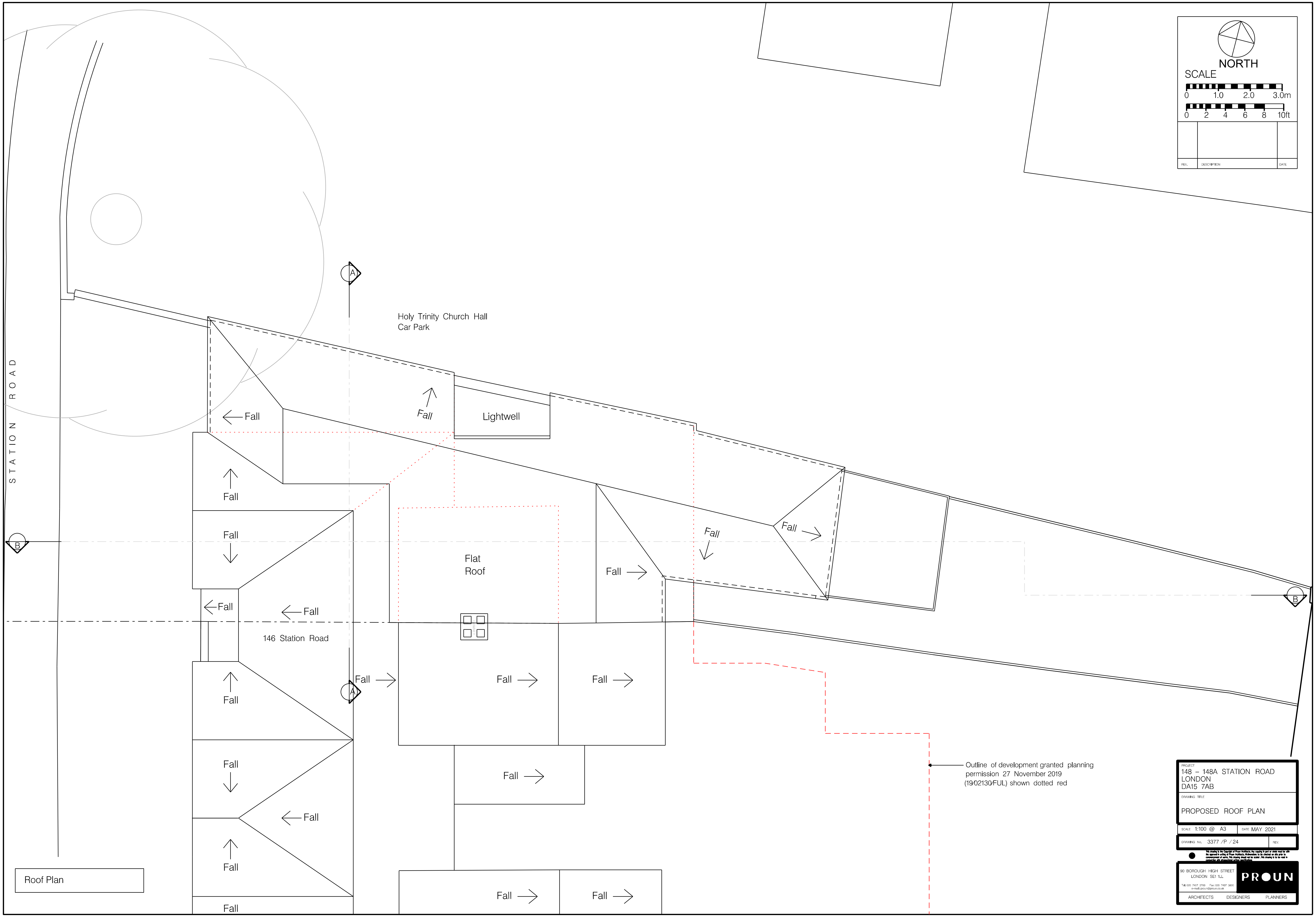
ARCHITECTS DESIGNERS PLANNERS



NORTH
SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft
REV.
DESCRIPTION
DATE
STATION ROAD
Holy Trinity Church Hall
Car Park
A
B
Lightwell
Fall
Flat
Roof
146 Station Road
Outline of development granted planning permission 27 November 2019 (19/02130/FUL) shown dotted red
Roof Plan
PROJECT
148 – 148A STATION ROAD
LONDON
DA15 7AB
DRAWING TITLE
PROPOSED ROOF PLAN
SCALE 1:100 @ A3
DATE MAY 2021
DRAWING No. 3377 /P / 24
REV.
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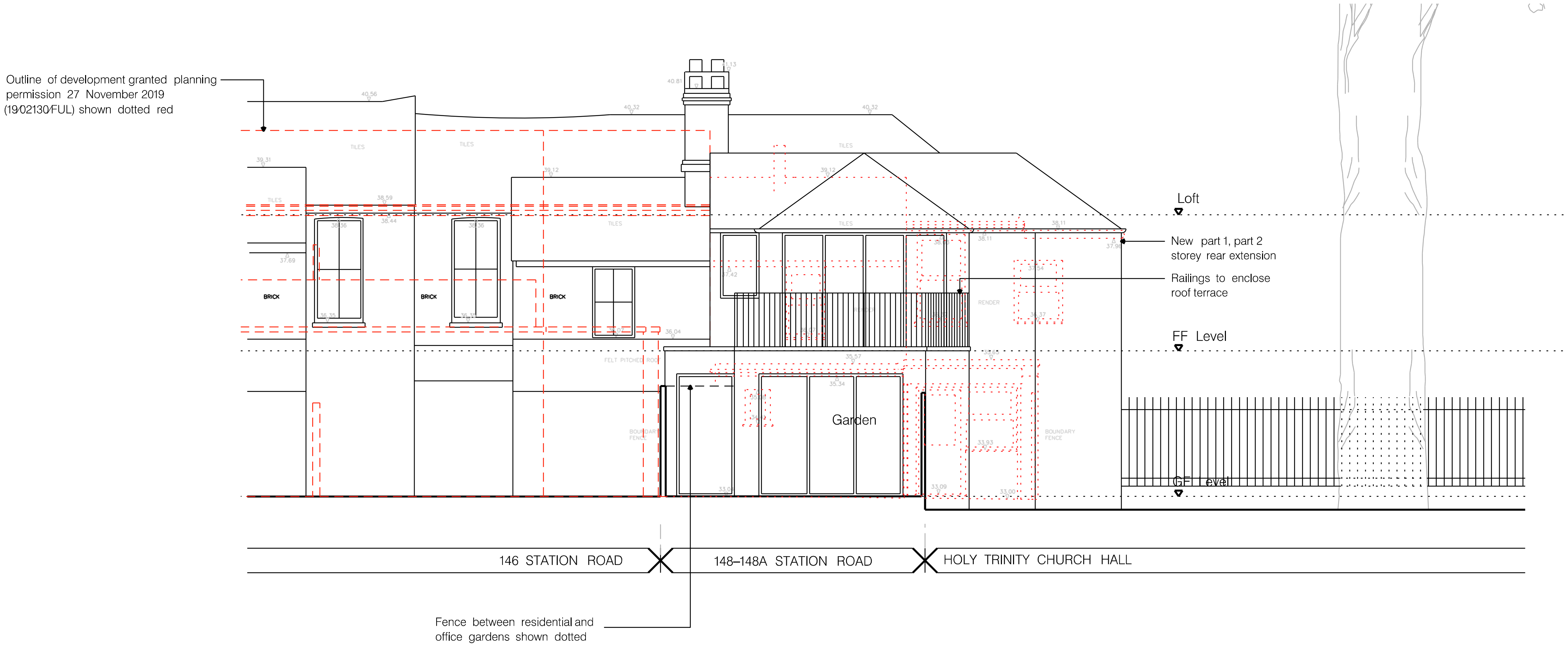
WEST ELEVATION (FRONT)

