

Unite Students & Manchester Metropolitan University

Cambridge Hall

Flood Risk Assessment & Drainage Strategy

Reference: CAM-ARP-ZZ-ZZ-RP-C-0001

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Abbreviation	Meaning
AOD	Above Ordnance Datum
BGS	British Geological Survey
CC	Climate Change
CCTV	Closed Circuit Television
CIRIA	Construction Industry Research and Information Association
EA	Environment Agency
FRA	Flood Risk Assessment
GMSF	Greater Manchester Spatial Framework
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MCC	Manchester City Council
NFM	Natural Flood Management
NPPF	National Policy Planning Framework
PPG	Planning Policy Guidance
PPS25	Planning Policy Statement 25
SFRA	Strategic Flood Risk Assessment
SPZ	Source Protection Zones
SuDS	Sustainable Drainage Systems

1. Introduction

This Flood Risk Assessment (FRA) and Drainage Strategy has been prepared by Ove Arup and Partners Ltd. (Arup) on behalf of Unite Students and Manchester Metropolitan University. It addresses the proposed redevelopment of Cambridge Halls of Residence and supports the Planning Application for both Phase 1 and Phase 2 of the project.

The redevelopment includes demolition of existing halls of residence and erection of two buildings of 30 and 24 storeys above ground, plus basement and rooftop plant levels, comprising purpose-built student accommodation with internal and external rooftop communal amenity space (Sui Generis). At ground floor level, commercial and community uses are proposed (Flexible Use Classes E, F1 or F2). Hard and soft landscaping and associated highway alteration works are proposed. Both new buildings will feature green courts and will be separated by Cavendish Street, allowing passage for pedestrians and cyclists. The proposed masterplan is shown in **Appendix A**.

This document includes a review of flood risk data for the site, obtained from the Environment Agency. It also considers the National Planning Policy Framework (MHCLG, 2024), Manchester City Council's Strategic Flood Risk Assessment (Manchester City Council, 2010), and the Environment Agency's Climate Change Allowance (DEFRA, 2020) guidance. The Climate Change Allowance guidance outlines the Environment Agency's recommended climate change allowances for development, considering flood risk and climate change for planning purposes.

This document also outlines the Drainage Strategy, detailing how attenuation measures, including Sustainable Drainage Systems (SuDS) and a Blue Roof System, will reduce surface water runoff to 50% of the current brownfield runoff rate, incorporating a 45% allowance for climate change during a 100-year return period rainfall event.



Figure 1 - Existing Cambridge Hall Building, view from the central courtyard looking north-east along the Cavendish Street

2. Existing Conditions

2.1 Site Description

The site is located in the North-West of England, within the Manchester City Council authority area in Greater Manchester. The site address is, Cambridge Halls of Residence, Cavendish Street, Manchester, M15 6TT. It is approximately 3 km east of Junction 3 of the M602 Motorway. The site covers an area of around 0.85 hectares and has a rectangular shape, measuring c.55 meters wide and 155 meters long. It is centred on National Grid Reference SJ 84156 96971 (see Figure 2).

Currently, the site is occupied by a four-storey student hall built in 1998. The building divides the site into three courtyards: the southern and northern courtyards are accessible to residents, while the central courtyard is integrated with Cavendish Street, providing a passage for pedestrians and cyclists traveling between Hulme and the Manchester University area. The proposed development will occupy the length of the site with the main entrance facing Higher Cambridge Street.

The FRA considers all surface water, groundwater, and flood risk receptors located within the site boundary of the proposed development.



Figure 2 - Extents of the site

2.2 Site Topography

Site is mostly flat, based on the site topography survey (CADPLAN, 2024) with site elevations varying from 36.70mAOD at the eastern boundary to 36.30mAOD at the western boundary.

2.3 Existing Surface Water Features

There are no surface water features directly adjacent to the site, but the following local water features are located near the proposed development:

- **Cornbrook:** is fully culverted main river and not visible on the ground surface watercourse that rises in east Manchester and discharges to the Manchester Ship Canal. The river passes c.210m to the south from the Cambridge Hall site.
- **River Medlock:** This river flows north of the site, approximately 320 meters away and discharges into the River Irwell in Manchester city centre. The River Medlock plays a significant role in the local

drainage system and flood management. The section of the river closest to the site is culverted under Hulme Street.

- **Rochdale Canal:** Located approximately 560 meters north of the site, the Rochdale Canal primarily serves as a navigable waterway for boats. The canal connects to the Bridgewater Canal and the River Medlock.



Figure 3 - Surrounding Surface Water Features to the north (left picture) and to the south (right picture)

2.4 Existing Drainage

There are 3 United Utilities (UU) combined sewers beneath the existing building footprint as shown in Figure 4. These include a 1950mm brick sewer 12m below ground level that is located within Cavendish St; a 600mm x 750mm sewer of unknown depth also located within Cavendish St; and a 300mm x 400mm combined sewer approximately 3.5m below ground level beneath the existing building (depths based on the United Utilities Records).

The building currently uses a combined surface water and foul system that connects to a UU 600 x 750mm sewer on Higher Chatham Street.

A CCTV survey was conducted in September 2024 which confirmed the locations of several combined sewers around the development and provided an assessment of their condition. However, the initial CCTV survey failed to provide full survey information due to sewer blockages and complications in surveying due to access chambers, depths and high flow rates. United Utilities were informed of these blockages and they have confirmed (by email 11/02/2025) that all the identified blockages have now been cleared. An additional CCTV survey is currently being commissioned to address information gaps from the first survey and is expected to be carried out in May 2025.

Refer to Figure 4 for an extract of the existing sewer network and to **Appendix E** for a full-size drawing.

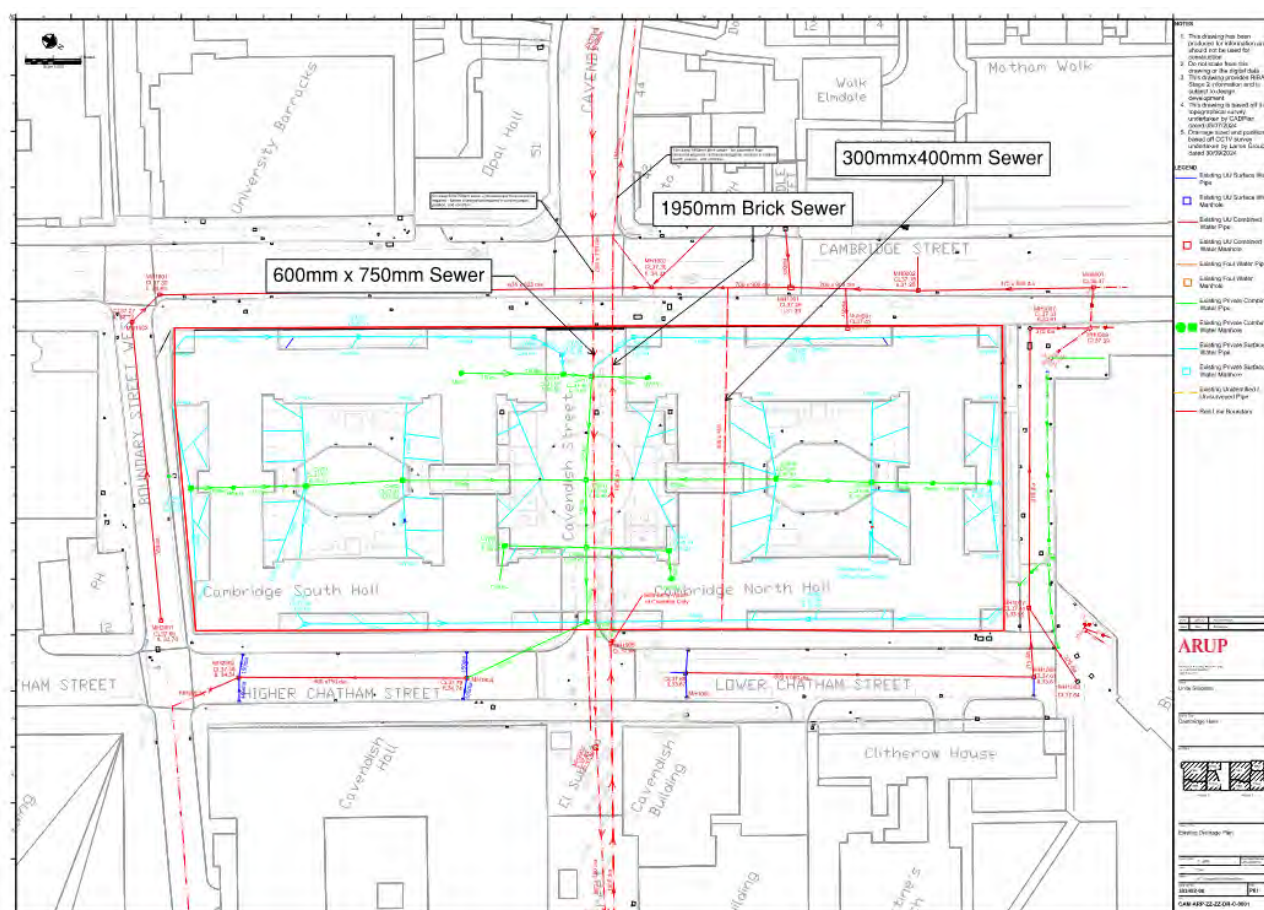


Figure 4 – Existing Sewer Network

3. Flood Risk Policy

3.1 National Planning Policy Framework (NPPF)

3.1.1 Overview of the policy

The National Planning Policy Framework (NPPF) revised in December 2024 sets out the government's planning policy relating to the management of flooding risk due to the new development (MHCLG, 2024). The policy states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. Where development is necessary, it must be made safe without increasing flood risk elsewhere.

The assessment of where a development can be located and whether the development type is suitable for a given level of risk can be carried out based on the 'Sequential Test' and if necessary, the 'Exception Test'. The Sequential Test aims to ensure that preference for developable land is given to land that has the lowest risk of flooding, based on the data available.

3.1.2 Flood Zone Classification

The system of 'Flood Zoning' assesses the risk posed by rivers and, in coastal areas, estuaries and the sea. The Flood Zoning system adopted in England (EA, 2021) is described in Table 1.

Table 1 Fluvial Flood Risk Zoning System

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 (0.1%) annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3).
Zone 2 Medium Probability	Land having between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map).
Zone 3a High Probability	Land having a 1 in 100 (1%) or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map).
Zone 3b Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map).

3.1.3 Vulnerability classification

The proposed use of Cambridge Hall as a student hall of residence is classified as a 'More Vulnerable' development according to the NPPF and the Flood Risk and Coastal Change PPG (MHCLG, 2012), which references 'Halls of residence'.

3.1.4 Sequential Test

Under the NPPF, the Sequential Test is a requirement for all new planning applications. It aims to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. The Sequential Test requires that development should only be considered within Flood Zone 2 if there are no appropriate development sites in Flood Zone 1. Development in Flood Zone 3 should only be considered if development is not possible in Flood Zone 2, assuming development in Flood Zone 1 has also been ruled out.

The sequential test follows a flow diagram to establish the next steps (Figure 5).

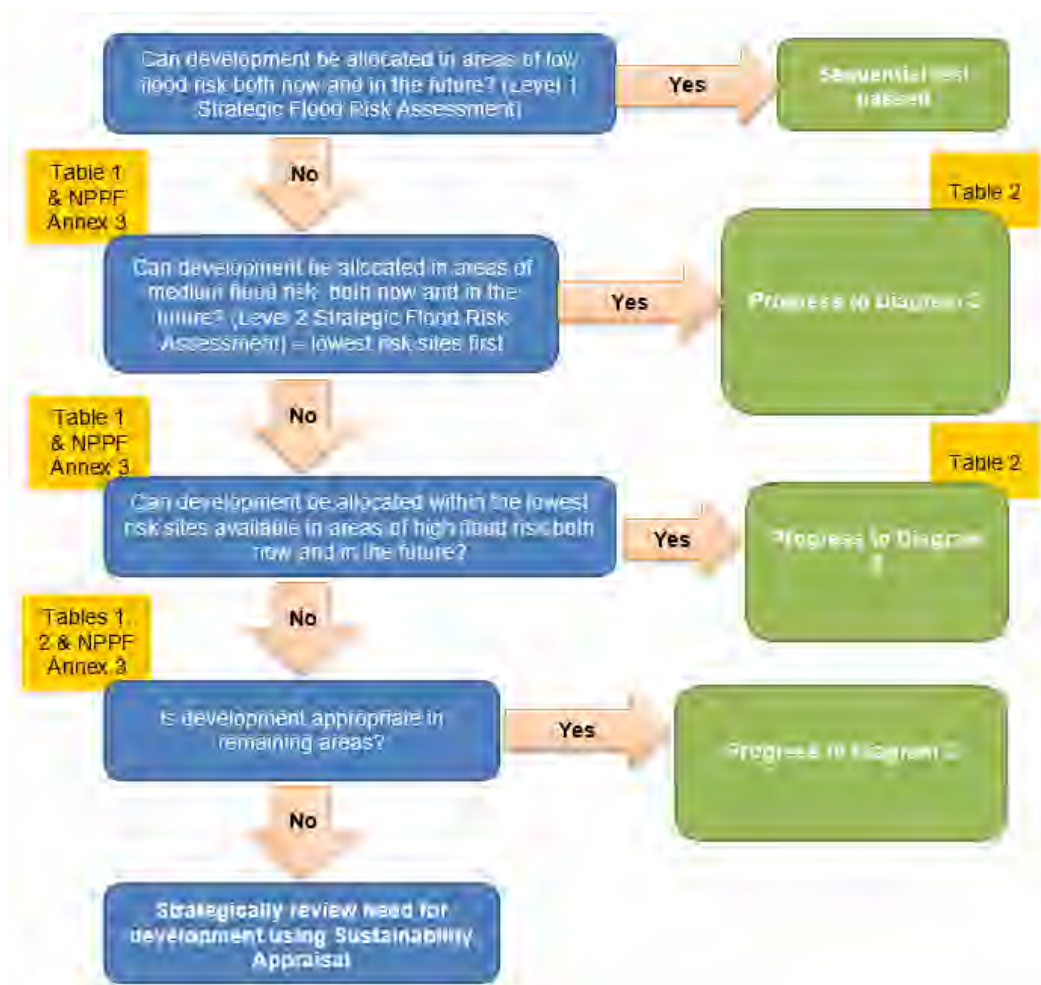


Figure 5 - Sequential Test Flow Chart (MHCLG, 2024)

There are some scenarios which require an Exception Test (Table 2), based on vulnerability classification of the development and Flood Zone proposed.

Table 2 - Flood Risk Vulnerability and Compatibility

Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception Test	✓	✓
Flood Zone 3a	Exception Test	✓	✗	Exception Test	✓
Flood Zone 3b “Functional Floodplain”	Exception Test	✓	✗	✗	✗

Key:

- ✓ Development is appropriate
- ✗ Development should not be permitted, “Exception Test” will be required.

