GeoSmart Information

SuDSmart Plus

Sustainable Drainage Assessment

Site Address

111a Foxley Lane
Purley
Greater London
CR8 3HQ

Grid Reference

529721, 161974

Report Prepared for

Barbarella Architecture & Design

Date

2022-09-26

Report Status

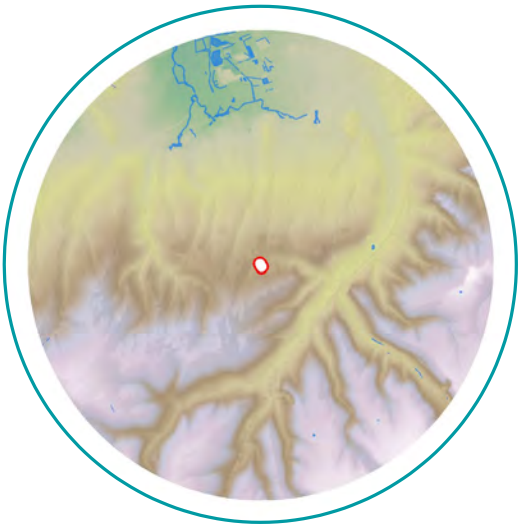
FINAL

Site Area

0.17 ha

Report Reference

77661.01R1



Discharge to ground

The proposed Sustainable Drainage Scheme (SuDS) strategy is comprised of green roofs, rainwater harvesting butts and a soakaway for attenuation of surface water runoff.

Surface water will be discharged to ground, subject to confirmation of the infiltration rates and depth to groundwater at the Site and the incorporation of SuDS.

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1 Executive summary

This report assesses the feasibility of a range of Sustainable Drainage Scheme (SuDS) options in support of the Site development process. A SuDS strategy is proposed to ensure surface water runoff can be managed effectively over the lifetime of the development.

SuDS suitability

Risk	Issue	Result
Discharge Location	What is the infiltration potential at the Site?	High
	What is the potential to discharge to surface water features?	Low
	What is the potential to discharge to sewers?	Medium
	What is the potential to discharge to highway drains?	Low
Flooding	What is the river (fluvial) flood risk at the Site?	Very Low
	What is the surface water (pluvial) flood risk at the Site?	Very Low to Low
	What is the groundwater flood risk at the Site?	Negligible
Pollution	Is the groundwater a protected resource?	Yes
	Is the surface water feature a protected resource?	N/A

Summary of existing and proposed development

The Site is currently used within a residential capacity as a two-storey detached, five-bedroom dwelling including associated access, car parking and landscaping.

Development proposals comprise the extension of the existing property to the rear and the construction of two, three-bedroom bungalows at the south of the Site, including the formation of new associated access and landscaping.

Summary of discharge routes

GeoSmart's SuDS Infiltration Potential (SD50) map indicates the Site has a High potential for infiltration, primarily due to the anticipated high permeability of the underlying geology (Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation – chalk). Infiltration to ground is therefore potentially feasible and is proposed as the primary option.

Ordnance Survey (OS) mapping indicates there are no surface water features within 500 m of the Site, with the nearest identified water feature c. 2.4 km east. Therefore, discharge to surface watercourse would not be feasible.

The asset location search included in Appendix D confirms the Site is located adjacent to the public sewer network along Foxley Lane, with the existing dwelling anticipated to drain to this. Due to the short distance to nearby sewers, discharging surface water runoff to the sewer is feasible, although it is noted that only a foul sewer has been identified and therefore should only be considered in the event that infiltration SuDS are confirmed to be inappropriate.

According to Google Streetview, highway gullies are located within Foxley Lane, indicating the presence of the highway drainage network.

Runoff rate and attenuation requirements

Discharging via infiltration requires 27.21 m^3 of attenuation to be provided to ensure there is no flooding as a result of the development in all storm events up to and including the 1 in 100 year including a 40% allowance for climate change. This volume is subject to the results of infiltration testing and would ensure runoff is not increased above the greenfield scenario.

Discharging off-Site requires 29.07 m^3 of attenuation to be provided to ensure there is no flooding within the development in all storm events up to and including the 1 in 100 year including a 40% allowance for climate change. This volume is subject to the discharge rate being restricted to 1 l/s (as close to the equivalent Greenfield 1 in 100 year rate as possible, without increasing the potential for blockages).

Proposed SuDS strategy

SuDS features comprised of green roofs, rainwater harvesting butts, a soakaway and permeable paving are proposed to attenuate a minimum of 27.21 m^3 of surface water runoff. The SuDS features would provide some water quality benefits (interception and filtration) prior to infiltrating to ground. Focused infiltration features over chalk should be sited at least 10 m from building foundations and 5 m from adjacent highways.

The proposed SuDS strategy would ensure surface water runoff is stored on-Site in SuDS features for the 1 in 100 year event including a 40% allowance for climate change and will not cause flooding to the proposed development in accordance with DEFRAs non-statutory technical standards (DEFRA, 2015).

SuDS & drainage network maintenance

The management and maintenance of the SuDS features, in line with the details and schedules outlined in Section 10 of this report, will be undertaken by contractors appointed by the owners and occupiers of the existing and proposed residential dwellings, where payments for the works will form part of the property deeds and / or rental agreements.

Recommendations / Next steps

A site investigation is required to confirm the infiltration capacity of the ground in line with BRE 365 guidelines to confirm the infiltration rate and the groundwater level.

Where site investigation confirms the underlying ground conditions are not conducive to infiltration, the capacity of the public sewer network should be confirmed with the utility provider and permission to connect should be obtained where required.

2 Proposed SuDS strategy

The most suitable SuDS options are outlined below and a SuDS strategy schematic is shown overleaf. Supporting information is provided in subsequent sections.

Table 1. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and infiltration SuDS.
SuDS features	Rainwater harvesting butts, green roof, permeable paving.
Discharge location	Infiltration.
Discharge rate	1 x 10^{-5} m/s (assumed infiltration rate in the absence of more detailed hydrogeological information, in line with typical infiltration rates in Table 25.1 of the CIRIA SuDS Manual (C753) (2015)).

Table 2. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater Harvesting	To comply with London Plan policy, rainwater harvesting butts should be established for each proposed dwelling. In terms of attenuation storage within this SuDS scheme, the volume of runoff which could be attenuated by Rainwater Harvesting has not been considered within the Preliminary SuDS schematic.
Green Roof	A green roof covering a total area of 276 m^2 (cover area of the extension and bungalow roofs, with a 10 m^2 allowance on each pair of buildings for solar panels and roof lights) with a green roof mix example volume of 55.20 m^3 (0.2 m depth) and Geocomposite example volume of 1.38 m^3 (0.005 m depth) would attenuate for 8.97 m^3.
Permeable paving	The paths and paved areas are proposed to be underlain by permeable paving and therefore will drain themselves. As such, the permeable paving will not be used to store surface water runoff from the roof areas, and therefore the volume of runoff which could be stored within the permeable paving has not been included within the Preliminary SuDS schematic.
Soakaway	A soakaway with an area of 16 m^2 (e.g. 4 x 4 m) and depth of 1.2 m, filled with geo-cellular crates with a 95% void ratio, would provide 18.24 m^3 attenuation.
Total Attenuation Provided	27.21 m^3

2. Proposed SuDS scheme layout

- Green roof
- Rainwater harvesting butt
- Soakaway
- Permeable paving (draining itself)
- Surface water drainage network
- Public foul sewer
- Exceedance flow routes
- Site boundary

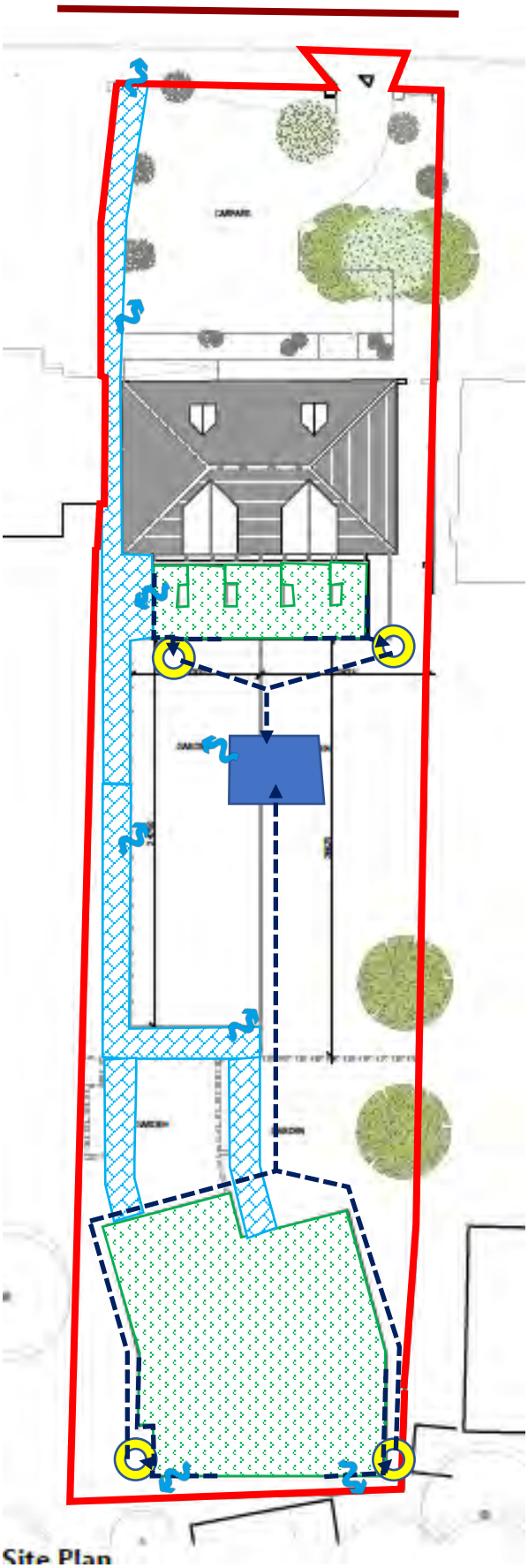
The SuDS scheme comprises a green roof on both the roof of the extension to the main dwellings, and to the roof of the proposed bungalows, which intercepts surface water runoff.

Surface water runoff from the green roof is then discharged to a rainwater harvesting butt for each dwelling, which then discharge to a shared soakaway in the garden.

The proposed soakaway should be at least 10 m from any buildings, and also should be 5 m from the Site boundary.

The proposed paths and paved areas should be underlain by permeable paving and are proposed to drain themselves.

Schematic is not to scale

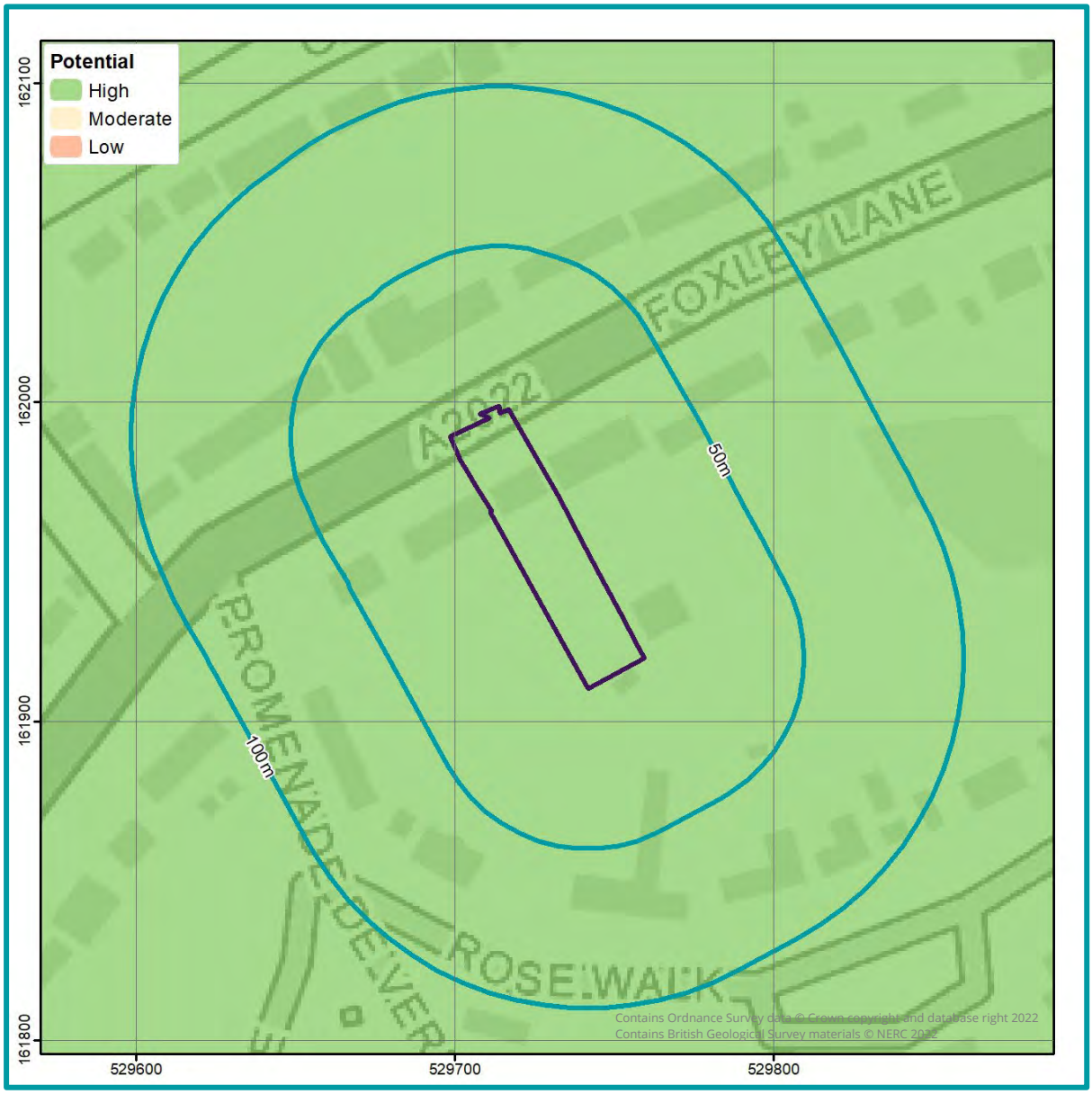


3 Site analysis

Site location

Figure 2. Aerial Imagery (Bluesky, 2022)

Figure 3. SuDS infiltration suitability (SD50) map (GeoSmart, 2022)



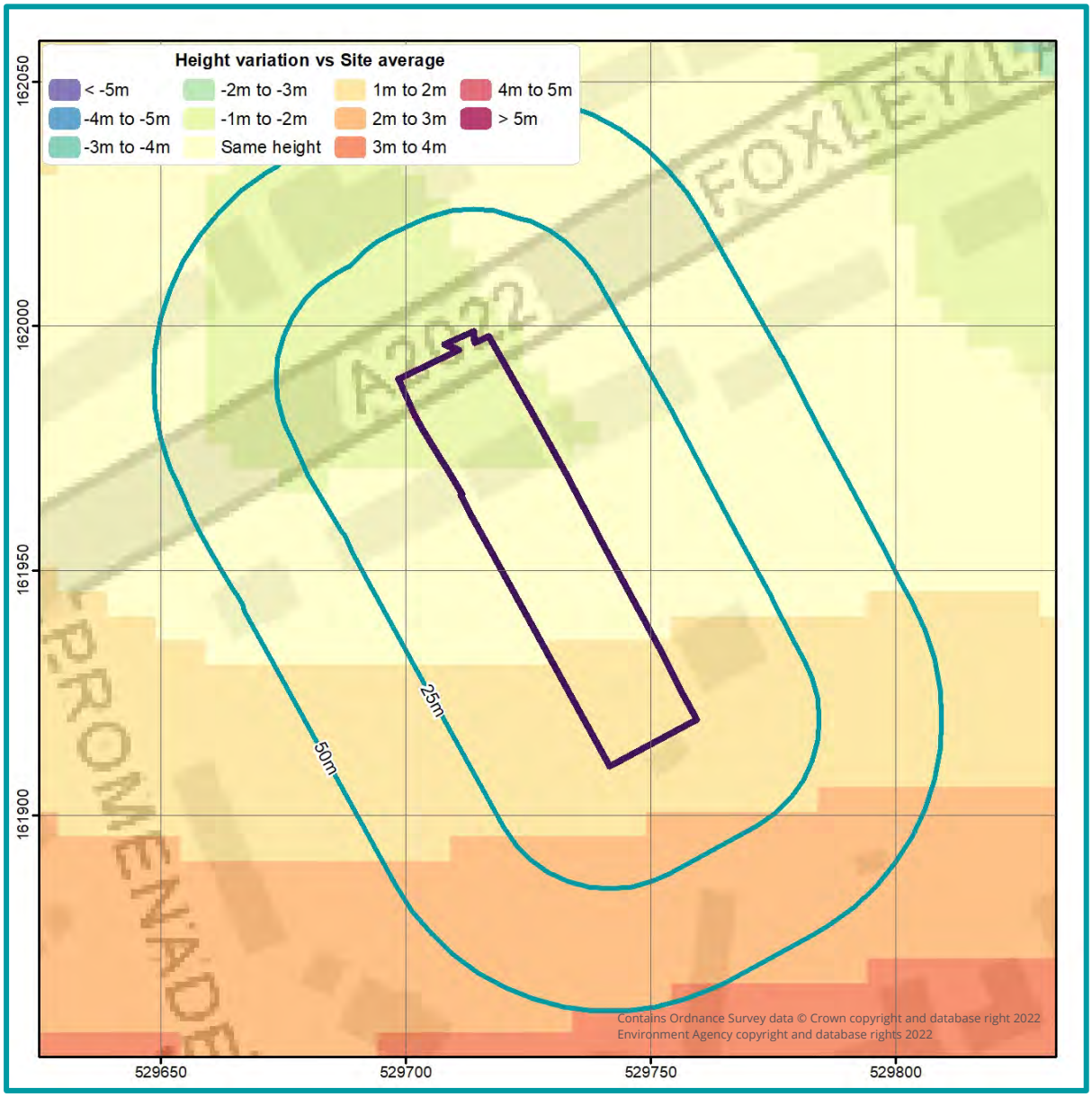
The GeoSmart SuDS Infiltration Suitability Map (SD50) screens the potential for infiltration drainage at the Site and indicates where further assessment is recommended. The map combines information on the thickness and permeability of the underlying material and the depth to the high groundwater table. It supports conceptual Site drainage design and the planning of further Site investigation.