EAST ELEVATION (REAR)



SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft

PROJECT
148 – 148A STATION ROAD
LONDON
DA15 7AB

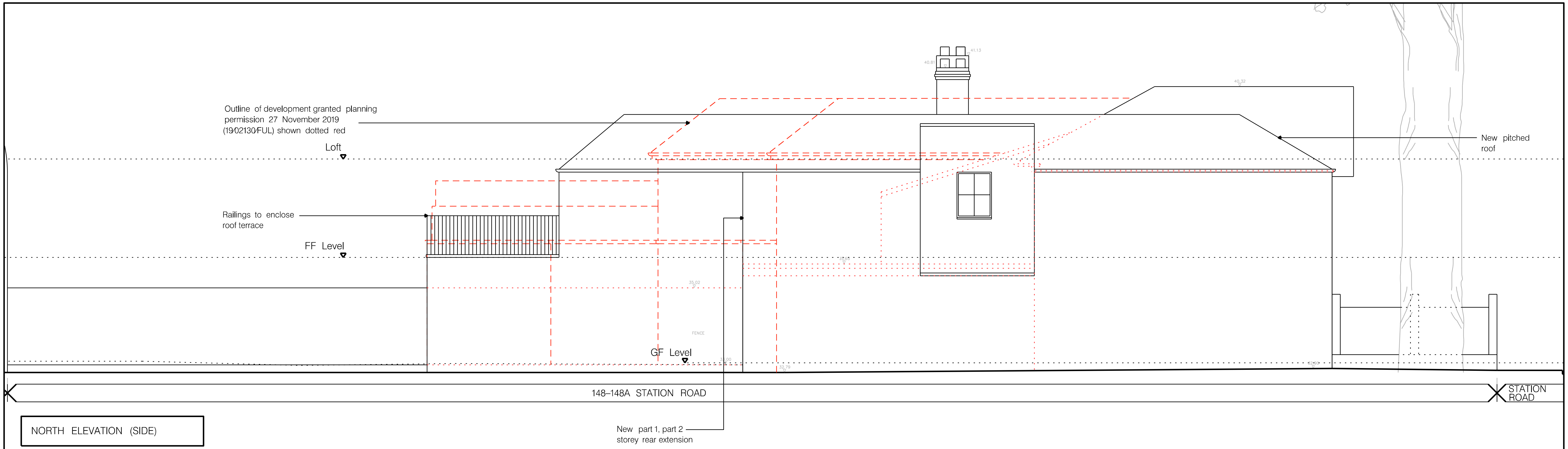
DRAWING TITLE
PROPOSED ELEVATIONS

SCALE 1:100 @ A3 DATE MAY 2021

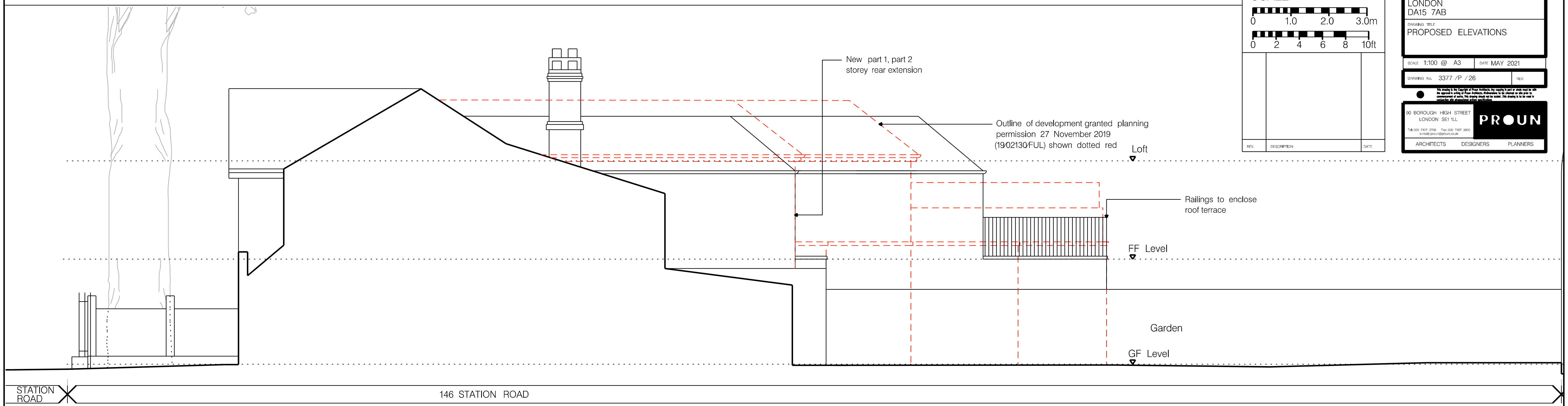
DRAWING No. 3377 /P /25 REV.

90 BOROUGH HIGH STREET
LONDON SE1 1LL

PROUN
ARCHITECTS DESIGNERS PLANNERS



NORTH ELEVATION (SIDE)



SOUTH ELEVATION (SIDE)

SCALE
0 1.0 2.0 3.0m
0 2 4 6 8 10ft

REV.	DESCRIPTION	DATE

PROJECT
148 – 148A STATION ROAD
LONDON
DA15 7AB

DRAWING TITLE
PROPOSED ELEVATIONS

SCALE 1:100 @ A3 | DATE MAY 2021

DRAWING No. 3377 /P / 26 | REV.