The Exception Test has two additional requirements before allowing a development to be permitted in the situations where suitable sites at lower risk of flooding are not available, after following the Sequential Test. These are¹:

- The development that is to be sited in a flood risk area will provide wider sustainability benefits to the community that outweigh the flood risk.
- The development will be safe for its lifetime, without increasing off-site flooding and taking into account the vulnerability of the development's users (vulnerability classification)

3.2 Local Flood Risk Policy

3.2.1 Greater Manchester City Council

Manchester City Council issued the Greater Manchester Strategic Flood Risk Assessment (GMSF) in 2018, outlining their plan for developments in the Greater Manchester area to manage flood risk and to aid sustainable building (GMCA, 2018).

There are 5 key policies for developers in this document:

Avoiding Development in Flood-Prone Areas:

- Developers should avoid building in locations with existing flood risk. This policy emphasises the need to protect vulnerable areas and prevent further exposure to flooding.

Evidence-Based Decision-Making:

- Developers must base their decisions on robust flood risk evidence. This requires understanding historical flood patterns, assessment of future risk, and considering cumulative flooding sources and cross-boundary impacts.

Collaborative Working:

- The framework encourages collaboration among stakeholders, including local authorities, developers, and environmental agencies. By working together, we can create more resilient communities and minimise flood risk.

Natural Flood Management (NFM):

- Developers should explore NFM approaches, such as sustainable drainage systems (SuDS) and green infrastructure. These nature-based solutions can help manage surface water and reduce flood risk.

Integration with Local Plans:

- Developers should align their proposals with local development plans. The GMSF complements existing policies and activities implemented by Greater Manchester local authorities.

The policies in the SFRA reinforce that the NPPF guidance should be followed to ensure that flood risk zones and vulnerabilities are identified, and lower risk options are considered. The SFRA complements Planning Policy Statement 25 (PPS25) Development and Flood Risk Practice Guide (DCLG, 2009) which emphasises on an approach to assess flood risk by a new development through the hierarchy of '*assess-avoid-substitute-control-mitigate*'. As well as this, the importance of SuDS and natural flood management are emphasised to improve the sustainability of the region's developments.

¹ <https://www.gov.uk/guidance/flood-risk-and-coastal-change#para25>

3.2.2 Manchester City Council

Additional level of guidance can be found in Level 2 Hybrid SFRA (Manchester City Council, 2010). The Level 2 Hybrid SFRA aligns with the strategic objectives of the GMSF by providing detailed flood risk assessments that help implement the broader strategies outlined in the framework. The guidance is supplemented with Critical Drainage Areas map (Manchester City Council, 2011) in **Appendix C** that indicates the proposed site is situated in the Conurbation Core **Critical Drainage Area**. As per the Level 2 Hybrid SFRA, if a development falls in this area, a detailed FRA is advised for all developments over 0.5 hectares, regardless of which Flood Zone the site falls within.

4. Flood Risk Appraisal

To ensure the development can be made safe throughout its lifetime, the following sections will explore in further detail the flood risk due to alternative sources such as rivers, surface water, groundwater or reservoir failure. In addition, the drainage strategy will outline how the discharge during a 1 in 100-year + climate change storm event can be attenuated on site to ensure the proposed development does not increase flood risk to the surrounding area.

4.1 Flood Zone



Figure 6 - Flood Map for Planning (Source: Environment Agency)

As per the Environment Agency's Flood Risk Map for Planning in Figure 6, the location of the site falls predominantly within Flood Zone 1. Although a small part of the south-westerly corner of the site is shown within Flood Zone 2, upon closer investigation, it appears to be due to the levels within the highway being at a lower level than the existing development – this is explored in more detail in Section 4.2.

4.2 Flood Risk from Rivers

Figure 7 demonstrates how climate change is predicted to increase the extents of areas at risk from flooding.

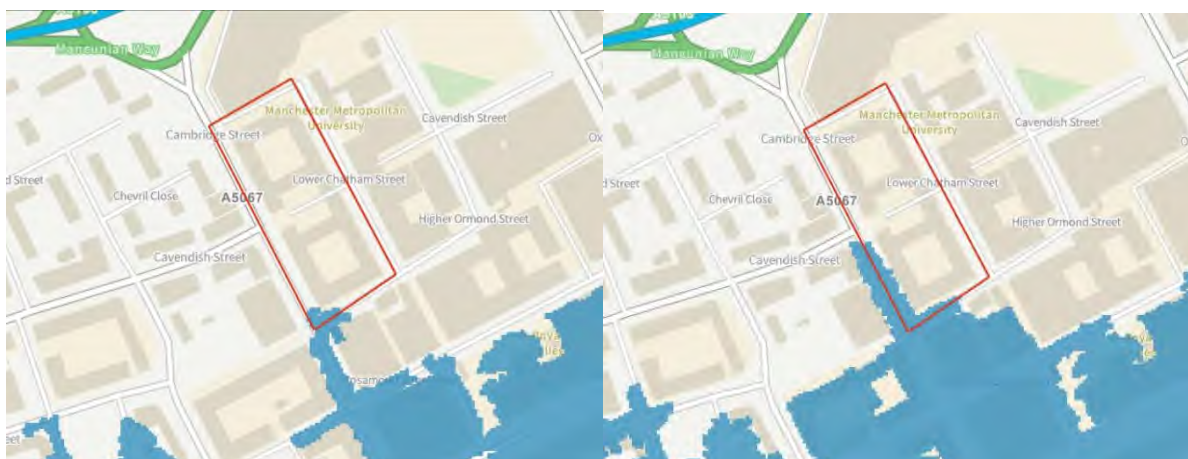


Figure 7 – 1 in 1000 year Flood Risk from Rivers and Sea (Flood Zone 2) – Present day vs Climate Change²

More detailed flood depths information has been obtained from the EA (Product 4), as shown in Figure 8. This provides flood depths at 20 locations in proximity to the site, with these positions illustrated in Figure 9.

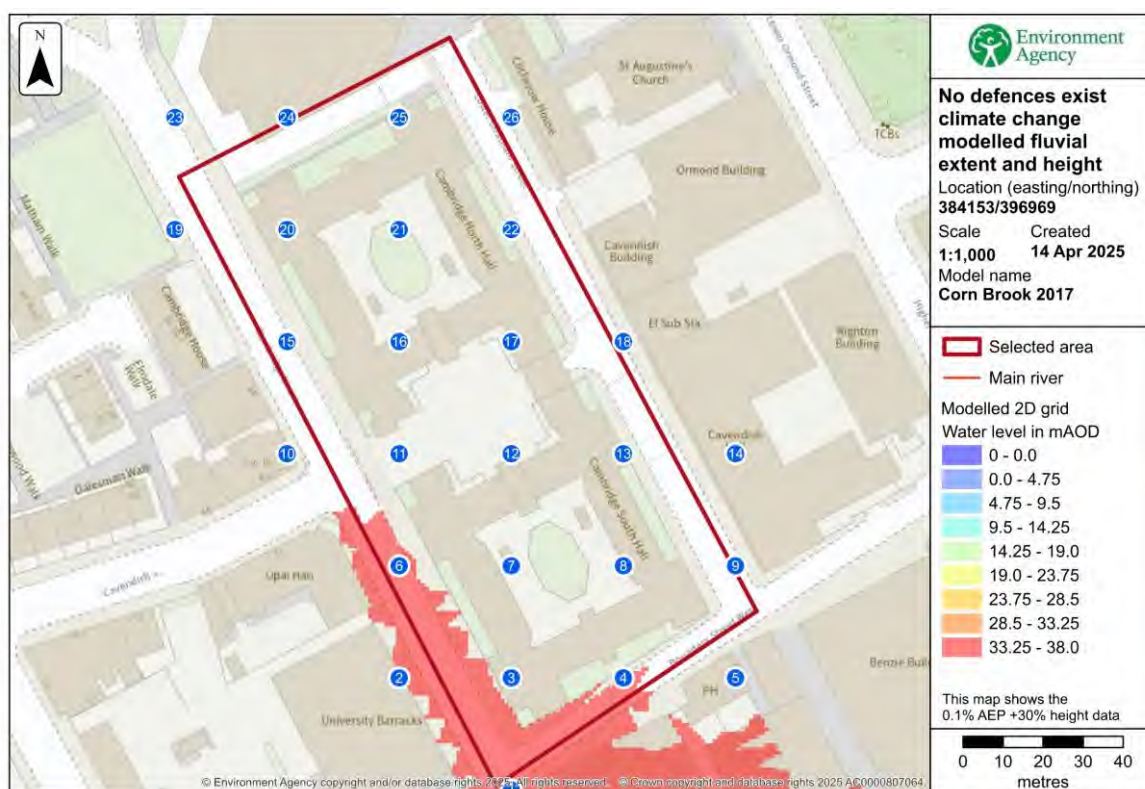


Figure 8 - EA Product 4 flood levels

Data Point 1 in Figure 8, at the junction of Boundary St West and Higher Cambridge Street, has a flood depth of 0.21m during a 0.1% AEP (annual exceedance probability) + climate change storm event³. Data Point 6, on Higher Cambridge Street, has a flood depth of 0.10m during a 0.1% AEP + climate change storm event.

² <https://flood-map-for-planning.service.gov.uk/>

³ EA Product 4 Cambridge Halls – Flood Risk Assessment Data, page 24, April 2025

The other data points including 2, 3 & 4 are shown on the fringe of the flood extent however, on interrogation of the flood depth and level data supplied, they do not have flooding during this storm event.



Figure 9 - Data Point approximate locations

An assessment has been made by comparing the flood depths against the existing site levels captured during the Topographical Survey (CADPLAN, 2024). The existing ground level at the location of datapoint 1 can be interpolated to be 36.3m, and data point 6 as 36.4m (Figure 10) - giving an approximate flood water level of 36.5mAOD near the site. As demonstrated by the existing ground levels in Figure 10: the footway of Boundary St West and Higher Cambridge Street are below this flood level, hence their inclusion in the flood extents in Figure 8; the southwestern corner of the site has existing ground levels of 36.38-36.51mAOD and so flood extents will just reach within the site boundary, approximately <0.1m deep, but don't extend beyond the existing and proposed building perimeter.

Consequently, the site is considered to be located within Flood Zone 1, meaning a low probability of flooding from the rivers or sea.

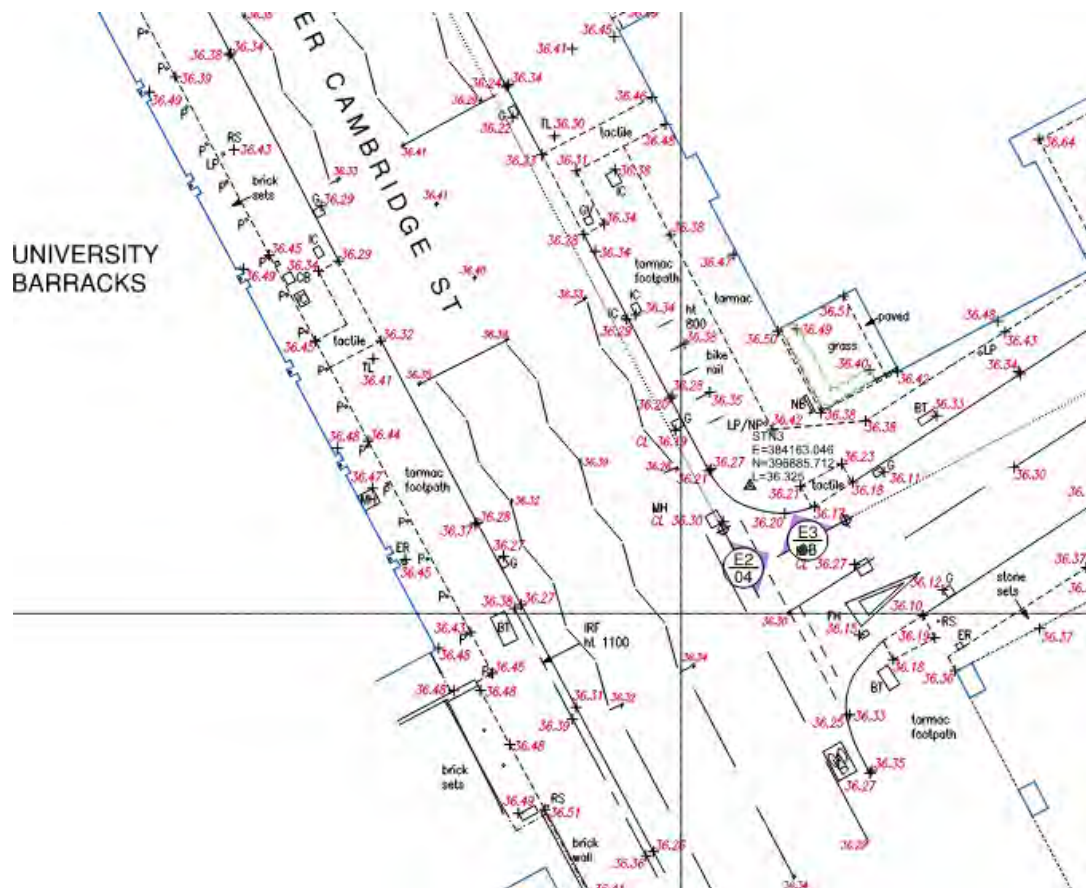


Figure 10 - Topographical Survey (CADPLAN, 2024)

4.3 Flood Risk from Surface Water

The Environment Agency defines surface water (pluvial) flooding scenarios as follows:

- **High risk:** Land with a greater than 3.3% annual probability of flooding from surface water (indicative of the 1 in 30-year return period).
- **Medium risk:** Land with a 3.3% to 1% annual probability of flooding from surface water (indicative of the 1 in 100-year return period).
- **Low risk:** Land with a 1% to 0.1% annual probability of flooding from surface water (indicative of the 1 in 1,000-year return period).
- **Very Low risk:** Land with less than a 0.1% annual probability of flooding from surface water. The viaduct stands approximately 15 meters above the watercourse below, rendering it less vulnerable to surface water flooding from overland flow beneath its structure.

The Environment Agency's Flood Risk from Pluvial sources map indicates that currently most of the site is not at notable risk of surface flooding, except for courtyards that fall within '**Low Chance**' to '**Medium Chance**' category and street adjacent to the north-east corner of the site is at '**High Chance**' of surface water flooding (Figure 11).

In the context of the lifetime of the proposed building, surface water flooding in years 2040-2060 will present overall higher chances of flooding with **‘Low Chance’** across the site and some minor **‘High Chance’** in courtyards and adjacent to the northern and southern boundary of the site. These localised areas of higher risk along the site boundary are due to the highways being at a lower elevation than the existing site, and the existing courtyards ground levels creating a ponding area for surface water runoff. This dark blue ‘high chance’

in Figure 11 corresponds with a depth of up to 20cm, whilst the low chance shading does not have a corresponding depth due to its reduced likelihood.

To address this increasing risk, the Drainage Strategy, presented in Section 5, demonstrates how the proposed drainage and attenuation will consider climate change and on top of that allow for reducing the existing surface water runoff rate by 50%, thus reducing risk of pluvial flooding. The proposed levels design will also look to mitigate surface water flood risk by designing falls away from building entrances where practical.



Figure 11 - Flood Risk from Surface water⁴

4.4 Existing Flood Risk from Groundwater

According to the British Geological Survey (BGS), the underlying bedrock at the site is the Chester Formation (Figure 12), primarily composed of sandstone. The BGS classifies this as a 'Principal' bedrock aquifer—a rock layer with high intergranular permeability, capable of significant water storage. Such aquifers can support water supply and river baseflow on a strategic scale.

