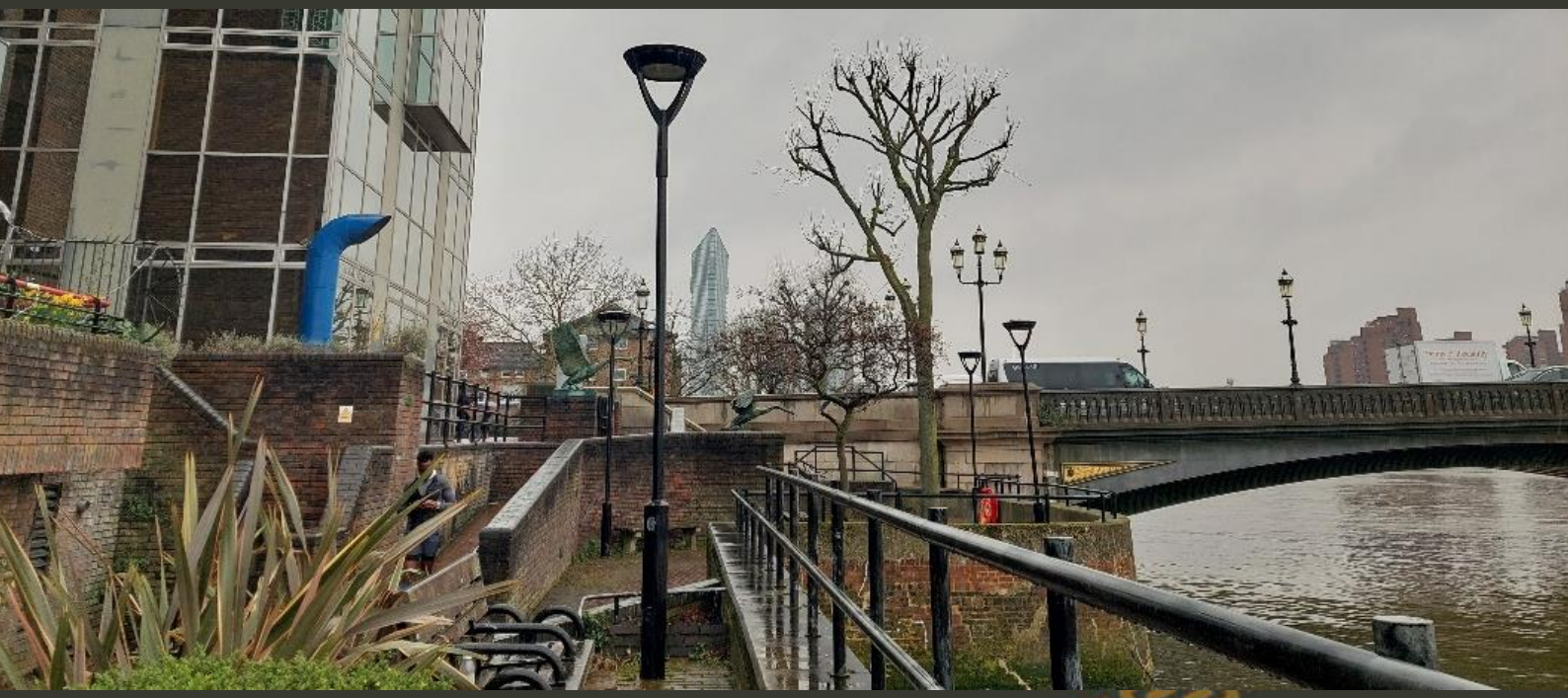
ONE BATTERSEA BRIDGE

DRAINAGE STRATEGY

April 2024

One Battersea Bridge: Drainage Strategy

P21383_R4
March 2024



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One Battersea Bridge: Drainage Strategy

Client

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1. Introduction

1.1. Instruction

Yellow Sub Geo Ltd (Yellow Sub) was instructed by Promontoria Battersea Ltd (the Client) to provide a Sustainable Drainage (SuDS) Strategy for 1 Battersea Bridge Road, London, SW11 3BZ (the Site). Instruction to proceed was provided by signed appointments document dated 23rd December 2021.

1.2. Background

The Client is seeking to obtain planning permission for a comprehensive redevelopment of the Site to include the demolition of existing building and erection of a part 9 storey, part 33 storey building (plus ground floor and basement levels) comprising residential use (Class C3), office use (Class E), community use (Class F2), and a restaurant (Class E), with associated car parking, cycle parking, public realm, landscaping and other associated works. Development plans are included in Appendix C and a more complete description of the proposed development is included in Section 3.

The Application is also supported by a Flood Risk Assessment (FRA; P21383_R3).

1.3. Scope

This report comprises a SuDS Strategy to demonstrate how surface water will be sustainably managed post-development. This includes:

- a summary of the baseline Site conditions relevant to surface water management;
- a review of the existing drainage arrangements;
- detailed review of the site topography and definition of the runoff catchment areas;
- defining the potential water quality risks posed by the development and the mitigation measures proposed to address this;
- presentation of a sustainable drainage scheme, with proposed layout, dimensions, levels and gradients of the features included;
- a SuDS exceedance plan;
- a SuDS scheme maintenance plan; and,
- performance calculations (i.e. drainage modelling) for the proposed SuDS network using Causeway Flow+ industry standard software.

1.4. Data Sources

The main sources of data utilised in this assessment are summarised below:

- Topographical survey data of the Site (see Appendix B);
- Proposed development layout plans provided by the Client (see Appendix C);
- Thames Water sewer asset location plans (see Appendix D);
- London Borough of Wandsworth Level 1 & 2 Strategic Flood Risk Assessment (SFRA) (AECOM, 2020) and (AECOM, 2020);

- London Borough of Wandsworth Surface Water Management Plan (SWMP) (Metis Consultants Ltd., 2021);
- The London Borough of Wandsworth Local Plan (Wandsworth, 2023);
- Wandsworth Sustainability Appraisal (London Borough of Wandsworth, 2022);
- Hydrological descriptor data from the Flood Estimation Handbook (FEH) website (UK Centre for Ecology & Hydrology, 2024);
- The CIRIA SuDS Manual (CIRIA, 2015);
- Environment Agency (EA) flood risk data;
- Port of London Authority hydrographic surveys of the River Thames (see Appendix E);
- British Geological Survey (BGS) 1:50,000 scale mapping and borehole logs;
- Ordnance Survey 1:25,000 scale mapping;
- Soilscapes soil mapping; and,
- EA LiDAR Digital Terrain Model (DTM) data.

1.5. Limitations

This report is written strictly for the benefit of the Client and bound by the conditions presented in Appendix A.

2. Site description

2.1. Site setting and surrounding area

The Site is located adjacent to Battersea Bridge on the southern bank of the River Thames in the London Borough of Wandsworth (SW11 3BZ). The National Grid Reference for the approximate centre of the Site is TQ 270 772. The Site covers a total area of 0.13 ha.

Figure 2.1 provides an aerial image of the Site to illustrate the pre-development layout and condition. The Site comprises an existing high rise office building.

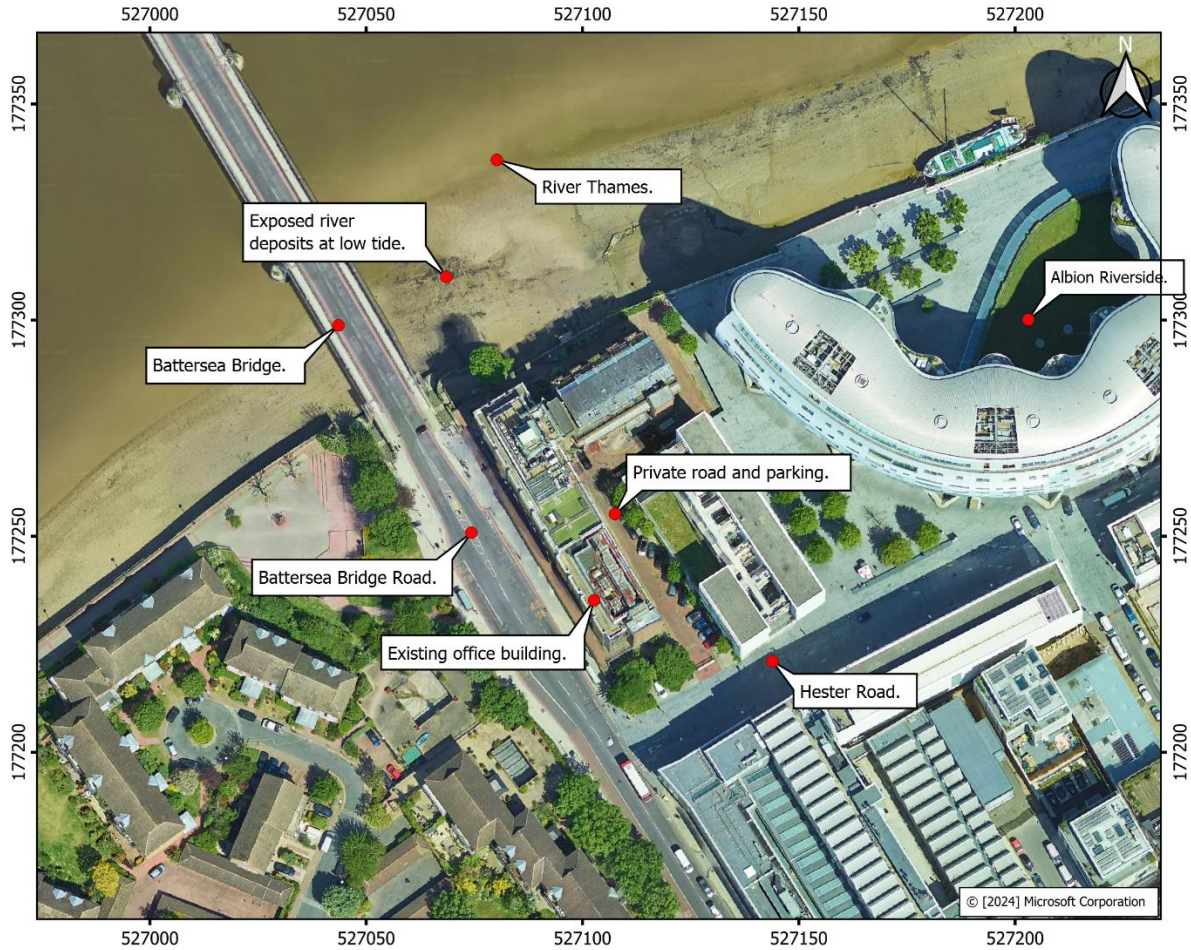

Figure 2.1 Current site layout

The Thames Path passes between the existing building and the River Thames (see Figure 2.2). The Site is bounded to the west by Battersea Bridge Road and by a minor private street to the east.

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Figure 2.2 Thames Path running between the Site (left) and the River Thames (right)

A topographical survey of the Site area is included in Appendix B. Ground levels at the Site range between c. 4.28m above Ordnance Datum (m aOD) and c. 7.12m aOD according to the survey data, with the greatest elevations noted in the west (around the main access doors), and lower elevations in the southeast and northeast. The ground elevation drops from the northern frontage of the building down to the river wall along the River Thames, as shown in Appendix B (the crest of the flood defence wall elevation is at around 5.1m aOD).