There is a High potential for infiltration SuDS across the Site. It is likely that the underlying geology at the Site has high permeability and an infiltration SuDS scheme should be possible at the Site.

Groundwater levels are expected to be sufficiently deep at the Site. However, a Site Investigation is recommended to confirm the infiltration capacity and the depth to

groundwater. Various options can be considered for infiltration SuDS and these include infiltration trenches, soakaways, swales and permeable pavements.

Figure 4. Site topography (GeoSmart, 2022)



An assessment of the topography at the Site has been undertaken using LiDAR DTM5 elevation data to identify the general slope and any localised depressions. The mapping shows a comparison between average ground levels on the Site with ground levels in the surrounding area.

The mapping confirms the overall Site is generally on a gradual slope, with ground levels falling from 101.1 mAOD along the southern boundary to 98.1 mAOD in the north. This is based on EA elevation data obtained for the Site to a 1 m resolution with a vertical accuracy of ±0.15 m. Further analysis could be undertaken by visiting the Site or by collecting additional topographic survey to provide further confirmation of ground levels.

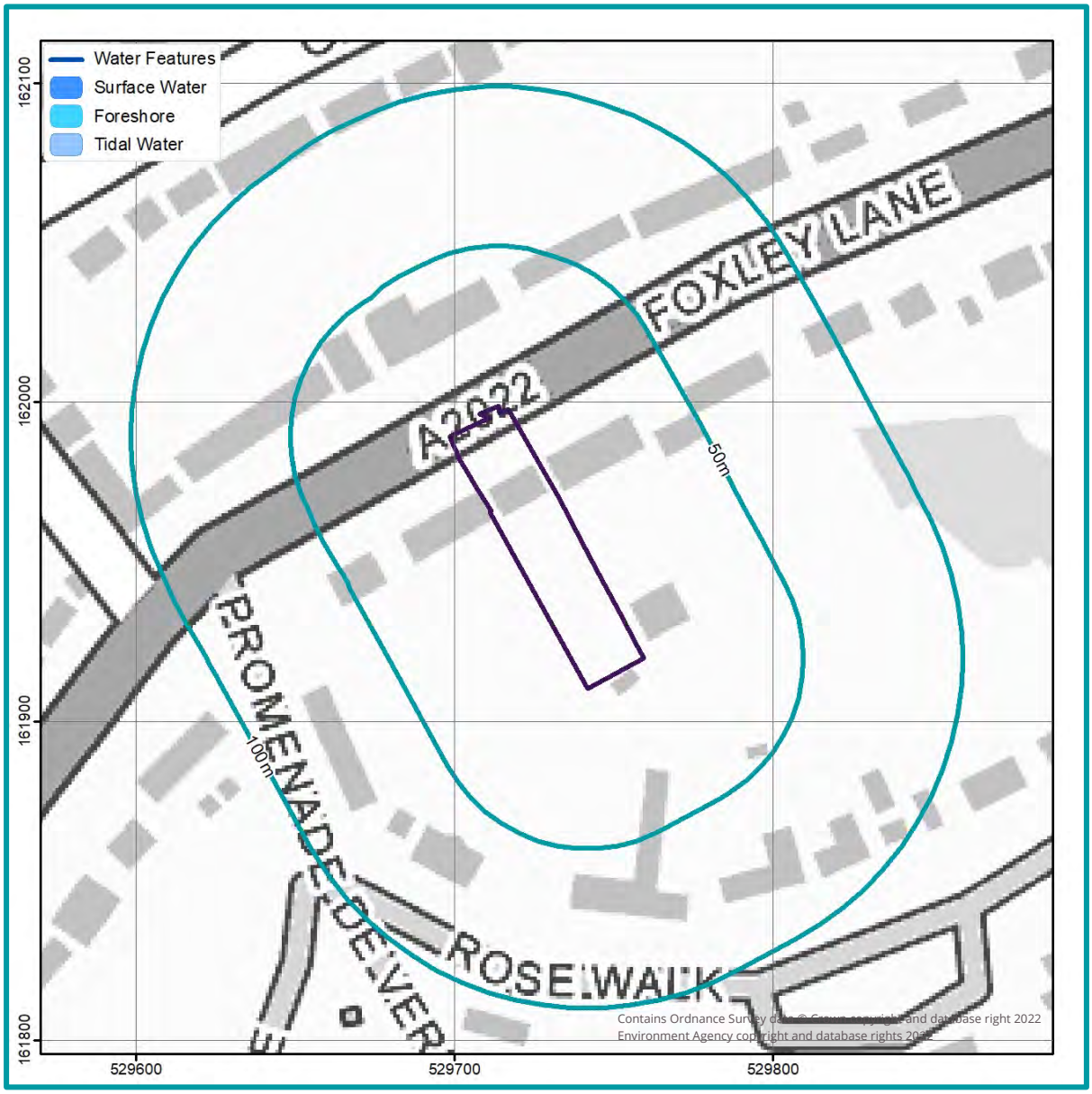
Figure 5. Source protection zone map (EA, 2022)

An assessment of the EA's groundwater Source Protection Zones (SPZs) has been undertaken within the vicinity of the Site and confirms the Site lies within an outer groundwater Source Protection Zone (SPZ II).

Infiltration, if possible, is likely to be acceptable providing risk screening identifies suitable mitigation measures, if required, to prevent an impact on water quality from the proposed or historical land use and contaminated land.

If further analysis is required, this would involve a review of Site specific contaminated land data. If hazards are identified, it is recommended that the Local Authority and the Environment Agency are contacted to confirm the susceptibility of any SPZs within the wider area.

Figure 6. Surface water features map (EA, 2022)



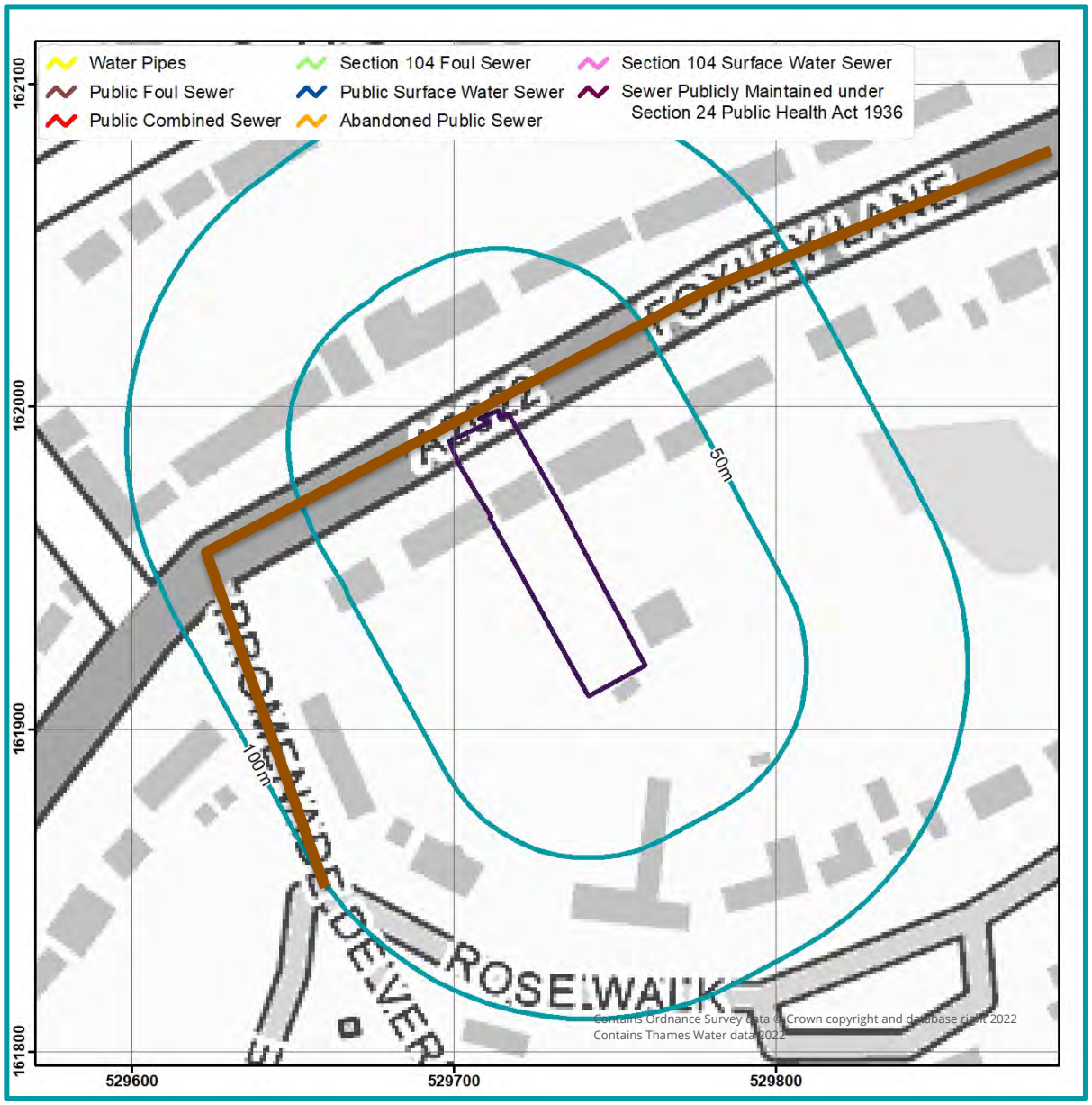
OS mapping indicates there are no surface water features within 500 m of the Site, with the nearest identified water feature being a pond c. 2.4 km east.

Given the absence of surface water features within close proximity to the Site, discharge to surface watercourse should not be considered.

According to the EA's Magic Map, the Site is not within 250m of a SSSI or SPA.

Further analysis could be undertaken by visiting the Site or by contacting the Local Council and the Environment Agency (EA) to confirm the presence, location and condition of any mapped or additional unmapped surface water features.

Figure 7. Sewer features map (OS & Thames Water, 2022)



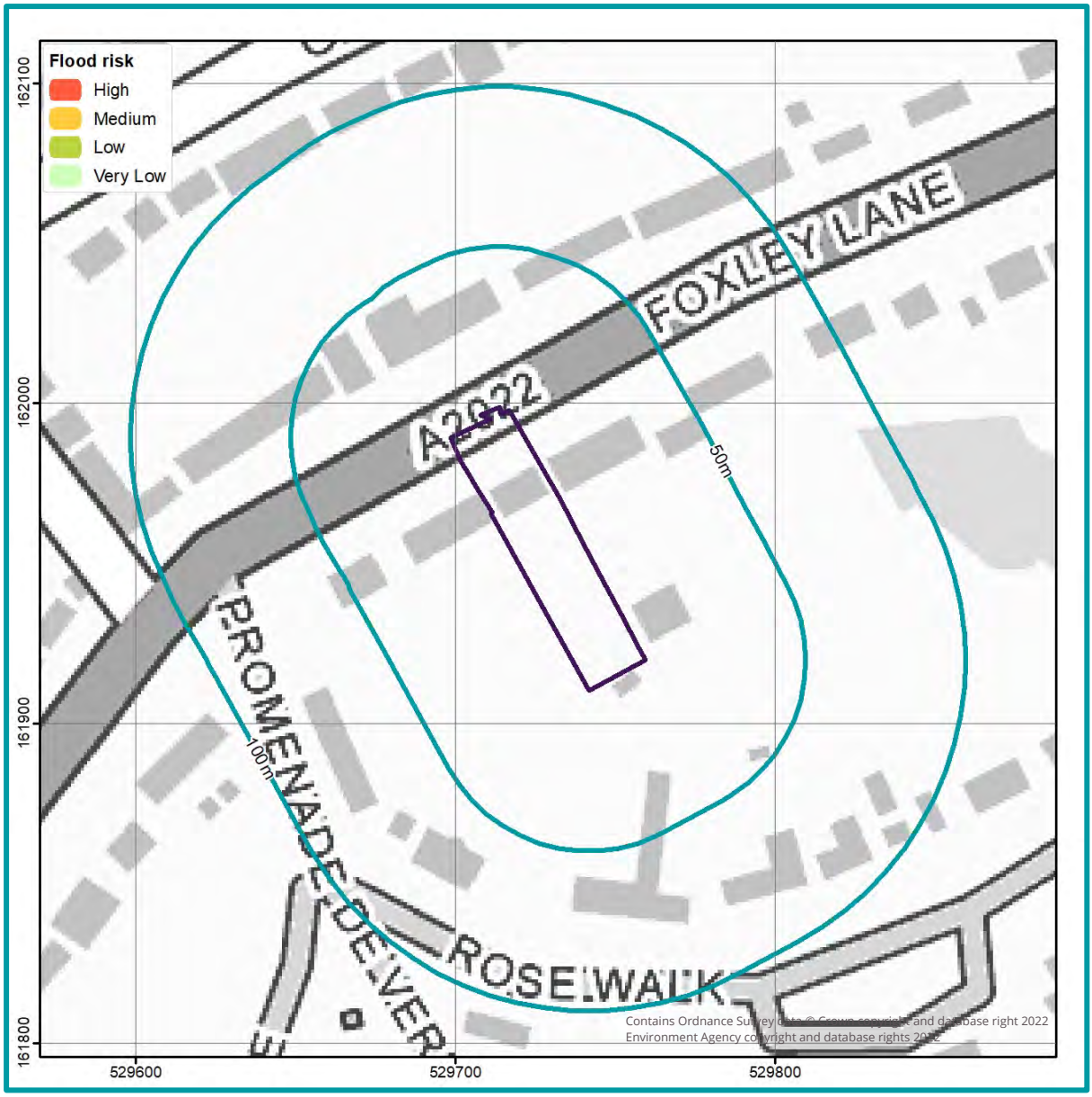
GeoSmart has undertaken an assessment of the location of sewer features within the vicinity of the Site. According to an asset location search undertaken at the Site (Thames Water, 2022; Appendix D), there are no public surface water sewer or combined sewers located within the vicinity of the Site.

However, a foul sewer is located along Foxley Lane, adjacent to the northern boundary of the Site. Given the developed residential land use along Foxley Lane and in the general area, and in the absence of identifiable surface water or combined sewers, it would be reasonable to expect that the foul sewer receives surface water from adjacent properties.

As such, discharge to the foul sewer should be considered should infiltration SuDS be considered unfeasible.

Further analysis of the connections and condition of the public surface water drainage system should be undertaken by carrying out a CCTV survey or by contacting the drainage provider or the Local Council to confirm the presence, location and condition of the sewer; in particular, further investigation and consultation may be required to confirm the absence of public combined and surface water sewers within the vicinity of the Site, and to confirm that the foul sewer receives surface water discharge. Consultation with the drainage provider would also be required to determine that sufficient capacity is available to accept the proposed discharge, and to gain permission to connect if required.

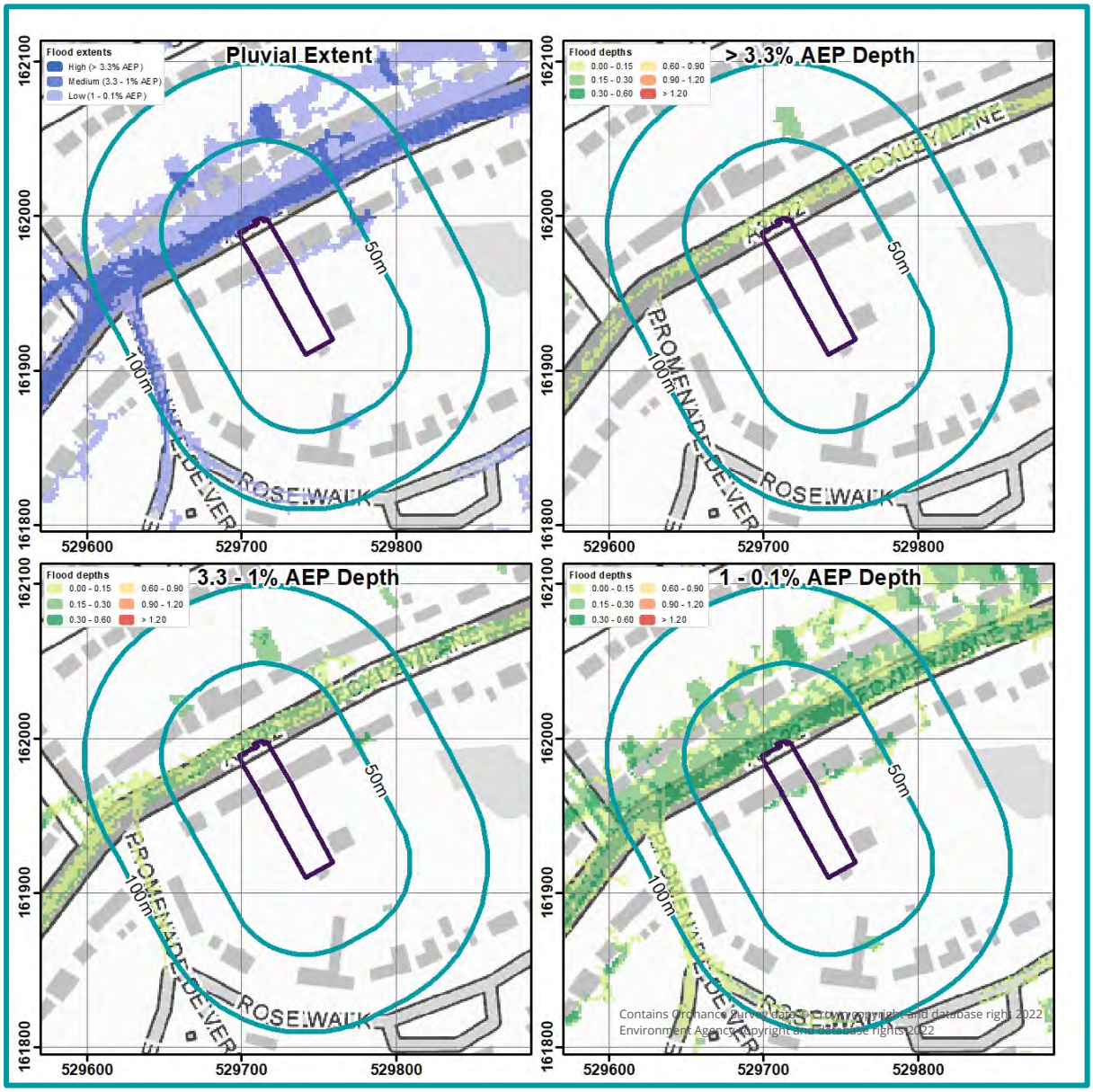
Figure 8. Risk of flooding from rivers & sea map (EA, 2022)



According to the EA's Risk of Flooding from Rivers and the Sea (RoFRS) map, the Site has a Very Low risk of flooding from fluvial or coastal flooding, with less than 0.1% annual probability of flooding, therefore the SuDs design is unlikely to be affected.