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LONDON SE1 1LL
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e–mail: proun@proun.co.uk

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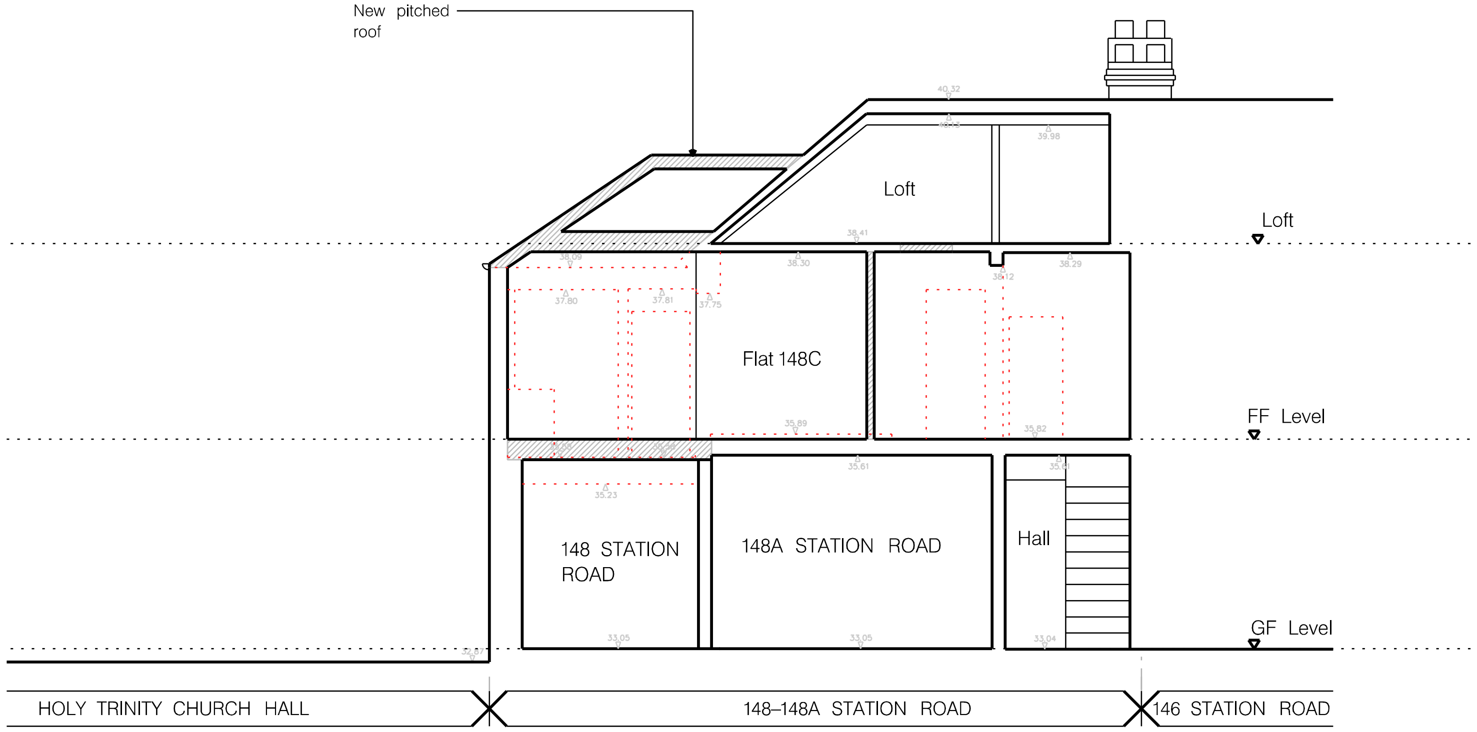
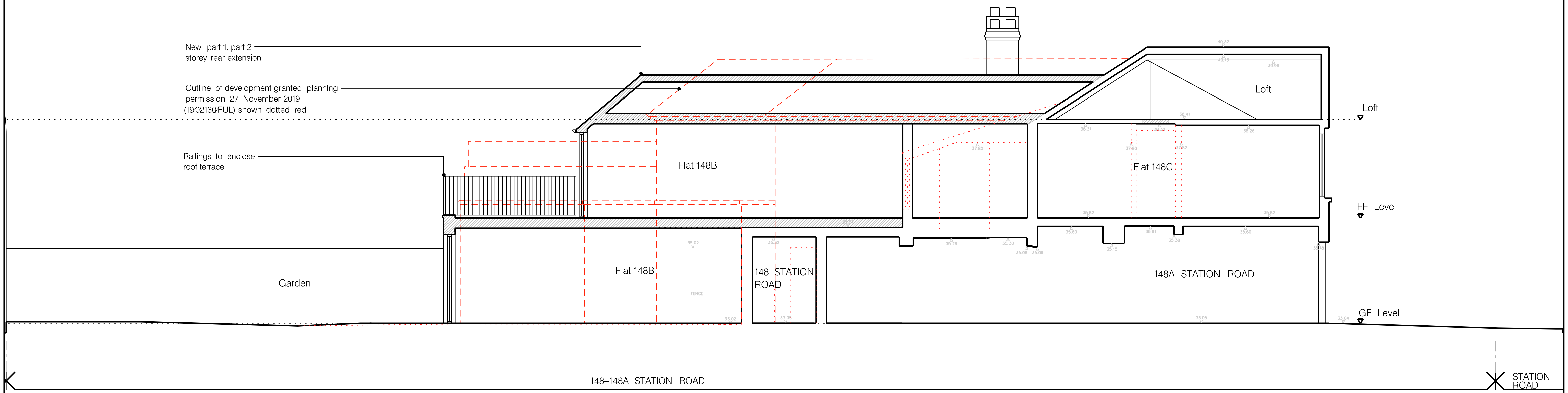
ARCHITECTS DESIGNERS PLANNERS



SECTION A–A



SECTION B–B

SCALE

0 1.0 2.0 3.0m

0 2 4 6 8 10ft

REV.	DESCRIPTION	DATE

PROJECT
148 – 148A STATION ROAD
LONDON
DA15 7AB

DRAWING TITLE
PROPOSED SECTIONS A–A AND B–B

SCALE 1:100 @ A3 | DATE MAY 2021

DRAWING No. 3377 /P / 27 | REV.

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LONDON SE1 1LL
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e-mail: proun@proun.co.uk

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Appendix D

BGS Data

HOLST & CO. LTD.

SITE INVESTIGATION DEPT. TQ47SE 41

5-7, NEW YORK ROAD 46440 -72730

LEEDS, 2

Contract No. T1175/F1090

Location Hatherley Road,

Client London Borough of Bexley

Borehole No. C

Ground Level

Date 14th February 196

BOREHOLE LOG

STRATA	Legend	Depth below Ground Level	Thickness of Strata	Type of Sample	c lb/sq. ft.	ø deg.	m.c %	y lb/cu. ft.
Top Soil		2'0"	2'0"					
Soft brown grey sandy clay		5'6"	3'6"					
Sand and gravel with traces of clay		8'0"	2'6"					
Moist grey brown sandy silt with occasional bands of gravel		13'0"	5'0"					

Water Struck at Land drain 1'9"

Maximum Observed Water Level 1'9"

HOLST & CO. LTD. TQ47SE 39 46467-72848

SITE INVESTIGATION DEPT.
5-7, NEW YORK ROAD
LEEDS, 2

Contract No. T1175/F1090

Borehole No. A

Location Hatherley Road,

Ground Level

Client London Borough of Bexley

Date 14th February 1969

BOREHOLE LOG

STRATA	Legend	Depth below Ground Level	Thickness of Strata	Type of Sample	c lb/sq. ft.	ø deg.	m.c %	y lb/cu. ft.	N
Top Soil		1'6"	1'6"						
Brown sandy clay and gravel		4'9"	3'3"						
Loose brown fine/medium Silty sand		10'0"	5'3"						

Water Struck at None encountered

Maximum Observed Water Level

TQ 47/72

TQ 47/72/271. 6" Kent 8 NE

271/383

WEST KENT MAIN SEWERAGE BOARD

Record of Strata met with during the construction of a manhole in June, 1954, at Hurst Road, Sidcup, 1100 feet E.N.E. of Sidcup Station. National Grid Reference T Q 465 727.