The ground elevation along Battersea Bridge Road falls in a southerly direction along the western edge of the Site, although the site elevations adjacent to the road are fairly level (but fall steeply in the far south of the Site).

2.2. Soils, Geology and Hydrogeology

According to British Geological Survey (BGS) 1:50,000 scale mapping the geological sequence underlying the Site is as follows:

- Superficial deposits: Alluvium and River Terrace Deposits.
- Solid geology: London Clay Formation (clay, sand and silt).

Based on the location of the Site, it is considered that Made Ground will also be present, particularly to the rear of the river wall.

Soilscapes provides high level information on natural soil characteristics across the UK. Soilscapes classifies the soil type at the Site as: 'Freely draining slightly acid loamy soils' (Cranfield Soil and AgriFood Institute, 2024). However, the characteristics of the natural soils are likely to have been modified over time due to the past development history at the Site and therefore the soil type and permeability may vary.

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A single nearby historical borehole log within the BGS database is summarised in Table 2.1.

Table 2.1 Strata encountered in nearby historical borehole log

Borehole ref	Strata	Maximum thickness (m)
	Concrete	0.1
	Made Ground	4.4
TQ27NE471	Fine to medium gravel with some coarse sand	2.5
	Fine to coarse gravel and fine to medium sand	3.7
	Stiff silty clay	>19.3

The superficial Alluvium and River Terrace Deposits beneath the Site are classified by the EA as a Secondary A Aquifer. These are layers of rock or drift deposits that have high intergranular and/ or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. The London Clay Formation is classified as unproductive strata. As the borehole log above, suggests, the natural superficial deposits in the area are likely to have been replaced with Made Ground to some extent, and the hydrogeological properties of this material can vary greatly, depending on the source material.

Groundwater vulnerability on Site is classed as medium to low. The Site is not located within a Source ProtectionZone (SPZ).

2.3. Climate

Standard Annual Average Rainfall at the Site is 604 mm according to the Flood Estimation Handbook hydrological descriptors (CEH, 2024).

2.4. Hydrology

The Site is located on the Bank of the River Thames. The Thames is tidal at this location, and tidal flood defences are located along the banks of the Thames to provide protection up to a 0.1% Annual Exceedance Probability (AEP) (1 in 1,000 year) flood event. Ransome's Dock is located 200m east of the Site.

The hydrological descriptors for the Site were obtained from the Flood Estimation Handbook (FEH). These are shown in Table 2.2.

Table 2.2 Hydrological point descriptors (CEH, 2024)

Descriptor	Value
NGR	TQ 27088 77248
BFIHOST19	0.895
PROPWET	0.29
SAAR 61-90	604 mm

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2.5. Flood risk

The Site lies predominantly within Flood Zone 3, although the Site is protected by flood defences along the bank of the River Thames and so the flood risk present in this area is residual (see Figure 2.3). Surface water (pluvial) flood risk in the area is negligible.

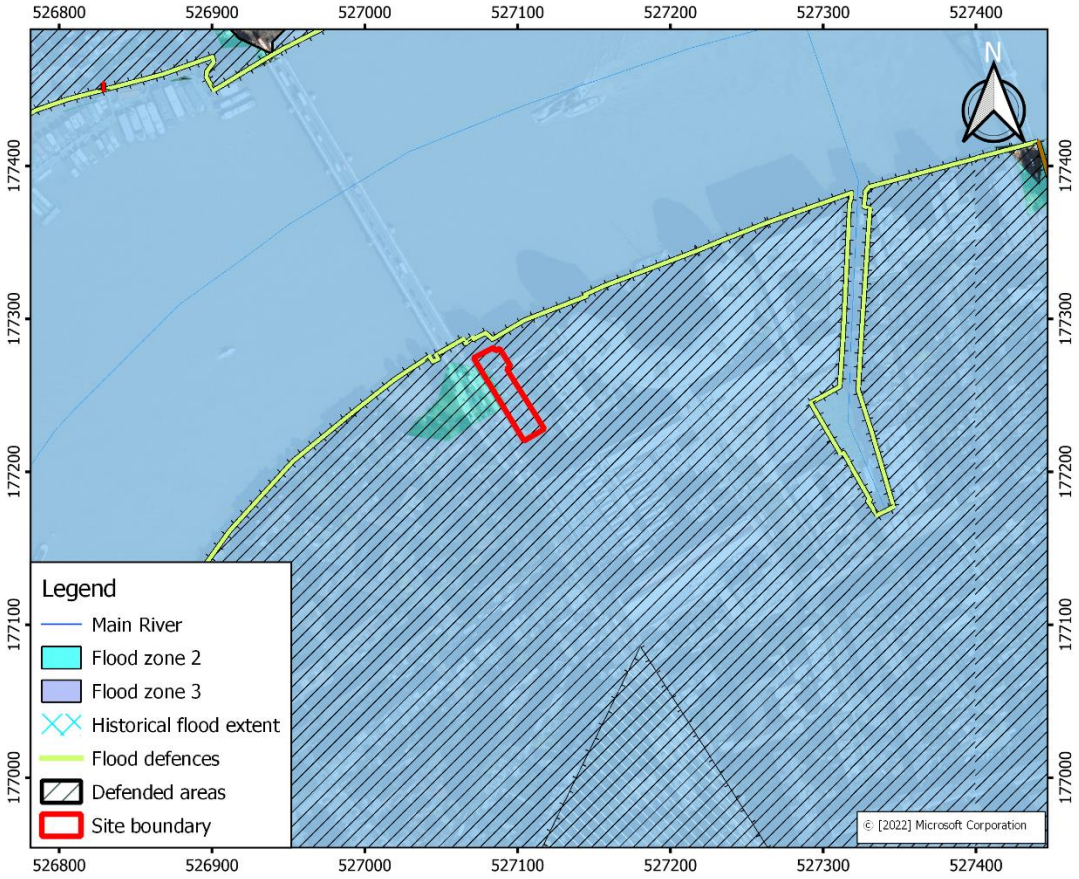

Figure 2.3 EA fluvial flood risk data

The London Borough of Wandsworth Level 1 SFRA (AECOM, 2015) includes information on groundwater flood risk in the borough. There is potential for groundwater ingress/ flooding for parts of the property situated below ground level in the vicinity of the Site according to this data.

The maximum extent of flooding from reservoirs encroaches across the Site area. However, reservoir flooding is extremely unlikely to occur and does not present an issue for the proposed development.

The Site is not situated within a Critical Drainage Area according to the London Borough of Wandsworth's Surface Water Management Plan (Metis Consultants Ltd., 2021).

The London Borough of Wandsworth Surface Water Management Plan (Metis Consultants Ltd., 2021) contains no records of historical flooding occurring at the Site or in the local vicinity.

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2.6. Current drainage arrangements

Public sewer asset plans for the Site and surrounding local area have been sourced from Thames Water and are presented in Appendix D (with an excerpt included as Figure 2.4 below).

The asset plans indicate that a Thames Water combined trunk sewer is present beneath Battersea Bridge Road. The sewer flows in a southwards direction past the Site.

Based on the information collected to date, the pre-existing surface water drainage conditions are expected to be as follows:

- A discharge to the River Thames via a private drainage run beneath the Thames Path; or
- A discharge to the Thames Water combined trunk sewer.

The very southern part of the Site is at a lower elevation that the rest of the plot. This area is thought to drain in a southerly direction, discharging to the Thames Water assets.

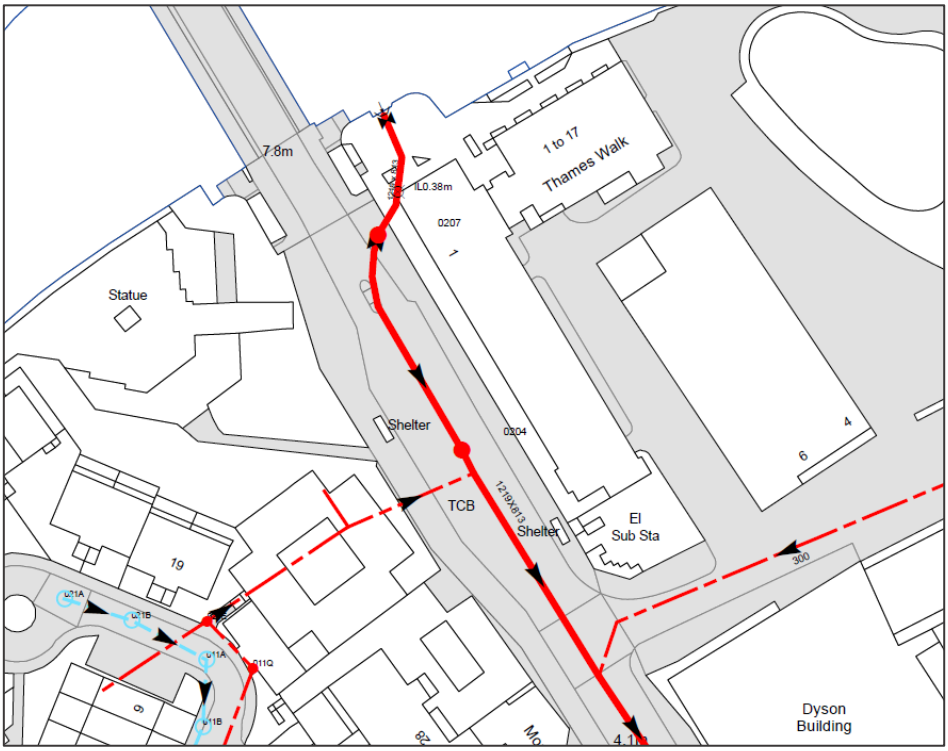

Figure 2.4 Thames Water sewer asset location plan

The precise layout of any existing drainage infrastructure in and around the Site will be confirmed with a comprehensive survey in due course. The drainage strategy presented here may be revised according to the results of the survey.

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3. Proposed development

The Proposed Development comprises of a comprehensive redevelopment of the site to include demolition of existing building and erection of a part 9 storey, part 33 storey building (plus ground floor and basement levels) comprising residential use (Class C3), office use (Class E), community use (Class F2), and a restaurant (Class E), with associated car parking, cycle parking, public realm, landscaping and other associated works.

Roof top areas will be located on levels 10, 33 and 34, as shown in be development plans in Appendix C. The rooftops will include a mix of blue/green infrastructure, as discussed in Section 4, and the ground floor level will include a variety of planted areas, including raised planters, rain gardens and tree pits. The upper levels have a larger footprint than the ground floor, which creates a canopy over such of the outdoor area at ground level.

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4. Sustainable Drainage (SuDS) Strategy

4.1. Introduction

The following sections describe the SuDS Strategy for the proposed development with due regard to DEFRA's Non-Statutory Technical Standards for SuDS (DEFRA, 2015), the PPG for Flood Risk and Coastal Change, the CIRIA SuDS manual (CIRIA, 2015) and the Building Regulations - drainage and waste disposal, document H. (HM Government, 2015)

SuDS aim to mimic the natural drainage characteristics of a site prior to its development by controlling surface water runoff as close to where the rain falls as possible e.g. through interception and re-use, evaporation and infiltration into the ground. Furthermore, SuDS provide opportunities to remove pollutants from runoff and also provide amenity and biodiversity benefits.

As the Site is currently occupied by a high-rise structure, and this will also be the case post-development, space for water features is somewhat limited. Blue-green infrastructure has been included on the rooftops and ground level where possible.