A separate Flood Risk Assessment has been undertaken (ref: 77661), where the potential risks to the development are discussed further.

Figure 9. Risk of surface water flooding map (EA,2022)

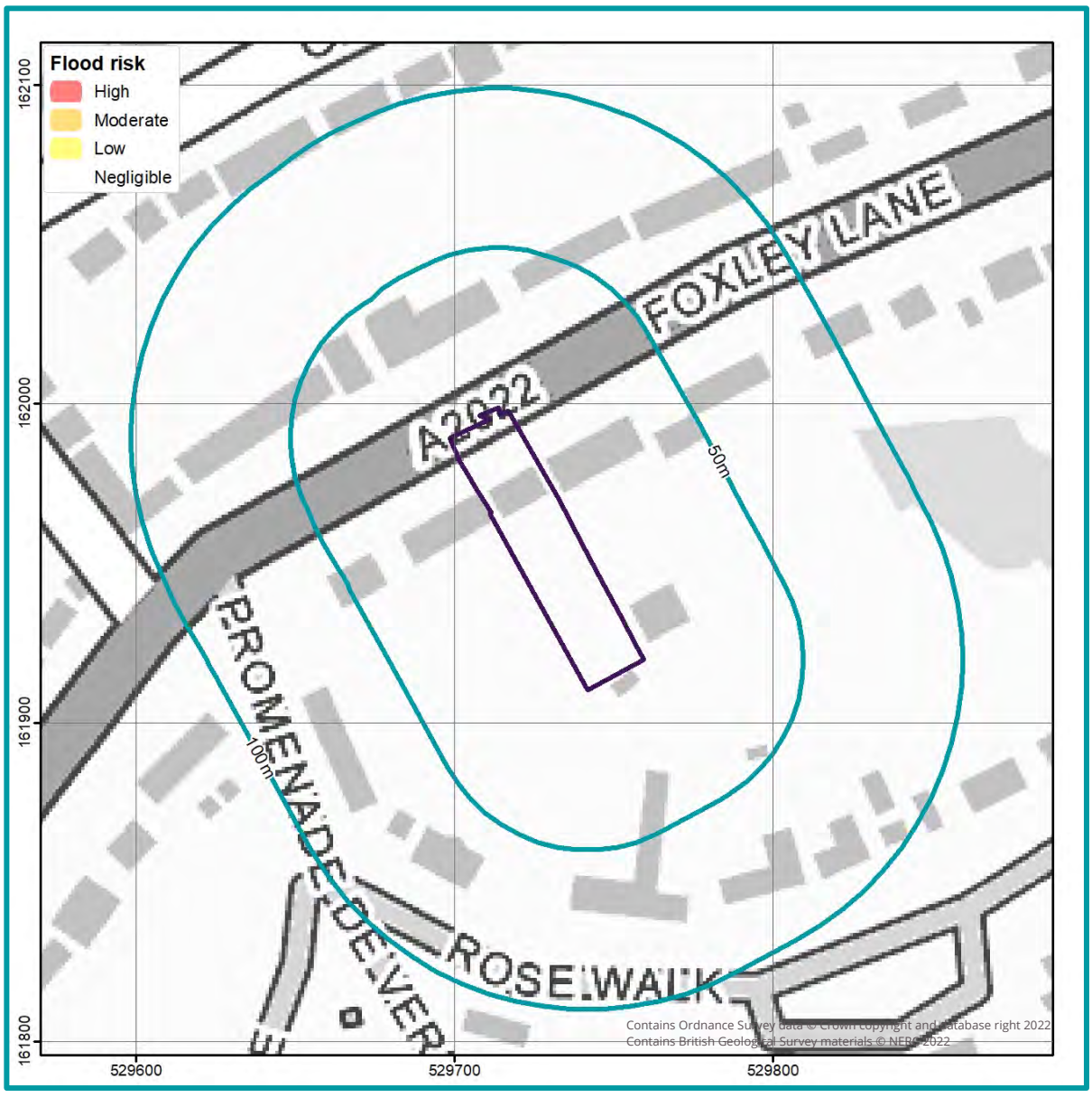


GeoSmart have undertaken an assessment of the risk of flooding from surface water (pluvial) sources within the vicinity of the Site using the EA's Risk of Flooding from Surface Water (RoFSW) mapping. The EA's mapping confirms the Site is considered to be at variable risk of surface water flooding, ranging from Very Low to Low.

Figure 9 confirms that there are no areas of the Site that would be affected in the 1 in 100 year event (1% AEP – Medium risk), and therefore the SuDS design is unlikely to be impacted by surface water flooding.

Further analysis could be undertaken by visiting the Site or by contacting the Local Council and the Environment Agency to confirm the pluvial flood risk, flood depths and velocities where applicable.

Figure 10. Groundwater flood risk (GW5) map (GeoSmart, 2022)



GeoSmart have undertaken an assessment of the risk of flooding from groundwater within the vicinity of the Site. GeoSmart's Groundwater Flood Risk Screening (GW5) map confirms the Site has a Negligible risk of groundwater flooding during a 1% annual probability (1 in 100 year) event.

4 Site context

Site information

The purpose of this report is to assess the potential for disposing of surface water through a Sustainable Drainage System (SuDS) for the site of 111a Foxley Lane, Purley, CR8 3HQ (the Site). The Site is located in Purley in a setting of primarily residential land use. Site plans and drawings are provided in Appendix A.

Development

The Site is currently used within a residential capacity as a two-storey detached, five-bedroom dwelling including associated access, car parking and landscaping.

Development proposals comprise the extension of the existing property to the rear and the construction of two, three-bedroom bungalows at the south of the Site, including the formation of new associated access and landscaping.

Geology, permeability and thickness

British Geological Survey (BGS) national superficial and bedrock geology mapping confirms the geological formations underlying the Site and each formation may have a range of permeability.

Table 3. Site Geology

Geology present on-Site		Potentially permeable?
Superficial geology (Figure 11)	None	N/A
Bedrock geology (Figure 12)	Lewes Nodular Chalk Formation, Seaford Chalk Formation And Newhaven Chalk Formation (LSNCK) – chalk	✓

The permeability of the underlying material at the Site shown within the BGS mapping is high, and therefore confirmation of the infiltration capacity is required.

The BGS website was used to extract ground information from the nearest borehole record to the Site (ref: TQ26SE76). This borehole is located approximately 670 m to the south-west of the Site at an elevation of c. 108 mAOD.

The borehole indicates the underlying geology to be comprised of chalk and flints to a depth of c. 97.53 m below ground level (bgl), chalk and marl with some flints to c. 114.30 mbgl and chalk marl to c. 152.41 mbgl, at which the borehole ended.

The borehole records confirm the underlying geology is comprised of chalk bedrock, likely to a depth of at least 150 mbgl.

Infiltration SuDs are proposed directly into a bedrock aquifer.

The soil infiltration coefficient must be sufficient to accommodate the constraints on the dimensions of the soakaway and its emptying time.

Depth to groundwater

The SuDS system should be designed to operate in periods of extreme groundwater levels.

According to borehole data and GeoSmart's Groundwater Flood Risk (GW5) map, shallow groundwater is unlikely to be an issue at the Site.

The TQ26SE76 borehole recorded a resting water level of 71.62 mbgl in May 1973.

An additional well (ref: TQ26SE145) is present c. 350 m west of the Site at an elevation of c. 103 mAOD. The well recorded fluctuations between 61.44 mbgl (in December 1904) and 54.56 mbgl (in April 1910).

The base of the infiltration system needs to be 1 m above the expected seasonal high-water table. Passage through unsaturated soil is important for improving the quality of infiltrating water before it reaches the water table.

Figure 11. Superficial Geology (BGS, 2022)

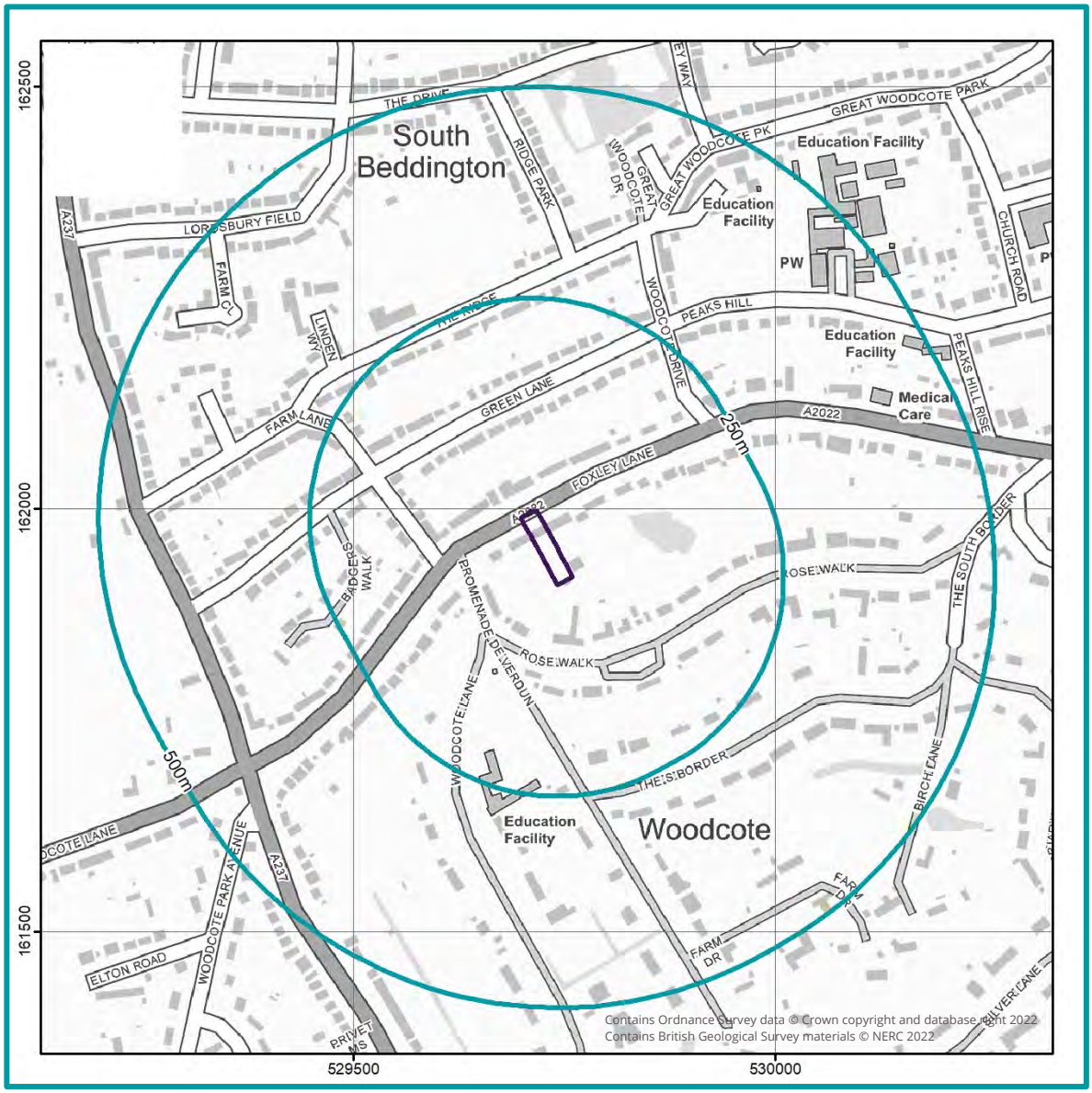
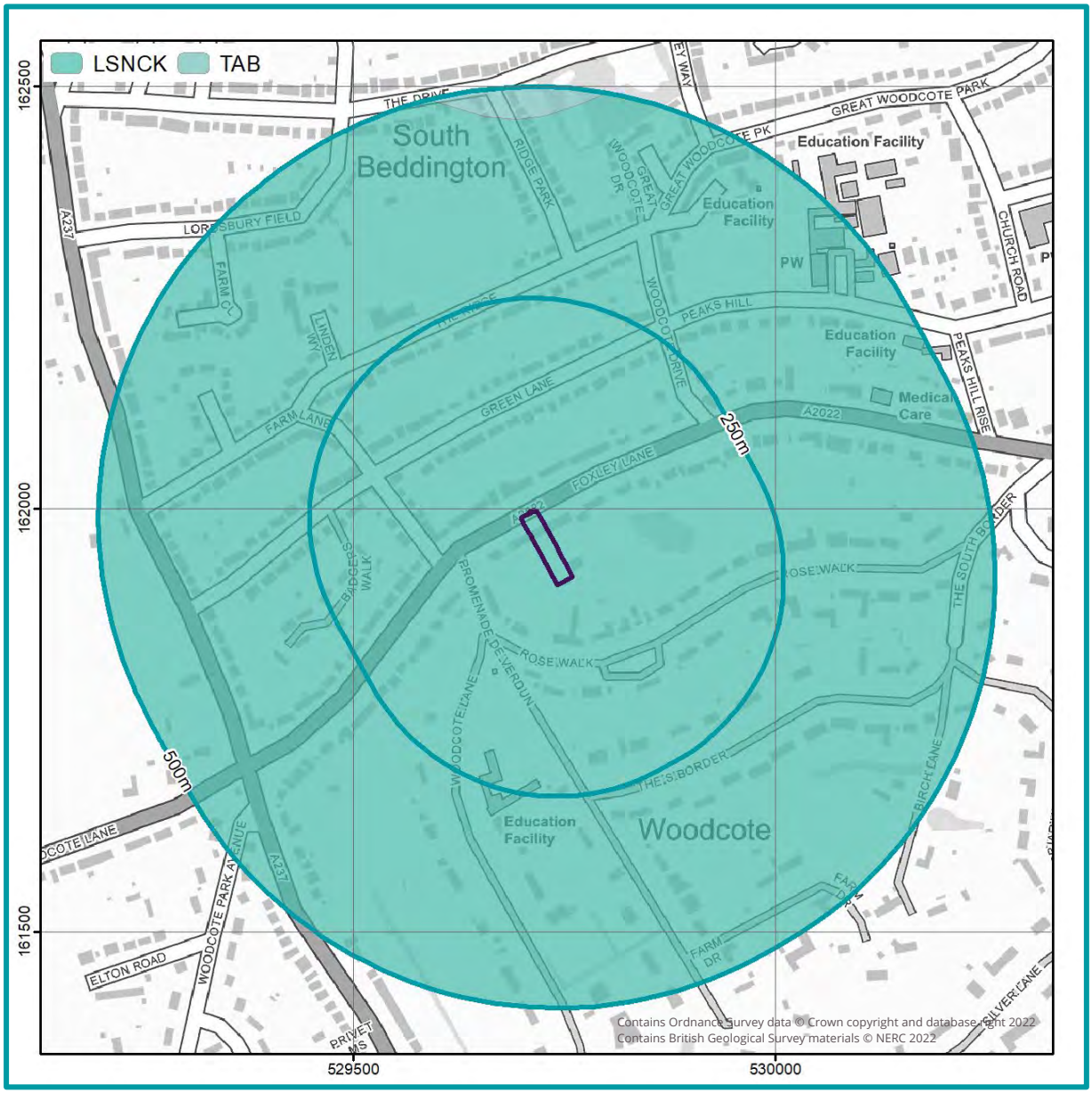


Figure 12. Bedrock Geology (BGS, 2022)



Ground conditions

Infiltration SuDS are proposed directly into soluble chalk bedrock. A detailed review of underlying ground conditions is recommended to ensure focused infiltration does not cause ground instability as a result of landslide or collapse associated with dissolution or shallow mining.

Given the Site's location above chalk bedrock, soakaways are recommended to be a minimum of 10 m away from the foundations of each building.