Road level 106.25 Newlyn datum

TQ 47 SE 23
4661 7279

Depth below road level

	0 - 9"	Concrete
	9" - 2'-6"	Stiff brown clay
Blackheath Beds. Specimens seen.	2'-6" - 12'-0"	Compact yellow sandy gravel
	12'-0" - 14'-0"	Hoggin
	14'-0" - 20'-0"	Fine sand with a little clay, gray and black
	20'-0" - 24'-0"	Gray ballast
	24'-0" - 27'-0"	Black gravel. Partly uncemented but partly with quantities of cemented shells
Woolwich Beds	27'-0" - 31'-0"	Fine, gray sand, some shell and small stones
	31'-0" - 42'-0"	Very firm clay, black, gray and yellow
	42'-0" - 46'-0"	Clay and sandy clay, gray
Thanet Sand	46'-0" - 49'-6"	Green sand, very firm

End of excavation

Water was found at a depth of 15'-0" but ceased at about 32'-0" below road level.

Cf. West Kent Sewerage No 4 bh (of about 1900) in W.S. Kent, p. 249. The top 10 ft of this, brickle, very close to the above, is undoubtedly Blackheath

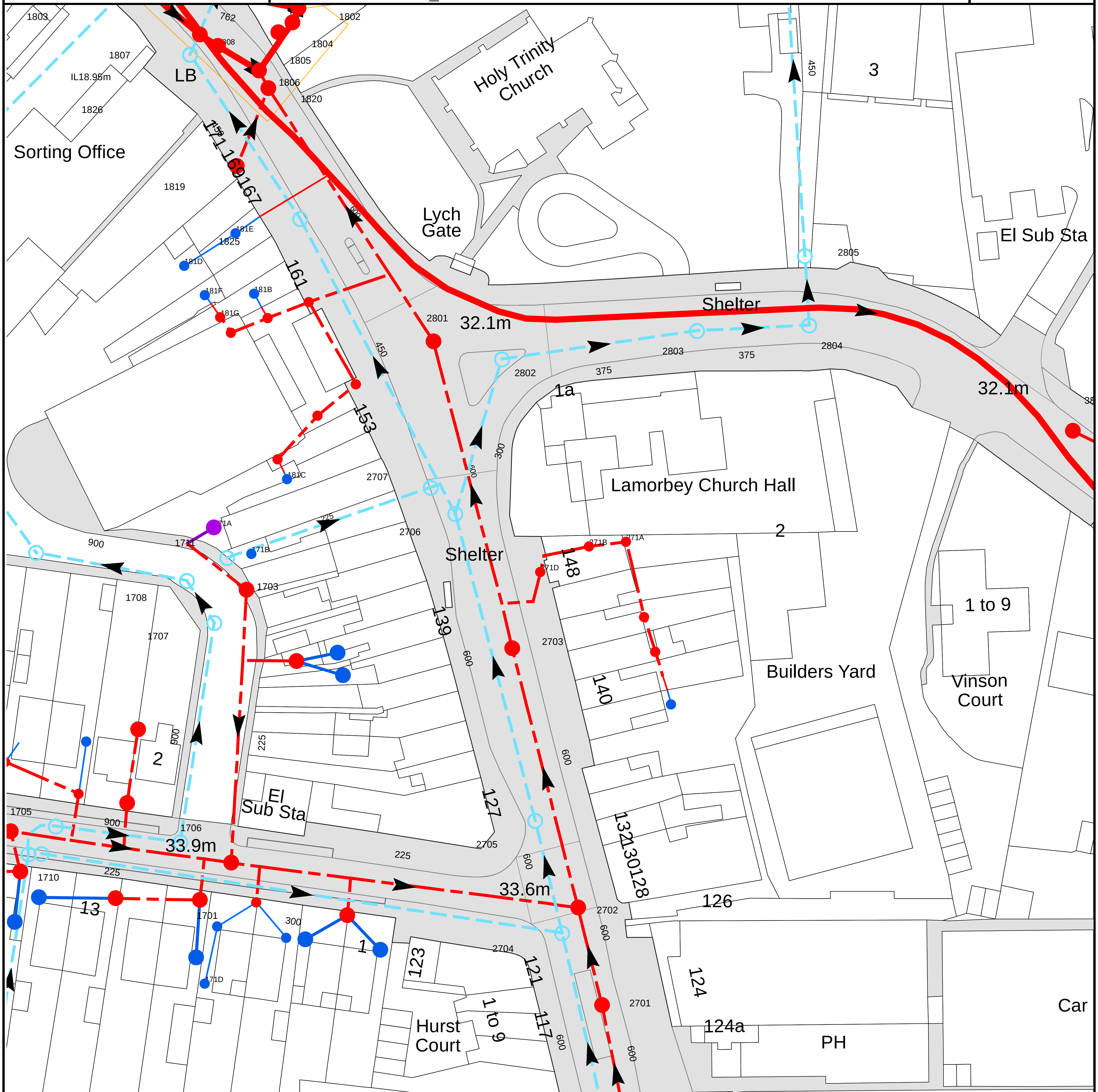
[illegible] 5/10/54

Sited by [illegible] on Kent 6" 8 NE/W. & 1" 271.
12.10.54. [illegible]