4.2. Climate change

The potential increase in rainfall intensity associated with climate change needs to be considered when designing drainage strategies. The recommended allowances for rainfall intensity in the London Management Catchment are included in Table 4.1.

Table 4.1 Climate change allowances for rainfall in the London Management Catchment

Epoch	Central allowance	Upper end allowance
	1 in 30 year (3.3%)	
2050s	20%	35%
2070s	20%	35%
	1 in 100 (1%)	
2050s	20%	40%
2070s	25%	40%

The EA guidance for climate change allowances in flood risk assessments (Environment Agency, 2022) recommends designing development so that with the upper end allowances for the 1 in 100 year event:

- "there is no increase in flood risk elsewhere; and,
- your development will be safe from surface water flooding".

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A design lifespan of 100 years has been assumed and the upper end allowances are applicable in runoff/drainage calculations for the proposed development.

4.3. Runoff destination

Surface water runoff must be disposed of using one or more of the following options in the order of priority shown, in accordance with the 2010 Building Regulations Approved Document Part H (HM Government, 2010) and the 2021 London Plan:

1) Rainwater use as a resource (most preferred);
2) Infiltration to ground;
3) Rainwater attenuation in green infrastructure features (e.g. rain gardens);
4) Discharge to a surface water body;
5) Discharge to a surface water sewer or drain; and
6) Discharge to a combined sewer (least preferred).

The London Plan acknowledges tidal watercourses (such as the River Thames at this location) as suitable receptors for direct runoff disposal.

The geological and hydrogeological conditions (shallow ground water levels, artificial material and potential legacy industrial contamination) indicate that the disposal of Site runoff to ground via point infiltration features is unlikely to be viable as the principal option in this instance.

A Thames Water combined trunk sewer is present beneath Battersea Road (see Appendix D). This is a viable receptor for runoff from the Site and is thought to receive some of the Site runoff currently.

A discharge to the adjacent tidal watercourse (River Thames) immediately adjacent to the north of the Site (see Figure 2.2) is considered the best practicable option in this instance for the majority of the Site. A discharge to tidal water along with some rainwater capture via blue-green infrastructure would be allowable in accordance with the guidance provided in the London Plan (as stated above).

Rainfall runoff will pass through a number of SuDS features before discharging to the adjacent tidal waters (River Thames). These include green roofs, blue roofs, podium gardens, raised planters, filter strips and tree pits. These features will slow the progress of water to the discharge point (and reduce the final peak velocities/ scour risk), provide attenuation capacity as well as amenity, water quality and biodiversity benefits (with regards to the green infrastructure).

4.4. Greenfield runoff, permissible discharge rates and scour risk

As discussed in the sections above, the most viable receptor for surface water runoff would be the tidal River Thames. Restricted discharge rates to tidal waters are not generally a requirement for new developments, but some attenuation should be expected to create SuDS features for the manifold benefits that they provide.

Given that the greenfield runoff rate is not a key design criteria in this instance (i.e. in setting a permissible discharge rate), the greenfield runoff rate for the Site has not been calculated.

However, the risk of scour at a tidal outfall must be mitigated, to safeguard the sediments/ bank and tidal defences. The outfall from the Site would be set into the river wall (with a non-return

flap valve). This wall is thought to be constructed from concrete and will be resistant to scour/ erosion, but fluvial/ marine sediments may be exposed at low tide. The design of the outfall and scour mitigation measures are discussed in Section 4.7.

4.5. Post-development catchment areas and drainage layout

The post-development Site will comprise a series of small rooftop surface water catchments. These will drain rain northwards (owing to the influence of the proposed drainage infrastructure) under gravity to the tidal River Thames.

A drainage network has been drafted based upon the proposed development plans (see Appendix F). Relevant elevations, dimensions, gradients, storage capacities and explanatory notes are included in this figure. A preliminary manhole schedule for the network is included in Appendix F; the cover levels are based on the estimated Site topography included in the current development plans (see Appendix C).

The ground elevation area will largely be under the canopy provided by the overlying floors (which have a greater surface area). This is particularly the case with regards to the area between the building and Battersea Bridge Road. This area will generate minimal rainfall runoff - with this being generated on the rooftop areas above.

The impermeable catchment areas draining to each node within the drainage network were delineated within CAD software, based on the proposed Site layout plans (see Appendix C). Note that urban creep is not expected to be a factor at the Site, given the significant constraints around the layout and space available. Urban creep is more relevant to standard residential developments, where private garden areas are often covered with impermeable surfaces under permitted development rights. Therefore, urban creep has not been factored into the impermeable surface area used in the calculations.

Runoff will be discharged to the tidal River Thames via a multi-level outfall, see Section 4.7.

4.6. SuDS features design

Dimensions, elevations, gradients and other details of each SuDS feature are included in the layout plans in Appendix F, along with a manhole schedule. Some additional explanatory notes on the proposed SuDS features are also included below.

4.6.1. Green roofs

Rooftops areas on levels 33 and 34 will have green (or brown) roofs. These will include a growing substrate for vegetation, a filter fleece, a root barrier, a drainage membrane, and a waterproofing layer. These will provide additional losses via interception, evaporation and transpiration in the long term.

A porous and permeable growing medium with a minimum recommended depth of c. 100mm will be installed over the underlying layers. The growing medium will be planted with sedum.

Outflow and overflow from the green roofs will drain down the downpipes to the ground level and sub-surface drainage infrastructure (and then onwards to the River Thames).

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4.6.2. Podium gardens

Raised podium gardens are included on the level 10 rooftop area. Cross sections through these features are included in Appendix C. These will be irregular, rounded features, around 1.00 m in height, and include a soil mix for the cultivation of plants.

4.6.3. Blue roofs

Permeable paving and a shallow drainage layer are included over much of the level 10 rooftop. The drainage layer will be a cellular storage structure, with a depth of c. 80 mm and have a geocellular structure. This drainage layer will receive percolating water from the overlying permeable paving as well as the podium gardens.

4.6.4. Tree pits and planters

Large planters will be installed along the edge of Battersea Bridge Road. These would be raised features, with a height of around 0.60 m and filled with a soil mix. These will be located under the overhang presented by the upper floors of the building and so receive relatively little rainfall (and thus not comprise a key component in the SuDS network).

Tree pits are included in the design in the west of the Site, close to Battersea Bridge. These will be slightly depressed relative to the surrounding paving and contain a loamy soil mix over gravel drainage, with a sandy transition layer in between.

These features will be under-drained with permeable pipes, allowing excess water to be transferred to the main drainage network.

4.6.5. Rain gardens

Planted rain garden areas are proposed in the northwest of the Site (adjacent to the bank of the Thames). These will be a shallow vegetated depressions, c. 0.30 m total depth, containing a filter medium over a geotextile and a drainage layer with perforated pipe underdrains (draining to the main network).

A sandy soil will be employed as the filter medium. This will have a hydraulic conductivity within the range of 0.1m/hr to 0.3m/hr, which will be tested in-situ under compacted conditions prior to the installation. Note that the conductivity of the medium will reduce over time and thus periodic replacement of the medium will be required, as detailed in Section 4.13.

Inspection pipes will be provided to the underdrains to allow for inspection and cleaning of the pipes.

Resistant materials (a suggested small landscaped rock riffle) will be installed at the inlets to the feature to reduce inflow velocities and reduce the risk of scour to the filter medium.

4.6.6. Potential rainfall water tank

As stated above, the planters at ground level will be located beneath the upper levels of the building. If a rainwater harvesting tank is required to provide a sustainable water resource for these features, one could be added to the drainage plans, either above or below ground level.

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4.6.7. Basement pumping station

A pump is proposed within the basement. This will allow for the transmission of surface or groundwater ingress to the River Thames. A rising main will convey water to manhole S1 from the basement.

The pump capacity and its inclusion in the drainage calculations is discussed in Section 4.9.

4.7. Outfall and scour mitigation

In order to minimise the risk of erosion/ scour from the outfall, a maximum outflow velocity of 1.5m/s has been set as a principal design criterion. It is understood that the EA considers this to be a reasonable measure to mitigate scour risk in these circumstances.

The inclusion of a dual elevation outfall has also been included to reduce the risk of erosion/ scour (through the plunging action of falling water during low tides) as well as to allow for free discharge during high tides. The lower elevation outlet will have an invert level of 2.95m aOD and the higher-level outlet will have an invert level of 4.25m aOD; these relate to elevations above the MHWN (2.85m aOD) and MHWS (4.04m aOD) elevations respectively, as stated on the London Port Authority hydrographic survey for the River Thames (see Appendix E).

The outfall orifice will include non-return flap valves to mitigate the risk of flood water ingress into the Site under potential instances of extreme high water elevations in the River Thames.

The simulated peak outflow velocity for the 1 in 30 year and for the 1 in 100 year event are below 1.5m/s (this includes relevant allowances for climate change). The discharge to the River Thames may require a permit from the EA or PLA.

4.8. Performance calculations

A drainage model has been built for the Site in Causeway "Flow+" v 10.4 industry standard software to give confidence that the proposed drainage network is viable/ appropriate.

Simulations were run for the 1 in 30-year and the 1 in 100-year events (including allowances for climate change as defined above). The catchment areas draining to each feature were delineated within CAD software using the proposed development plans (Appendix C). There has been no allowance for urban creep in this instance as there is no scope for this to occur at the Site.

The infiltration rate for all SuDS features was set to zero, assuming there will be negligible discharge to ground.

A nominal additional inflow rate of 1.5l/s was added for manhole S1 to represent the incoming groundwater from the basement sump. It is assumed that the basement design will include waterproofing measures to prevent groundwater ingress; this additional inflow rate is therefore a conservative assumption.

The contributing runoff areas for the rooftops were attributed to the green and blue roof features directly. These green and glue roof areas, and the podium gardens, were modelled as depth area features, with the dimensions and porosities set as appropriate.

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A dual elevation orifice flow control device has been included to control off-Site discharge to the River Thames. Simulated off-site flow velocities are below 1.5m/s (a requirement for the mitigation of scour risk).

Appendix G contains the settings/ configuration of the model build and the output from the drainage simulations. This demonstrates no flooding of the proposed system under the 1 in 30(+CC) event or the 1 in 100(+CC) event.

4.9. Tide locking and residual flood risk

Drainage modelling has been undertaken for a high-tide scenario. A tidal water stage hydrograph was added to the outfall location to simulate water levels during a spring tidal range. This causes the lower outfall to be submerged (for the longer duration storms), but the upper outfall to continue to function (being set above the mean high water spring elevation). The model results for this scenario are included in Appendix G.

4.10. Exceedance routes

Due consideration needs to be given to the exceedance routes that could occur during events above the design standard of the various components of the proposed SuDS Strategy.

No flooding is predicted for the 1 in 30 or 1 in 100 year scenarios (with climate change allowances). The direction of exceedance flows under a very extreme scenarios (in exceedance of the 1 in 100 year + climate change scenario) is included in Appendix F.

4.11. Water quality

SuDS techniques can be used to effectively manage the quality of surface water flowing across a site. Different methods can be used to intercept pollutants and allow them to degrade or be stored in-situ without impacting the quality of water further downstream. 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 5mm to 10mm of rainfall (i.e. the 'first flush') should be adequately treated using SuDS.