Water quality

The Site lies within an SPZ; therefore, consultation with the Local Authority and assessment of historical land uses should be undertaken to confirm the presence of contaminated material, as this could limit the use of infiltration SuDS at the Site.

Infiltration systems should not be used where there is a risk of contaminating groundwater by infiltrating polluted runoff or where receiving groundwater is particularly sensitive.

The influence of surface runoff on water quality will depend on whether there is a source of contamination on-Site and the sensitivity of the receiving environment, either groundwater or surface water. The intervening pathway from source to receptor including mitigation and natural attenuation will determine the final impact.

The impact of contaminants on the groundwater will be reduced by travel and natural attenuation through the unsaturated soil zone. A greater depth of unsaturated zone and the presence of significant clay and organic material will provide greater protection for the underlying groundwater. Rapid flow through fractures will provide less protection than intergranular flow around soil and rock particles.

5 National & local policy context

National Guidance

CIRIA SuDS Manual (C753) (2015)

A development should utilise sustainable drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. Use infiltration techniques, such as porous surfaces in non-clay areas,
2. attenuate rainwater in ponds or open water features for gradual release,
3. attenuate rainwater by storing in tanks or sealed water features for gradual release,
4. discharge rainwater direct to a watercourse,
5. discharge rainwater to a surface water sewer / drain,
6. discharge rainwater to the combined sewer.

Defra - Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems (2015)

Peak Flow control

For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

Volume control

Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event. The runoff volume must be discharged at a rate that does not adversely affect flood risk.

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

Ministry of Housing, Communities & Local Government – National Planning Practice Guidance: Flood risk assessments: climate change allowances (2014)

The Peak rainfall intensity allowances section provides advice on the increased rainfall effects on river levels and land and urban drainage systems. As of May 2022, the applicable climate change allowance is defined by specific Management Catchment for the 1 in 30 (≥ 3.3% AEP) and 1 in 100 (< 3.3 to 1% AEP) year event.

As the Site is located within the London Management Catchment, the following climate change allowances are applicable.

Table 1. London Management Catchment peak rainfall allowances

London Management Catchment	3.3% Annual exceedance rainfall event		1% Annual exceedance rainfall event	
	2050s	2070s	2050s	2070s
Central	20%	20%	20%	25%
Upper end	35%	35%	40%	40%

The drainage system should be designed to make sure there is no increase in the rate of runoff discharged from the Site for the upper end allowance.

Where on-Site flooding for the upper end allowance presents a significant flood hazard (for example, depths and velocities of surface water runoff cause a significant danger to people), you will need to take further mitigation measures to protect people and property (for example, raising finished floor levels). As a minimum, there should be no significant flood hazard to people from on-Site flooding for the central allowance.

Sub-national Drainage Policy

London Plan - Policy 5.13 Sustainable drainage (2021)

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)

Local Policy

Croydon Local Plan – Policy DM25: Sustainable Drainage Systems and reducing flood risk (Croydon Council, 2018):

DM25.3 Sustainable drainage systems are required in all development and should:

a. Ensure surface run-off is managed as close to the source as possible;
b. Accord with the London Plan Sustainable Drainage Hierarchy;
c. Achieve better than greenfield runoff rates;
d. Be designed to be multifunctional and incorporate sustainable drainage into landscaping and public realm to provide opportunities to improve amenity and biodiversity;
e. Achieve improvements in water quality through a sustainable drainage system management train; and
f. Be designed with consideration of future maintenance.

Croydon Council – Advice to Planning Applicants (2019):

For all Major Planning Applications, a surface water drainage assessment should be carried out to demonstrate that the proposed development makes use of sustainable drainage systems (SuDS) and will not create an increased risk of flooding from surface water to the development site and the surrounding area. The Drainage Strategy should be carried out in accordance with the London Plan 2016 and the Sustainable Design and Construction Supplementary Planning Guidance (SPG), the National Planning Policy Framework (NPPF) and the Planning Practice Guide (PPG) and the adopted Croydon Local Plan (2018). All development should make use of SuDS and give preference to infiltration over discharge to a watercourse, which in turn is preferable to discharge to surface water sewer and in turn combined sewer. Further, the design of the proposed drainage system should adhere to the Defra Non-Statutory Technical Standards (NSTS).

6 Storage, volume and peak flow rate

Suggested minimum and aspirational storage requirements for an infiltration or attenuation SuDS scheme for the development footprint are set out below, with more detail provided in subsequent sections. Storage volumes may be reduced (but not below the minimum level) if the design incorporates off-Site discharge.

Table 2. Storage requirements at the proposed development Site (Discharge

Attenuation scenario		Attenuation required (m^3)	Explanation
Discharge runoff via infiltration	1 in 100 year including 40% CC	27.21	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year event, including a 40% allowance for climate change*. This is based on an assumed infiltration rate of 1 x 10^{-5} m/s in the absence of more detailed hydrogeological information; this infiltration rate is in line with the typical infiltration rates included within Table 25.1 of the CIRIA SuDS Manual (C753) (2015) and should be revised in line with infiltration testing. This attenuation volume also assumes that attenuation will be provided within a green roof and soakaway, as detailed within the preliminary SuDS schematic; the proposed path and paved areas are assumed to drain themselves (via the use of permeable paving) and are therefore excluded from the attenuation volume. Additional storage may be required should alternative features be utilised within the scheme.

*Subject to confirmation through infiltration testing. See Appendix B for associated calculations.

Table 3. Storage requirements at the proposed development Site (Discharge runoff to public sewer network)

Attenuation scenario		Attenuation required (m^3)	Explanation	
Discharge runoff to public sewer network	1 in 30 year	12.56	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 30 year (2 hour, Critical Storm Duration) event*. Flooding of the Site of 5.81 m^3 should be contained within permeable landscaped areas within the Site to ensure no flooding of internal areas during the 1 in 100 year storm event.	A further 10.70 m^3 should be managed within overland flow routes to ensure there is no increase in flood risk in all events up to the 1 in 100 year including 40% allowance for climate change.
	1 in 100 year	18.37	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year (2 hour, Critical Storm Duration) event*.	
	1 in 100 year including 40% CC	29.07	Attenuation required to ensure surface water runoff is attenuated in all storm events up to and including the 1 in 100 year (3 hour, Critical Storm Duration) event including a 40% allowance for climate change*.	

*See Appendix C for associated runoff and discharge calculations. Discharge rates all restricted to 1 l/s (as close to the 1 in 100 year greenfield runoff rate as possible without increasing the potential for blockages).

Surface water runoff

An increase in impermeable area on-Site will result in greater rainfall runoff. Reduction in runoff will help mitigate flood risk both on and off-Site. Further information on the surface water runoff calculations is provided in Section 12 'Background Information'.

The existing dwelling and front driveway are understood to be retained as part of development proposals, with minor alterations to convert the dwelling into two semi-detached houses and accommodate access to the proposed bungalows in the rear of the Site.

Therefore, the driveway and front dwellings are anticipated to drain as existing and are excluded from the runoff calculations. However, an extension has been proposed to the front dwellings, which has been included within the SuDS scheme.

Guidance

The Non-Statutory Technical Guidance for SuDS (Defra, March 2015) states:

"Where reasonably practicable, for Greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the Greenfield runoff volume for the same event. Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the Greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event."

Table 4. Change in impermeable area associated with the development

Total Site area	1861 m^2
Impermeable area (and as a percentage of the total area of the proposed development footprint of 1268 m^2**)	
Pre-development	Post-development
346 m^2 (27%)	482 m^2 (38%)
Impermeable land use: 326 m^2 paving and pool area, 17 m^2 outbuildings Permeable land use: landscaped areas	New impermeable land use: 231 m^2 bungalow building footprint, 65 m^2 extension to main house, 186 m^2 paving* New permeable land use: 786 m^2 landscaping

*Please note, while these areas will be utilized for SuDS, for the calculations these areas will be classed as impermeable in order to assess the potential run-off volumes and rates for the Site post- development and the potential holding capability of the proposed SuDS features.

** The existing dwelling and front driveway will be retained as part of development proposals, with minor alterations to convert the dwelling into two semi-detached houses and accommodate access to the proposed bungalows in the rear of the Site. Therefore, the driveway and front dwellings are anticipated to drain as existing and are excluded from the runoff calculations. It is noted that an extension has been proposed to the front dwellings, which is included within the SuDS scheme.

Guidance

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

(Defra, March 2015, non-statutory guidance).

Peak discharge rates

The table below presents peak discharge rates for a range of storm events used to assess the impact of the proposed development and select the maximum permitted discharge rate. Further information on the calculation and control of peak discharge rates is provided in Section 12 'Background Information'.

Table 5. Peak discharge rates associated with the development

Rainfall event	Greenfield runoff rates (l/s)	Existing runoff rates[1] (l/s)	Potential runoff rates without attenuation (l/s)	Potential minus existing (l/s)
QBAR	0.02	N/A	N/A	N/A
6 hour 1 in 1 year	0.02	0.52	0.67	0.15
6 hour 1 in 10 year	0.04	0.84	1.07	0.23
6 hour 1 in 30 year	0.05	1.09	1.40	0.31
6 hour 1 in 100 year	0.07	1.42	1.82	0.40
6 hour 1 in 100 year + 20% CC	N/A	N/A	2.19	0.76
6 hour 1 in 100 year + 40% CC	N/A	N/A	2.55	1.13

[1] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 method.

Relevant national, local and regional planning policy has been consulted in section 5 to determine restrictions on runoff from previously developed and greenfield sites. In some cases, greenfield rates may be requested, but in practice it is difficult to restrict discharge rates at any one control point to less than 1 l/s without increasing the risk of any potential blockages occurring in the drainage network.

Total discharge volumes

The table below presents discharge volumes for a range of storm events used to assess the impact of the proposed development and calculate the required storage volumes. Further information on the calculation of total discharge volumes is provided in Section 11 'Methodology and Limitations'. Total discharge volumes associated with the development.

Table 6. Total discharge volumes associated with the development

Rainfall event	Greenfield runoff volume (m^3)	Existing runoff volume[2] (m^3)	Potential runoff volume without attenuation (m^3)	Potential minus existing (m^3)
QBAR	3.48	N/A	N/A	N/A
6 hour 1 in 1 year	3.27	11.31	14.47	3.16
6 hour 1 in 10 year	5.36	18.09	23.09	5.00
6 hour 1 in 30 year	6.84	23.63	30.23	6.60
6 hour 1 in 100 year	8.90	30.76	39.35	8.59
6 hour 1 in 100 year + 20% CC	N/A	N/A	47.22	16.46
6 hour 1 in 100 year + 40% CC	N/A	N/A	55.09	24.33

[2] Assumes 100% runoff from impermeable surfaces. Assumes Greenfield runoff from permeable surfaces calculated using the IoH124 method.

Critical storm duration and volume requirements

Storage volumes for a range of return periods including the 1 in 30 year, 1 in 100 year and 1 in 100 year plus climate change (40%) events have been calculated to assess the impact of the proposed development. The required storage volumes for attenuation features have been calculated for the critical storm durations, limited to a maximum discharge rate of 1 l/s (as close to the 1 in 100 year greenfield runoff rate as possible without increasing the potential for blockages).

Table 7. Critical Storm Duration and Attenuation volume requirements

Return Period	Runoff rate restriction (l/s)	Critical Storm Duration (hr)	Attenuation volume required (m^3)
1 in 30 year	1	2	12.56
1 in 100 year	1	2	18.37
1 in 100 year including a 40% climate change	1	3	29.07

7 Runoff destination

Options for the destination for the runoff generated on-Site have been assessed in line with the prioritisation set out in the Building Regulations Part H document (HM Government, published in 2010 and updated in 2015) and Defra's Non-statutory Technical Standards for SuDS (2015).

Flow attenuation using infiltration SuDS (discharge to ground) is generally the preferred option. If discharge to ground is not available, runoff discharge to surface water is the other preferred method. Only if these two options are impractical should discharge to the sewer network be considered.

Discharge to ground

The Site has High potential for infiltration, with permeable underlying chalk bedrock. Based on the available borehole information and groundwater flood risk mapping, a deep groundwater table is likely to be present beneath the Site, which is unlikely to impact the proposed SuDS features.

There are no known issues identified relating to Site contamination, but the Site is located within a SPZ.

Given the High potential for infiltration and the underlying geology at the Site, infiltration SuDS are likely to be feasible and are proposed.

A site investigation comprising trial pits is recommended to confirm the depth to groundwater and allow infiltration tests to be undertaken to confirm the feasibility of an infiltration SuDS scheme.

Discharge to surface watercourse

There are no surface water features within 500 m of the Site, with the nearest identified water feature being a pond c. 2.4 km east.

Given the absence of surface water features within close proximity to the Site, discharge to surface watercourse is not feasible and therefore is not proposed.

Discharge to sewer

According to an asset location search undertaken at the Site (Thames Water, 2022; Appendix D), there are no public surface water sewer or combined sewers located within the vicinity of the Site.

However, a foul sewer is located along Foxley Lane, adjacent to the northern boundary of the Site. Given the developed residential land use along Foxley Lane and its vicinity as well as the absence of nearby surface water or combined sewers, the foul sewer could potentially receive surface water runoff from nearby properties.

As such, discharge to the public foul sewer is potentially feasible, and should be considered in the event that infiltration SuDS are proven unfeasible at the Site.

It is noted that the existing dwelling is likely to drain to the public sewer network, and this will continue for the existing building footprint and driveway post-development.

The topographic gradient on the Site falls to the north, towards the public foul sewer along Foxley Lane. Therefore, it would be feasible to drain the majority of the Site under gravity to the existing sewer network.

8 Water quality

A key requirement of any SuDS system is that it protects the receiving water body from the risk of pollution. This can be effectively managed by an appropriate "train" or sequence of SuDS components that are connected in series. The frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5-10 mm of rainfall (first flush) should be adequately treated with SuDS.

The minimum number of treatment stages will depend on the sensitivity of the receiving water body and the potential hazard associated with the proposed development SuDS Manual (CIRIA, 2015). The proposed development is very low hazard (surface water runoff from roof). The Site does lie within an SPZ and therefore additional treatment stages may be required.

Table 8. Level of hazard

Hazard	Source of hazard
Very Low	Residential roof drainage
Low	Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.
Medium	Commercial, industrial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).
High	Areas used for handling and storage of chemicals and fuels, handling of storage and waste (incl. scrap-yards).

The recommended minimum number treatment stages suggested for the different runoff waters identified for the proposed development is highlighted in the table overleaf.

Table 9. Minimum number of treatment stages for runoff

		Sensitivity of the receiving water body		
		Low	Medium	High
Hazard	Low	1	1	1
	Med	2	2	2
	High	3	3	3

Green roofs, rainwater harvesting and a soakaway would offer sufficient treatment stages (storage/attenuation, filtration through sub-base and filtration through the unsaturated soil zone).

9 Proposed SuDS strategy

Sustainable drainage systems

DEFRA's non-statutory requirements for SuDS require the below ground drainage systems to have the capacity to accommodate at least the 1 in 30 year event and to manage the 1 in 100 year event without flooding of on-site buildings and substations. All runoff should be managed on-Site though for the 1 in 100 year event, accounting for the maximum impacts of climate change to ensure flood risk is not increased to third-parties.

It is assumed that drainage from areas outside the development footprint will continue to use existing drainage arrangements.

A surface water drainage strategy (summarised in Section 2 of this report) includes the following SuDS features to intercept, attenuate and treat surface water runoff.

Primary SuDS Strategy:

Ground conditions at the Site are conducive to infiltration. Therefore, surface water runoff will be managed within SuDS features and infiltrated to ground.

Table 10. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and infiltration SuDS.
SuDS features	Rainwater harvesting butts, green roof, permeable paving.
Discharge location	Infiltration.
Discharge rate	1 x 10^{-5} m/s (assumed infiltration rate in the absence of more detailed hydrogeological information, in line with typical infiltration rates in Table 25.1 of the CIRIA SuDS Manual (C753) (2015)).

Table 11. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater Harvesting	To comply with London Plan policy, rainwater harvesting butts should be established for each proposed dwelling. In terms of attenuation storage within this SuDS scheme, the volume of runoff which could be attenuated by Rainwater Harvesting has not been considered within the Preliminary SuDS schematic.
Green Roof	A green roof covering a total area of 276 m^2 (cover area of the extension and bungalow roofs, with a 10 m^2 allowance on each pair of buildings for solar panels and roof lights) with a green roof mix example volume of 55.20 m^3 (0.2 m depth) and Geocomposite

	example volume of 1.38 m^3 (0.005 m depth) would attenuate for 8.97 m^3.
Permeable paving	The paths and paved areas are proposed to be underlain by permeable paving and therefore will drain themselves. As such, the permeable paving will not be used to store surface water runoff from the roof areas, and therefore the volume of runoff which could be stored within the permeable paving has not been included within the Preliminary SuDS schematic.
Soakaway	A soakaway with an area of 16 m^2 (e.g. 4 x 4 m) and depth of 1.2 m, filled with geo-cellular crates with a 95% void ratio, would provide 18.24 m^3 attenuation.
Total Attenuation Provided	27.21 m^3

Green Roof

Green Roofs are proposed on the roofs of the extension to each front dwelling and the proposed bungalows. The green roofs will aim to intercept and store runoff within a porous substrate (depth of 0.2 m) over a total area of 286 m^2, and would attenuate up to 9.29 m^3 of surface water runoff (green roof calculations based on calculations within best practice guidance document - London Borough of Tower Hamlets SuDS Guidance, Section 3.5).

It is noted that a 10 m^2 allowance of roof area has been reserved for solar panels and roof lights within the proposed development. Should more area be required, the area of green roof could be proportionally lowered, and the volume of the soakaway could be increased to compensate.