The BGS Geology of Britain Viewer identifies the superficial deposits beneath the site as Glaciofluvial Sheet Deposit (Figure 13) composed of sand and gravel.

The EA state that 'flooding from groundwater is unlikely in this area'⁵. The site is situated within SPZ3 of an Environment Agency Groundwater Source Protection.

According to the Manchester City Council SFRA Flooding from Groundwater map (Figure 14), the site boundary along the south-western corner is next to an area at risk of groundwater flooding.

As such, the site does not fall in an area at risk of groundwater flooding.

During the recent Ground Investigation works (December 2024 – January 2025), groundwater was encountered at approximately 3m depth. Subsequent monitoring of installations confirmed a water level of circa 33.5-33.9mAOD, typically around 33.6mAOD. Following a geotechnical review of all data and allowing for future variability, for the design of below ground elements we will utilise a design water level of 34.6mOD, to mitigate the against the risk of groundwater flooding.

⁴ [Environment Agency] "Surface water: understand your flood risk" n.d. [<https://check-long-term-flood-risk.service.gov.uk>](Accessed [9 April 2025])

⁵ [Environment Agency] "Groundwater and reservoirs: understand your flood risk" <https://check-long-term-flood-risk.service.gov.uk/ground-water> (Accessed 8th April 2025)

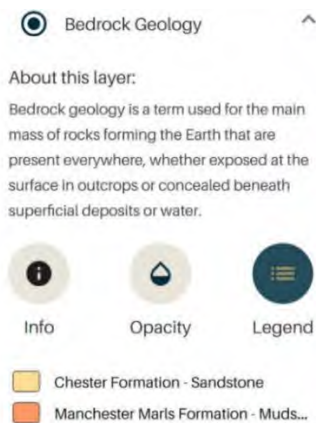


Figure 12 - BGS Bedrock Geology⁶

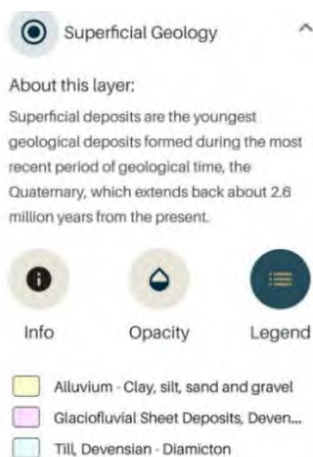


Figure 13 - BGS Superficial Geology⁷



Figure 14 - Groundwater Flood Risk (Manchester City Council, 2024)

⁶ [BGS] "BGS Geology Viewer: Superficial Geology" n.d. [https://geologyviewer.bgs.ac.uk/?_ga=2.101482625.1082748692.1725897680-1720724764.1725897680] (accessed [10 September 2024])

⁷ [BGS] "BGS Geology Viewer: Superficial Geology" n.d. [https://geologyviewer.bgs.ac.uk/?_ga=2.101482625.1082748692.1725897680-1720724764.1725897680] (accessed [10 September 2024])

4.5 Flood Risk from Reservoirs

The Environment Agency's Risk from Reservoir Flooding Map indicates that the site lies within the flood extent in the event of reservoir flooding, as shown in Figure 15. Reservoirs that could affected this area are noted as Audenshaw No. 1, No.2 and No. 3 which are situated in Tameside and owned by United Utilities⁸ located over 6km away. Note: the flood extents from these reservoirs also cover a large extent south of Manchester city centre.



Figure 15 - Flood Risk from Reservoir Failure Map (Environmental Agency, 2025)

4.6 Flood Risk from Canals

As shown in Figure 16 the closet canal is the Rochdale canal located over 550m away. In our assessment, we have determined that there is no significant risk of flooding from the canal, based on Urban Design Zoning for Manchester Ship Canal and Grey Irwell Map (Manchester City Council, 2011) and based on the lack of known flooding records in Flood Risk Assessment Data (Product 4) provided by the EA.



Figure 16 - Location of the closest canal

⁸ <https://check-long-term-flood-risk.service.gov.uk/ground-water>

4.7 Flood Risk from Sewers

Current United Utilities Records indicate that the sewer located on Higher Chatham Street currently changes in size from a 600x750mm to a 450mm VC on Boundary Street West. The reduction in cross section area of the pipe may cause a backflow during extreme rainfall events, leading to sewer flooding. Further discussions will be undertaken with UU to confirm capacity of this network with the proposed flow rates from the new superstructure, but note the site currently drains surface water to this sewer which will be reduced post development – as discussed in Section 5.

4.8 Flood Risk Summary

The flood risk for the site can be summarised as:

- The site is located within Flood Zone 1 meaning **low probability of flooding from the rivers** or sea.
- The flood extents for the 0.1% AEP storm event touch the south-western corner of the site. A review of the flood depths and levels compared to ground levels demonstrate that this **flood risk is limited to the highway, footway and minor landscaping along the site boundary**.
- The site has very low and low probability of surface water (pluvial) flooding. With climate change, this increases to **low chance of pluvial flooding** across the majority of the site and some minor localised areas of high chance risk in the existing courtyards and adjacent to the northern and southern boundary of the. This risk is considered mitigated by proposing a comprehensive drainage and attenuation strategy outlined in Section 5.
- The site is outside of Groundwater flood risk area, and therefore deemed at **low risk of groundwater flooding**.
- The site is situated in **area at risk of reservoir flooding** if there were to be a catastrophic failure of the Audenshaw reservoirs, however a large extent south of Manchester city centre is also within this extent.
- The site is **not in an area at risk of canal flooding**.

Due to the vast amount of Manchester impacted by the reservoir flood extent, it is not possible to allocate a site outside of the flood extent for Cambridge Halls rather than the site reviewed in this FRA.

Considering the above points and all the data presented in Sections 4.1-4.6, Cambridge Halls is considered to have **Low Probability of Flooding**.

In accordance with NPPF, the development is classified as 'More Vulnerable' due to its proposed usage as halls of residence.

For this development the Sequential Test is **passed** as the site falls into Low Flood Risk Probability Category which is suitable for 'More Vulnerable' class development (Figure 17). The Exception test is not required, as highlighted in the table below.

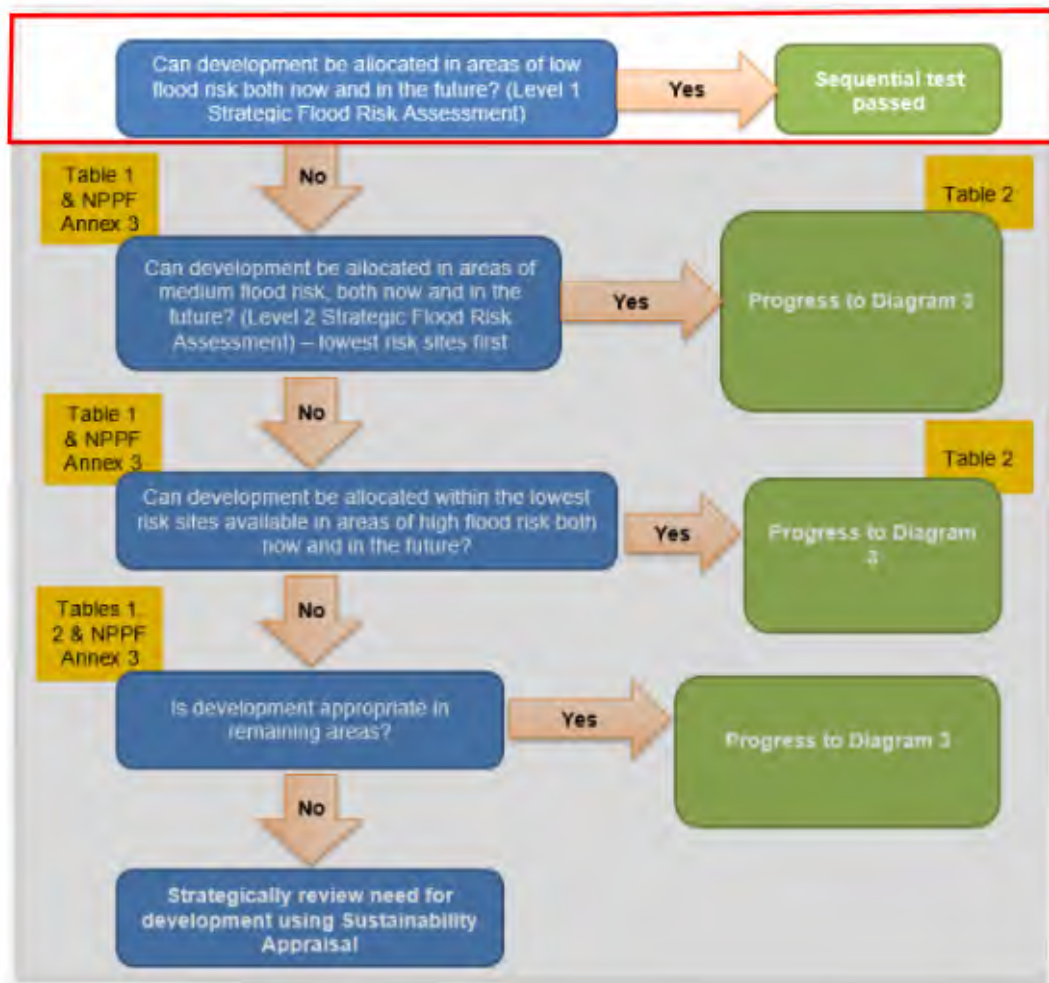


Figure 17 - Sequential Test Flow Chart (MHCLG, 2024)

Table 3 - Flood Risk Vulnerability and Compatibility

Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Low Probability	✓	✓	✓	✓	✓
Medium Probability	✓	✓	Exception Test	✓	✓
High Probability	Exception Test	✓	✗	Exception Test	✓

Key:

- ✓ Development is appropriate
- ✗ Development should not be permitted, “Exception Test” will be required.

5. Drainage Strategy

5.1 Surface Water Runoff

A drainage strategy is proposed to manage surface water on site and limit runoff flows post-redevelopment. As part of this drainage strategy, since all of the site is brownfield land and is an active development, the whole site has been taken as impermeable and to be actively drained, when calculating offsite peak discharge flows and attenuation requirements.

A CCTV survey has been undertaken in September 2024 to better understand the existing private sewer network on the existing site. This confirms that the site is currently actively drained, with the private surface water sewer network from the building roofs and public realm areas discharging to the private on-site combined sewer network before ultimately discharging to the UU combined sewer network. For details of the existing private and public sewer network on site and on the adjacent streets refer to drawing CAM-ARP-ZZ-ZZ-DR-C-0001 shown in **Appendix E**.

Section C of the Construction and Design Guidance for the Sewerage Sector (Water UK, 2021) requires that new developments have the capacity within the on-site drainage network to store the runoff from a 1 in 30-year rainfall event, accounting for the effects of climate change over the design life. The guidance also requires that the runoff from a 1 in 100-year rainfall event can be stored on the site and will not worsen flooding to an adjacent area.

As this site will be 'permanent', the effects of climate change need to be considered. The Environment Agency has estimated that developments with design lives beyond 2060s' must design for a 40% CC increase in rainfall for 1 in 30-year events, and 45% increase in rainfall for 1 in 100-year events in the Irwell Catchment (DEFRA, 2020).

The historical flooding data, in **Appendix B**, shows the area around the student halls does not have a record of flooding on the site, but nonetheless, reducing existing runoff by 50% is required due to its location within a Critical Drainage Area, and due to expected higher chance of surface flooding in years 2040-2060 (See section 4.3), thus the drainage network must be able to store and attenuate the additional rainfall to achieve run off reduction and account for climate change. This 50% reduction to brownfield flows has been agreed in principle during high-level discussions with the LLFA during October 2024.

The existing run off rates were estimated using the Modified Rational Method be up to 198 l/s for 1:100 years design storm. Based on this result, the maximum allowable run off rate after 50% reduction was calculated to be 98.7 l/s. Post development, the storage capacity needed to meet this maximum run-off requirement has been calculated as circa. 270m³ through Info drainage Quick Storage Estimate. For comparison, this has also been checked using the Wallingford Procedure which gave a volume of circa. 170 m³ (DENWC, 1981). The more conservative value of these two results is being used at this stage. The storage volume design will be optimised as the design develops.

As the two proposed buildings are split into Phase 1 & 2, the drainage strategy has been developed independently for Phase 1 and Phase 2 and linked with a common outfall, to allow the site to be constructed in phases whilst providing sufficient drainage infrastructure for each phase as standalone.

5.1.1 Assumptions

- The development is to be permanent
- The existing runoff rate will be reduced by 50% (existing actively drained brownfield site)
- Critical rainstorm event of 15-minute duration
- The entire site area is impermeable

5.2 Attenuation

Local flood risk management guidance states that the reduction of surface water runoff, wherever possible, should be achieved through the implementation of Sustainable Drainage Systems (SuDS) (Manchester City Council, 2010), Greater Manchester's Sustainable Drainage Design Guide (Greater Manchester Combined Authority, 2024). SuDS are designed to maximise the opportunities and benefits from surface water management. SuDS can improve the quality of life in developments and urban spaces by making them more vibrant, visually attractive, sustainable and more resilient to change. They achieve this by improving urban air quality, regulating building temperatures, reducing noise and delivering recreation and education opportunities. (CIRIA, 2015). From a suite of options and by considering the nature of the site, three types of interventions have been proposed for this development: rain gardens, permeable paving, and blue roof systems on the proposed building. These proposals are in line with the landscape architect's proposal as shown in **Appendix A**.

The achievable depth for the proposed SuDS is limited by the depth of the outfall connection from the existing private sewer to the UU combined sewer in Higher Chatham Street (MH1904). Based on the CCTV survey and Topographical survey, it has been concluded that the minimum total depth of 1.2m is achievable for all types of interventions across the site and this depth has been assumed for calculations.

5.2.1 Rain garden

Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes and treat pollution through the use of engineered soils and vegetation. Runoff collected by the system ponds temporarily on the surface and then filters through the vegetation and underlying soil (CIRIA, 2015).

At this stage, none of the interventions are designed in detail; however, below is a list of the main components of the system that shall be further specified as the design develops:

Inlet – The inlet design is critical and should be designed to prevent scour and erosion and to evenly distribute water onto the filter surface.

Depth of extended detention – This is temporary storage of water on the surface to capture the volume that requires treatment and (if required) to provide attenuation. Normally this will be at a maximum depth of 150–300 mm.

Vegetation – Vegetation influences the performance of the system through direct uptake of pollutants and by facilitating physical and chemical processes in the soil that remove nutrients. It also prevents erosion of the surface soil layers and helps maintain the permeability of the filter medium. Vegetation can have a strong influence on the amenity and biodiversity value of the system. Vegetation selection is very site specific and requires the input of landscape architects, ecologists, or horticultural or arboriculture experts.