The proposed development will include green and blue rooftops and paving areas (no roadways or parking areas). The CIRIA SuDS manual categorises runoff from residential dwellings as presenting a very low water quality hazard and runoff from other buildings and amenity uses as presenting a low hazard rating (see Table 4.2). A Very Low - Low hazard rating would seem appropriate for the Site as a whole.

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Table 4.2 Water quality hazard ratings (CIRIA, 2015)

Land use	Hazard level
Residential roof drainage	Very Low
Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.	Low
Commercial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).	Medium
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemical and fuels (other than domestic fuel oil) are delivered, handled, stored used or manufactured, industrial sites.	High
Trunk roads and motorways	High

The CIRIA SuDS manual (CIRIA, 2015) indices approach has been used to assess the proposed water quality control measures against the likely pollutants contained in runoff water.

As the proposed development is considered to have a Very Low-Low hazard rating, hazard indices of 0.3 for total suspended solids (TSS), 0.2 for metals and 0.05 for hydrocarbons have been applied (i.e. the values for a Low hazard land use).

The measures detailed in Table 4.3 are examples of SuDS features which can be included in a drainage strategy for a proposed development, to mitigate a potential increase in pollutants within on-site and off-site runoff. The text in bold are measures included in this instance. Removal indices are included for each feature type relative to the specific pollutant.

Table 4.3 Mitigation indices for SuDS components (discharges to surface water)

Component Type	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Permeable paving	**0.7**	**0.6**	**0.7**
Bioretention system	**0.8**	**0.8**	**0.8**
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5

The inclusion of bioretention features (rain gardens), and permeable paving within the Detailed SuDS Strategy will provide treatment to mitigate the Very low to Low hazard associated with runoff from the development.

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A sediment trap (i.e. sump within the final manhole upstream of the River Thames) will be included as an additional measure to prevent the release of silt/sediment to the river.

4.12. Water management during construction phase

The arrangements for surface water management during the construction phase will be set out in the Construction Environment Management Plan (CEMP) which will include a surface water management plan.

4.13. SuDS maintenance

Inspection and long-term maintenance of SuDS components ensures efficient operation and prevents failure. Surface SuDS components can be managed using landscape maintenance techniques.

Table 4.4 describes the management and maintenance requirements for the SuDS features included. These requirements will be implemented following the completion of the proposed development, and will be undertaken by a private management company.

Table 4.4 Management and maintenance requirements for SuDS features

SuDS device	Maintenance requirements	Maintenance frequency
Permeable paving	• Initial inspection. • Inspect silt accumulation rates and establish appropriate brushing frequencies • Inspect for evidence of poor operation and/or weed growth. • Rehabilitation of surface and upper substructure.	• Monthly for first three months. • Annual. • Three-monthly, 48 hours after large storms in first six months • Every 10 to 15 years or as required
Green roofs	• Routine inspection for damage/wear. • Inlet/outlet cleaning. • Apply a slow-release fertilizer. • Weeding. • Replace dying/dead plants. • Inspect roof structural components, including the waterproof membrane and edging. • Watering during droughts	• Quarterly and after severe weather events. • Quarterly or as needed. • Annually, typically in spring. • Semi-annually or as needed. • Annually. • Annually. • As needed.

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SuDS device	Maintenance requirements	Maintenance frequency
Blue roofs	• Debris and sediment removal. • Waterproof membrane inspection. • Outlet and filter maintenance. • Structural Integrity Check	• Bi-annually or as needed. • Annually. • Bi-annually. • Annually
Pump	• Routine tests as per manufacturers guidance.	• Monthly or as per manufacturers guidance.
Bio-retention areas/rain gardens and planters.	• Litter/ trash removal • Replace plans to maintain density • Infill any holes or scour in porous medium • Sediment monitoring and silt removal. • Remove and replace filter medium and vegetation	• Monthly • As required • As required (check after storms) • Annually or every three years • As required, but likely c. 20 years

Suitable access to the drainage features included in the proposed scheme would be provided and maintained to ensure future maintenance can be undertaken.

4.14. Construction details

Construction details of the included SuDS features and a construction method statement covering the methods proposed for installing the drainage network described in this document will be presented in due course. This will cover the materials to be used, the plant required and health and safety issues to be addressed.

4.15. Biodiversity and amenity

SuDS schemes present opportunities to enhance habitat for wildlife on-Site and this often improves the biodiversity of the surrounding areas. Ponds, constructed wetlands and other surface water features are landscape assets that have amenity value and improve the aesthetics of a site more than conventional drainage systems.

The green roofs, podium gardens, planters, rain gardens and tree pits included will enhance the biodiversity and amenity value of the Site post-development. The majority of these features will be located on the ground level, where residents and visitors will regularly pass them as they arrive and leave the Site (being a communal public space). Ecological diversity will be enhanced by selective planting within the green features.

Registered in England and Wales with Company No. 10888960 at Rabble Studio, 103 Bute Street, Cardiff, CF10 5AD.

5. Conclusions

This report provides a SuDS Strategy for the proposed redevelopment of One Battersea Bridge. A sequence of SuDS features including green and blue roofs, podium gardens, raised planters, rain gardens, and tree pits will be used to manage surface water runoff from the Site over the lifetime of the Proposed Development.

SuDS features will be used to intercept, store and transfer runoff prior to being discharged to the tidal River Thames (adjacent to the northern site boundary) at a controlled velocity of below 1.5m/s, mitigating the potential scour risk. A basement pump has been included in the scheme to remove incidental surface water / groundwater ingress.

A preliminary assessment of the performance of the proposed system under the 1 in 30 year + 35% and the 1 in 100 year +40% storms was undertaken and shows that the proposed SuDS scheme is capable of managing stormwater runoff without any flooding.

Appropriate management and maintenance arrangements for the proposed SuDS scheme will be in place throughout the lifetime of the Proposed Development.

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6. References

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Appendix A Report conditions

Report Conditions

This report has been prepared by Yellow Sub Geo Ltd. (Yellow Sub Geo) in its professional capacity as soil and groundwater 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 Yellow Sub Geo 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, taking account of the terms of reference agreed with the client. The findings are based on the information made available to Yellow Sub Geo 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.

Where necessary and appropriate, the report represents and relies on published information from third party, publicly and commercially available sources which is used in good faith of its accuracy and efficacy. Yellow Sub Geo cannot accept responsibility for the work of others.

Site investigation results necessarily rely on tests and observations within exploratory holes only. The inherent variation in ground conditions mean that the results may not be representative of ground conditions between exploratory holes. Yellow Sub Geo take no responsibility for variation in ground conditions between exploratory positions.

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, Yellow Sub Geo may, by prior written agreement, agree to such release, if it is acknowledged that Yellow Sub Geo accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. Yellow Sub Geo 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 Yellow Sub Geo except as expressly agreed with Yellow Sub Geo in writing. Yellow Sub Geo reserves the right to withhold and/ or negotiate the transference of reliance on this report, subject to legal and commercial review.

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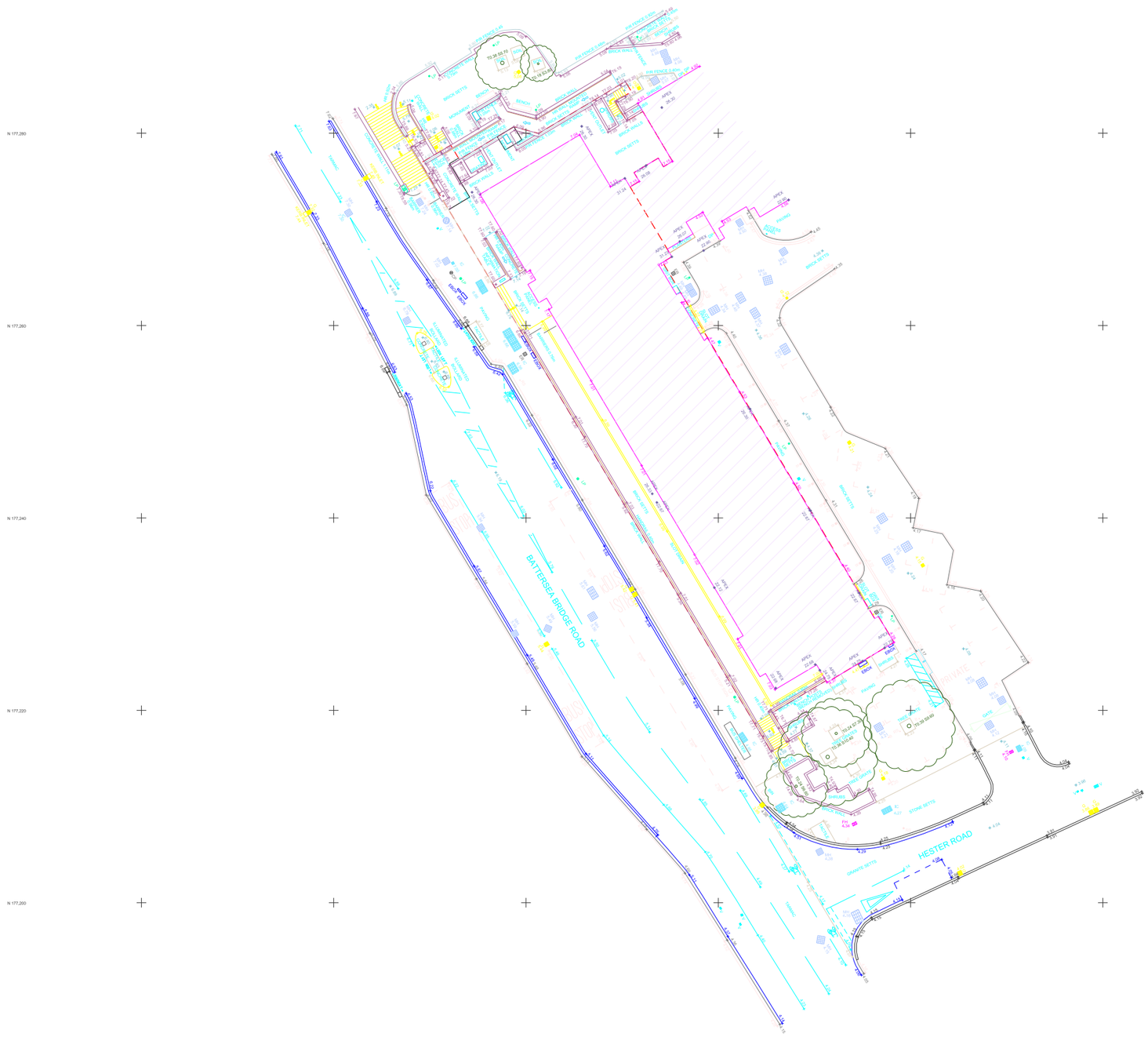
Appendix B Topographic Site survey



TOPOGRAPHIC SURVEY

SIMPSONHAUGH

1:500@A3

Appendix C Site development plans

Private
Refuse Storage
1,006 ft²
93 m²

Bulk
Waste

Private
cycle lift

restaurant
lift

MAOV

AOV

W

E

Car lift
228 ft²
21 m²

4.25 m

Car Parking
2,100 ft²
195 m²
4.25 m

AOV

MAOV

Plant Room
170 ft²
16 m²

Plant Room
1,801 ft²
167 m²
4.25 m

Afford.
Refuse
513 ft²
48 m²

4.25 m

Commercial
Refuse Storage
133 ft²
12 m²

office
cycle
storage

Afford.
cycle lift

Substation
186 ft²
17 m²
4.25 m

AOV

toilet

disabled
toilet

Community
606 ft²
56 m²
4.8 m

POST

Class E
223 ft²
21 m²
4.8 m

Space not in use
due to
leveldifference

4.8 m

NOTES:

- For details of soft and hard landscape please refer to Landscape Architects' drawings.
- Structure under coordination

PRINT SCALE CHECK: 50MM SEGMENTS

© FARRELLS 2019

Rockwell

0 3m 5m
1:150

1 : 100 @ A1

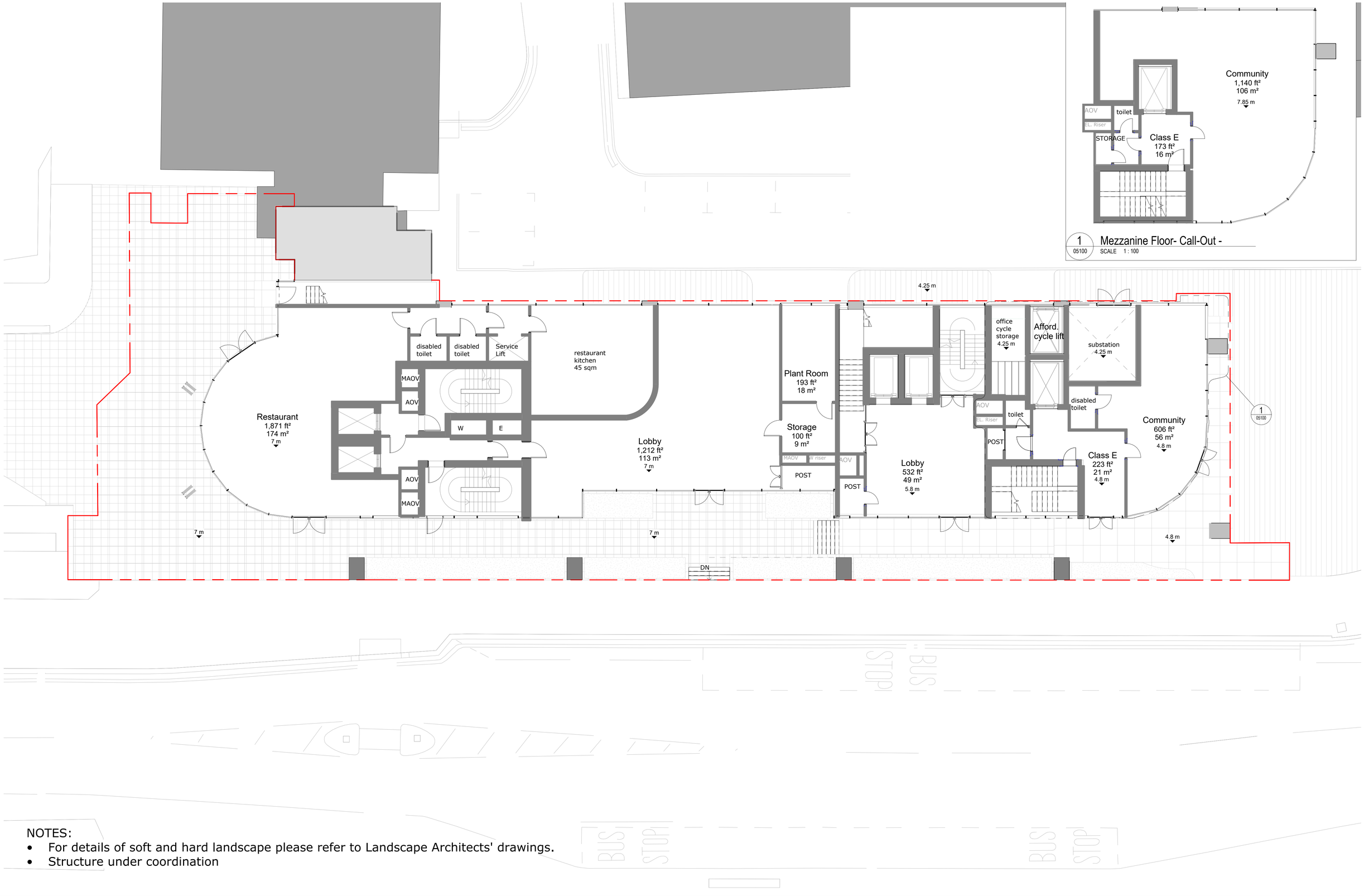
ONE BATTERSEA BRIDGE

LOWER GROUND FLOOR

14 February 2024

OBB-FAR-ZZ-LGF-DR-A-05098

FARRELLS



NOTES:

- For details of soft and hard landscape please refer to Landscape Architects' drawings.
- Structure under coordination

PRINT SCALE CHECK: 50MM SEGMENTS

© FARRELLS 2019

Rockwell

0 3m 5m
1:150

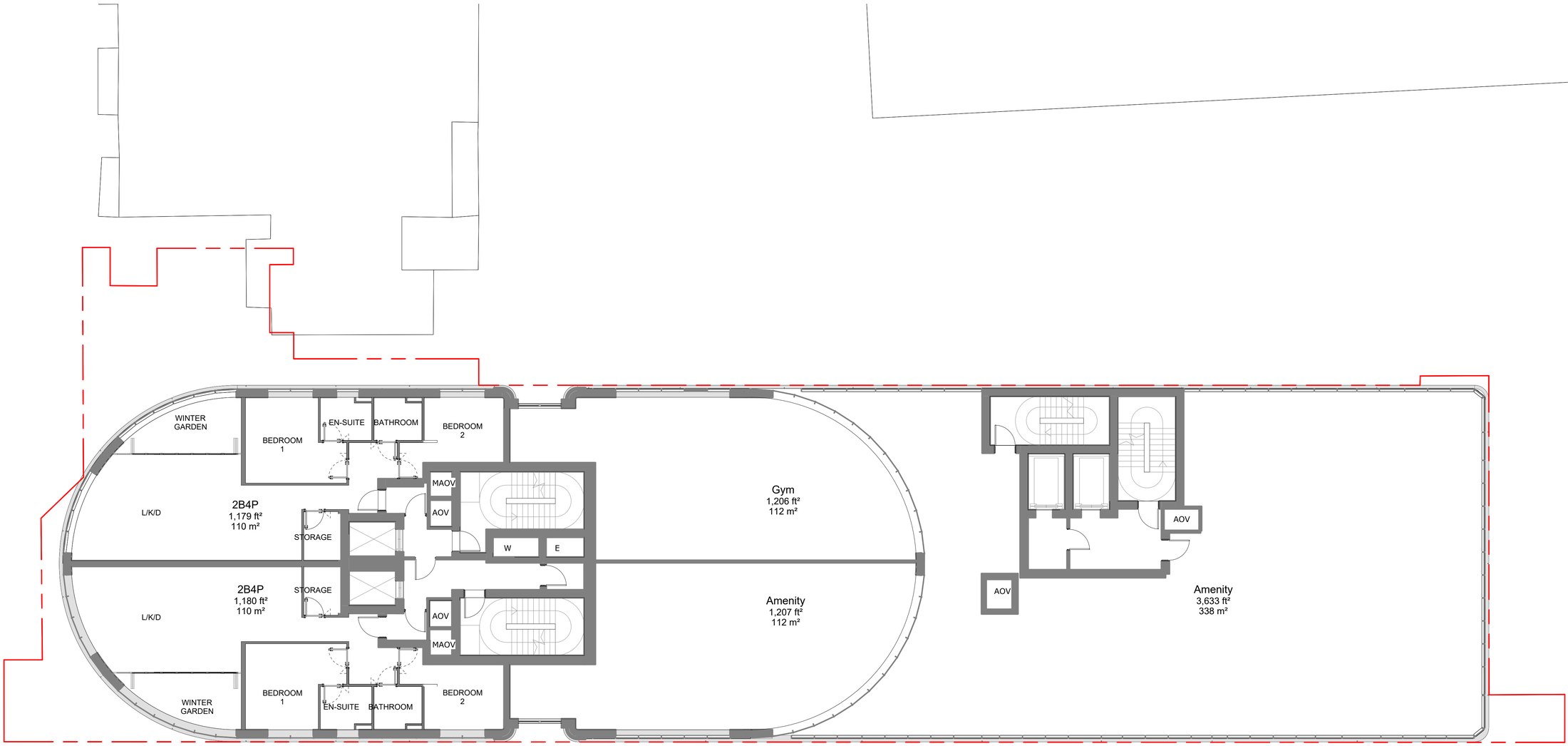
1 : 100 @ A1

ONE BATTERSEA BRIDGE

GROUND FLOOR PLAN

14 February 2024

OBB-FAR-ZZ-00-DR-A-05100 FARRELLS

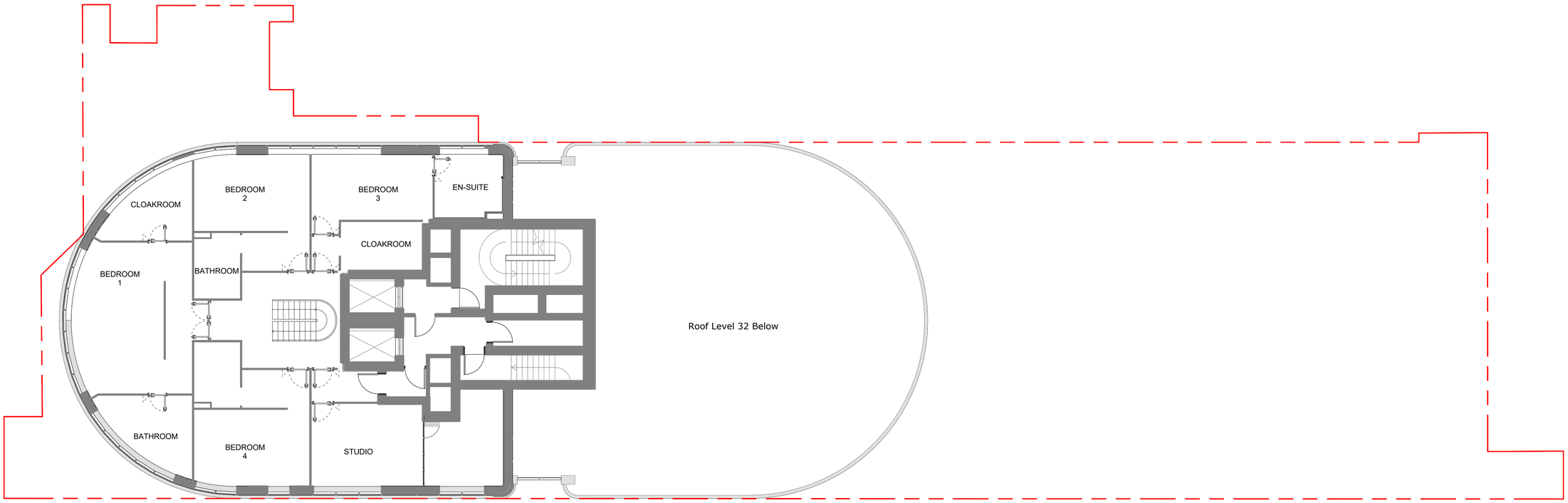


NOTES:

- For details of soft and hard landscape please refer to Landscape Architects' drawings.
- Structure under coordination