Interception via green/brown roofs will enable the storage of run-off and infiltrate collected water gradually into the underlying substrate; this provides various levels of storage depending on the surface area of the feature and the thickness / type of the substrate being use. The different types of green roof include the following:

- Extensive roofs, have low substrate depths (and therefore low loadings on the building structure), simple planting and low maintenance requirements; these tend not to be accessible.
- Intensive roofs (or roof gardens) have deeper substrates (and therefore higher loadings on the building structure) that can support a wide variety of accessible planting but which tend to require more intensive maintenance.

The type of green roof is not specified by the SuDS scheme and can be chosen to suit the landscaping requirements of the development.

Green roofs can also provide improvements to water quality as they intercept water at the source, and the layering of the substrate can incorporate filtration measures to remove pollutants from the system. Green Roofs are roofs which incorporate planting, often sedum or wildflower and meadow planting, grasses and mosses. In fact, some can even be planted

with trees and shrubs. Brown roofs are similar to green roofs; the main difference is that whilst green roofs are often installed partly for the aesthetic value, whereas brown roofs tend to be installed for environmental reasons, such as to encourage plants and wildlife.

In addition, although green roofs absorb most of the rainfall that they receive during frequent events, there will always be a need to discharge excess water to the building's drainage system and these areas should be positively drained. The hydraulic performance of green roofs once saturated tends to be fairly similar to standard roofs. Therefore, the hydraulic design of green roof drainage should follow the advice in BS EN 12056-3:2000. Useful information is also provided in BS 6229:2003. Detailed guidelines for the planning, execution and upkeep of green roof sites are contained within GRO (2014).

It is recommended that attenuation should be provided in the form of a high porosity substrate underlying the growing medium (approximately 50% depending on the supplier), which would provide sufficient storage (depending on loading requirements of a fully saturated substrate). It is likely that the high porosity medium would only have to be relatively thin in order to achieve the attenuation requirements. Surface water would then be throttled to a suitable rate at a downpipe entrance before discharging to the rainwater harvesting butt and soakaway.

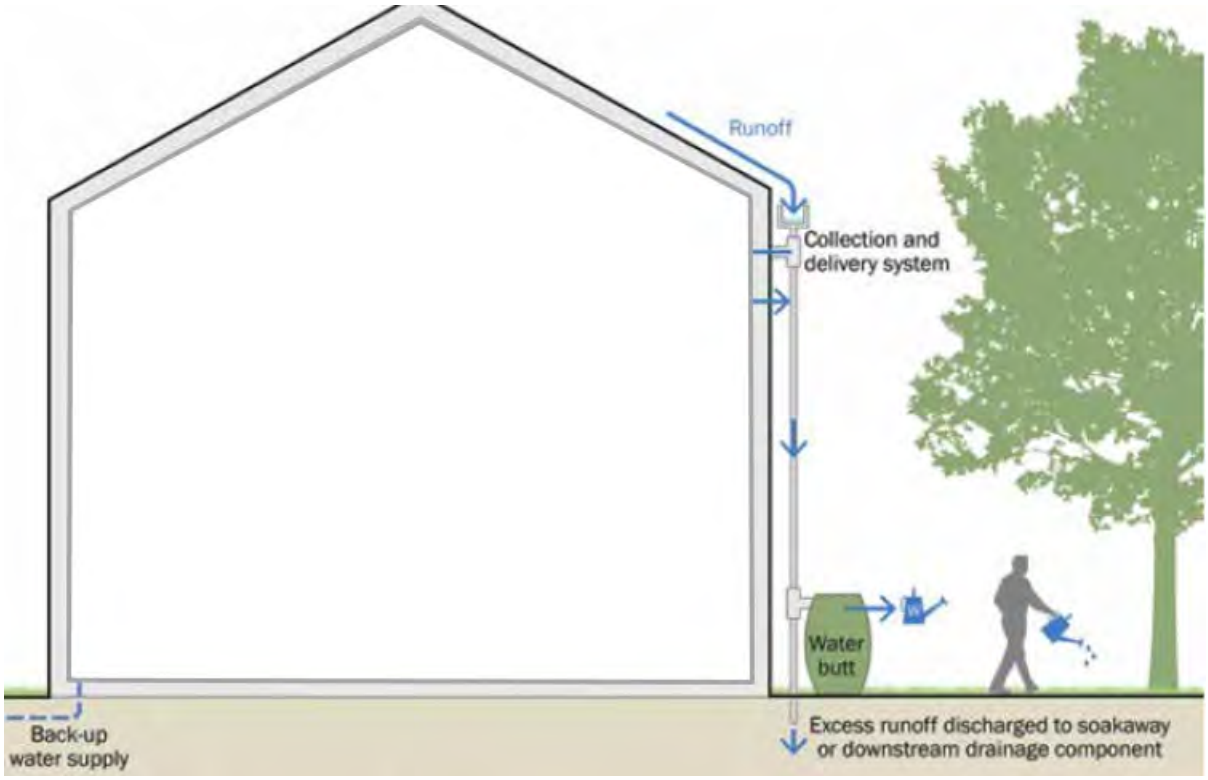
Rainwater harvesting

To comply with London Plan policy, a rainwater harvesting butt is proposed for each dwelling. The run-off from the proposed development roof should be led into rainwater harvesting butts via rainwater downpipes and guttering to catch run-off from each bungalow or extension roofs. Overflow from the butts should be discharged into the storage system provided by the soakaway.

Due to the relatively insignificant amounts of attenuation provided by rainwater harvesting tanks in this instance and the requirement to retain water for non-potable uses such garden maintenance, the volume of run-off which could be attenuated by rainwater harvesting has not been considered within the report.

As there is an issue with the storage capability of Rainwater Harvesting tanks, this method should have a fixed attenuation volume and a controlled outlet to discharge into the proposed SuDS feature. An overflow system will be required for implementation on the Site due to exceedance events (where the pumps fail or there is a blockage within the system / or the number of residents and subsequent water usage is reduced).

Roof run-off is generally less polluted than run-off from road surfaces but can still generate pollutants such as sediments. Pollutants would be captured by the collection and filtration system and, by reducing the volume of run-off generated from the Site. Primary screening devices are used to prevent leaves and other debris from entering the butt and first flush devises can be designed to divert the first part of the rainfall away from the main storage tank and can pick up most of the dirt, debris and contaminates that collect on a residential roof.



Modified from Figure 11.3 of the CIRIA SuDS Manual (C753) (2015)

Permeable paving

Permeable Paving is proposed for the access path and new paved areas to intercept runoff, and is proposed to drain itself. Suitable aggregate materials (angular gravels with suitable grading as per CIRIA, 2015) will improve water quality due to their filtration capacity and usually work to a 30% porosity. A geotextile layer will be required for paving underlain by aggregate material to intercept silt/particles. Permeable pavements are multi-layered surfacing systems. The surface layer is constructed out of permeable material allowing infiltration of water through gaps along its surface. A geomembrane isolates stored water from the surrounding soil, especially in contaminated areas and a geotextile layer prevents clogging and damage to the geo-cellular modules.

The geotextile layer works to intercept silt/particles flowing through the system via direct rainfall, or through vehicle use deposited onto the car park area and into the permeable paving. The majority of silt would be trapped within the top 30mm of the joining material between the paving blocks. Paving could implement an impermeable liner close to the building or creating a separate compartment within the permeable sub-base close to the building to further divert attenuated water away from building foundations.

The permeable paving is proposed to drain itself, mimicking greenfield conditions, and as such is not included within the drainage scheme for the remainder of the proposed development. Note that the permeable paving would be used for storage within the secondary SuDS strategy.

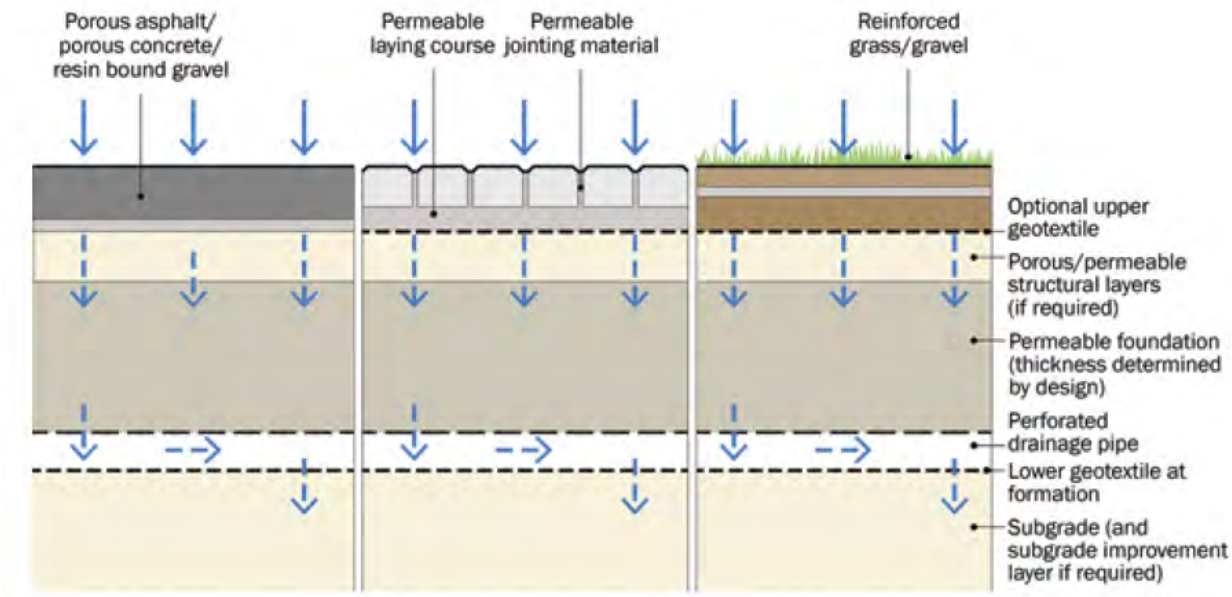


Figure 20.13 of the CIRIA SuDS Manual (C753) (2015)

Soakaways

Soakaways should be used to store run-off and infiltrate collected water gradually into the ground.

The base of the infiltration features should lie at an elevation at least 1 m above the highest winter groundwater levels, to ensure there is sufficient space for surface water to discharge. Soakaway excavation should be outside of the root zone of any protected trees, and soakaways should not be within 5 m of the building footprint and ideally 2.5 m away from the Site boundary to account for any further development. In the case of the Site, given the underlying chalk bedrock, a 10 m buffer from any proposed buildings is recommended to mitigate against any potential ground stability issues.

The soakaway will be used to infiltrate surface water runoff from the building footprint and will receive runoff via the proposed green roof and rainwater harvesting system.

Drainage protection devices

A non-return flap value is recommended for outflow pipes to reduce the risk of backflow from the channel/sewer during a large scale rainfall event.

Exceedance Flows

Exceedance flow routes are included within the proposed SuDS drainage layout. Where possible, exceedance flows should be directed away from buildings and into non-essential areas of the Site such as the driveway and garden. The SuDS system recommended for the Site should provide enough storage that this method would only be utilized during a worst case scenario.

Secondary SuDS strategy:

Where infiltration to ground is not achievable at the Site, an attenuation volume of 29.07 m³ should be stored within lined SuDS features to accommodate the calculated 3 hour Critical Storm Duration for surface water discharge runoff, restricted to 1 l/s (as close to the 1 in 100 year greenfield runoff rate as possible, without increasing the potential for blockages).

Permeable paving can still be incorporated if discharge to ground is not achievable. However, paving will need to be lined to avoid infiltration of surface water and subsequent interference with the groundwater system.

Table 12. Proposed SuDS type, features, discharge location and rate restriction

SuDS type	Source control (interception) and attenuation SuDS.
SuDS features	Rainwater harvesting, green roof, permeable paving.
Discharge location	Public sewer network.
Discharge rate	1 l/s (as close to the 1 in 100 year greenfield runoff rate as possible, without increasing the potential for blockages).

Table 13. Proposed SuDS sizing (dimensions) and attenuation volumes

Rainwater Harvesting	To comply with London Plan policy, rainwater harvesting butts should be established for each proposed dwelling. In terms of attenuation storage within this SuDS scheme, the volume of run-off which could be attenuated by Rainwater Harvesting has not been considered within the Preliminary SuDS schematic.
Green Roof	A green roof covering a total area of 276 m^2 (cover area of the extension and bungalow roofs, with a 10 m^2 allowance for solar panels and roof lights for each pair of houses) with a green roof mix example volume of 55.20 m^3 (0.2 m depth) and Geocomposite example volume of 1.38 m^3 (0.005 m depth) would attenuate for 8.97 m^3.
Lined permeable paving	A 186 m^2 area of lined permeable paving (underlain with a Type 3 aggregate material with 30% porosity) within the proposed path and paved areas to a depth of 0.4 m would result in c. 22.32 m^3 attenuation.
Total Attenuation Provided	31.29 m^3
Total Attenuation Required	29.07 m^3

Freeboard Storage Provided	2.22 m³

Flow control devices and systems

Hydrobrake Flow control systems can be used to reduce the runoff rate from the Site. These are usually a device used for controlling water flow into a connecting feature, such as a sewer, to a specific attenuation performance. The design consists of an intake, a volute and an outlet and the configuration is critical to ensure discharge control. For drainage areas which are less than 3 ha, outlet throttle diameters would have to be small (<150mm diameter) to achieve outflow rates which could result in blockage. For most SuDS features, a flow control device will comprise a fixed orifice or a throttle such as a short pipe.

A Vortex Control is usually a self-activating vortex flow device which directs water into a volute to form a vortex. For the Site, rainwater down pipes from the development roofs should drain directly into the rainwater harvesting butt and soakaway to reduce infill from potential flood water.

Policy compliance

An attenuation volume of 27.21 m³ for infiltration will comply with the following policies required by the London Borough of Croydon:

- Complies with the drainage hierarchy preference of storing rainwater for re-use and infiltration to ground (in accordance with Policy 5.13 of the London Plan (Greater London Authority, 2021) and Policy DM25 of the Croydon Local Plan (Croydon Council, 2018));
- Includes a green roof for additional amenity and biodiversity benefits, in line with the landscaping requirements for the Site, and ensures surface water runoff will be managed as close to the source as possible (in accordance with Policy DM25 of the Croydon Local Plan (Croydon Council, 2018)); and
- Reduces runoff rates to as close to greenfield scenario as possible (in accordance with Policy DM25 of the Croydon Local Plan (Croydon Council, 2018)).

10 SuDS maintenance

Regular maintenance is essential to ensure effective operation of the SuDS features over the intended lifespan of the proposed development. The SuDS Manual (C753) (CIRIA, 2015) provides a maintenance schedule for SuDS with details of the necessary required actions as shown in the Table below.

Table 14. SuDS operation and recommended maintenance requirements

Asset type	Maintenance schedule (and frequency)
Soakaways	Regular maintenance: • Remove sediment and debris from pretreatment and inspection chamber. Clean gutters, filters, downpipes. Trim roots prevent blockages (annually). • Reconstruct/ clean if performance deteriorates, replace clogged geotextile (as required) Monitoring: • Inspect inlets/outlets, silt traps – note rate of accumulation (monthly). • Check water levels and emptying time (annually).
Permeable pavements	Regular maintenance: • Brushing and vacuuming (three times per year). • Trimming any roots and surrounding grass and weeds that may be causing blockages (annually or as required). Monitoring: • Initial inspection (monthly). • Inspect for poor performance and inspection chambers (annually).
Hydro-Brake Flow Control	Low amounts of maintenance required as there are no moving parts within the Hydro-Brake® Flow Control. • Initial monthly inspection at the manhole once the construction phase is over. If blockages occur they normally do so at the intake. Hydro-Brake® Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur. Inspection should be undertaken annually or when a storm event occurs.
Underground drainage pipe network	Regular maintenance: • Remove sediment and debris from pre-treatment devices and floor of inspection tube or chamber (annually). • Cleaning of gutters and any filters on downpipes (annually).

Asset type	Maintenance schedule (and frequency)
	• Trimming any roots that may be causing blockages (annually or as required). Monitoring: • Inspect silt traps and note rate of sediment accumulation (monthly in the first year and then annually).
Green Roof	Regular inspection: • Inspect all components (soil substrate, vegetation, drainage, irrigation systems, membranes and roof structure, waterproofing, structural stability (annually and after severe storms) • Inspect soil substrate for evidence of erosion channels (annually and after severe storms). • Inspect drain inlets for unrestricted run-off (annually and after severe storms). • Inspect underside of roof for leakage (annually and after severe storms). Regular maintenance: • Remove litter and debris from inlet drains (six monthly, annually or as required). • Cleaning of clippings (six monthly or as required). • Trimming of grasses and removal of nuisance weeds and invasive vegetation (six monthly or as required). • Replace dead plants (annually or as required). Monitoring: • Stabilise any erosion channels with extra soil substrate (as required). • Identify sources of erosion and control (as required). • Investigate and repair drain inlet if inlet has settled, cracked or moved (as required).
Rainwater Harvesting	Regular maintenance: • Inspection of tank for debris and sediment build up (annually and following poor performance). • Inspection of inlets, outlets, overflow areas, pumps and filters (annually and following poor performance). • Cleaning of tank, inlets, outlets, gutters, roof drain filters and withdrawal devices (annually or as required). Remedial actions: • Repair or overflow erosion damage or damage to tank and associated components (as required)

Client checklist

A drainage strategy has been recommended as suitable on the basis of the information provided. Prior to installation of the Site drainage system it is recommended that the client carries out the following checks to confirm the development proposals. Geosmart would be able to support with any updates required to the drainage scheme, please contact us and we would be happy to provide you with a proposal to undertake the work.