Filter medium – This material is normally sand-based with some source of organic matter and slow-release plant nutrients to maintain healthy plant growth. It filters out pollutants and controls the rate at which water filters through the system, which is a key influence on the effectiveness. It is normally 750–1000 mm deep, although for very small catchments it can be less than this (e.g. where a raised planter is draining only a small area of roof). An absolute minimum of 400 mm is recommended, and in such situations, the system should only contain ground cover plants. Proprietary filter media that have enhanced performance may be used to reduce the area and depth of filter medium required.

Transition layer – This is required to prevent the washing of fines from the filter medium into the drainage layer. To achieve this, it should be at least 100 mm deep and should be designed using standard geotechnical filter criteria. Alternatively, a geotextile layer can be used, which again should be designed using standard filter criteria.

Drainage layer – The purpose of this layer is to collect water from the filter medium and allow it to reach the perforated pipes easily. The drainage layer should provide adequate cover to the perforated pipes (typically at least 100 mm) and should be of sufficient thickness to ensure that the flow rate of water through it to the pipes is greater than the flow rate of water into the layer from the overlying filter medium and/or transition layer.

Geocellular units can also be used in place of the drainage layer and pipes, especially if extra attenuation storage volume is required.

Perforated pipes – These collect water from the system and convey it downstream. They may not be required if the system is designed to infiltrate. Pipes should have a rodding eye to allow access for cleaning (this could be combined with the overflow).

Overflow – This is achieved with standpipes, weirs or other channels to direct flow to downstream components, once the volume of the system has been exceeded.

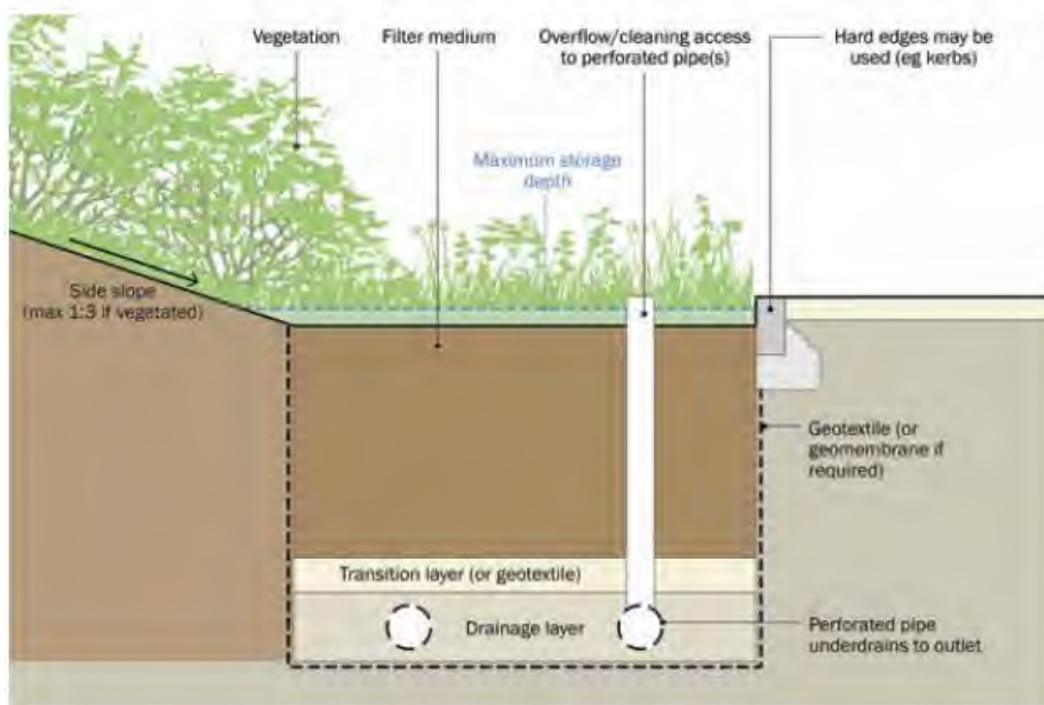


Figure 18 - Rain Garden general cross section (CIRIA, 2015)

Assumptions have been made (See Table 3) about the depths and porosity of the individual layers of proposed rain gardens, based on CIRIA guidance, Greater Manchester SuDS Design Guide and previous project experience. These assumptions will be further refined in the later stages of the design. The resulting volume obtained from 1m² plan area of rain garden is equal to 0.35m³ of storage.

Rain Garden			
Layer	Depth	Porosity	Source
Detention	0.05	1.00	
Mulch	0.05	0.00	
Filtration	0.60	0.25	c753 p350
Geotextile	0.00	0.00	
Drainage	0.50	0.30	c753 p659
Volume per m2:		0.35	

Table 4 - Rain garden attenuation volume (m³ storage per m² garden)

5.2.2 Permeable Paving

Permeable pavements have a surface that is formed of material that is itself impervious to water. The materials are laid to provide void space through the surface to the sub-base (e.g. standard concrete block paving is specifically designed to allow rainwater falling onto the surface or runoff discharged over the surface to infiltrate through the joints or voids between the blocks into the underlying pavement structure) (CIRIA, 2015).

At this stage, none of the interventions are designed in detail however below is a list of the main components of the permeable paving system that need to be further specified as design develops:

Infiltration of rainwater through the pervious surface – surface infiltration rates should be significantly greater than the design rainfall intensity to avoid surface water ponding. A minimum value of 2500mm/h is considered reasonable for a new pavement surface. There is no doubt that the rate of infiltration reduces over time due to accumulation of silt and debris in the pore spaces. However, it is very rare that clogging causes complete sealing of the whole surface, and normally it will continue to provide sufficient drainage capacity.

Slope – on sloping sites, the volume of available storage within the subbase will be reduced when compared to a flat surface. Where slopes are 3% or greater, the designers should consider terracing or internal check dams to provide the series of compartments.

Overflow – for the subbase storage to operate effectively, the system requires flow controls. These are generally small orifice plates in a control chamber and can be very small (min. 20mm) because the risk of blockage is low.

Outflow – outflow from the sub-base should be via a system of perforated pipes or fin drains that provide a large surface area for water to flow into. Perforated pipes should extend at least 1m into the sub-base, and the pipes should be slotted and the capacity of the pipe to convey water should be sufficient to manage anticipated flows.

Expected Loading - pervious pavement can be designed to accommodate a range of traffic loads, and traffic categories. It is expected that the proposed pavement will be classified as category 4 – Mainly pedestrian traffic with emergency HGV vehicles only but this assumption can change at the later design stage.

Choice and thickness of layers – the design of pavement will likely comprises following layers: surfacing made of modular paving units or alternatives, bedding for the levelling of pavement units, base usually comprising either porous asphalt, asphalt concrete, or hydraulically bound material, sub-base and capping that should give sufficient load spreading to provide an adequate construction platform, and potential subgrade improvement layer if the existing ground conditions have particularly low load bearing capacity.

Figure 20.13 Pervious pavement system types: Type B – partial infiltration

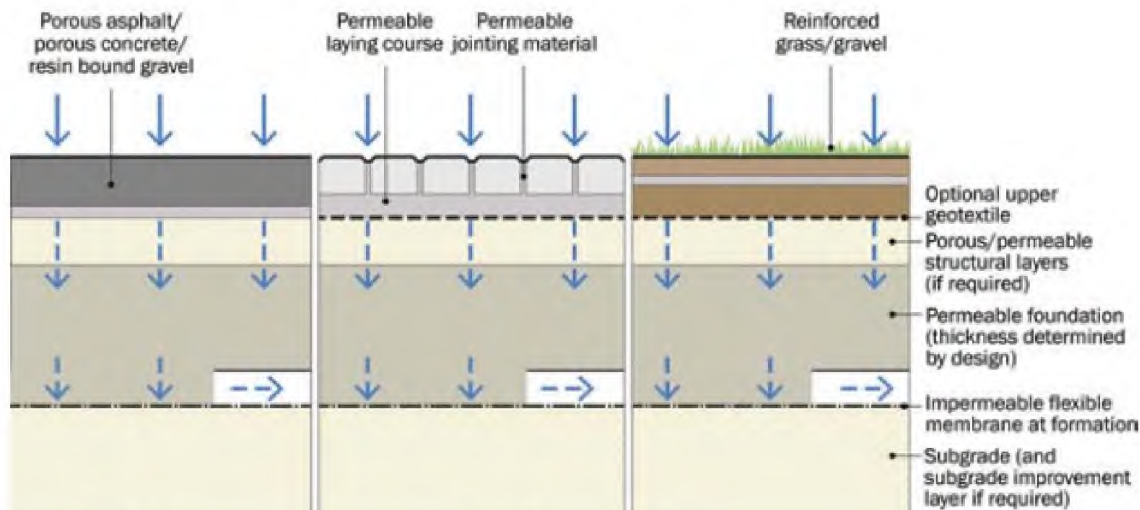


Figure 20.14 Pervious pavement system types: Type C – no infiltration

Figure 19 - Permeable paving general section (CIRIA, 2015)

Preliminary assumptions have been made (See Table 4) about the depths and porosity of the individual layers of proposed permeable paving, based on CIRIA guidance, Greater Manchester SuDS Design Guide and previous project experience. These assumptions will be further refined in the later stages of the design. The resulting volume obtained from 1m² plan area of rain garden is equal to 0.27m³ of storage.

Table 5 Permeable paving attenuation volume (m³ storage per m² paving)

Permeable Paving			
Layer	Depth	Porosity	Source
Surfacing + Bedding	0.13	0.00	c753 p402
Base + Subbase	1.07	0.30	
Volume per m2:		0.32	

5.2.3 Blue Roofs

Blue roofs are designed to replicate natural drainage processes by attenuating and reducing the flow rates of rainwater runoff from rooftops. This method effectively contributes to delivering sustainable drainage systems (SuDS), in dense urban environments (CIRIA, 2024).

At this stage none of the interventions are designed in detail, however, below is a list of the main components of the system that need to be further specified as design develops:

Structural Capability – capability of the attenuation zone to meet the current and future requirements for the roof.

Resistance of components to degradation – corrosion protection of all components, capacity for thermal expansion, wind uplift, floatation and fire.

Roof Outlets – total desirable number of roof outlets for any blue roof area

Overflows – provided to BS EN 12056-3:2000 Rainfall Category 1

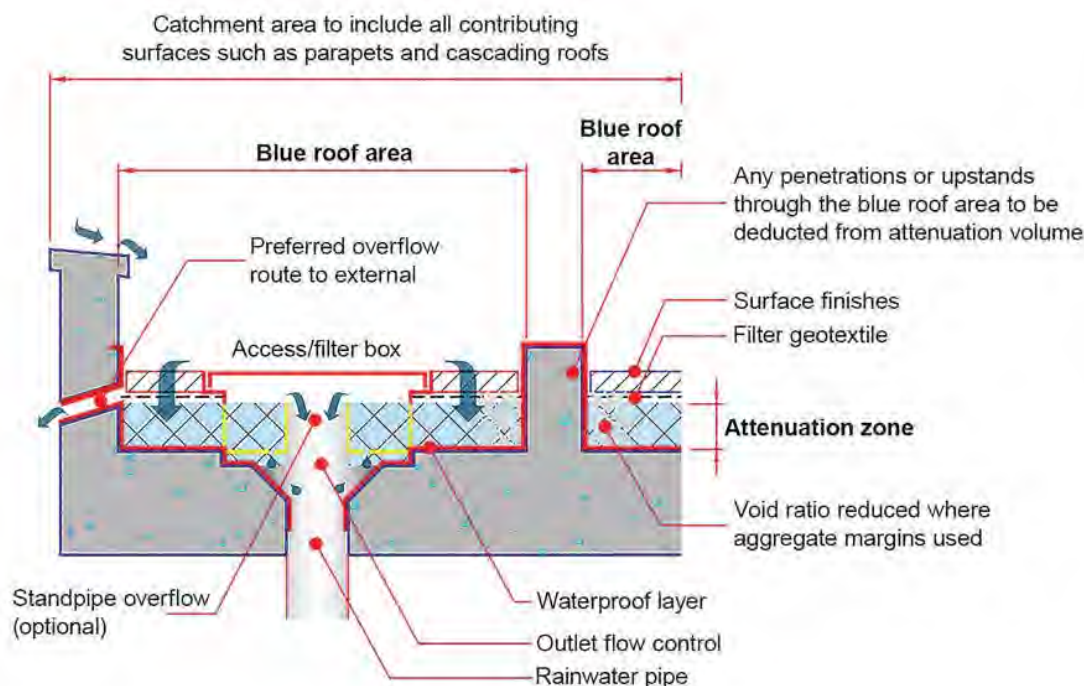


Figure 20 - General blue roof section (CIRIA, 2024)

Preliminary assumptions have been made (See Table 5) about the depths and porosity of the individual layers of proposed blue roof. These assumptions will be further refined in the later stages of the design. The resulting volume obtained from 1m² plan area of rain garden is equal to 0.12m³ of storage.

Table 6 - Blue roof attenuation volume (m³ storage per m² blue roof)

Blue Roof			
Layer	Depth	Porosity	Source
Base + Subbase	0.15	0.80	c817 p41
Volume per m2:		0.12	

There is flexibility within the drainage design and landscape masterplan for this to be a blue roof or a green roof – the holistic solution will be refined as design develops.

5.2.4 Sizing and location of proposed attenuation

Preliminary sizing has been completed and proposed SuDS have been distributed across the site. For a Proposed Drainage Plan drawing and Catchment Plan refer to **Appendix E**. Current calculations show that the proposed development can exceed the required attenuation volumes by approximately 50% for both phases. As the design develops and more information regarding utility constraints and landscaping proposals is developed, the attenuation strategy will be refined, and the most effective interventions will be progressed. By over-provided attenuation at this stage, we mitigate the risk that constraints will pose on the drainage strategy. Where achievable, the design development will look to exceed the 50% brownfield runoff rate reduction if possible.

Provisional space has been provided for below ground storage (attenuation tanks and/or oversized pipes) in both phases - this is to ensure that spatial reservation is accounted for during design development. A large proportion of the proposed attenuation volumes are situated within the central corridor. This central corridor is to act as landscaped public realm and coordination between the landscape architect team and drainage team is ongoing to ensure that landscaping can be provided as active blue-green SuDS assets. Within this central corridor there are two UU combined sewers which are to be retained within an easement – UU have been

engaged regarding these assets and to confirm easement widths. The type, depth and moveability of the SuDS proposed within this central corridor is to be coordinated with UU (their easement and planting restrictions). Therefore, additional space has been allocated for storage at this stage, to mitigate the above risks which could reduce the attenuation volumes achievable in the central corridor.

Design development will ensure that source-control SuDS features take precedence over the below ground storage at the next design stage.

5.2.5 Phase 1 (southern) Attenuation

Phase 1 attenuation includes permeable paving in the courtyard, two raingardens along Cambridge Street and Boundary Street West and a combination of rain gardens and permeable paving on Cavendish Street, north from the United Utilities Sewer Easement. For the breakdown of volumes refer to Table 7.

Table 7 - Phase 1 attenuation volume breakdown

Phase 1	
SuDS Feature	Volume [m3]
Permeable Paving	60
Raingarden 1	33
Raingarden 2	25
SuDS Opportunity 1	87
Below Ground Attenuation	Provisional
Sum	205
Attenuation Required	134
Provided [%]	153%

5.2.6 Phase 2 (northern) Attenuation

Phase 2 attenuation includes a blue roof on the single-storey super kitchen in the courtyard, a raingarden positioned along the Cambridge Street, and a combination of rain gardens and permeable paving on Cavendish Street, south of the United Utilities sewer easement. For the breakdown of volumes refer to Table 8.