Appendix E

Thames Water Asset Plans

Asset Location Search Sewer Map - ALS/ALS/24/2020_4207315



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 546231,172788

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
18DH	n/a	n/a
18DI	n/a	n/a
2707	n/a	n/a
2801	n/a	n/a
2706	n/a	n/a
2802	n/a	n/a
2703	n/a	n/a
271D	n/a	n/a
271B	n/a	n/a
271A	n/a	n/a
2803	n/a	n/a
2805	n/a	n/a
2804	n/a	n/a
3801	n/a	n/a
17BE	n/a	n/a
17BC	n/a	n/a
17GF	n/a	n/a
1707	n/a	n/a
1703	n/a	n/a
1708	n/a	n/a
1711	n/a	n/a
171B	n/a	n/a
1709	n/a	n/a
171A	n/a	n/a
181C	n/a	n/a
18DG	n/a	n/a
18DD	n/a	n/a
18DJ	n/a	n/a
181G	n/a	n/a
18EA	n/a	n/a
181F	n/a	n/a
181B	n/a	n/a
181D	n/a	n/a
181E	n/a	n/a
1825	n/a	n/a
1826	n/a	n/a
1807	31.102	28.212
1808	n/a	n/a
1819	n/a	n/a
1806	31.402	29.372
1820	n/a	n/a
1805	n/a	n/a
1804	n/a	n/a
1802	31.39	n/a
171D	n/a	n/a
17CI	n/a	n/a
17DB	n/a	n/a
17DA	n/a	n/a
17CJ	n/a	n/a
17CE	n/a	n/a
17DE	n/a	n/a
17CH	n/a	n/a
17CG	n/a	n/a
17CF	n/a	n/a
17CD	n/a	n/a
1701	n/a	n/a
1704	n/a	n/a
1710	n/a	n/a
1706	n/a	n/a
1702	n/a	n/a
1705	n/a	n/a
17BD	n/a	n/a
17BF	n/a	n/a
17BG	n/a	n/a
17GE	n/a	n/a
17GD	n/a	n/a
17DD	n/a	n/a
17DC	n/a	n/a
2705	n/a	n/a
2704	n/a	n/a
2702	n/a	n/a
2701	n/a	n/a
2709	n/a	n/a
2710	n/a	n/a
2708	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.

Appendix F

Greenfield Run-Off Rates and Volume Calculations

IH 124 Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (ha)	50.000	Urban	0.750
SAAR (mm)	600	Region Number	Region 6

Results	**l/s**
QBAR Rural	76.1
QBAR Urban	282.8
Q1 year	240.4
Q1 year	240.4
Q2 years	287.1
Q5 years	380.6
Q10 years	429.6
Q20 years	471.7
Q25 years	482.5
Q30 years	491.1
Q50 years	518.9
Q100 years	566.9
Q200 years	605.1
Q250 years	615.7
Q1000 years	685.4

Greenfield Runoff Volume

FEH Data

Return Period (years)	100
Storm Duration (mins)	360
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Areal Reduction Factor	1.00
Area (ha)	61.500
SAAR (mm)	627
CWI	91.860
SPR Host	16.280
URBEXT (2000)	0.5000

Results

Percentage Runoff (%)	31.25
Greenfield Runoff Volume (m³)	15567.750

Appendix G

Pre-Development SW Run-Off Rates and Volume Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	5.000	0.050	100.0	0.004	5.00	0.0	0.600	o	100	Pipe/Conduit	🔓
1.001	5.000	0.050	100.0	0.003	0.00	0.0	0.600	o	100	Pipe/Conduit	🔓

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.11	31.500	0.004	0.0	0.0	0.0	0.77	6.0	0.5
1.001	50.00	5.22	31.450	0.007	0.0	0.0	0.0	0.77	6.0	0.9

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	450.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	1	+0%					31.523
1.001	2	15 Winter	1	+0%					31.480

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.077	0.000	0.12		0.6	OK	
1.001	2	-0.070	0.000	0.19		1.0	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	450.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	30	+0%					31.543
1.001	2	15 Winter	30	+0%					31.511

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.057	0.000	0.38		2.0	OK	
1.001	2	-0.039	0.000	0.67		3.6	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	450.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+0%					31.557
1.001	2	15 Winter	100	+0%					31.541

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.043	0.000	0.57		3.0	OK	
1.001	2	-0.009	0.000	1.00		5.3	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313

Synthetic Rainfall Details

F (1km)	2.594
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	450.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

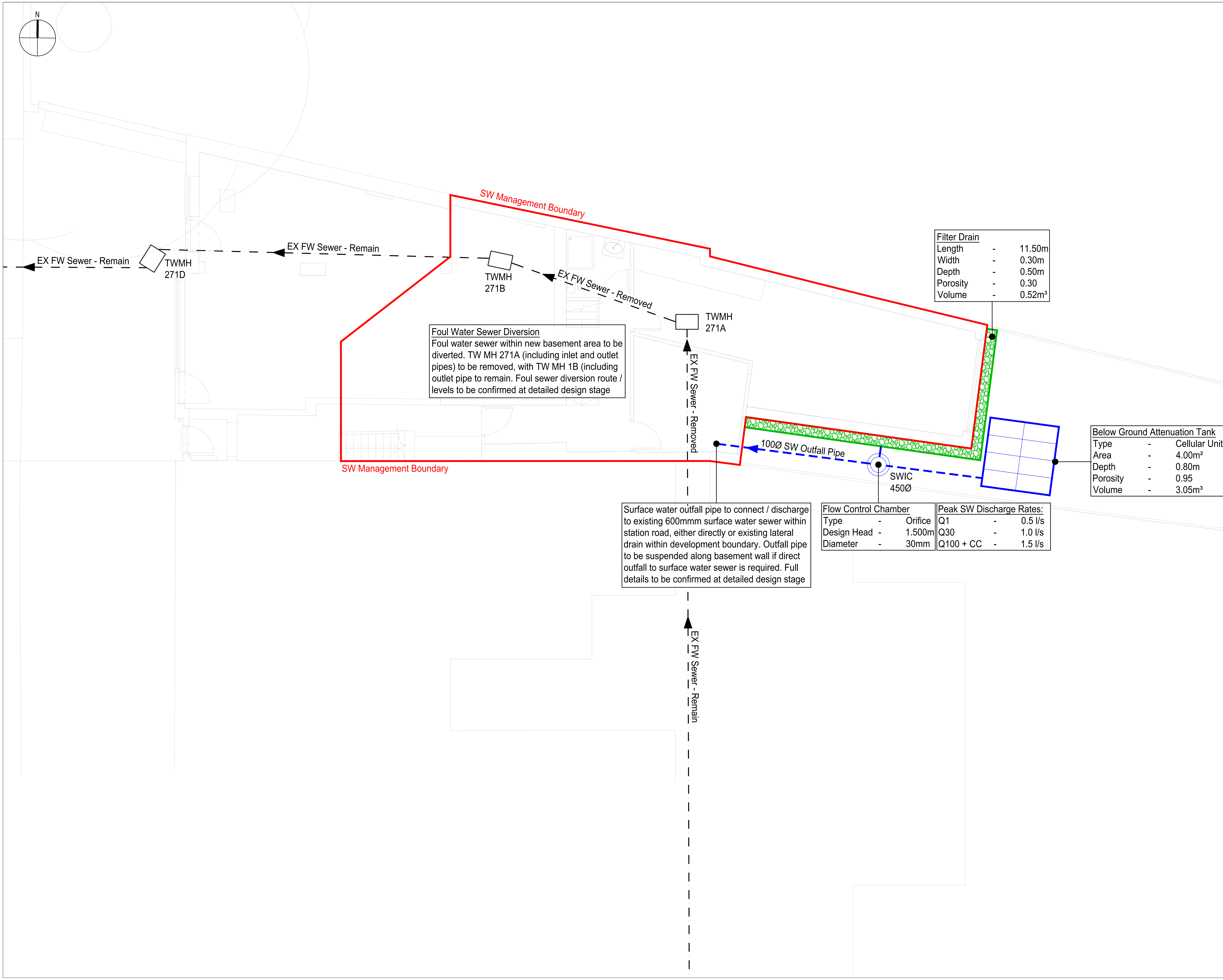
Profile(s)	Summer and Winter
Duration(s) (mins)	360
Return Period(s) (years)	100
Climate Change (%)	0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
1.000	1	360 minute 100 year Summer I+0%	33.000	31.519	-0.081	0.000	0.08
1.001	2	360 minute 100 year Summer I+0%	33.000	31.475	-0.075	0.000	0.14