Table 15. Potential SuDS limitations

Conditions in Non-Statutory Technical Standards (Defra, 2015), limitations to infiltration SuDS	Do these conditions arise at the Site?
Is the surface runoff greater than the rate at which water can infiltrate into the ground?	
Is there an unacceptable risk of ground instability?	
Is there an unacceptable risk of mobilising contaminants?	
Is there an unacceptable risk of pollution to groundwater?	
Is there an unacceptable risk of groundwater flooding?	
Is the infiltration system going to create a high risk of groundwater leakage to the combined sewer?	

Table 16. SuDS design considerations

Confirm that potential flooding on-Site in excess of the design storm event and exceedance flow routes have been considered.	
Review options for the control of discharge rates (e.g. hydrobrake).	
Confirm the owners/adopters of the drainage system. Consider management options for multiple owners.	
Is there an unacceptable risk of pollution to groundwater?	
Review access and way leave requirements.	
Review maintenance requirements.	

Health and safety considerations for SuDS

GeoSmart reports may include outline strategies or designs to support with development plans. Any drawings or advice provided do not comprise any form of detailed design. Implementation of any conceptual scheme options may constitute 'Construction Work' as defined by CDM Regulations (2015).

The CDM Regulations place specific Health and Safety duties on those commissioning, planning and undertaking construction works. If you are uncertain what this means you should seek the advice of your architect, builder or other competent professional.

GeoSmart does not provide health and safety advisory services but we are required to advise you of your general responsibilities under CDM (visit http://geosmartinfo.co.uk/knowledge-hub/cdm-2015/ for more information).

Please remember that detailed design work should be undertaken by a competent professional who might be your engineer, architect, builder or another competent party.

11 Methodology and limitations of study

This report assesses the feasibility of infiltration SuDS and alternative drainage strategies in support of the Site development process. From April 6th 2015 SuDS are regulated by Local Planning Authorities and will be required under law for major developments in all cases unless demonstrated to be inappropriate. What is considered appropriate in terms of costs and benefits by the Planning Authority will vary depending on local planning policy, and Site setting. The Lead Local Flood Authority will require information as a statutory consultee on major planning applications with surface water drainage implications. The National Planning Policy Framework requires that new developments in areas at risk of flooding should give priority to the use of SuDS and demonstrate that the proposed development does not increase flood risk downstream to third parties.

How was the suitability of SuDS estimated for the Site?

There are a range of SuDS options available to provide effective surface water management that intercept and store excess runoff. When considering these options, the destination of the runoff should be assessed using the order of preference outlined in the Building Regulations Part H document (HM Government, 2010) and Defra's National Standards for SuDS (2015):

1. Discharge to the ground;
2. Discharge to a surface water body;
3. Discharge to a surface water sewer;
4. Discharge to a local highway drain; and
5. Discharge to a combined sewer.

Data sets relating to each of the potential discharge options have been analysed to assess the feasibility of each option according to the hierarchy set out above. Hydrogeological characteristics for the Site are assessed in conjunction with the occurrence of SPZ's to assess infiltration suitability. The Site has been screened to determine whether flood risk from groundwater, surface water, fluvial or coastal sources may constrain SuDS. The distance to surface water bodies and sewers has been reviewed gauge whether these provide alternative options.

GeoSmart SuDS Infiltration Suitability Map (SD50)

The GeoSmart SuDS Infiltration Suitability Map (SD50) screens the suitability for infiltration drainage in different parts of the Site and indicates where further assessment is recommended. In producing the SuDS Infiltration Suitability Map (SD50), GeoSmart used data from the British Geological Survey on groundwater levels, geology and permeability to screen

for areas where infiltration SuDS may be suitable. The map classifies areas into 3 categories of High, Medium and Low suitability for infiltration SuDS. This can then be used in conjunction with additional data on Site constraints to give recommendations for SuDS design and further investigation.

The primary constraint on infiltration potential is the minimum permeability of the underlying material and in some cases the range in permeability may be considerable, ranging down to low. The map classifies these areas as moderate infiltration suitability requiring further investigation. In cases where the thickness of the receiving permeable horizon is less than 1.5 meters then additional Site investigation is recommended. If the Site is at risk of groundwater flooding for up to the 1% annual occurrence the map classifies these areas as moderate infiltration suitability requiring further investigation.

The GeoSmart SuDS Infiltration Suitability Map (SD50) is a national screening tool for infiltration SuDS techniques but a Site specific assessment should be used before final detailed design is undertaken. Further information on the GeoSmart SuDS Infiltration Suitability Map (SD50) is available at geosmartinfo.co.uk

How is the suitability to discharge to sewers and watercourses calculated?

The suitability to discharge to discharge to sewers and watercourses has been calculated using the distance from the Site to both. For example, where the Site is within 50m of a surface water body. Discharge to surface water is potentially appropriate subject to land access arrangements and a feasibility assessment. Where the Site is within 50m of a sewer, discharge to sewer is potentially appropriate subject to land access arrangements and a feasibility assessment. The utility company should be contacted to agree connection feasibility and sewer capacity.

Further information relating to sewers available in the area can be found in Appendix D.

What is a Source Protection Zone?

The Environment Agency have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which is occasionally applied. The zones are used to set up pollution prevention measures in areas which are at a higher risk. The shape and size of a zone depends on the condition of the ground, how the groundwater is removed, and other environmental factors. Inner zone (Zone 1) is defined as the 50 day travel time from any point below the water table to the source (minimum radius of 50 metres). Outer zone (Zone 2) is defined by a 400 day travel time. Total catchment (Zone 3) is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

How was surface water runoff estimated from the Site?

In accordance with The SuDS Manual (C753) (CIRIA, 2015), the Greenfield runoff from the Site has been calculated using the IoH124 method and is assumed representative of the runoff generated on the undeveloped surfaces that are affected by the proposed development. The method used for calculating the runoff complies with the NPPF (MHCLG, 2019). For the impermeable surfaces, it has been assumed that 100% runoff will occur (calculations provided in Appendix C). Rainfall data is derived from the Flood Estimation Handbook (FEH), developed by NERC (2009). Only areas affected by the proposed development are considered in the flow and volume calculations. Permeable areas that remain unchanged are not included in the calculations as it is assumed these will not be actively drained and attenuated.

What is the peak discharge rate?

An estimation of peak runoff flow rate and volume is required to calculate infiltration, storage and discharge requirements. The peak discharge rate is the maximum flow rate at which surface water runoff leaves the Site during a particular storm event, without considering the impact of any mitigation such as storage, infiltration or flow control. Proposed discharge rates (with mitigation) should be no greater than existing rates for all corresponding storm events. If all drainage is to infiltration there will be no discharge off-Site. Discharging all flow from Site at the existing 1 in 100 event would increase flood risk during smaller events. Flow restriction is generally required to limit the final discharge from Site during all events as a basic minimum to the green field QBAR rate. A more complex flow restriction which varies the final discharge rate from the Site depending on the storm event will reduce the volume of storage required on-Site. Drainage to infiltration SuDS is subtracted from the total discharge off-Site to achieve a beneficial net affect.

What is the total discharge volume?

The total discharge volume is calculated on the basis of the surface water runoff that has the potential to leave the Site as a result of the assumed 6 hour duration design storm event. The runoff is related to the underlying soil conditions, impermeable cover, rainfall intensity and duration of the storm event. The total volume generated by the current Site is compared to the potential total volume from the developed Site (not taking into consideration any mitigation). The difference provides the minimum total volume that will need to be stored and infiltrated on-Site or released at a controlled rate. Guidance indicates that the total discharge volume should never exceed the runoff volume from the development Site prior to redevelopment for that event and should be as close as is reasonably practicable to the Greenfield runoff volume.

12 Background SuDS information

SuDS control surface water runoff close to where it falls. SuDS are designed to replicate, as closely as possible, the natural drainage from the Site before development to ensure that the flood risk downstream does not increase as a result of the Site being developed, and that the Site will have satisfactory drainage under current and likely future climatic conditions. SuDS provide opportunities to reduce the causes and impacts of flooding; remove pollutants from urban runoff at source; and combine water management with green space with benefits for amenity, recreation and wildlife. Government planning policy and planning decisions now include a presumption in favour of SuDS being used for all development Sites, unless they can be shown to be inappropriate.

For general information on SuDS see our website: http://geosmartinfo.co.uk/

Infiltration SuDS

Government policy for England is to introduce sustainable drainage systems (SuDS) via conditions in planning approvals. Guidance indicates that capturing rainfall runoff on-Site and infiltrating it into the ground (infiltration SuDS) is the preferred method for managing surface water without increasing flood risk downstream.

The greatest benefit to general flood risk is if all runoff is infiltrated on-Site, however, this may not be feasible due to physical and economic constraints in which case infiltration may be considered as a part of an integrated drainage solution. The final design capacity for an infiltration SuDS system depends on the Site constraints and the requirements of the individual Planning Authority and the Lead Local Flood Authority.

The capacity of the ground to receive infiltration depends on the nature, thickness and permeability of the underlying material and the depth to the high groundwater table. The final proportion of the Site drained by infiltration will depend on topography, outfall levels and a suitable drainage gradient. It is important to note that, even if the whole Site cannot be drained by infiltration, the use of partial infiltration is encouraged, with the remainder of runoff discharged via other SuDS systems.

Types of infiltration SuDS

Infiltration components include infiltration trenches, soakaways, swales and infiltration basins without outlets, rain gardens and permeable pavements. These are used to capture surface water runoff and allow it to infiltrate (soak) and filter through to the subsoil layer, before returning it to the water table below.

An infiltration trench is usually filled with permeable granular material and is designed to promote infiltration of surface water to the ground. An infiltration basin is a dry basin or depression designed to promote infiltration of surface water runoff into the ground. Soakaways are the most common type of infiltration device in the UK where drainage is often connected to over-sized square or rectangular, rubble-filled voids sited beneath lawns.

According to the guidance in Building Research Establishment (BRE) Digest 365 (2016) a soakaway must be able to discharge 50% of the runoff generated during a 1 in 10 year storm event within 24 hours in readiness for subsequent storm flow. This is the basic threshold criteria for a soakaway design and the internal surface area of the proposed soakaway design options should be calculated on this basis by taking into account the soil infiltration rate for the Site.

Developers need to ensure their design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any machinery access required.

SuDS maintenance and adoption

Regular maintenance is essential to ensure effective operation of the soakaway(s) over the intended lifespan of the proposed development. A maintenance schedule for SuDs is required. Sewerage undertakers or Local Authorities may adopt SuDS and will require maintenance issues to be dealt with in accordance with their Management Plan. If the SuDS will not be adopted other provision is required with associated financial implications. Maintenance is a long-term obligation requiring the upkeep of all elements of the SuDS, including mechanical components (e.g. pumps), as well as inspections, regular maintenance and repair.

Additional background SuDS information can be found on our website: http://geosmartinfo.co.uk/

13 Further information

The following table includes a list of additional products by GeoSmart:

Additional GeoSmart Products			
✓	Additional assessment: EnviroSmart Report		Provides a robust desk-based assessment of potential contaminated land issues, taking into account the regulatory perspective. Our EnviroSmart reports are designed to be the most cost effective solution for planning conditions. Each report is individually prepared by a highly experienced consultant conversant with Local Authority requirements. Ideal for pre-planning or for addressing planning conditions for small developments. Can also be used for land transactions. Please contact info@geosmartinfo.co.uk for further information.

14 References and glossary

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GeoSmart Information

Glossary

General terms

Attenuation	Reduction of peak flow and increased duration of a flow event.
Combined sewer	A sewer designed to carry foul sewage and surface water in the same pipe.
Detention basin	A vegetated depression, normally is dry except after storm events, constructed to store water temporarily to attenuate flows. May allow infiltration of water to the ground.
Evapotranspiration	The process by which the Earth's surface or soil loses moisture by evaporation of water and by uptake and then transpiration from plants.
FEH	Flood Estimation Handbook, produced by Centre for Ecology and Hydrology, Wallingford (formerly the Institute of Hydrology).
Filter drain or trench	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water, but may also be designed to permit infiltration.
First flush	The initial runoff from a site or catchment following the start of a rainfall event. As runoff travels over a catchment it will collect or dissolve pollutants, and the "first flush" portion of the flow may be the most contaminated as a result. This is especially the case for intense storms and in small or more uniform catchments. In larger or more complex catchments pollution.
Flood plain	Land adjacent to a watercourse that would be subject to repeated flooding under natural conditions (see Environment Agency's Policy and practice for the protection of flood plains for a fuller definition).
Greenfield runoff	This is the surface water runoff regime from a site before development, or the existing site conditions for brownfield redevelopment sites.
Impermeable surface	An artificial non-porous surface that generates a surface water runoff after rainfall.
Permeability	A measure of the ease with which a fluid can flow through a porous medium. It depends on the physical properties of the medium, for example grain size, porosity and pore shape.

Runoff	Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or if rainfall is particularly intense.
Sewerage undertaker	This is a collective term relating to the statutory undertaking of water companies that are responsible for sewerage and sewage disposal including surface water from roofs and yards of premises.
Soakaway	A subsurface structure into which surface water is conveyed to allow infiltration into the ground.
Treatment	Improving the quality of water by physical, chemical and/or biological means.

The terms included in this glossary have been taken from CIRIA (2015) guidance.

Data Sources

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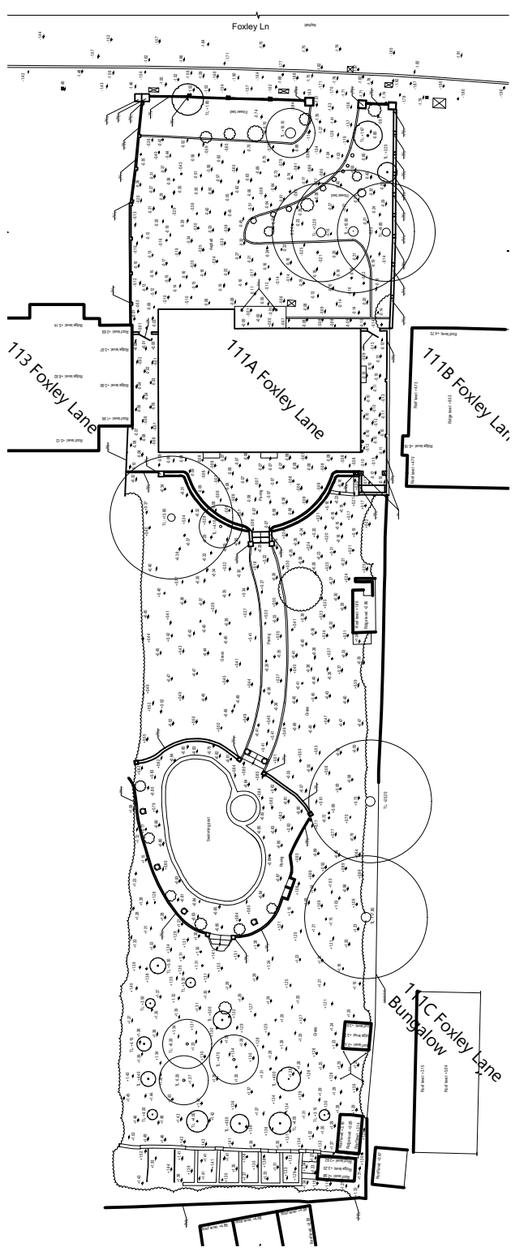
Flood Risk (Groundwater) and SuDS infiltration suitability (SD50)	GeoSmart, BGS & OS GW5 (v2.4) Map (GeoSmart, 2022) Contains British Geological Survey materials © NERC 2022 Ordnance Survey data © Crown copyright and database right 2022
Sewer Location	Contains Ordnance Survey data © Crown copyright and database right 2022 Contains Thames Water data 2022
Topographic Data	OS LiDAR/EA Contains Ordnance Survey data © Crown copyright and database right 2022 Environment Agency copyright and database rights 2022

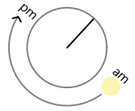
15 Appendices

GeoSmart Information

Appendix A

Site plans (layout and topography)





EXISTING **Site Plan**

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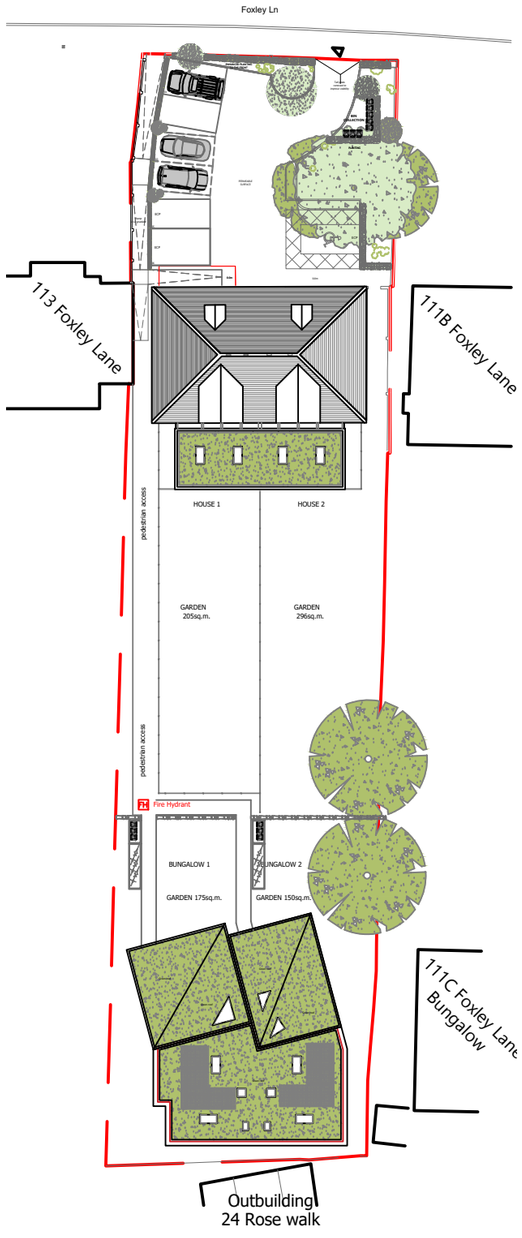
0m 2.5m 5m 12.5m 25m

Scale 1:500



PROPOSED **Site Plan**

1:500@A1

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Notes:

Do not scale - verify all dimensions before commencing work. Report suspected discrepancies or omissions.