PRINT SCALE CHECK: 50MM SEGMENTS

© FARRELLS 2019



NOTES:

- For details of soft and hard landscape please refer to Landscape Architects' drawings.
- Structure under coordination

PRINT SCALE CHECK: 50MM SEGMENTS

© FARRELLS 2019

Rockwell

0 1m 4m
1:100

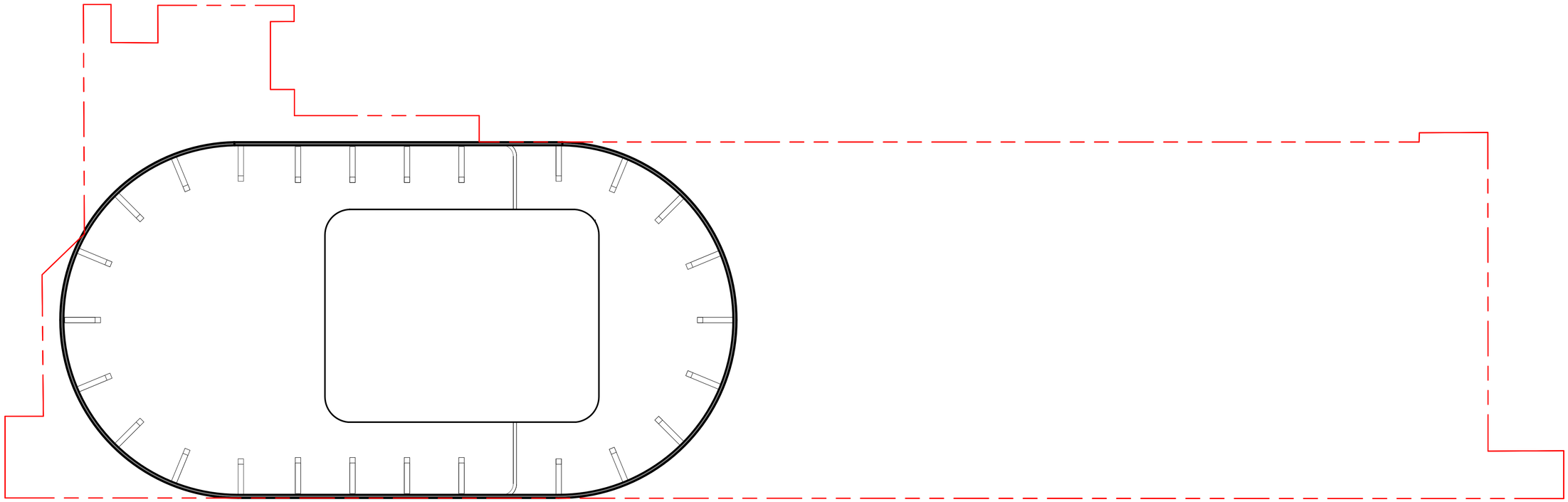
1 : 100 @ A1

ONE BATTERSEA BRIDGE

LEVEL 33 PLAN - LAYOUT

14 February 2024

OBB-FAR-ZZ-18-DR-A-05133 FARRELLS



NOTES:

- For details of soft and hard landscape please refer to Landscape Architects' drawings.
- Structure under coordination

PRINT SCALE CHECK: 50MM SEGMENTS

© FARRELLS 2019

Rockwell

0 1m 4m
1:100

1 : 100 @ A1

ONE BATTERSEA BRIDGE

LEVEL 34 ROOF PLAN - LAYOUT

14 February 2024

OBB-FAR-ZZ-18-DR-A-05134 FARRELLS

Appendix D Thames Water sewer asset location plans

Asset location search

Property Searches

Yellow Sub Geo
Flat 2,Alexandra Mews,150 Alexandra Mews

SOUTHAMPTON
SO15 5TY

Search address supplied The Glassmill
1
Battersea Bridge Road
London
SW11 3BZ

Your reference P21383

Our reference ALS/ALS Standard/2022_4612017

Search date 22 March 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: The Glassmill, 1, Battersea Bridge Road, London, SW11 3BZ

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

Waste Water Services

Please provide a copy extract from the public sewer map.

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

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

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

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

For your guidance:

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

Clean Water Services

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

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

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

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

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

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

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

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

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

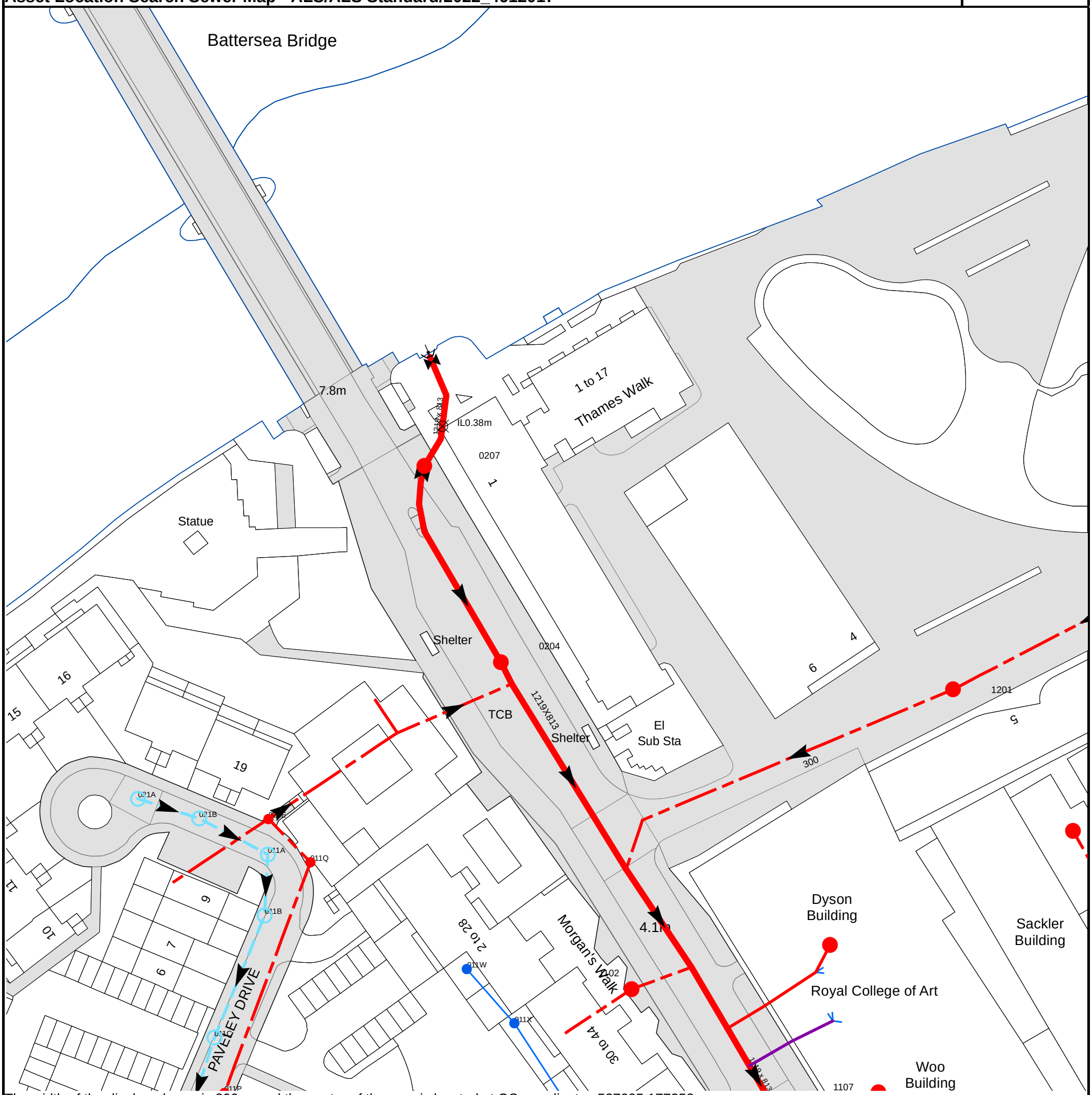
Clean Water queries

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_4612017



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 527095,177252

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.

Based on the Ordnance Survey Map (2020) with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

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
0207	7.02	.39
011W	n/a	n/a
0204	5.55	.36
011X	n/a	n/a
1102	n/a	n/a
11BG	n/a	n/a
11BD	n/a	n/a
1201	4.04	1.02
1202	3.74	1.3
011C	n/a	n/a
011B	n/a	n/a
011Q	n/a	n/a
011A	n/a	n/a
021E	n/a	n/a
021B	n/a	n/a
021A	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 diverts 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

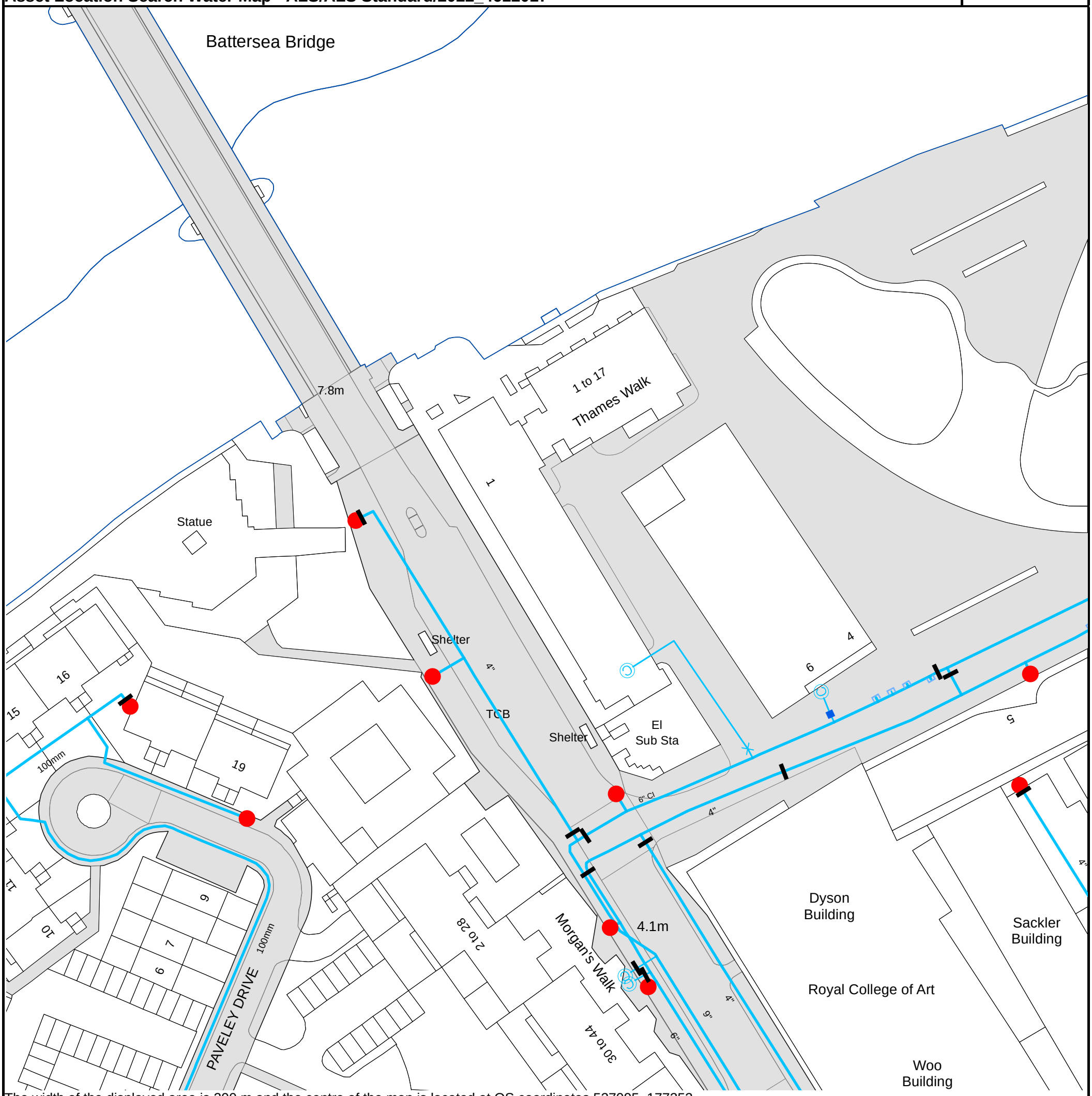
Ducts may contain high voltage cables. Please check with Thames Water.