PN	US/MH Name	Overflow (l/s)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1		2.430	0.4	OK
1.001	2		4.255	0.7	OK

Appendix H

Below Ground Drainage Management Layout



Rev	Description	Drn	Chk	Date
P2	Issued for Planning	MDS	NC	07.06.21
P1	Issued for Planning	MDS	NC	06.07.20

Client
-

Project
148 Station Road
Sidcup, Bexley

Drawing
Surface Water
Management Layout

Scale	Date	Drawn by	Checked
1:50@A1 / 1:100@A3	Jul '20	MDS	NC

Status
Planning

Earth Environmental & Geotechnical

Job No.	Drg. No.	Rev
609	DR-100	P2

Appendix I

Surface Water Management Calculations

Summary of Results for 1 year Return Period

Half Drain Time : 10 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	31.566	0.066	0.0	0.4	0.4	0.3	O K
30 min Summer	31.573	0.073	0.0	0.5	0.5	0.4	O K
60 min Summer	31.572	0.072	0.0	0.4	0.4	0.4	O K
120 min Summer	31.562	0.062	0.0	0.4	0.4	0.3	O K
180 min Summer	31.553	0.053	0.0	0.4	0.4	0.3	O K
240 min Summer	31.547	0.047	0.0	0.3	0.3	0.2	O K
360 min Summer	31.539	0.039	0.0	0.3	0.3	0.2	O K
480 min Summer	31.535	0.035	0.0	0.2	0.2	0.2	O K
600 min Summer	31.532	0.032	0.0	0.2	0.2	0.2	O K
720 min Summer	31.530	0.030	0.0	0.2	0.2	0.1	O K
960 min Summer	31.527	0.027	0.0	0.2	0.2	0.1	O K
1440 min Summer	31.524	0.024	0.0	0.1	0.1	0.1	O K
2160 min Summer	31.520	0.020	0.0	0.1	0.1	0.1	O K
2880 min Summer	31.518	0.018	0.0	0.1	0.1	0.1	O K
4320 min Summer	31.515	0.015	0.0	0.1	0.1	0.1	O K
5760 min Summer	31.514	0.014	0.0	0.1	0.1	0.1	O K
7200 min Summer	31.513	0.013	0.0	0.0	0.0	0.1	O K
8640 min Summer	31.512	0.012	0.0	0.0	0.0	0.1	O K
10080 min Summer	31.511	0.011	0.0	0.0	0.0	0.1	O K
15 min Winter	31.575	0.075	0.0	0.5	0.5	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	34.977	0.0	0.7	22
30 min Summer	21.636	0.0	0.8	30
60 min Summer	13.383	0.0	1.0	44
120 min Summer	8.278	0.0	1.2	76
180 min Summer	6.251	0.0	1.4	106
240 min Summer	5.121	0.0	1.5	134
360 min Summer	3.866	0.0	1.7	194
480 min Summer	3.168	0.0	1.9	254
600 min Summer	2.714	0.0	2.0	314
720 min Summer	2.392	0.0	2.2	374
960 min Summer	1.994	0.0	2.4	494
1440 min Summer	1.543	0.0	2.8	736
2160 min Summer	1.194	0.0	3.2	1104
2880 min Summer	0.996	0.0	3.6	1460
4320 min Summer	0.723	0.0	3.9	2152
5760 min Summer	0.577	0.0	4.2	2928
7200 min Summer	0.484	0.0	4.4	3656
8640 min Summer	0.419	0.0	4.5	4400
10080 min Summer	0.371	0.0	4.7	5088
15 min Winter	34.977	0.0	0.7	22

Summary of Results for 1 year Return Period

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	31.582	0.082	0.0	0.5	0.5	0.4	O K
60 min Winter	31.576	0.076	0.0	0.5	0.5	0.4	O K
120 min Winter	31.558	0.058	0.0	0.4	0.4	0.3	O K
180 min Winter	31.546	0.046	0.0	0.3	0.3	0.2	O K
240 min Winter	31.540	0.040	0.0	0.3	0.3	0.2	O K
360 min Winter	31.534	0.034	0.0	0.2	0.2	0.2	O K
480 min Winter	31.530	0.030	0.0	0.2	0.2	0.1	O K
600 min Winter	31.527	0.027	0.0	0.2	0.2	0.1	O K
720 min Winter	31.525	0.025	0.0	0.1	0.1	0.1	O K
960 min Winter	31.523	0.023	0.0	0.1	0.1	0.1	O K
1440 min Winter	31.519	0.019	0.0	0.1	0.1	0.1	O K
2160 min Winter	31.517	0.017	0.0	0.1	0.1	0.1	O K
2880 min Winter	31.515	0.015	0.0	0.1	0.1	0.1	O K
4320 min Winter	31.513	0.013	0.0	0.0	0.0	0.1	O K
5760 min Winter	31.512	0.012	0.0	0.0	0.0	0.1	O K
7200 min Winter	31.511	0.011	0.0	0.0	0.0	0.1	O K
8640 min Winter	31.510	0.010	0.0	0.0	0.0	0.0	O K
10080 min Winter	31.509	0.009	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	21.636	0.0	0.9	30
60 min Winter	13.383	0.0	1.1	46
120 min Winter	8.278	0.0	1.4	76
180 min Winter	6.251	0.0	1.6	106
240 min Winter	5.121	0.0	1.7	134
360 min Winter	3.866	0.0	1.9	194
480 min Winter	3.168	0.0	2.1	256
600 min Winter	2.714	0.0	2.3	316
720 min Winter	2.392	0.0	2.4	378
960 min Winter	1.994	0.0	2.7	500
1440 min Winter	1.543	0.0	3.1	740
2160 min Winter	1.194	0.0	3.6	1116
2880 min Winter	0.996	0.0	4.0	1468
4320 min Winter	0.723	0.0	4.4	2192
5760 min Winter	0.577	0.0	4.6	3024
7200 min Winter	0.484	0.0	4.9	3488
8640 min Winter	0.419	0.0	5.1	4416
10080 min Winter	0.371	0.0	5.2	5144

Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.010

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003	4	8	0.003	8	12	0.002	12	16	0.002