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Client:

Site address:
IIIa Foxley Lane
CR8 3HQ

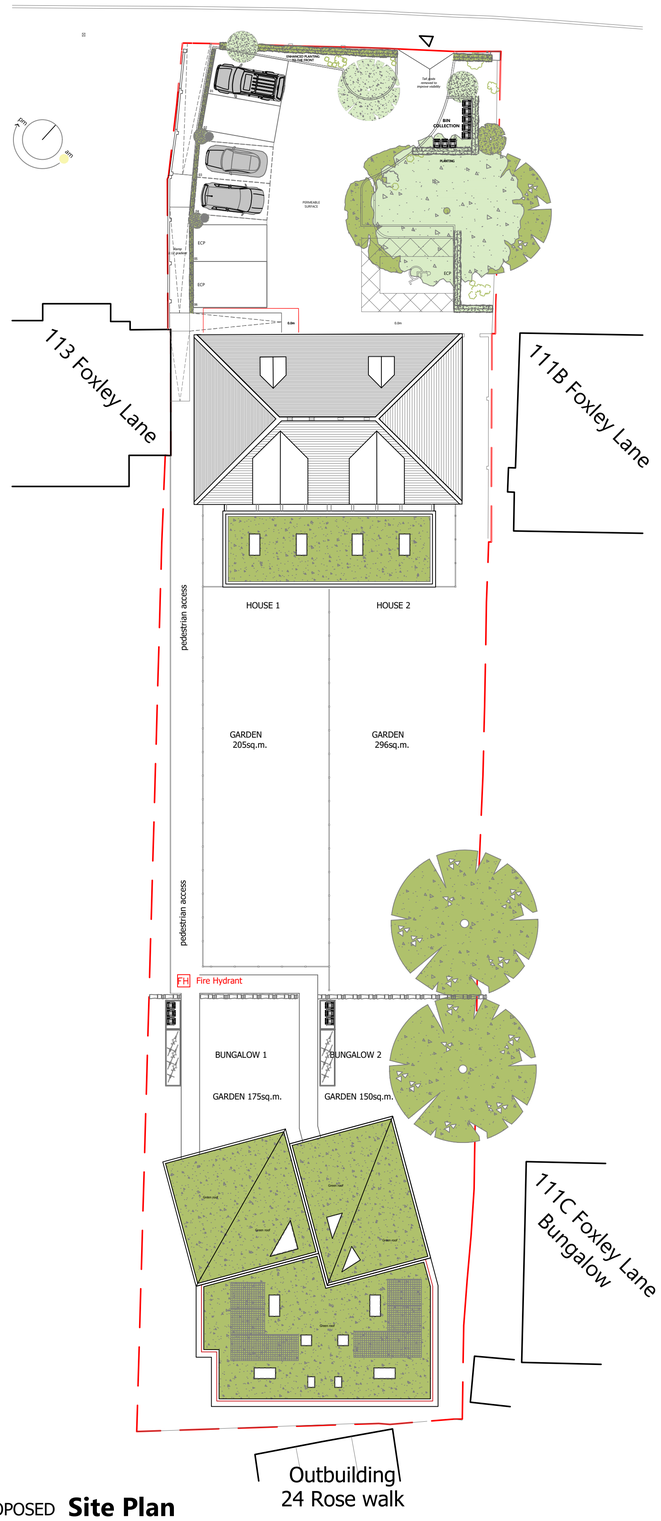
Drawn by:

Drawn date:
10/10/2022

Scale:
1:500 @ A1

Name:
SITE PLAN_ EXISTING AND PROPOSED

Drawing number:
01



PROPOSED **Site Plan**

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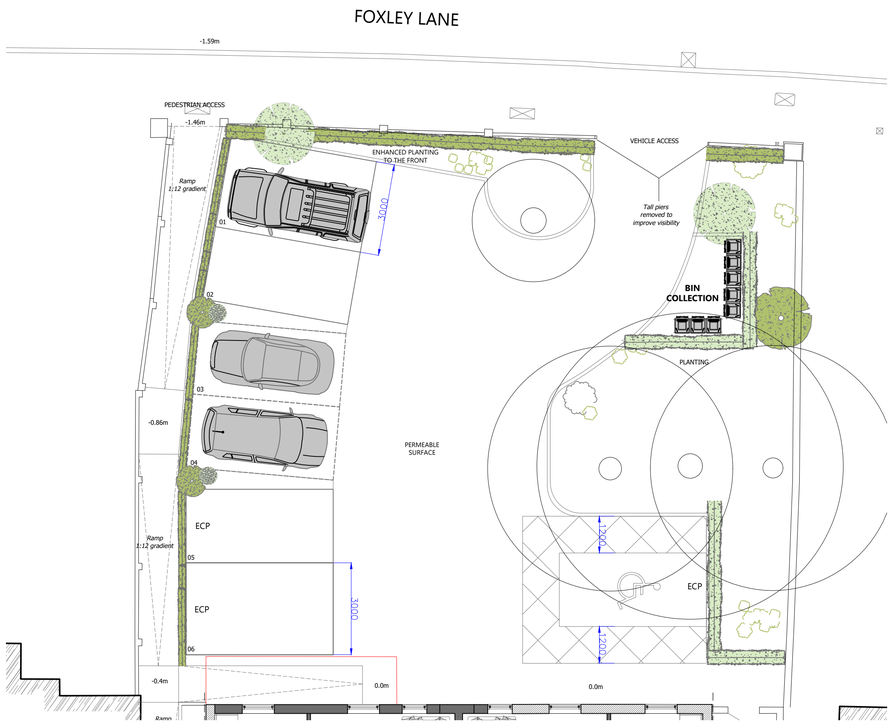
Scale 1:200



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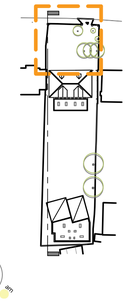
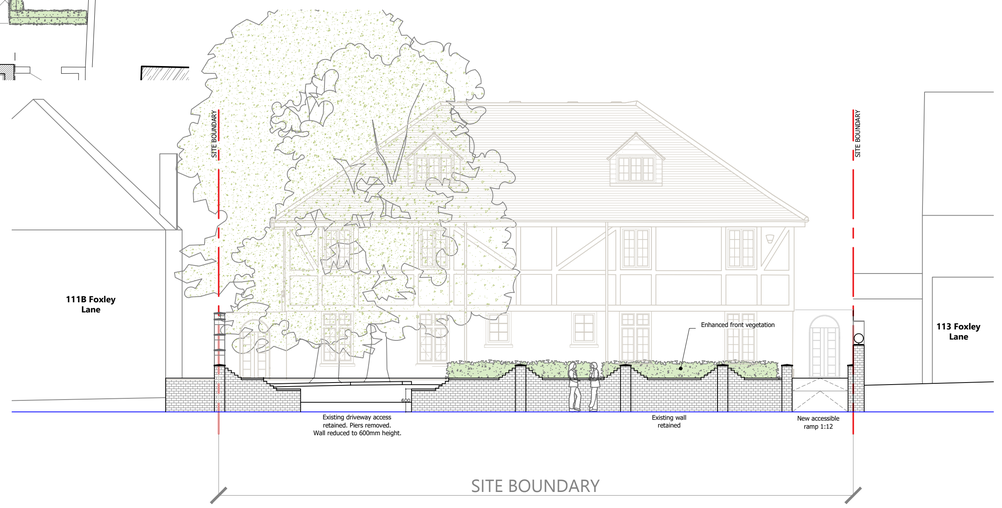


Key Plan



PROPOSED **Front Street Elevation**

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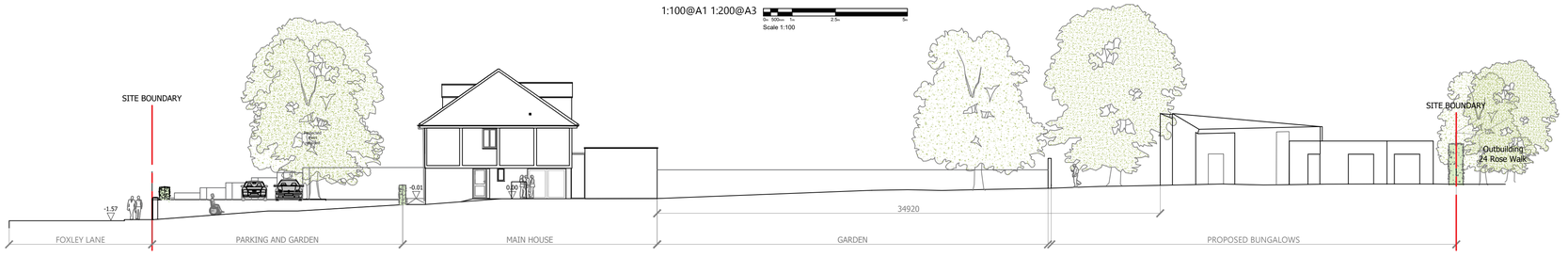
Scale 1:100



PROPOSED **Site Section**

1:200@A1 1:400@A3

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NOTES:
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CLIENT:

SITE ADDRESS:
IIIA FOXLEY LANE
CR8 3HQ

DRAWN BY:
DRAWN DATE:
10 / 10 / 2022
SCALE:
AS SHOWN

NAME:
PROPOSED SITE PLAN, SECTION & STREET ELEVATIONS

DRAWING NUMBER:
02

PROPOSED **Ground Floor Plan**

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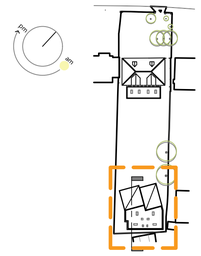
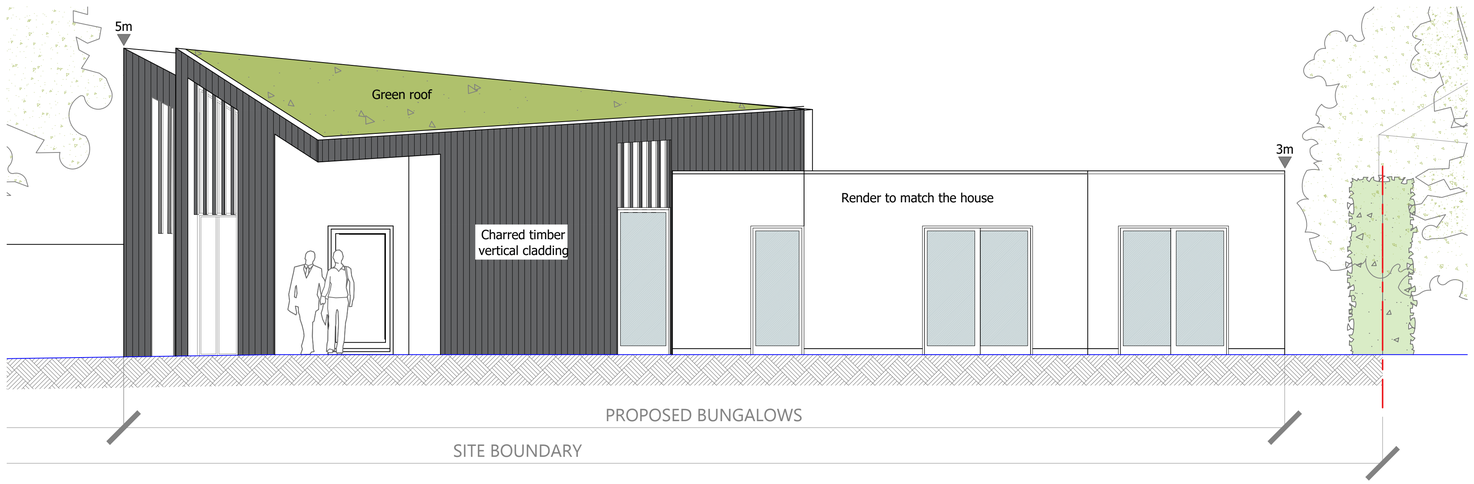
Scale 1:100



Key Plan



PROPOSED **South East Elevation** (Side)

1:100@A1 1:200@A3

PROPOSED **Section AA**

1:50@A1 1:100@A3

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CLIENT:

SITE ADDRESS:
111A FOXLEY LANE
CR8 3HQ

DRAWN BY:

DRAWN DATE:
10/10/2022
SCALE:
AS SHOWN

NAME:
PROPOSED BUNGALOWS PLAN, ELEVATIONS AND SECTION

DRAWING NUMBER:
05

GeoSmart Information

Appendix B

Rainfall runoff calculations – infiltration

Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	2	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
1	0.030	5.00	10.000	450	0.300
2	0.000	5.00	10.000	450	0.600
3	0.019	5.00	10.000		0.450

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	15.000	0.600	9.700	9.400	0.300	50.0	150	5.18	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.426	25.2	4.1	0.150	0.450	0.030	0.0	41	1.051

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

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

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	0	0	0
100	40	0	0

Node 2 Soakaway Storage Structure

Base Inf Coefficient (m/hr)	0.03600	Invert Level (m)	8.200	Depth (m)	1.200
Side Inf Coefficient (m/hr)	0.03600	Time to half empty (mins)	1188	Inf Depth (m)	
Safety Factor	2.0	Pit Width (m)	4.000	Number Required	1
Porosity	0.95	Pit Length (m)	4.000		

Node 3 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.03600	Invert Level (m)	9.550	Slope (1:X)	80.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	75	Depth (m)	0.300
Safety Factor	2.0	Width (m)	10.000	Inf Depth (m)	
Porosity	0.30	Length (m)	19.000		

Results for 2 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	1	152	9.717	0.017	0.7	0.0372	0.0000	OK
960 minute winter	2	915	8.360	-1.040	0.4	2.4332	0.0000	OK
120 minute winter	3	84	9.650	0.100	1.0	1.3017	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
240 minute winter	1	1.000	2	0.7	0.616	0.027	0.0166
960 minute winter	2	Infiltration		0.1			
120 minute winter	3	Infiltration		0.4			

Results for 30 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	1	21	9.752	0.052	6.8	0.1126	0.0000	OK
720 minute winter	2	675	8.765	-0.635	0.9	8.5887	0.0000	OK
120 minute winter	3	90	9.721	0.171	2.2	3.6394	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
30 minute winter	1	1.000	2	6.2	1.159	0.245	0.0800
720 minute winter	2	Infiltration		0.1			
120 minute winter	3	Infiltration		0.7			

Results for 100 year Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	1	19	9.769	0.069	10.1	0.1490	0.0000	OK
960 minute winter	2	885	8.978	-0.422	0.9	11.8293	0.0000	OK
120 minute winter	3	90	9.747	0.197	2.8	4.8487	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
30 minute winter	1	1.000	2	10.0	1.310	0.399	0.1151
960 minute winter	2	Infiltration		0.1			
120 minute winter	3	Infiltration		0.8			

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	9.797	0.097	17.9	0.2094	0.0000	OK
720 minute winter	2	705	9.586	0.186	1.6	18.2772	0.0000	OK
120 minute winter	3	94	9.791	0.241	3.9	7.1662	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)
15 minute winter	1	1.000	2	16.7	1.460	0.664	0.1719
720 minute winter	2	Infiltration		0.2			
120 minute winter	3	Infiltration		0.9			

GeoSmart Information

Appendix C

Rainfall runoff calculations – attenuation

Greenfield Site Run-Off Calculations usng the IoH124 method

Greenfield peak run-off rate (QBAR):

Parameters	Input	Units	Comments
Area	50	ha	mimimum 50ha
SAAR	710	mm	FEH CD ROM (NERC, 2009)
SPR	0.10	N/A	Soil run-off coefficient
Region	6	N/A	Region on Hydrological area map

QBAR

$$Q_{BAR(rural)} = 1.08AREA^{0.89}SAAR^{1.17}SPR^{2.17}$$

Where:

$Q_{BAR(rural)}$	is the mean annual flood (a return period of 2.3 years) in l/s
AREA	is the area of the catchment in km² (minimum of 0.5km²)
SAAR	is the standard average rainfall for the period 1941 to 1970 in mm
SPR	is the soil run-off coefficient

$Q_{BAR(rural)}$ can be factored by the UK Flood Studies Report regional growth curves to produce peak flood flows for any return period.