- 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.

Asset Location Search Water Map - ALS/ALS Standard/2022_4612017



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 527095, 177252.

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.

Based on the Ordnance Survey Map (2020) with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

Asset Location Search - Water Key

Water Pipes (Operated & Maintained by Thames Water)

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

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

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

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

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

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

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

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

Valves

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

Hydrants

- Single Hydrant

Meters

- Meter

End Items

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

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

Operational Sites

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

Other Symbols

- Data Logger

Casement: Ducts may contain high voltage cables. Please check with Thames Water.

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

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

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

Terms and Conditions

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

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

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

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

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

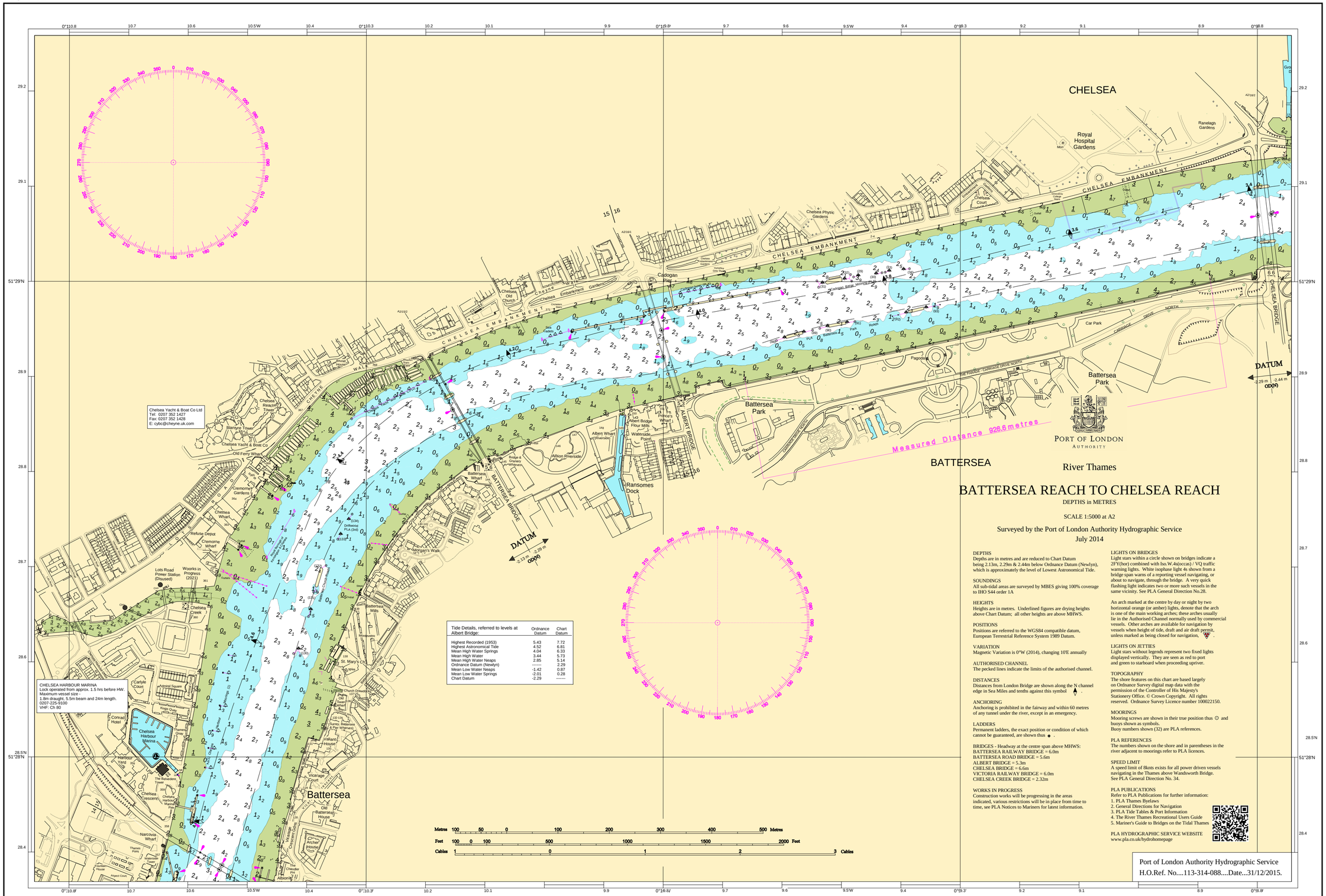
If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria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

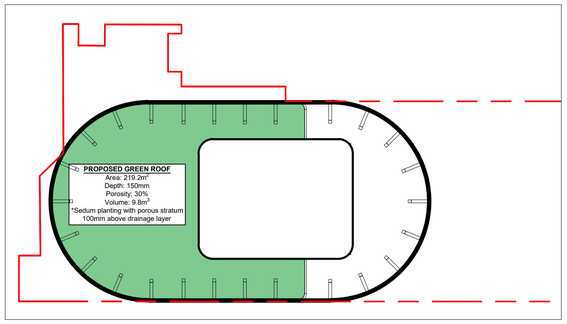
Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

Appendix E Hydrographic survey of River Thames

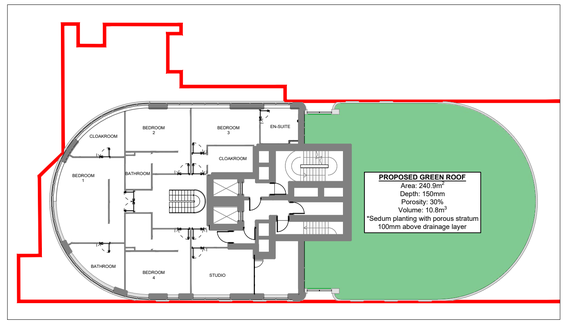


Edition Date: December 2015, Edition Version: (3); Corrections: (2016/12), (2016/33), (2017/15), (2017/29), (2017/34), (2017/45), (2018/04), (2018/7), (2019/11), (2019/20), (2019/26), (2021/21), (2022/6), (2022/9), (2023/21), (2023/32)

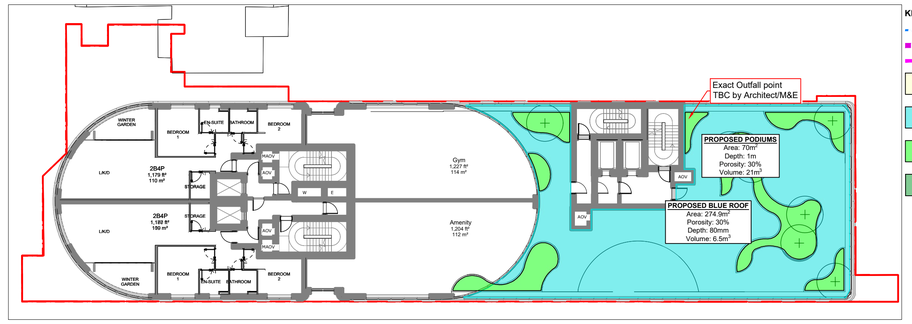
Appendix F Detailed SuDS layout and manhole schedule



ROOF PLAN - LEVEL 34



ROOF PLAN - LEVEL 33



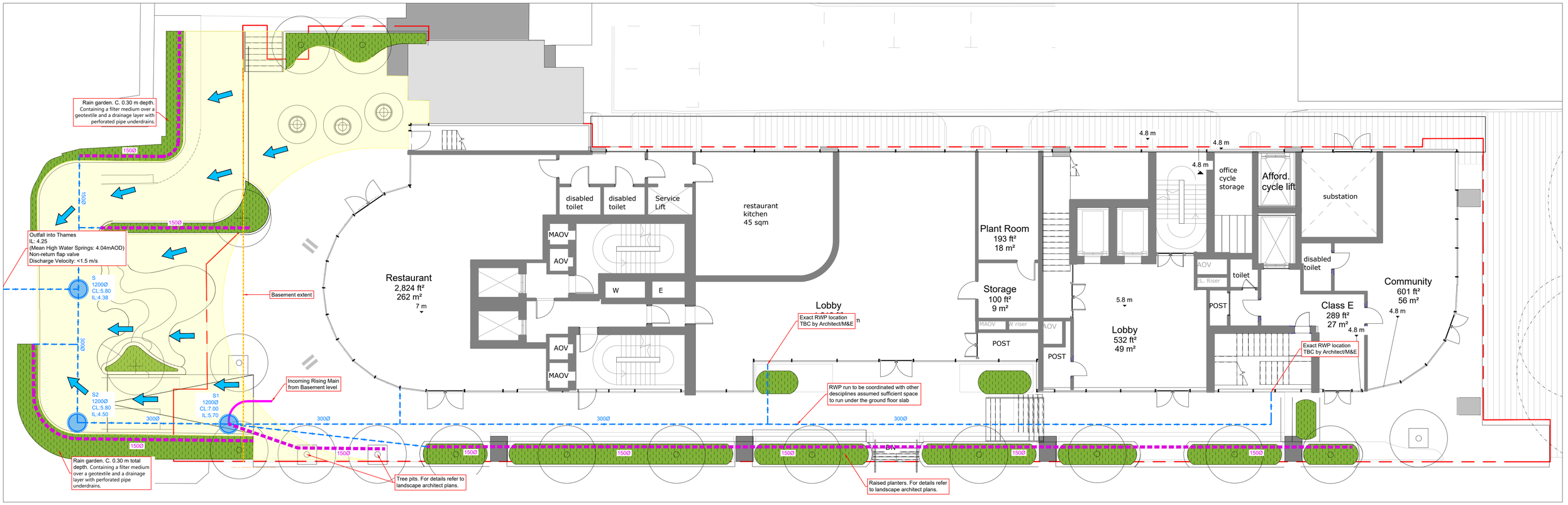
ROOF PLAN - LEVEL 10

KEY

- Proposed surface drainage
- Proposed Perforated pipe
- Proposed rising main
- Ground floor catchment area 217m²
- Proposed Blue roof
- Proposed Lanscape podiums. Refer to landscape architect for details
- Proposed Green roof
- Exceedance flow arrow

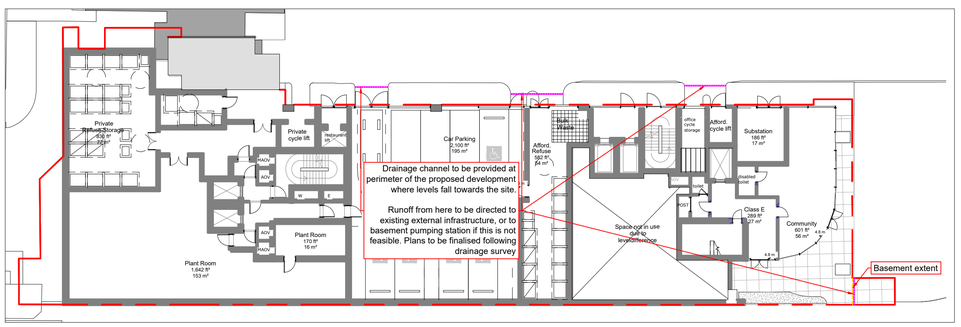
GENERAL NOTES

1. This drawing should not be reproduced in whole or part without the written consent of Yellow Sub Geo Ltd.
2. Do not scale from this drawings. Units are in metres unless otherwise specified.
3. The contractor is to check all information provided prior to commencing works and seek clarification from the engineer in respect to any ambiguities found.
4. This drawing should be read in conjunction with all other scheme specific drawings.
7. All drainage works shall be constructed in accordance with building regulation's Part H and / or the latest sewerage sector guidance Appendix C design and construction guidance.
8. Prior to construction the existing outfall locations are to be confirmed and verified.
9. The climate change allowances for the 3.3% and 1% aep are in accordance with ea's guidance "flood risk assessments: climate change allowances".
10. The attenuation storage has been designed to accommodate up to and including the 1 in 100 year return period including climate change allowance as per the ea guidance.