Model Details

Storage is Online Cover Level (m) 33.000

Complex Structure

Pipe

Diameter (m) 0.150 Length (m) 1.000
Slope (1:X) 100.000 Invert Level (m) 31.500

Cellular Storage

Invert Level (m) 31.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	4.0	0.0	2.600	0.0	0.0
0.200	4.0	0.0	2.800	0.0	0.0
0.400	4.0	0.0	3.000	0.0	0.0
0.600	4.0	0.0	3.200	0.0	0.0
0.800	4.0	0.0	3.400	0.0	0.0
1.000	0.0	0.0	3.600	0.0	0.0
1.200	0.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Infiltration Trench

Infiltration Coefficient Base (m/hr) 0.00000 Trench Width (m) 0.3
Infiltration Coefficient Side (m/hr) 0.00000 Trench Length (m) 11.5
Safety Factor 2.0 Slope (1:X) 0.0
Porosity 0.30 Cap Volume Depth (m) 0.000
Invert Level (m) 32.500 Cap Infiltration Depth (m) 0.000

Orifice Outflow Control

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 31.500

Summary of Results for 30 year Return Period

Half Drain Time : 17 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	31.765	0.265	0.0	0.9	0.9	1.3	O K
30 min Summer	31.783	0.283	0.0	1.0	1.0	1.4	O K
60 min Summer	31.763	0.263	0.0	0.9	0.9	1.3	O K
120 min Summer	31.720	0.220	0.0	0.9	0.9	1.1	O K
180 min Summer	31.684	0.184	0.0	0.8	0.8	0.9	O K
240 min Summer	31.656	0.156	0.0	0.7	0.7	0.8	O K
360 min Summer	31.617	0.117	0.0	0.6	0.6	0.6	O K
480 min Summer	31.593	0.093	0.0	0.5	0.5	0.5	O K
600 min Summer	31.577	0.077	0.0	0.5	0.5	0.4	O K
720 min Summer	31.565	0.065	0.0	0.4	0.4	0.3	O K
960 min Summer	31.551	0.051	0.0	0.4	0.4	0.3	O K
1440 min Summer	31.540	0.040	0.0	0.3	0.3	0.2	O K
2160 min Summer	31.533	0.033	0.0	0.2	0.2	0.2	O K
2880 min Summer	31.529	0.029	0.0	0.2	0.2	0.1	O K
4320 min Summer	31.524	0.024	0.0	0.1	0.1	0.1	O K
5760 min Summer	31.520	0.020	0.0	0.1	0.1	0.1	O K
7200 min Summer	31.517	0.017	0.0	0.1	0.1	0.1	O K
8640 min Summer	31.516	0.016	0.0	0.1	0.1	0.1	O K
10080 min Summer	31.515	0.015	0.0	0.1	0.1	0.1	O K
15 min Winter	31.801	0.301	0.0	1.0	1.0	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	112.381	0.0	2.1	23
30 min Summer	65.864	0.0	2.5	32
60 min Summer	38.601	0.0	2.9	48
120 min Summer	22.623	0.0	3.4	78
180 min Summer	16.551	0.0	3.7	110
240 min Summer	13.259	0.0	4.0	140
360 min Summer	9.700	0.0	4.4	200
480 min Summer	7.771	0.0	4.7	260
600 min Summer	6.543	0.0	4.9	320
720 min Summer	5.685	0.0	5.1	378
960 min Summer	4.635	0.0	5.6	498
1440 min Summer	3.476	0.0	6.3	736
2160 min Summer	2.606	0.0	7.0	1100
2880 min Summer	2.125	0.0	7.6	1468
4320 min Summer	1.496	0.0	8.1	2204
5760 min Summer	1.166	0.0	8.4	2872
7200 min Summer	0.961	0.0	8.6	3672
8640 min Summer	0.821	0.0	8.9	4296
10080 min Summer	0.718	0.0	9.0	5056
15 min Winter	112.381	0.0	2.4	23

Summary of Results for 30 year Return Period

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	31.820	0.320	0.0	1.0	1.0	1.6	O K
60 min Winter	31.789	0.289	0.0	1.0	1.0	1.4	O K
120 min Winter	31.721	0.221	0.0	0.9	0.9	1.1	O K
180 min Winter	31.670	0.170	0.0	0.7	0.7	0.8	O K
240 min Winter	31.635	0.135	0.0	0.7	0.7	0.7	O K
360 min Winter	31.592	0.092	0.0	0.5	0.5	0.5	O K
480 min Winter	31.569	0.069	0.0	0.4	0.4	0.3	O K
600 min Winter	31.555	0.055	0.0	0.4	0.4	0.3	O K
720 min Winter	31.546	0.046	0.0	0.3	0.3	0.2	O K
960 min Winter	31.539	0.039	0.0	0.3	0.3	0.2	O K
1440 min Winter	31.532	0.032	0.0	0.2	0.2	0.2	O K
2160 min Winter	31.527	0.027	0.0	0.2	0.2	0.1	O K
2880 min Winter	31.524	0.024	0.0	0.1	0.1	0.1	O K
4320 min Winter	31.519	0.019	0.0	0.1	0.1	0.1	O K
5760 min Winter	31.516	0.016	0.0	0.1	0.1	0.1	O K
7200 min Winter	31.515	0.015	0.0	0.1	0.1	0.1	O K
8640 min Winter	31.514	0.014	0.0	0.1	0.1	0.1	O K
10080 min Winter	31.513	0.013	0.0	0.0	0.0	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	65.864	0.0	2.8	32
60 min Winter	38.601	0.0	3.2	48
120 min Winter	22.623	0.0	3.8	82
180 min Winter	16.551	0.0	4.2	114
240 min Winter	13.259	0.0	4.5	144
360 min Winter	9.700	0.0	4.9	204
480 min Winter	7.771	0.0	5.2	262
600 min Winter	6.543	0.0	5.5	320
720 min Winter	5.685	0.0	5.7	380
960 min Winter	4.635	0.0	6.2	494
1440 min Winter	3.476	0.0	7.0	736
2160 min Winter	2.606	0.0	7.9	1104
2880 min Winter	2.125	0.0	8.6	1476
4320 min Winter	1.496	0.0	9.0	2168
5760 min Winter	1.166	0.0	9.4	2952
7200 min Winter	0.961	0.0	9.7	3704
8640 min Winter	0.821	0.0	9.9	4152
10080 min Winter	0.718	0.0	10.1	5088

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.010

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.003	4	8	0.003	8	12	0.002	12	16	0.002

Model Details

Storage is Online Cover Level (m) 33.000

Complex Structure

Pipe

Diameter (m) 0.150 Length (m) 1.000
Slope (1:X) 100.000 Invert Level (m) 31.500

Cellular Storage

Invert Level (m) 31.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	4.0	0.0	2.600	0.0	0.0
0.200	4.0	0.0	2.800	0.0	0.0
0.400	4.0	0.0	3.000	0.0	0.0
0.600	4.0	0.0	3.200	0.0	0.0
0.800	4.0	0.0	3.400	0.0	0.0
1.000	0.0	0.0	3.600	0.0	0.0
1.200	0.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Infiltration Trench

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	0.3
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	11.5
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	32.500	Cap Infiltration Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 31.500