Table 8 - Phase 2 attenuation volume breakdown

Phase 2	
SuDS Feature	Volume [m3]
Blue Roof	68
Rain Garden 3	29
SuDS Opportunity 1	103
Below Ground Attenuation	Provisional
Sum	190
Attenuation Required	134
Provided [%]	142%

5.3 Proposed Outfall

The drainage design considered all levels of the discharge hierarchy:

- **Infiltration:** Whilst infiltration SuDS may be the most suitable for new development, developers must consider the risk of contamination to underlying aquifers (Manchester City Council, 2010). Following a desk-based assessment, an intrusive ground investigation was carried out on-site to gain insights into

the underlying geology. The exploratory holes generally show made ground (up to 5.2m thick), comprising both granular and cohesive materials overlaying glacial till (silty clay) as natural ground. Sandstone bedrock is then encountered. Given the extent of cohesive deposits, this would suggest low permeabilities and very low infiltration potential. To determine the feasibility of incorporating infiltration into the surface water drainage design, three BRE365 soil infiltration test pits (SA01 to SA03) were excavated to a depth 2m bgl in made ground and superficial deposits. Permeability values ranging from 1.01E-06 to 5.96E-06 m/s was obtained from testing; these results indicate that the ground has low permeability. Infiltrating through Made Ground could also create a pathway for potential contaminants to migrate into the shallow sandstone aquifer, which is classified as a Principal Aquifer. Infiltration is therefore not being progressed further for this site.

- **Discharge to surface water bodies:** There are two surface water bodies in relative proximity of the site: Cornbrook (culverted) circa. 210m to the south and River Medlock located circa. 320m to the north (See Figure 3). It is considered impractical to discharge to either of these two water bodies as they are deemed too far to provide a reasonable connection, maintaining a gravity network. In addition, the works would cause significant disruption along main highways into Manchester city centre, with the requirement to install deep excavations across the highway to form new connections to the watercourse(s) (for example at the junction of Higher Cambridge Street and Booth Street West).
- **Discharge to surface water sewers:** There are no known surface water sewers within the proximity of the proposed development (based off desktop studies), therefore it has been ruled out as a possible connection option.
- **Discharge to combined sewers:** Given the impracticality of alternative options, it is proposed that the site will utilise the existing connection point to the 600x750mm combined sewer on Higher Chatham Street. Sections 5.2 outlines how the proposed attenuation is designed to reduce the discharge rates by 50% compared to the existing brownfield runoff rate.

5.4 Maintenance

To ensure the long-term performance and effectiveness of the SuDS features, a maintenance plan must be implemented as outlined in the CIRIA SuDS Manual C753. The plan would need to include the following elements:

1. Rain Gardens

Maintenance of rain gardens, as per Clause 32.3.6 in CIRIA C753, involves regular inspections and activities to sustain their hydraulic and aesthetic performance:

- **Regular Inspections:** Inspections should be conducted quarterly to check for sedimentation, erosion, or poor plant health (C753, Clause 32.3.6.4). Inlets and outlets must be inspected for blockages to ensure effective water flow.
- **Routine Maintenance:** Debris, litter, and weeds should be removed at least biannually. Vegetation density must be maintained by replacing dead or unhealthy plants annually (C753, Clause 32.3.6.5).
- **Remedial Actions:** Stabilise eroded areas with soil and vegetation consistent with the original design. If filter media is compromised, it may require replacement or rejuvenation through scarification (C753, Clause 32.3.6.7).

2. Permeable Paving

Maintenance procedures for permeable paving should adhere to Clause 20.6 of CIRIA C753:

- **Sweeping and Cleaning:** Annual sweeping and suction cleaning should be performed to remove sediment and restore permeability (C753, Clause 20.6.3).

- **Inspection:** Regular inspections should be undertaken to check for clogging, sediment accumulation, or debris. Specialized deep cleaning may be required if infiltration rates are significantly reduced (C753, Clause 20.6.4).
- **Material Replacement:** Jointing material should be replaced as needed during maintenance to preserve structural and hydraulic performance (C753, Clause 20.6.6).

3. Blue Roofs

Maintenance tasks for blue roofs should include:

- **Inspections:** Semi-annual inspections and post-storm checks should be undertaken to ensure that drainage inlets and outlets are free of blockages. The roof's waterproofing layer should be inspected annually.
- **Routine Maintenance:** Removal of debris and cleaning of drainage components should be conducted to maintain proper drainage.
- **Specialist Cleaning:** Gravel or modular units should be cleaned if sediment impairs performance. Throttled outlets may need adjustment to achieve the designed flow rates.

4. Below Ground Attenuation

Maintenance tasks should be undertaken to ensure the long-term performance of below-ground storage tanks in accordance with CIRA SuDS Manual C753:

- **Regular Inspections:** Visual inspections of silt trap manholes should be conducted annually to check for sediment accumulation and blockages that may impede performance (C753, Clause 21.3.5).
- **Routine Cleaning:** Removal of silt and debris should be carried out as required, following observations during inspections. Suction tankers may be used for sediment removal in larger systems (C753, Clause 21.3.6).
- **Structural Integrity Checks:** Geotextiles and other structural components should be inspected for wear or damage during maintenance cycles, with rehabilitation scheduled every 10–25 years, depending on sediment load and component design (C753, Clause 21.3.7).
- **Performance Monitoring:** Monitoring of infiltration rates and water levels should be performed through inspection access points, ensuring the system functions within its designed specifications (C753, Clause 21.3.5).

5. Maintenance Schedule

A detailed maintenance schedule should be developed during the design phase, tailored to the specific site and finalised SuDS features. This schedule must account for regular and remedial actions, adjusted based on ongoing inspections and performance evaluations.

5.5 Proposed Foul Drainage

It is expected that the development will reuse one or more of existing foul drainage gravity connections, anticipated to be found in locations shown in Figure 21. Foul loadings will increase given the additional occupancy of the proposed development. However, with the reduction in the flow rate of surface water entering the combined sewer, this impact would be offset by the proposed surface water discharge restrictions. Hydraulic modelling will be conducted at the further design stage when more information is obtained on proposed flow rates. This will allow UU to review the capacity of their network and inform of the impact the expected additional discharge into the combined sewer network will have in this location.

The proposed foul discharge strategy will consider:

- Diversion, disconnection, and abandonment of existing foul drainage from the proposed building.
- Protection of the UU sewers in Cavendish Street.
- Abandonment of UU sewer beneath the existing northern building.
- New connections into the existing combined sewer network.
- Capacity verification of the existing network with proposed flows.

For details of the existing private and public sewer network on site and on the adjacent streets refer to drawing CAM-ARP-ZZ-ZZ-DR-C-0001 shown in **Appendix E**.



Figure 21 - Foul Drainage Connections

5.6 Consultation

Local authorities, such as Manchester City Council are designated as Lead Local Flood Authorities (LLFAs) and are responsible for leading on local flood risk management. As the site area exceeds 0.5 ha and is located within the Council's Critical Drainage Area, early engagement with the LLFA took place during the concept design stage (Table 8). Early engagement with United Utilities has also been initiated, as the proposal will need to coordinate with existing UU sewers on Cavendish Street and includes connections to combined sewer network.

<u>Date</u>	<u>Consultee</u>	<u>Format</u>	<u>Discussion/ Outcome</u>
27/06/24	UU	Email	Overview of scheme and request for confirmation on easement requirements for sewers on Cavendish Street. Request for re-use of existing build-over agreement.
01/07/24	UU	Email	UU confirmed a 3m easement would apply either side of centreline of their sewers as per Building Regulations H4. Requested if possible – 5m clearance either side of centreline for the 12m deep sewer given its size and material.
08/07/24	UU	Email	UU confirmed no build over agreement would be provided for Cavendish Street
09/07/24	UU	Email	UU advised a diversion of the 12m deep sewer may be possible – however this would incur significant costs.
15/08/24	MCC (LLFA)	Email	Pre-planning enquiry to inform of scheme and agree discharge restrictions.
08/10/24	MCC (LLFA)	Meeting	Overview of the proposed scheme – agreement in principle to 50% reduction in run-off granted actively drained brownfield site – pending FRA submission. LLFA confirmed no further engagement needed until planning submission.
08/11/24	UU	Email	UU advised of blockages in their network post CCTV survey – clearance needed to confirm condition of remaining UU sewers within the site boundary. Clearance works planned by UU Dec 2025.
12/11/24	UU	Email	UU acknowledgement of blockages – UU networks team informed for clearing
04/12/24	UU	Email	Updated UU on current drainage strategy and progress of the design development
09/12/24	UU	Email	UU confirmed no further information required at this stage
11/02/2025	UU	Email	UU confirmed cleaning all reported blockages of surrounding sewers.

Table 9: Consultation overview

6. Conclusion and Next Steps

6.1 Conclusion

This Flood Risk Assessment and Drainage Strategy report demonstrates that the proposed development site can effectively manage flood risk through a combination of sustainable drainage systems and flood mitigation measures. By analysing historical data, current site conditions, and future climate change projections, the report identifies potential flood hazards and outlines strategies to mitigate these risks.

Key measures include the implementation of blue roofs, permeable paving, rain gardens, and below ground storage, along with a comprehensive maintenance plan for each element. These strategies shall ensure that surface water runoff is managed efficiently, reducing the likelihood of flooding, and protecting the development and its occupants.

In conclusion, with the adoption of the recommended drainage strategy and flood mitigation measures, the development site will be resilient to flood risk, promoting safety, sustainability, and long-term viability. Regular monitoring and maintenance will further enhance the effectiveness of these measures, ensuring the site's preparedness for future climatic changes.

6.2 Next Steps

- Further engagement with UU and LLFA on agreed outfall locations and to confirm surface water discharge restrictions.
- Progress the drainage strategy into a detailed design, specifying the types and locations of SuDS and drainage networks, to mitigate against flooding.
- Collaborate closely with architects, engineers, and other design team members to integrate the drainage strategy into the overall spatial design.
- Survey the position of the United Utilities sewers that cross site which are to remain post development – to confirm plan positions and spatial design with wider design team.
- Prepare and submit necessary documentation for regulatory approvals, ensuring compliance with local planning and environmental regulations.
- Develop a comprehensive risk management plan, identifying potential risks and mitigation strategies related to flooding and drainage.
- Maintenance plan – Identify plan, owner, and frequency of maintenance for SuDS.
- Agree strategy and points of connections for foul flows – to drain to existing surrounding combined sewer(s) by gravity.

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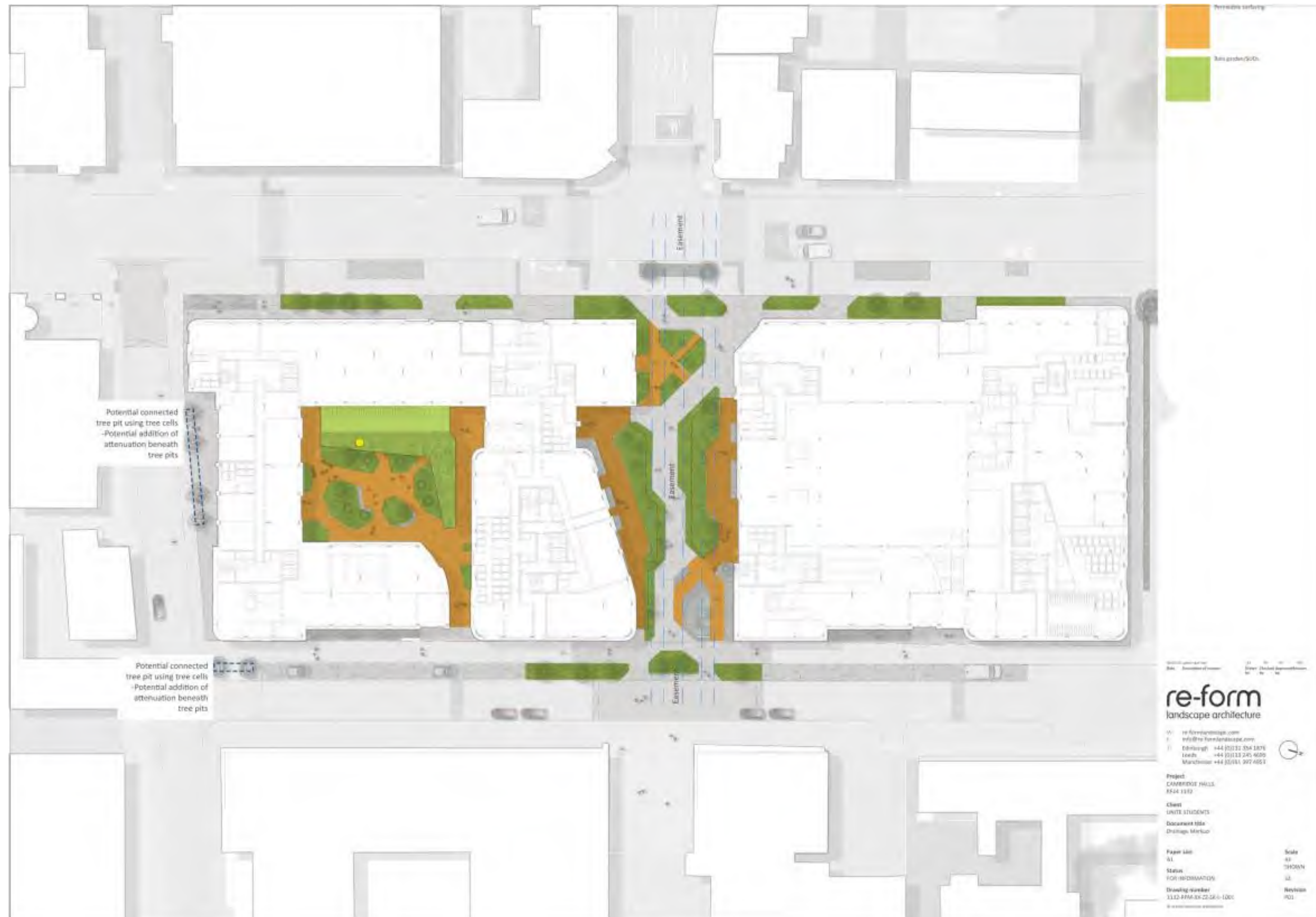
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Appendix A – Layout Masterplan



Appendix B - Historical Flooding Data

Flood risk assessment data



Location of site: 384153 / 396969 (shown as easting and northing coordinates)