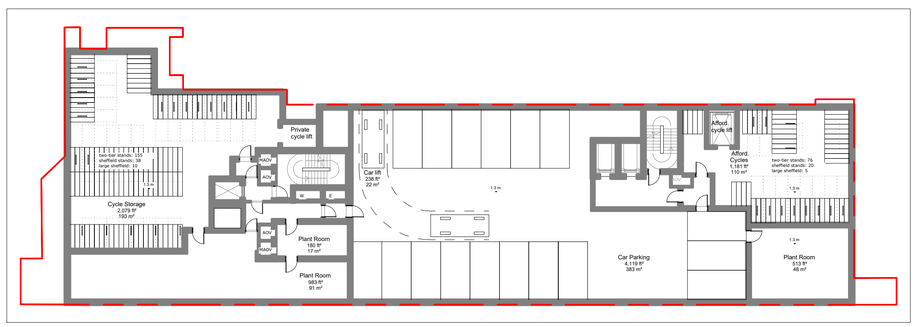


GROUND FLOOR PLAN

Scale 1:100



LOWER GROUND FLOOR PLAN



BASEMENT FLOOR PLAN

Client
PROMONTORIA BATTERSEA LTD

Project
ONE BATTERSEA BRIDGE

Revision record

Revision	Drawn by	Check by	Notes
P01	HK	ACE	First Issue

Drawing Number
P21383-100

Drawing Title
PROPOSED DRAINAGE STRATEGY PLAN

Scale @ A1
1:250

N

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Appendix G Drainage calculations

Design Settings

Rainfall Methodology	FEH-22	Maximum Time of Concentration (mins)	30.00	Preferred Cover Depth (m)	1.200
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0	Include Intermediate Ground	✓
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00	Enforce best practice design rules	✓
CV	1.000	Connection Type	Level Soffits		
Time of Entry (mins)	5.00	Minimum Backdrop Height (m)	0.200		

Nodes

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Node Type	Diameter (mm)	Depth (m)
	39-GF	0.022	5.00	135.000	Junction		0.150
	38-GF	0.024	5.00	131.200	Junction		0.150
	10-BF	0.027	5.00	41.200	Junction		0.100
	10-Podium	0.007	5.00	42.200	Junction		1.000
✓	S1		5.00	7.000	Manhole	900	1.500
✓	S2			5.800	Manhole	900	1.500
✓	S3	0.016	5.00	5.800	Manhole	900	1.529
✓	Outfall			5.800	Junction		1.546

Links (Input)

Name	US Node	DS Node	Length (m)	US IL (m)	DS IL (m)	Slope (1:X)	Dia (mm)	Link Type	Rain (mm/hr)
1.000	S1	S2	7.862	5.500	4.300	6.6	300	Circular	50.0
1.001	S2	S3	6.925	4.300	4.271	238.8	300	Circular	50.0
1.002	S3	Outfall	4.000	4.271	4.254	235.3	300	Circular	50.0

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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Node Type	MH Type	Connections	Link	IL (m)	Dia (mm)	Link Type
39-GF	-31.416	-79.060	135.000	0.150		Junction						
38-GF	-28.530	-86.269	131.200	0.150		Junction						
10-BF	-28.128	-92.983	41.200	0.100		Junction						
10-Podium	-17.456	-92.797	42.200	1.000		Junction						
S1	-42.578	-97.033	7.000	1.500	900	Manhole	Adoptable		0	1.000	300	Circular
S2	-50.440	-96.959	5.800	1.500	900	Manhole	Adoptable		1	1.000	300	Circular
									0	1.001	300	Circular
S3	-50.440	-90.034	5.800	1.529	900	Manhole	Adoptable		1	1.001	300	Circular
									0	1.002	300	Circular
Outfall	-54.440	-90.034	5.800	1.546		Junction			1	1.002	300	Circular

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Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	1.000	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 %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0	100	40	0	0
30	35	0	0				

Node Outfall Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	-2.010	90	-0.700	180	1.220	270	2.740	360	3.300	450	2.710	540	1.180	630	-0.650	720	-1.770
15	-1.890	105	-0.390	195	1.520	285	2.910	375	3.280	465	2.510	555	0.870	645	-0.920		
30	-1.720	120	-0.070	210	1.810	300	3.050	390	3.230	480	2.280	570	0.560	660	-1.170		
45	-1.500	135	0.260	225	2.070	315	3.160	405	3.140	495	2.030	585	0.250	675	-1.380		
60	-1.260	150	0.580	240	2.320	330	3.240	420	3.030	510	1.760	600	-0.060	690	-1.560		
75	-0.990	165	0.900	255	2.550	345	3.290	435	2.880	525	1.480	615	-0.360	705	-1.690		

Node 39-GF Offline Head/Flow Control

Flap Valve	x	Loop to Node	S1	Invert Level (m)	134.850

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Head (m)	Flow (l/s)
0.080	3.000

Node 38-GF Offline Head/Flow Control

Flap Valve x | Loop to Node S1 | Invert Level (m) 131.050

Head (m)	Flow (l/s)
0.080	3.000

Node 10-BF Offline Head/Flow Control

Flap Valve x | Loop to Node S1 | Invert Level (m) 41.100

Head (m)	Flow (l/s)
0.080	12.000

Node 10-Podium Offline Head/Flow Control

Flap Valve x | Loop to Node 10-BF | Invert Level (m) 41.200 | Design Depth (m) 0.300 | Design Flow (l/s) 1.0

Head (m)	Flow (l/s)
0.300	2.000

Node Outfall Offline Orifice Control

Flap Valve ✓ | Loop to Node | Invert Level (m) 4.250 | Diameter (m) 0.300 | Discharge Coefficient 0.600

Node Outfall Offline Orifice Control

Flap Valve x | Loop to Node | Invert Level (m) 2.900 | Diameter (m) 0.300 | Discharge Coefficient 0.600

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Node 39-GF Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	134.850
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	219.0	0.0	0.150	219.0	0.0

Node 38-GF Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	131.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	240.0	0.0	0.150	240.0	0.0

Node 10-BF Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	41.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	275.0	0.0	0.080	275.0	0.0

Node 10-Podium Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	41.200
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	70.0	0.0	1.000	70.0	0.0

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Results for 2 year Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	39-GF	80	134.872	0.022	1.3	1.5218	0.0000	OK
120 minute winter	38-GF	78	131.073	0.023	1.5	1.7466	0.0000	OK
120 minute winter	10-BF	78	41.107	0.007	1.7	1.9171	0.0000	OK
240 minute winter	10-Podium	164	41.215	0.015	0.3	1.0731	0.0000	OK
120 minute winter	S1	78	5.521	0.021	4.3	0.0134	0.0000	OK
120 minute winter	S2	78	4.353	0.053	4.3	0.0336	0.0000	OK
15 minute winter	S3	11	4.328	0.057	5.4	0.0484	0.0000	OK
15 minute winter	Outfall	11	2.953	-1.301	5.4	0.0000	0.0000	OK

US Node	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
39-GF	S1	0.8				3.8
38-GF	S1	0.9				4.3
10-BF	S1	1.1				5.7
10-Podium	10-BF	0.1				1.6
S1	S2	4.3	0.865	0.010	0.0411	
S2	S3	4.3	0.511	0.060	0.0591	
S3	Outfall	5.4	0.595	0.075	0.0363	
Outfall		0.0				0.0
Outfall		5.4				29.8

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Results for 30 year +35% CC Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	39-GF	26	134.936	0.086	11.1	5.9225	0.0000	OK
30 minute winter	38-GF	26	131.139	0.089	12.2	6.6602	0.0000	OK
30 minute winter	10-BF	25	41.127	0.027	13.8	7.2928	0.0000	OK
240 minute winter	10-Podium	172	41.247	0.047	0.9	3.3068	0.0000	OK
30 minute winter	S1	25	5.534	0.034	11.6	0.0213	0.0000	OK
30 minute winter	S2	22	4.393	0.093	11.6	0.0591	0.0000	OK
15 minute winter	S3	11	4.378	0.107	18.3	0.0908	0.0000	OK
15 minute winter	Outfall	11	3.019	-1.235	18.2	0.0000	0.0000	OK

US Node	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
39-GF	S1	3.0				8.7
38-GF	S1	3.0				9.5
10-BF	S1	4.1				12.7
10-Podium	10-BF	0.3				4.7
S1	S2	11.6	1.108	0.027	0.0895	
S2	S3	11.6	0.675	0.162	0.1377	
S3	Outfall	18.2	0.834	0.252	0.0872	
Outfall		0.0				0.0
Outfall		18.1				51.9

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Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute winter	39-GF	46	134.976	0.126	9.9	8.6613	0.0000	OK
60 minute winter	38-GF	47	131.180	0.130	10.8	9.8018	0.0000	OK
30 minute winter	10-BF	25	41.137	0.037	18.8	9.9322	0.0000	OK
240 minute winter	10-Podium	176	41.265	0.065	1.3	4.5517	0.0000	OK
30 minute winter	S1	25	5.535	0.035	13.1	0.0226	0.0000	OK
15 minute winter	S2	12	4.403	0.103	12.5	0.0658	0.0000	OK
15 minute winter	S3	11	4.396	0.125	24.1	0.1057	0.0000	OK
15 minute winter	Outfall	11	3.043	-1.211	24.0	0.0000	0.0000	OK

US Node	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
39-GF	S1	3.0				9.2
38-GF	S1	3.0				10.0
10-BF	S1	5.6				17.3
10-Podium	10-BF	0.4				6.3
S1	S2	13.1	1.140	0.030	0.1002	
S2	S3	13.1	0.698	0.183	0.1628	
S3	Outfall	24.0	0.898	0.332	0.1067	
Outfall		0.0				0.0
Outfall		23.9				61.9

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