$Q_{BAR(rural)}$	=	8.54	l/s for 50ha site
Divided by 50 to scale down	=	0.17	l/s/ha
Actual Area of the entire Site	=	0.13	ha

Return Periods (Growth curves obtained from DEFRA report)

Return Period		Growth Factor	l/s/ha	Peak site run-off rate (l/s)
1	**$Q_{BAR(rural)}$ x**	**0.85**	**0.15**	**0.018**
2	$Q_{BAR(rural)}$ x	0.88	0.15	0.02
5	$Q_{BAR(rural)}$ x	1.28	0.22	0.03
10	$Q_{BAR(rural)}$ x	1.62	0.28	0.04
25	$Q_{BAR(rural)}$ x	2.14	0.37	0.05
30	**$Q_{BAR(rural)}$ x**	**2.24**	**0.38**	**0.049**
50	$Q_{BAR(rural)}$ x	2.62	0.45	0.06
100	**$Q_{BAR(rural)}$ x**	**3.19**	**0.54**	**0.07**
200	$Q_{BAR(rural)}$ x	3.86	0.66	0.08

Greenfield total run-off volume:

= actual area of the entire site x SPR x 6 hour rainfall depth

Return Period	6 hour rainfall (mm) from FEH CD-ROM	Area (ha)	SPR	Total run-off (m^3)
2.3 (QBAR)	27.43	0.13	0.10	3.5
1	25.81	0.13	0.10	3.3
10	42.31	0.13	0.10	5.4
30	53.92	0.13	0.10	6.8
100	70.19	0.13	0.10	8.9

Developed site run-off calculation sheet

1 in 1 year

Proposed impermeable area	0.048	ha
CC Factor	40%	
Total volume for surfaces during 6 hour event	12.44	m^3
Total volume for 6 hour event inc CC	17.42	m^3
Total volume for 6 hour event exc CC	12.44	m^3

Duration	Rainfall 1 yr event	Run-off rate 1 yr event	Run-off rate 1 yr +cc event
hours	mm	m^3	m^3
0.25	7.57	3.65	5.11
0.5	9.69	4.67	6.54
0.75	11.09	5.35	7.48
1	12.12	5.84	8.18
2	17.13	8.26	11.56
3	20.32	9.79	13.71
4	22.63	10.91	15.27
5	24.39	11.76	16.46
6	25.81	12.44	17.42
8	27.94	13.47	18.85
10	29.57	14.25	19.95
12	30.91	14.90	20.86
16	33.11	15.96	22.34
20	34.95	16.85	23.58
24	36.60	17.64	24.70
28	38.11	18.37	25.72
32	39.52	19.05	26.67
36	40.86	19.69	27.57
40	42.13	20.31	28.43
44	43.35	20.89	29.25
48	44.53	21.46	30.05

1 in 30 year

Proposed impermeable area	0.048	ha
CC Factor	40%	
Total volume for surfaces during 6 hour event	25.99	m^3
Total volume for 6 hour event inc CC	36.39	m^3
Total volume for 6 hour event exc CC	25.99	m^3

Duration	Rainfall 30 yr event	Run-off volume 30 yr event	Run-off volume 30 yr +cc event
hours	mm	m^3	m^3
0.25	20.47	9.87	13.81
0.5	26.73	12.88	18.04
0.75	30.60	14.75	20.65
1	33.50	16.15	22.61
2	41.00	19.76	27.67
3	45.71	22.03	30.85
4	49.13	23.68	33.15
5	51.76	24.95	34.93
6	53.92	25.99	36.39
8	57.29	27.61	38.66
10	59.93	28.89	40.44
12	62.12	29.94	41.92
16	65.64	31.64	44.29
20	68.54	33.04	46.25
24	71.09	34.27	47.97
28	73.33	35.35	49.48
32	75.37	36.33	50.86
36	77.26	37.24	52.14
40	79.02	38.09	53.32
44	80.69	38.89	54.45
48	82.27	39.65	55.52

Outflow at 1 l/s	inflow from rain	Diff (storage required)
0.90	9.87	8.97
1.80	12.88	11.08
2.70	14.75	12.05
3.60	16.15	12.55
7.20	19.76	12.56
10.80	22.03	11.23
14.40	23.68	9.28
18.00	24.95	6.95
21.60	25.99	4.39
28.80	27.61	-1.19
36.00	28.89	-7.11
43.20	29.94	-13.26
57.60	31.64	-25.96
72.00	33.04	-38.96
86.40	34.27	-52.13
100.80	35.35	-65.45
115.20	36.33	-78.87
129.60	37.24	-92.36
144.00	38.09	-105.91
158.40	38.89	-119.51
172.80	39.65	-133.15

1 in 100 year

Proposed impermeable area	0.048	ha
CC Factor	40%	
Total volume for surfaces during 6 hour event	33.83	m^3
Total volume for 6 hour event inc CC	47.36	m^3
Total volume for 6 hour event exc CC	33.83	m^3

Duration	Rainfall 100 yr event	Run-off volume 100 yr event	Run-off volume 100 yr +cc event
hours	mm	m^3	m^3
0.25	26.39	12.72	17.81
0.5	34.81	16.78	23.49
0.75	40.09	19.32	27.05
1	43.85	21.14	29.59
2	53.05	25.57	35.80
3	59.08	28.48	39.87
4	63.60	30.66	42.92
5	67.20	32.39	45.35
6	70.19	33.83	47.36
8	74.93	36.12	50.56
10	78.67	37.92	53.09
12	81.78	39.42	55.19
16	86.81	41.84	58.58
20	90.80	43.77	61.27
24	94.15	45.38	63.53
28	97.05	46.78	65.49
32	99.62	48.02	67.22
36	101.95	49.14	68.80
40	104.07	50.16	70.23
44	106.04	51.11	71.56
48	107.87	51.99	72.79

		100yr Scenario	CC Scenario
Outflow at 1 l/s	inflow from rain	Diff (storage required)	Diff (storage required)
0.90	17.81	11.82	16.91
1.80	23.49	14.98	21.69
2.70	27.05	16.62	24.35
3.60	29.59	17.54	25.99
7.20	35.80	18.37	28.60
10.80	39.87	17.68	29.07
14.40	42.92	16.26	28.52
18.00	45.35	14.39	27.35
21.60	47.36	12.23	25.76
28.80	50.56	7.32	21.76
36.00	53.09	1.92	17.09
43.20	55.19	-3.78	11.99
57.60	58.58	-15.76	0.98
72.00	61.27	-28.23	-10.73
86.40	63.53	-41.02	-22.87
100.80	65.49	-54.02	-35.31
115.20	67.22	-67.18	-47.98
129.60	68.80	-80.46	-60.80
144.00	70.23	-93.84	-73.77
158.40	71.56	-107.29	-86.84
172.80	72.79	-120.81	-100.01

Summary

Entire site area:	0.127	ha
Climate Change Factor	40%	

	Current	*Proposed*
Permeable Surface (ha)	0.092	0.079
Impermeable Surface (ha)	0.035	0.048

1 in 1 year

Greenfield run-off volume total: 3.27 m^3

RUN-OFF During a 1 in 1 year 6 hour event:	**Greenfield Site**	**Current Development**	**Proposed Development**	**Proposed Development +CC**
From permeable surfaces (using GF total run-off) (m^3)	3.27	2.38	2.03	2.84
From impermeable surfaces (m^3)		8.93	12.44	17.42
TOTAL run-off produced from Site (m^3)	3.27	11.31	14.47	20.26

Difference between greenfield site and proposed +cc development (m^3):	**16.98**
	519%
Difference between current and proposed +cc development (m^3):	**8.95**
	79%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):	**0.02**

1 in 10 year

Greenfield run-off volume total: 5.36 m^3

RUN-OFF During a 1 in 1 year 6 hour event:	**Greenfield Site**	**Current Development**	**Proposed Development**	**Proposed Development +CC**
From permeable surfaces (using GF total run-off) (m^3)	5.36	3.90	3.33	4.66
From impermeable surfaces (m^3)		14.19	19.76	27.67
TOTAL run-off produced from Site (m^3)	5.36	18.09	23.09	32.32

Difference between greenfield site and proposed +cc development (m^3):	**26.96**
	502%
Difference between current and proposed +cc development (m^3):	**14.24**
	79%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):	**0.04**

1 in 30 year

Greenfield run-off volume total: 6.84 m^3

RUN-OFF During a 1 in 30 year 6 hour event:	**Greenfield Site**	**Current Development**	**Proposed Development**	**Proposed Development +CC**
From permeable surfaces (using GF total run-off) (m^3)	6.84	4.97	4.24	5.93
From impermeable surfaces (m^3)		18.66	25.99	36.39
TOTAL run-off produced from Site (m^3)	6.84	23.63	30.23	42.32

Difference between greenfield site and proposed +cc development (m^3):	**35.48**
	519%
Difference between current and proposed +cc development (m^3):	**18.69**
	79%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):	**0.05**

1 in 100 year

Greenfield run-off volume total: 8.90 m^3

RUN-OFF During a 1 in 100 year 6 hour event:	**Greenfield Site**	**Current Development**	**Proposed Development**	**Proposed Development +CC**
From permeable surfaces (using GF total run-off) (m^3)	8.90	6.47	5.52	7.72
From impermeable surfaces (m^3)		24.29	33.83	47.36
TOTAL run-off produced from Site (m^3)	8.90	30.76	39.35	55.09

Difference between greenfield site and proposed +cc development (m^3):	**46.19**
	519%
Difference between current and proposed +cc development (m^3):	**24.33**
	79%
Peak Greenfield run-off rate that must not be exceeded in the run-off from the proposed development (l/s):	**0.07**

GeoSmart Information

Appendix D

Asset location search (Thames Water, 2022)

Asset location search

Property Searches

GeoSmart Information Ltd
1st Floor Old Bank Buildings
Suite 9-11Bellstone
SHREWSBURY
SY1 1HU

Search address supplied 111B
Foxley Lane
Purley
CR8 3HQ

Your reference 77661

Our reference ALS/ALS Standard/2022_4712984

Search date 5 September 2022

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0800 009 4540

Asset location search

Property Searches

Search address supplied: 111B, Foxley Lane, Purley, CR8 3HQ

Dear Sir / Madam

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

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

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

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

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

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

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the address below:

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

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

Asset location search

Thames Water Property Searches

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Sutton & East Surrey Water
London Road
Redhill
Surrey
RH1 1LJ

Asset location search

Property Searches

Tel: 01737 772 000
Fax: 01737 766 807

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

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

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

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

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

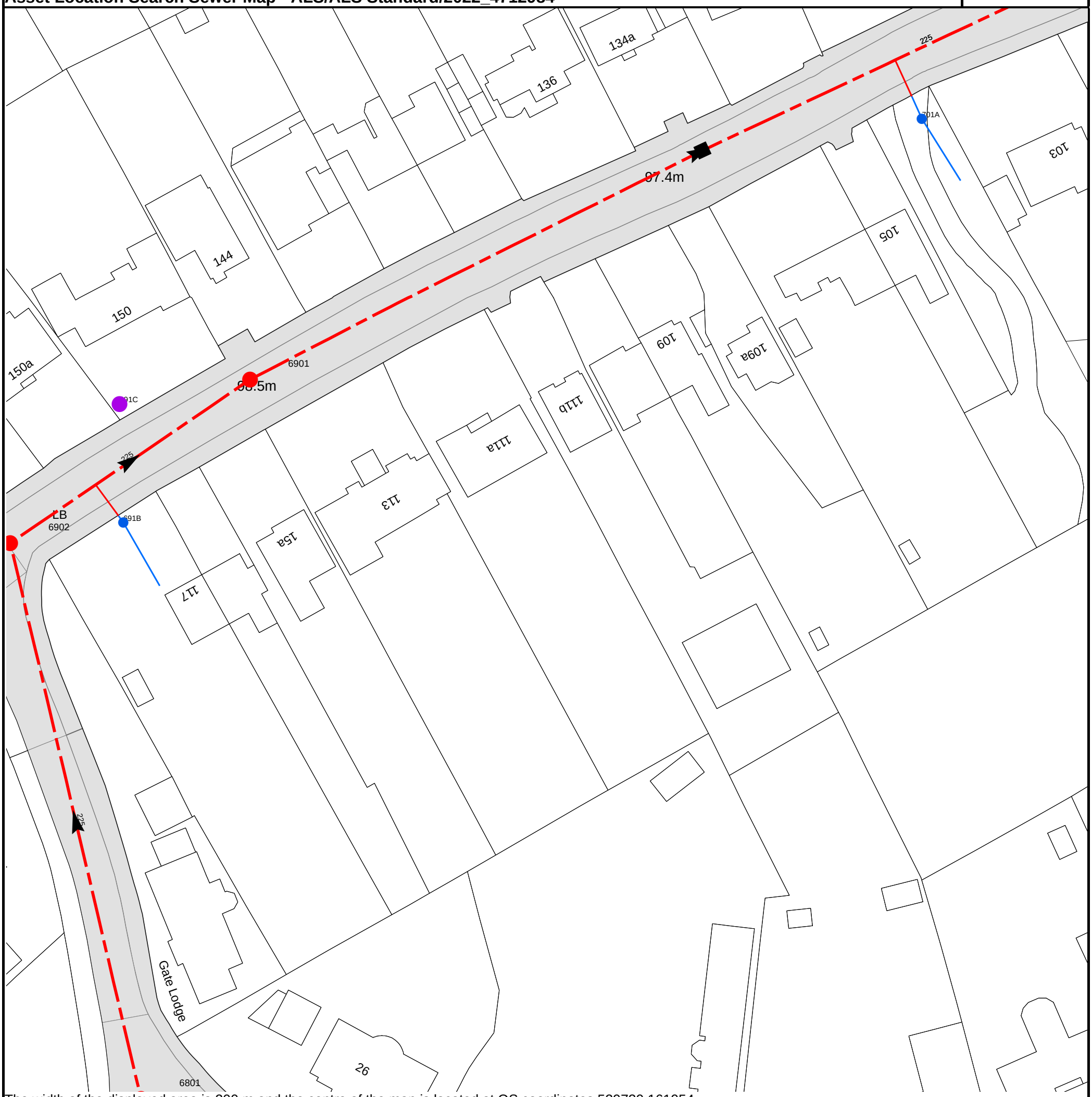
Clean Water queries

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

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

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2022_4712984



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 529730,161954

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
6902	99.21	97.41
691C	n/a	n/a
691B	n/a	n/a
6901	98.37	n/a
701A	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.

Asset Location Search - Sewer Key

Public Sewer Types (Operated and maintained by Thames Water)

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

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

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

- Storm Sewer
- Sludge Sewer
- Foul Trunk Sewer
- Surface Trunk Sewer
- Combined Trunk Sewer
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Vacuum
- Thames Water Proposed
- Vent Pipe
- Gallery

Other Sewer Types (Not operated and maintained by Thames Water)

- Sewer
- Culverted Watercourse
- Proposed
- Decommissioned Sewer
- Content of this drainage network is currently unknown
- Ownership of this drainage network is currently unknown

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
- Meter
- Dam Chase
- Vent
- Fitting

Operational Controls

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

- Ancillary
- Drop Pipe
- Control Valve
- 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.

- Inlet
- Outfall
- Undefined End

Other Symbols

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

- Change of Characteristic Indicator
- Public / Private Pumping Station
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Chamber
- Operational Site

Ducts or Crossings

- Casement — Ducts may contain high voltage cables. Please check with Thames Water.
- Conduit Bridge
- Subway
- Tunnel

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plan are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate the 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 indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimeters.
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, please contact Property Searches on 0800 009 4540.

Terms and Conditions

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

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

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

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

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

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

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

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

Disclaimer

This report has been prepared by GeoSmart in its professional capacity as soil, groundwater, flood risk and drainage specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client and is provided by GeoSmart solely for the internal use of its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to GeoSmart at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, GeoSmart may, by prior written agreement, agree to such release, provided that it is acknowledged that GeoSmart accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. GeoSmart accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against GeoSmart except as expressly agreed with GeoSmart in writing.

For full T&Cs see http://geosmartinfo.co.uk/terms-conditions

Further information

Information on confidence levels and ways to improve this report can be provided for any location on written request to info@geosmart.co.uk or via our website. Updates to our model are ongoing and additional information is being collated from several sources to improve the database and allow increased confidence in the findings. Further information on groundwater levels and flooding are being incorporated in the model to enable improved accuracy to be achieved in future versions of the map. Please contact us if you would like to join our User Group and help with feedback on infiltration SuDS and mapping suggestion.

Important consumer protection information

This search has been produced by GeoSmart Information Limited, Suite 9-11, 1st Floor, Old Bank Buildings, Bellstone, Shrewsbury, SY1 1HU.

Tel: 01743 298 100

Email: info@geosmartinfo.co.uk

GeoSmart Information Limited is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom.
- sets out minimum standards which firms compiling and selling search reports have to meet.
- promotes the best practice and quality standards within the industry for the benefit of consumers and property professionals.
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.
- By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

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

Complaints

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

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

TPOs contact details:

The Property Ombudsman scheme

Milford House

43-55 Milford Street

Salisbury

Wiltshire SP1 2BP

Tel: 01722 333306

Fax: 01722 332296

Email: admin@tpos.co.uk

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

Please ask your search provider if you would like a copy of the search code

Complaints procedure

GeoSmart Information Limited is registered with the Property Codes Compliance Board as a subscriber to the Search Code. A key commitment under the Code is that firms will handle any complaints both speedily and fairly. If you want to make a complaint, we will:

- Acknowledge it within 5 working days of receipt.
- Normally deal with it fully and provide a final response, in writing, within 20 working days of receipt.
- Keep you informed by letter, telephone or e-mail, as you prefer, if we need more time.
- Provide a final response, in writing, at the latest within 40 working days of receipt.
- Liaise, at your request, with anyone acting formally on your behalf.

If you are not satisfied with our final response, or if we exceed the response timescales, you may refer the complaint to The Property Ombudsman scheme (TPOs): Tel: 01722 333306, E-mail: admin@tpos.co.uk.

We will co-operate fully with the Ombudsman during an investigation and comply with his final decision. Complaints should be sent to:

Martin Lucass

Commercial Director

GeoSmart Information Limited

Suite 9-11, 1st Floor,

Old Bank Buildings,

Bellstone, Shrewsbury, SY1 1HU

Tel: 01743 298 100

martinlucass@geosmartinfo.co.uk

16 Terms and conditions, CDM regulations and data limitations

Terms and conditions can be found on our website:

http://geosmartinfo.co.uk/terms-conditions/

CDM regulations can be found on our website:

http://geosmartinfo.co.uk/knowledge-hub/cdm-2015/

Data use and limitations can be found on our website:

http://geosmartinfo.co.uk/data-limitations/