Document created on: 14 April 2025

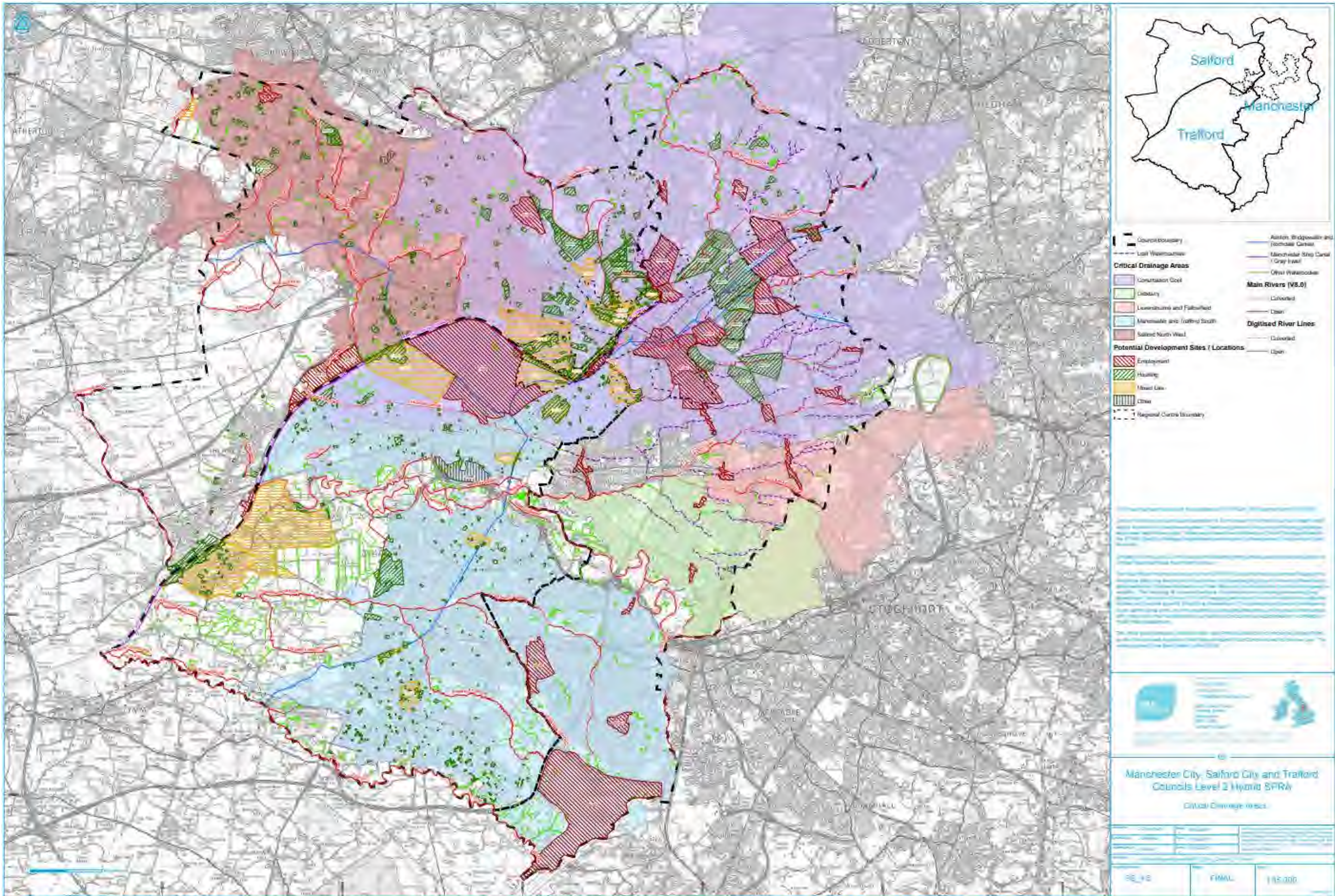
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Customer reference number: WVXRMHR1MAJ3

Map showing the location that flood risk assessment data has been requested for.



Appendix C – Critical Drainage Areas Map



Appendix D - InfoDrainage Quick Storage Estimate

Rainwater Storage – Modelled InfoDrainage data

30-year return period:

The 'Quick Storage Estimate' dialog box is shown with the 'Variables' tab selected. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area displays the following variables and values:

Variable	Value
FSR Rainfall	30
Return Period (years)	30
Region	England and Wales
Map	M5-60 (mm) 18.000
Ratio R	0.362
Cv (Summer)	0.750
Cv (Winter)	0.840
Impervious Area (ha)	0.850
Maximum Allowable Discharge (l/s)	79.1
Infiltration Coefficient (m/hr)	0.00000
Safety Factor	2.0
Climate Change (%)	40

Buttons at the bottom: Analyse, OK, Cancel, Help. A status bar at the bottom reads: Enter Climate Change between -100 and 600.

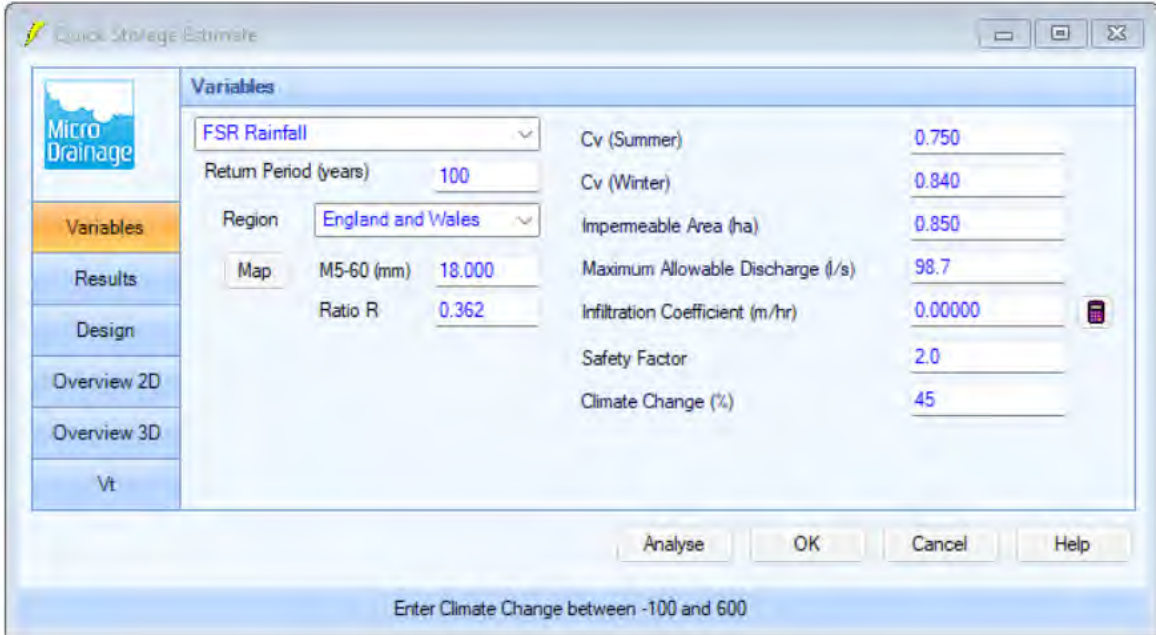
The 'Quick Storage Estimate' dialog box is shown with the 'Results' tab selected. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area displays the following results:

Global Variables require approximate storage of between 92 m³ and 191 m³.

These values are estimates only and should not be used for design purposes.

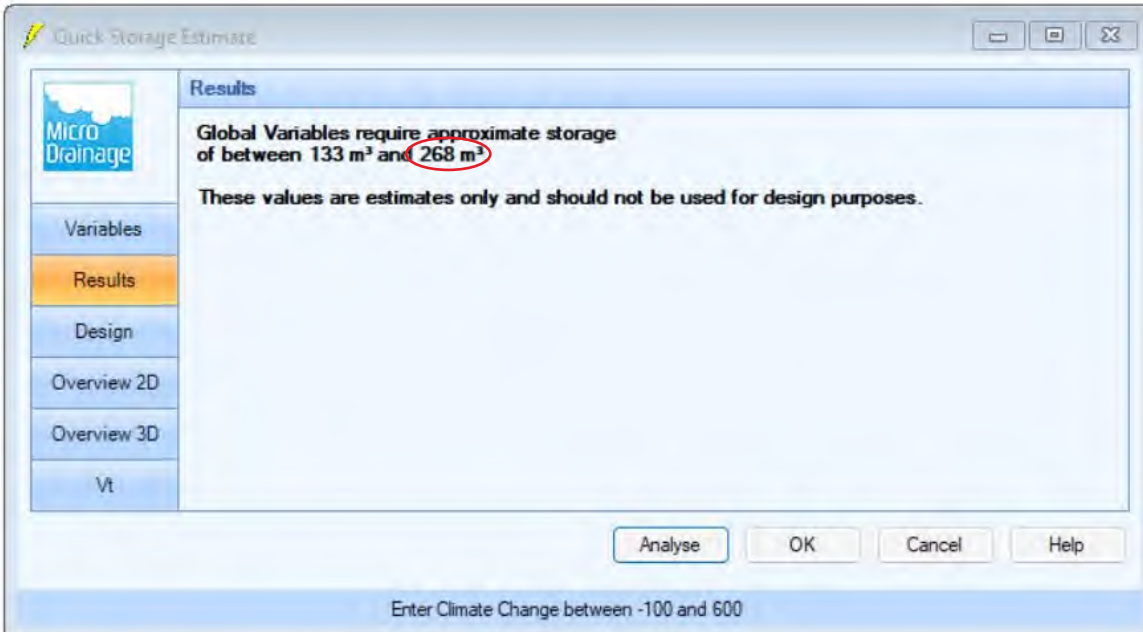
Buttons at the bottom: Analyse, OK, Cancel, Help. A status bar at the bottom reads: Enter Climate Change between -100 and 600.

100-year return period:



The screenshot shows the 'Variables' tab of the 'Quick Storage Estimate' window. The left sidebar contains a vertical menu with 'Variables' selected. The main area is divided into two columns of input fields. The first column includes 'FSR Rainfall' (dropdown), 'Return Period (years)' (100), 'Region' (England and Wales), 'Map' (M5-60 (mm) 18.000), and 'Ratio R' (0.362). The second column includes 'Cv (Summer)' (0.750), 'Cv (Winter)' (0.840), 'Impervious Area (ha)' (0.850), 'Maximum Allowable Discharge (l/s)' (98.7), 'Infiltration Coefficient (m/hr)' (0.00000), 'Safety Factor' (2.0), and 'Climate Change (%)' (45). At the bottom, there are 'Analyse', 'OK', 'Cancel', and 'Help' buttons, and a status bar that reads 'Enter Climate Change between -100 and 600'.

Variable	Value
FSR Rainfall	[Dropdown]
Return Period (years)	100
Region	England and Wales
Map	M5-60 (mm) 18.000
Ratio R	0.362
Cv (Summer)	0.750
Cv (Winter)	0.840
Impervious Area (ha)	0.850
Maximum Allowable Discharge (l/s)	98.7
Infiltration Coefficient (m/hr)	0.00000
Safety Factor	2.0
Climate Change (%)	45

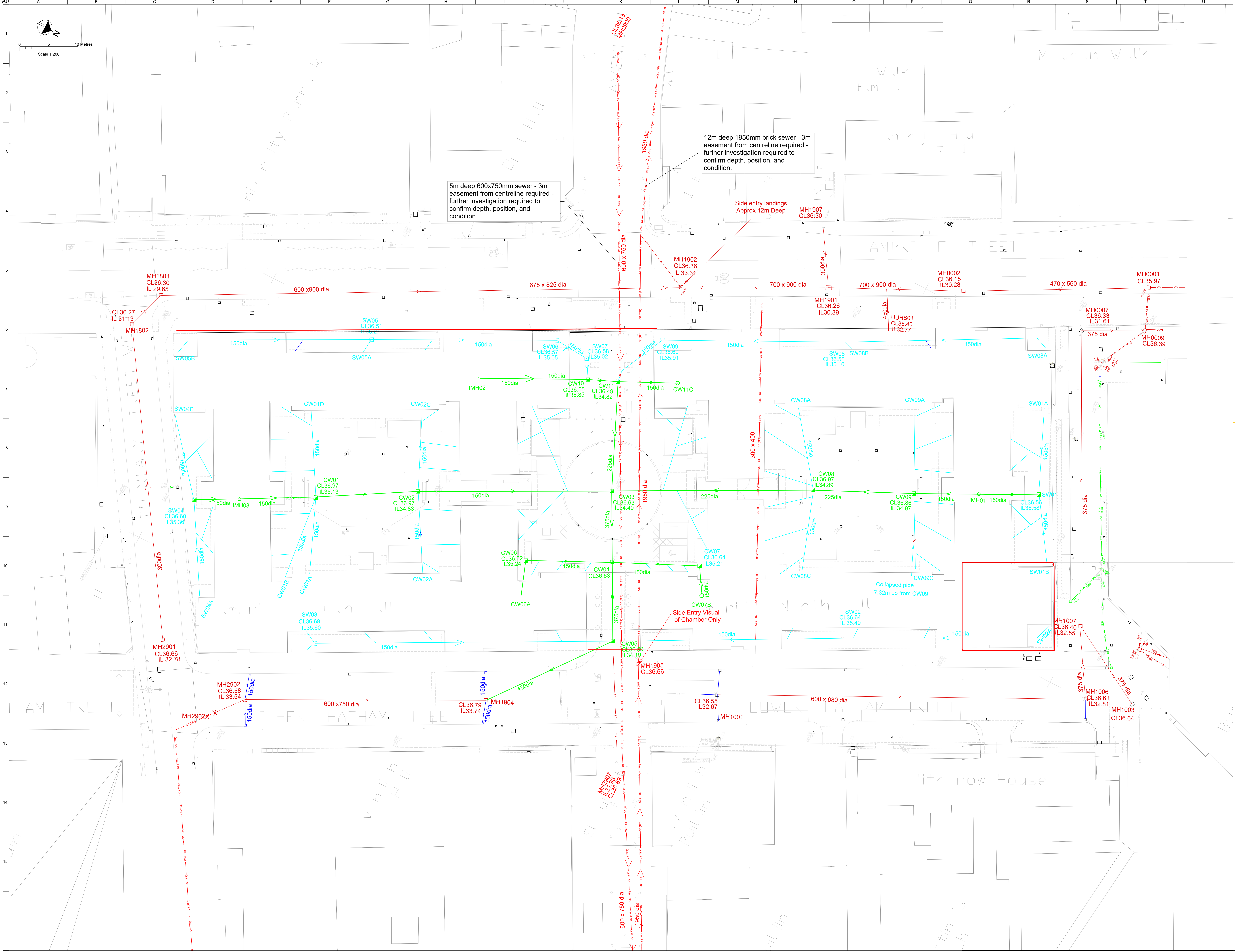


The screenshot shows the 'Results' tab of the 'Quick Storage Estimate' window. The left sidebar has 'Results' selected. The main area displays the following text: 'Global Variables require approximate storage of between 133 m³ and 268 m³', where '268 m³' is circled in red. Below this, it says 'These values are estimates only and should not be used for design purposes.' At the bottom, there are 'Analyse', 'OK', 'Cancel', and 'Help' buttons, and a status bar that reads 'Enter Climate Change between -100 and 600'.

Global Variables require approximate storage of between 133 m³ and 268 m³

These values are estimates only and should not be used for design purposes.