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

Half Drain Time : 23 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	32.148	0.648	0.0	1.5	1.5	3.1	O K
30 min Summer	32.184	0.684	0.0	1.5	1.5	3.3	O K
60 min Summer	32.143	0.643	0.0	1.5	1.5	3.1	O K
120 min Summer	32.049	0.549	0.0	1.4	1.4	2.7	O K
180 min Summer	31.970	0.470	0.0	1.3	1.3	2.3	O K
240 min Summer	31.907	0.407	0.0	1.2	1.2	2.0	O K
360 min Summer	31.814	0.314	0.0	1.0	1.0	1.5	O K
480 min Summer	31.751	0.251	0.0	0.9	0.9	1.2	O K
600 min Summer	31.706	0.206	0.0	0.8	0.8	1.0	O K
720 min Summer	31.672	0.172	0.0	0.7	0.7	0.8	O K
960 min Summer	31.631	0.131	0.0	0.6	0.6	0.6	O K
1440 min Summer	31.587	0.087	0.0	0.5	0.5	0.4	O K
2160 min Summer	31.558	0.058	0.0	0.4	0.4	0.3	O K
2880 min Summer	31.544	0.044	0.0	0.3	0.3	0.2	O K
4320 min Summer	31.534	0.034	0.0	0.2	0.2	0.2	O K
5760 min Summer	31.529	0.029	0.0	0.2	0.2	0.1	O K
7200 min Summer	31.526	0.026	0.0	0.1	0.1	0.1	O K
8640 min Summer	31.523	0.023	0.0	0.1	0.1	0.1	O K
10080 min Summer	31.521	0.021	0.0	0.1	0.1	0.1	O K
15 min Winter	32.234	0.734	0.0	1.6	1.6	3.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	239.295	0.0	4.5	24
30 min Summer	137.553	0.0	5.2	33
60 min Summer	79.069	0.0	5.9	50
120 min Summer	45.451	0.0	6.8	82
180 min Summer	32.876	0.0	7.4	114
240 min Summer	26.126	0.0	7.8	144
360 min Summer	18.898	0.0	8.5	206
480 min Summer	15.018	0.0	9.0	266
600 min Summer	12.566	0.0	9.4	326
720 min Summer	10.863	0.0	9.8	384
960 min Summer	8.786	0.0	10.5	504
1440 min Summer	6.514	0.0	11.7	742
2160 min Summer	4.830	0.0	13.0	1104
2880 min Summer	3.906	0.0	14.1	1468
4320 min Summer	2.719	0.0	14.7	2144
5760 min Summer	2.102	0.0	15.1	2936
7200 min Summer	1.722	0.0	15.5	3624
8640 min Summer	1.463	0.0	15.8	4400
10080 min Summer	1.275	0.0	16.1	5080
15 min Winter	239.295	0.0	5.0	24

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	32.275	0.775	0.0	1.6	1.6	3.7	O K
60 min Winter	32.219	0.719	0.0	1.6	1.6	3.5	O K
120 min Winter	32.080	0.580	0.0	1.4	1.4	2.8	O K
180 min Winter	31.966	0.466	0.0	1.3	1.3	2.3	O K
240 min Winter	31.880	0.380	0.0	1.1	1.1	1.8	O K
360 min Winter	31.766	0.266	0.0	0.9	0.9	1.3	O K
480 min Winter	31.696	0.196	0.0	0.8	0.8	1.0	O K
600 min Winter	31.651	0.151	0.0	0.7	0.7	0.7	O K
720 min Winter	31.621	0.121	0.0	0.6	0.6	0.6	O K
960 min Winter	31.588	0.088	0.0	0.5	0.5	0.4	O K
1440 min Winter	31.556	0.056	0.0	0.4	0.4	0.3	O K
2160 min Winter	31.540	0.040	0.0	0.3	0.3	0.2	O K
2880 min Winter	31.535	0.035	0.0	0.2	0.2	0.2	O K
4320 min Winter	31.528	0.028	0.0	0.2	0.2	0.1	O K
5760 min Winter	31.524	0.024	0.0	0.1	0.1	0.1	O K
7200 min Winter	31.521	0.021	0.0	0.1	0.1	0.1	O K
8640 min Winter	31.518	0.018	0.0	0.1	0.1	0.1	O K
10080 min Winter	31.517	0.017	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	137.553	0.0	5.8	33
60 min Winter	79.069	0.0	6.6	52
120 min Winter	45.451	0.0	7.6	86
180 min Winter	32.876	0.0	8.3	118
240 min Winter	26.126	0.0	8.8	150
360 min Winter	18.898	0.0	9.5	212
480 min Winter	15.018	0.0	10.1	272
600 min Winter	12.566	0.0	10.6	330
720 min Winter	10.863	0.0	10.9	388
960 min Winter	8.786	0.0	11.8	506
1440 min Winter	6.514	0.0	13.1	742
2160 min Winter	4.830	0.0	14.6	1112
2880 min Winter	3.906	0.0	15.7	1452
4320 min Winter	2.719	0.0	16.4	2236
5760 min Winter	2.102	0.0	17.0	2872
7200 min Winter	1.722	0.0	17.4	3632
8640 min Winter	1.463	0.0	17.7	4408
10080 min Winter	1.275	0.0	18.0	5176

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 546300 172900 TQ 46300 72900
C (1km)	-0.023
D1 (1km)	0.307
D2 (1km)	0.368
D3 (1km)	0.212
E (1km)	0.313
F (1km)	2.594
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.010

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.003	4	8	0.003	8	12	0.002	12	16	0.002

Model Details

Storage is Online Cover Level (m) 33.000

Complex Structure

Pipe

Diameter (m) 0.150 Length (m) 1.000
Slope (1:X) 100.000 Invert Level (m) 31.500

Cellular Storage

Invert Level (m) 31.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	4.0	0.0	2.600	0.0	0.0
0.200	4.0	0.0	2.800	0.0	0.0
0.400	4.0	0.0	3.000	0.0	0.0
0.600	4.0	0.0	3.200	0.0	0.0
0.800	4.0	0.0	3.400	0.0	0.0
1.000	0.0	0.0	3.600	0.0	0.0
1.200	0.0	0.0	3.800	0.0	0.0
1.400	0.0	0.0	4.000	0.0	0.0
1.600	0.0	0.0	4.200	0.0	0.0
1.800	0.0	0.0	4.400	0.0	0.0
2.000	0.0	0.0	4.600	0.0	0.0
2.200	0.0	0.0	4.800	0.0	0.0
2.400	0.0	0.0	5.000	0.0	0.0

Infiltration Trench

Infiltration Coefficient Base (m/hr) 0.00000 Trench Width (m) 0.3
Infiltration Coefficient Side (m/hr) 0.00000 Trench Length (m) 11.5
Safety Factor 2.0 Slope (1:X) 0.0
Porosity 0.30 Cap Volume Depth (m) 0.000
Invert Level (m) 32.500 Cap Infiltration Depth (m) 0.000

Orifice Outflow Control

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 31.500