Appendix E – Civils Drawings



NOTES

- This drawing has been produced for information and should not be used for construction
- Do not scale from this drawing or the digital data
- This drawing provides RIBA Stage 2 information and is subject to design development
- This drawing is based off the topographical survey undertaken by CADPlan dated 05/07/2024 and revised on 13/02/2025
- Drainage sized and positions based off CCTV survey undertaken by Lanes Group dated 30/09/2024

LEGEND

- Existing UU Surface Water Pipe
- Existing UU Surface Water Manhole
- Existing UU Combined Water Pipe
- Existing UU Combined Water Manhole
- Existing Foul Water Pipe
- Existing Foul Water Manhole
- Existing Private Combined Water Pipe
- Existing Private Combined Water Manhole
- Existing Private Surface Water Pipe
- Existing Private Surface Water Manhole
- Existing Unidentified / Un-surveyed Pipe
- Red Line Boundary

P02	24/04/25	Revised For Updated Topo Survey
P01	20/12/24	For Information
Issue	Date	Description

ARUP

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Client
Unite Students

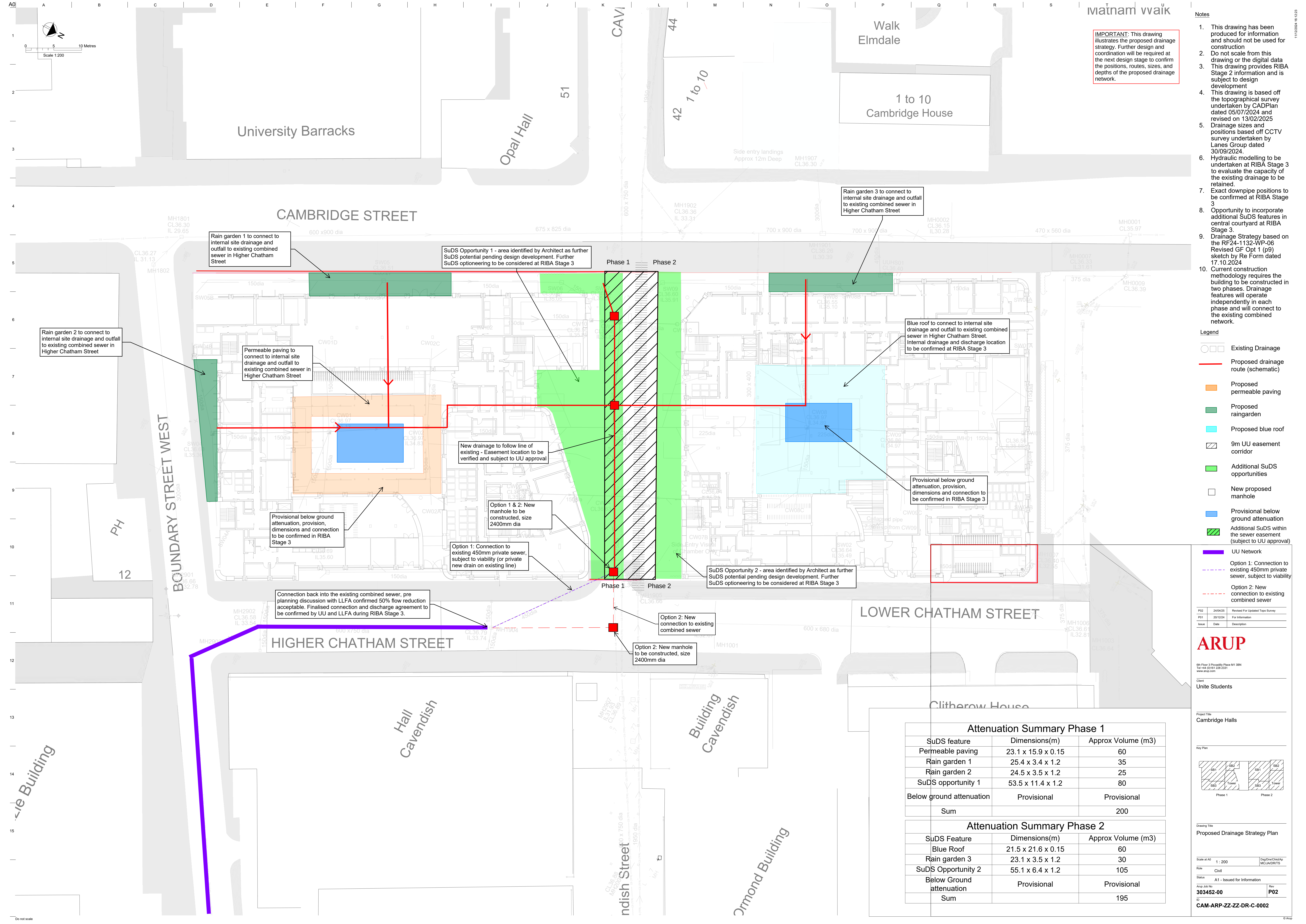
Project Title
Cambridge Halls

Key Plan

SB1	SB2
SB3	SB4
SB5	SB6
SB7	SB8
SB9	SB10
SB11	SB12
SB13	SB14
SB15	SB16
SB17	SB18
SB19	SB20
SB21	SB22
SB23	SB24
SB25	SB26
SB27	SB28
SB29	SB30
SB31	SB32
SB33	SB34
SB35	SB36
SB37	SB38
SB39	SB40
SB41	SB42
SB43	SB44
SB45	SB46
SB47	SB48
SB49	SB50
SB51	SB52
SB53	SB54
SB55	SB56
SB57	SB58
SB59	SB60
SB61	SB62
SB63	SB64
SB65	SB66
SB67	SB68
SB69	SB70
SB71	SB72
SB73	SB74
SB75	SB76
SB77	SB78
SB79	SB80
SB81	SB82
SB83	SB84
SB85	SB86
SB87	SB88
SB89	SB90
SB91	SB92
SB93	SB94
SB95	SB96
SB97	SB98
SB99	SB100

Drawing Title
Existing Drainage Plan

Scale at A0	1 : 200	Drawn/Checked/Approved MCJ/ADR/TS
Role	Civil	
Status	A1 - Issued for Information	
Arup Job No	303452-00	Rev P02
ID	CAM-ARP-ZZ-ZZ-DR-C-0001	



- Notes
- This drawing has been produced for information and should not be used for construction
 - Do not scale from this drawing or the digital data
 - This drawing provides RIBA Stage 2 information and is subject to design development
 - This drawing is based off the topographical survey undertaken by CADPlan dated 05/07/2024 and revised on 13/02/2025
 - Drainage sizes and positions based off CCTV survey undertaken by Lanes Group dated 30/09/2024.
 - Hydraulic modelling to be undertaken at RIBA Stage 3 to evaluate the capacity of the existing drainage to be retained.
 - Exact downpipe positions to be confirmed at RIBA Stage 3
 - Opportunity to incorporate additional SuDS features in central courtyard at RIBA Stage 3.
 - Drainage Strategy based on the RF24-1132-WP-06 Revised GF Opt 1 (p9) sketch by Re Form dated 17.10.2024
 - Current construction methodology requires the building to be constructed in two phases. Drainage features will operate independently in each phase and will connect to the existing combined network.

- Legend
- Existing Drainage
 - Proposed drainage route (schematic)
 - Proposed permeable paving
 - Proposed raingarden
 - Proposed blue roof
 - 9m UU easement corridor
 - Additional SuDS opportunities
 - New proposed manhole
 - Provisional below ground attenuation
 - Additional SuDS within the sewer easement (subject to UU approval)
 - UU Network
 - Option 1: Connection to existing 450mm private sewer, subject to viability
 - Option 2: New connection to existing combined sewer

PI0224/04/25Revised For Updated Topo Survey

PI0120/12/24For Information

IssueDateDescription

ARUP

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Client

Unite Students

Project Title

Cambridge Halls

Key Plan

Drawing Title

Proposed Drainage Strategy Plan

Scale at A0

1 : 200

DwgDwn/Chkd/Up

MCJ/AJDR/TS

Rate

Civil

Status

A1 - Issued for Information

Arup Job No

303452-00

Rev

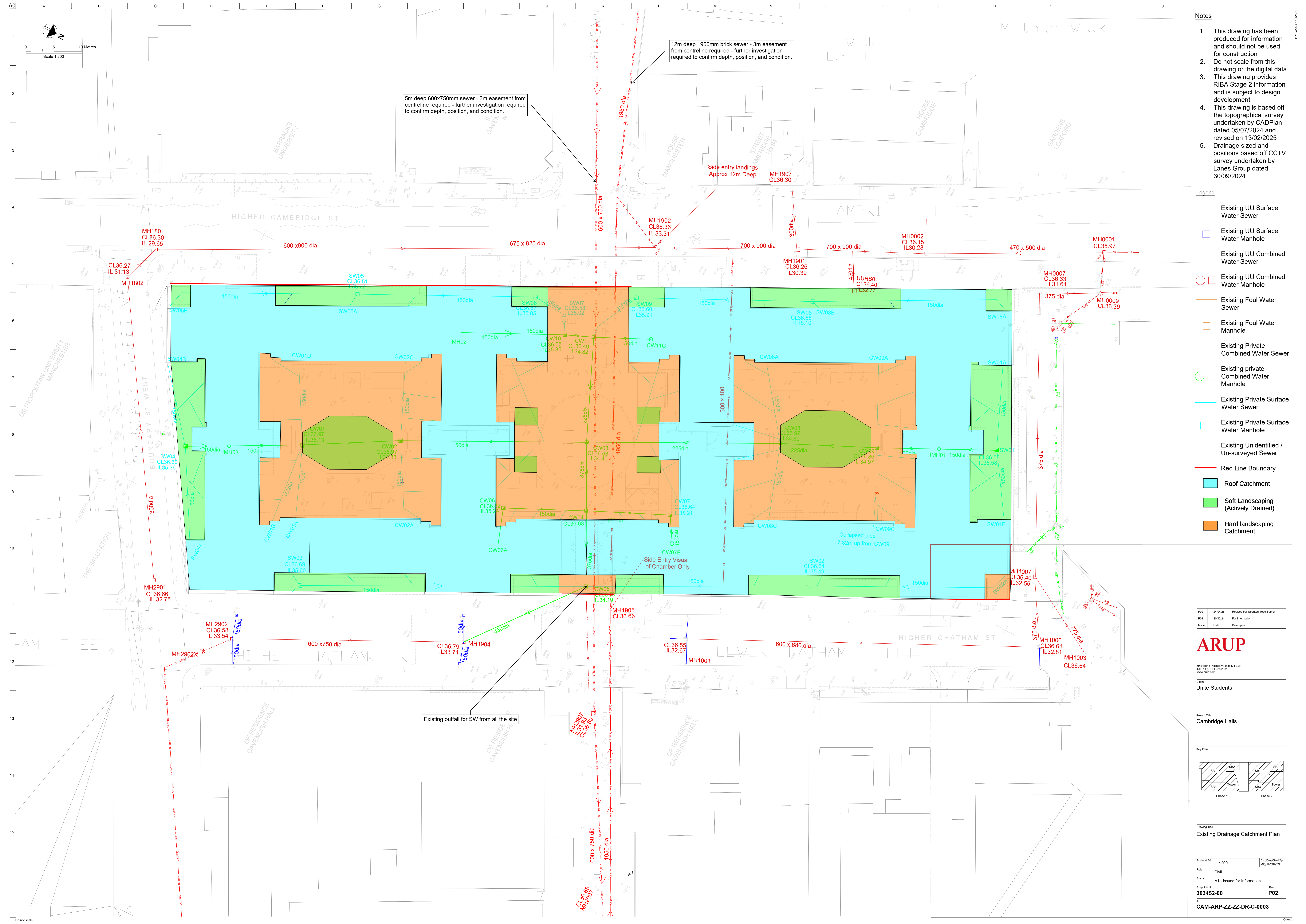
P02

ID

CAM-ARP-ZZ-ZZ-DR-C-0002

Attenuation Summary Phase 1		
SuDS feature	Dimensions(m)	Approx Volume (m3)
Permeable paving	23.1 x 15.9 x 0.15	60
Rain garden 1	25.4 x 3.4 x 1.2	35
Rain garden 2	24.5 x 3.5 x 1.2	25
SuDS opportunity 1	53.5 x 11.4 x 1.2	80
Below ground attenuation	Provisional	Provisional
Sum		200

Attenuation Summary Phase 2		
SuDS Feature	Dimensions(m)	Approx Volume (m3)
Blue Roof	21.5 x 21.6 x 0.15	60
Rain garden 3	23.1 x 3.5 x 1.2	30
SuDS Opportunity 2	55.1 x 6.4 x 1.2	105
Below Ground attenuation	Provisional	Provisional
Sum		195



- Notes
1. This drawing has been produced for information and should not be used for construction
 2. Do not scale from this drawing or the digital data
 3. This drawing provides RIBA Stage 2 information and is subject to design development
 4. This drawing is based off the topographical survey undertaken by CADPlan dated 05/07/2024 and revised on 13/02/2025
 5. Drainage sized and positions based off CCTV survey undertaken by Lanes Group dated 30/09/2024

- Legend
- Existing UU Surface Water Sewer
 - Existing UU Surface Water Manhole
 - Existing UU Combined Water Sewer
 - Existing UU Combined Water Manhole
 - Existing Foul Water Sewer
 - Existing Foul Water Manhole
 - Existing Private Combined Water Sewer
 - Existing private Combined Water Manhole
 - Existing Private Surface Water Sewer
 - Existing Private Surface Water Manhole
 - Existing Unidentified / Un-surveyed Sewer
 - Red Line Boundary
 - Roof Catchment
 - Soft Landscaping (Actively Drained)
 - Hard landscaping Catchment

P02	24/04/25	Revised For Updated Topo Survey
P01	20/12/24	For Information
Issue	Date	Description

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Client
Unite Students

Project Title
Cambridge Halls

Key Plan

Phase 1 Phase 2

Drawing Title
Existing Drainage Catchment Plan

Scale at A0: 1 : 200
Rule: Civil
Status: A1 - Issued for Information
Rev: P02

Arup Job No: 303452-00
ID: CAM-ARP-ZZ-ZZ-DR-C-0003



- Notes
1. This drawing has been produced for information and should not be used for construction
 2. Do not scale from this drawing or the digital data
 3. This drawing provides RIBA Stage 2 information and is subject to design development
 4. This drawing is based off the topographical survey undertaken by CADPlan dated 05/07/2024 and revised on 13/02/2025
 5. Drainage sizes and positions based off CCTV survey undertaken by Lanes Group dated 30/09/2024.
 6. Hydraulic modelling to be undertaken at RIBA Stage 3 to evaluate the capacity of any existing drainage to be retained.
 7. Exact downpipe positions to be confirmed at RIBA Stage 3
 8. Opportunity to incorporate additional SuDS features in central courtyard at RIBA Stage 3.
 9. Drainage Strategy based on the RF24-1132-WP-06 Revised GF Opt 1 (p9) sketch by Re Form dated 17.10.2024

- Legend
- Existing Drainage
 - Schematic Drainage Route
 - UU Network
 - Blue Roof Catchment
 - Permeable Paving Catchment
 - Rain Garden Catchment
 - SuDS Opportunity Catchment
 - Option 1: Connection to existing 450mm private sewer, subject to viability
 - Option 2: New connection to existing combined sewer

IMPORTANT: This drawing illustrates the proposed drainage strategy. Further design and coordination will be required at the next design stage to confirm the positions, routes, sizes, and depths of the proposed drainage network.

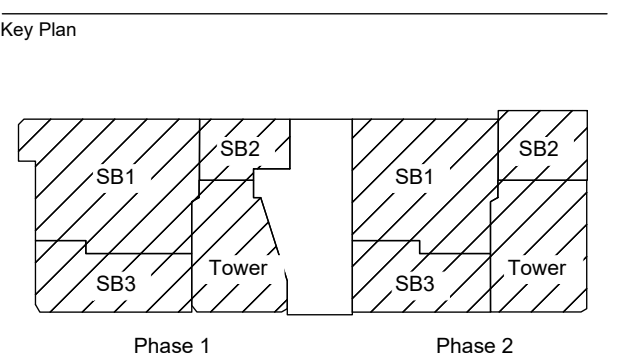
P02	24/04/25	Revised For Updated Topo Survey
P01	20/10/24	For Information
Issue	Date	Description

ARUP

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Client
Unite Students

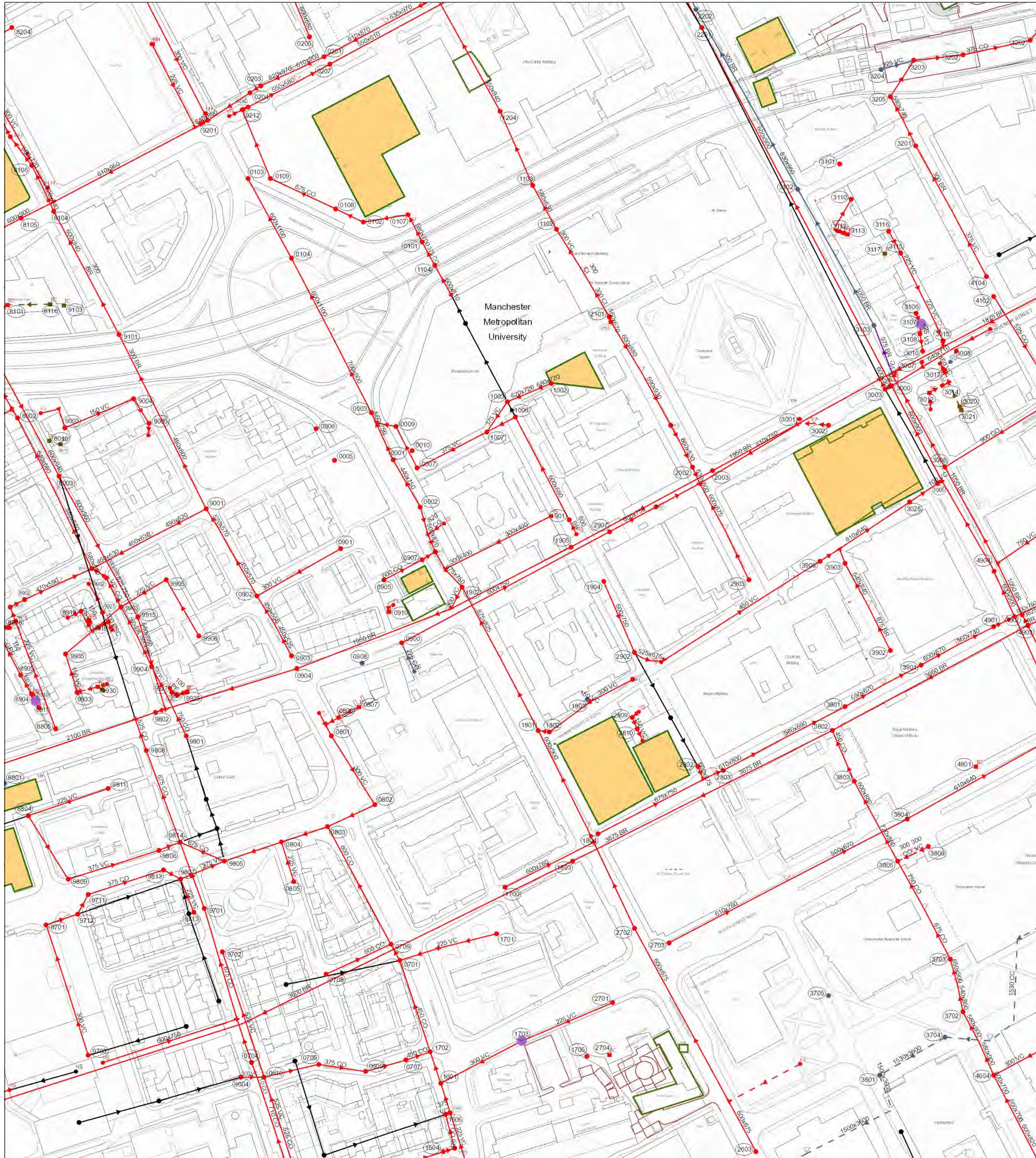
Project Title
Cambridge Halls



Drawing Title
Proposed Drainage Catchment Plan

Scale at A0	1 : 200	Drawn/Checked/Approved	MCJ/ADR/TS
Role	Civil		
Status	A1 - Issued for Information		
Arup Job No	303452-00	Rev	P02
ID	CAM-ARP-ZZ-ZZ-DR-C-0004		

Appendix F – United Utilities Records



Refo	Cover	Func	Invert	Size x	Size y	Shape	Matl	Length	Grad
1702	CO	0	31.44	450			BR	11.88034	1 in 171
1803	CO	0	31.44	450			BR	379.131	
0009	CO	0	31.44	450			VC	11.18008	
9711	CO	0	31.44	450			CO	43.70504	
3103	CO	0	31.44	450			BR	34.41693	
1103	CO	0	31.44	450			BR	44.77723	
4901	37.77	CO	31.83	450			BR	6.70804	
0609	34.9	CO	31.83	450			CO	23.23455	
9923	CO	0	31.44	450			VC	18.05026	
1007	CO	0	31.44	450			VC	43.1763	
0201	34.75	CO	24.93	610			BR	18.78829	
4604	CO	0	31.44	450			BR	18.67772	
3806	37.02	CO	34.33	300			VC	9.944272	1 in 0.28376497
2007	CO	0	31.44	450			CO	27.37044	
1802	36.19	CO	31.1	300			VC	6.082763	1 in 43
4202	38.88	CO	31.52	375			BR	14.21267	1 in 203
0104	32.41	CO	28.37	600			BR	50.11986	
9902	35.49	CO	30.02	550			BR	5	1 in 100
0003	35.9	CO	30.39	700			BR	48.30214	1 in 45
1204	CO	0	31.44	450			BR	82.36504	
3801	37.35	CO	30.69	600			BR	22.82542	1 in 208
9808	35.27	CO	24.9	525			CO	18.02776	
2803	CO	0	31.44	450			BR	140.0643	
0802	35.8	CO	32.06	300			VC	28.63564	1 in 37
0707	CO	0	31.44	450			CO	14.01056	
0601	35.63	CO	33.06	300			VC	52.83038	
8804	CO	0	31.44	450			VC	41.34005	1 in 181
0809	34.79	CO	31.94	375			VC	52.40762	
2101	37.14	CO	28.5	300			CI	27.78489	1 in 1
4904	37.88	CO	32.22	600			VC	54.95051	
0205	CO	0	31.44	450			VC	80.23092	1 in 103
2901	36.54	CO	31.97	300			VC	24.54264	1 in 327
6807	35.23	CO	30.81	375			CO	13.07304	
1207	CO	0	31.44	450			CO	20.05125	
3801	36.43	SW	33.88	1500			CO	31.02195	
3115	CO	0	31.44	450			VC	43.24533	
9917	CO	0	31.44	450			PSC	16.16164	
3903	37.46	CO	34.04	610			BR	54.89618	
9913	CO	0	31.44	450			CO	10.58698	1 in 776
9701	34.98	CO	27.92	675			CO	38.81314	
2002	37.05	CO	27.91	630			BR	9.84858	
3802	37.4	CO	20.78	3875			BR	180.1031	
4903	37.81	CO	0	1050			VC	6.642311	
3108	CO	0	31.44	450			VC	9.75594	
9933	CO	0	31.44	450			VC	22.10219	1 in 298
3704	36.45	SW	34.02	1530			CO	41.07133	
1804	CO	0	31.44	450			BR	72.00751	1 in 34
0108	35.47	CO	30.72	675			VC	39.4644	
3003	37.73	CO	0	600			BR	6.188076	
3008	37.79	CO	33.52	640			BR	38.8495	1 in 175
9935	CO	0	31.44	450			VC	39.9147	
9705	34.81	CO	32.54	300			VC	36.68767	
1801	36.21	CO	30.96	600			BR	45.17743	1 in 762
3803	36.72	CO	28.11	690			BR	13.13515	
1002	CO	0	31.44	450			BR	13.89244	
8002	34.96	CO	28.81	640			BR	18.54775	1 in 96
3025	CO	0	31.44	450			BR	122.2249	1 in 105
4903	37.81	CO	22.03	3600			BR	15.20769	
3702	CO	0	31.44	450			BR	52.48031	
2702	36.29	CO	31.97	600			BR	189.0641	
0207	34.85	CO	0	550			VC	63.85637	
1001	36.52	CO	33.01	600			VC	2.815737	
3005	37.9	CO	0	100			BR	24.18977	1 in 806
3801	37	CO	30.78	590			CO	27.18615	1 in 136
3203	37.13	CO	32.68	375			VC	35.8469	1 in 149
0906	35.25	CO	33.04	225			CO	40.85452	1 in 35
0109	35.14	CO	29.56	675			BR	46.51881	1 in 89
9901	35.48	CO	29.86	580			BR	4.11281	
3000	CO	0	31.44	450			BR	53.85563	
3001	35.41	CO	32.23	480			BR	12.05993	1 in 238
2001	36.98	CO	27.88	600			CO	30.90709	1 in 2
0708	CO	0	31.44	450			CO	38.21952	
3805	CO	0	31.44	450			CO	25.05993	
0610	34.8	CO	31.95	375			CO	30.90709	1 in 238
3803	36.43	CO	29.83	675			CO	40.41381	1 in 2
2810	CO	0	31.44	450			VC	7.175132	1 in 51
0701	35.73	CO	31.11	600			CO	10.16865	1 in 72
9212	34.35	CO	28.45	550			BR	3.613208	1 in 104
3204	37.09	SW	34.62	225			BR	28.6531	1 in 239
3006	37.88	CO	28.1	1050			BR	38.47077	1 in 185
2803	36.54	CO	31.29	610			BR	38.47077	1 in 107
0203	34.37	CO	28.68	600			VC	44.94441	1 in 158
0801	35.54	CO	32.81	300			VC	53.8653	1 in 107
9914	36.1	CO	27.87	675			BR	6.800188	
4104	37.94	CO	35.14	375			BR	23.85041	1 in 140
2809	CO	0	31.44	450			VC	41.16122	
3007	37.67	CO	24.65	1950			VC	56.42175	1 in 83
9003	CO	0	31.44	450			VC	12.2302	1 in 249
1703	35.78	CO	31.94	300			VC	57.30619	1 in 118
9604	CO	0	31.44	450			BR	33.10589	1 in 156
9916	CO	0	31.44	450			CO	26.63363	1 in 332
9712	CO	0	31.44	450			CO	33.20076	1 in 46
0605	34.68	CO	33.2	225			BR	18.18104	1 in 59
3102	37.09	SW	26.95	630			VC	95.04575	
2202	36.37	SW	26.49	300			VC	30.14034	
9805	35.06	CO	30.53	675			VC	20.15668	
0804	35	CO	30.79	600			BR	3.162278	
0007	CO	0	31.44	450			CO	23.85372	
0001	35.41	CO	32.37	490			BR	64.14047	1 in 2102
2201	36.47	CO	31.44	450			VC	223.27	
0202	34.27	CO	28.31	550			VC	21.0238	
1003	CO	0	31.44	450			VC	13.85537	
2101	37.14	CO	28.28	560			BR	27.25949	1 in 78
3205	CO	0	31.44	450			BR	21.0238	
3001	37.38	CO	32.16	610			CO	54.83791	1 in 551
3000	CO	0	31.44	450			BR	105.424	
9801	35.4	CO	30.28	750			BR	8.062258	1 in 0.29564568
3106	CO	0	31.44	450			BR	42.54409	1 in 118
1102	CO	0	31.44	450			CO	23.15476	1 in 104
8902	35.21	CO	31.61	470			CO	17.23419	1 in 431
1700	CO	0	31.44	450			CO	19.70064	1 in 45
1005	36.84	CO	24.38	1950			BR	47.01004	1 in 448
9902	CO	0	31.44	450			VC	54.23099	1 in 111
3002	37.57	CO	32.44	510			PSC	8.018335	
1605	CO	0	31.44	450			BR	7.68004	
1904	36.83	CO	33.85	600			BR	12.54563	1 in 45
9905	35.29	CO	32.78	225			BR	6.052258	
1602	35.23	CO	31.54	450			VC	42.54409	1 in 118
9713	CO	0	31.44	450			VC	23.15476	1 in 104
6204	33.53	CO	29.85	600			BR	17.23419	1 in 431
9802	35.28	CO	23.7	2100			BR	19.70064	1 in 45
2902	36.8	CO	32.77	600			BR	47.01004	1 in 448
2701	36.22	CO	34.43	225			VC	54.23099	1 in 111
9916	CO	0	31.44	450			VC	8.018335	
6201	33.89	CO	30.07	600			PSC	7.68004	
0000	CO	0	31.44	450			BR	12.54563	1 in 45
9803	37.16	CO	24.41	1950			BR	68.54994	
1604	CO	0	31.44	450			CO	6.51502	
9004	CO	0	31.44	450			VC	16.07307	
4102	37.97	CO	31.45	525			CO	66.03786	
2103	37.04	CO	0	600			BR	32.75989	
9915	CO	0	31.44	450			CO	52.87496	
0610	34.8	CO	26.24	525			VC	72.6876	1 in 186
9906	CO	0	31.44	450			PE	3.303437	
9201	34.12	CO	24.48	620			BR	1.414214	
1605	CO	0	31.44	450			VC	2.753439	
9701	34.56	CO	32.1	375			CO	18.35546	1 in 1
3201	37.53	CO	34.37	300			BR	15.65248	
8003	35.11	CO	30.12	440			CO	88.92625	1 in 137
0705	34.8	CO	31.82	375			CO	28.0673	1 in 368
9914	CO	0	31.44	450			VC	8.576575	
0709	CO	0	31.44	450			CO	73.53867	
2903	37.11	CO	28.87	630			BR	29.96965	
3804	36.84	CO	32.92	610			BR	102.9563	
0202	36.06	CO	30.12	440			BR	30.01666	
3107	CO	0	31.44	450			VC	5.466803	
0001	35.96	CO	33.96	440			VC	14.31762	1 in 8
1006	CO	0	31.44	450			VC	17.76769	1 in 223
3202	37.24	CO	32.47	375			BR	37.85499	1 in 125
8106	34.07	CO	30.23	680			BR	10	
3106	CO	0	31.44	450			VC	6.266931	1 in 141
3902	37.33	CO	34.43	675			BR	28.83282	1 in 1
0903	35.46	CO	32.82	450			BR	19.23538	1 in 179
9903	35.37	CO	30.12	750			CO	8.944272	