

# **2404-09 – Starbucks Rochdale**

## **Civil Engineering**

## **Drainage Strategy**

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## 1 Introduction

Design Engineering Workshop were instructed by Starbucks Coffee Company (UK) Limited to act as the structural and civils engineers in support of a planning application. The proposals for the purposes of drainage considerations include a new-build drive-through retail unit and associated hardstanding on the grounds of an existing retail park.

This report summarises the surface and foul water drainage scheme for the site inclusive of potential discharge locations.

The site location is shown below in the context of the wider neighbourhood:

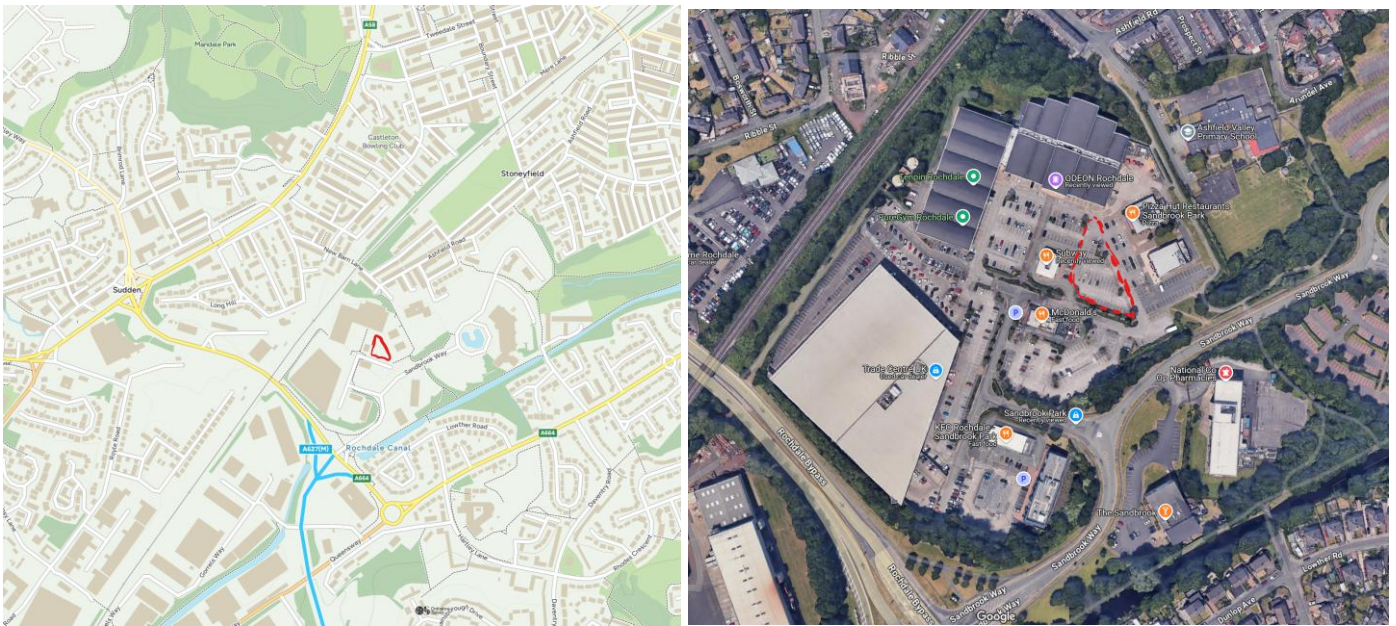


Figure 1-1 Location plan. Site boundary is marked approximately (courtesy of Ordnance survey and Google)

### 1.1 Objective & Terms of Reference

The objective of this report is to demonstrate that the foul and surface water drainage design meets the requirements of United Utilities as the sewerage undertaker, the EA, DEFRA and Rochdale Borough Council as LLFA and includes:

- An overview of the site context including land use and geology based on a review of online geological mapping and site investigation reports
- An overview of flood risk based on a review of existing flood risk reports, online flood risk mapping and statutory authority asset plans
- Identification of design criteria including the outgoing flow rates and stormwater storage calculation in line with local authority requirements and policy
- Confirmation of maintenance agreements

### 1.2 Scope and Involvement

The following report is provided to demonstrate the surface water drainage strategy for the new-build drive-through retail unit.

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## 2 Rochdale Metropolitan Borough Council Core Strategy (October 2016)

The Rochdale Metropolitan Borough Council Core Strategy was adopted in October 2016 and contains the following Policies relating to flood risk and drainage:

### G8 – Managing water resources and flood risk

We will ensure that new development (including flood risk mitigation measures) does not lead to any form of increased flooding locally or further downstream, does not impeded natural water and flood risk management, is not detrimental to existing or potential flood storage areas, contributes where possible to alleviating existing flood risk, is itself well protected from flood risk and ensures prudent use of water resources. We will require:

- a. Compliance with a 'sequential' approach to new development and flood risk, directing development away from areas of high risk, in accordance with the National Planning Policy Framework;
- b. Full regard to and compliance with the advice of the Environment Agency (or equivalent agency) and the objectives and priorities for flood risk management set out in the Local Flood Risk Management Strategy, including any mitigation measures recommended for particular sites;
- c. Full regard to the published evidence of local flood risk and its significance as included in Strategic Flood risk Assessments, Surface Water Management Plans and other recognised sources of flood risk data and the production of additional Flood Risk Assessments (FRAs) as appropriate;
- d. Incorporation of appropriate measures of the management of surface and flood water, including flood storage areas. Sustainable Urban Drainage Systems (SUDS) and the protection of 'overland flow paths';
- e. Compliance with any Surface Water Management Plan or drainage strategies produced, such as for the identified critical drainage areas of Littleborough and Heywood;
- f. The avoidance of culverting, and support the opening of culverts wherever possible;
- g. The incorporation of measures for the conservation of water to minimise potable water consumption, including rainwater collection measures, which should be integral to the design of buildings and spaces;
- h. Development that does not directly or indirectly lead to pollution of existing water resources such as watercourse and groundwater or the degradation of the quantity of groundwater;
- i. The incorporation of measures to improve water quality and;
- j. The taking of opportunities to improve the habitat value of watercourses and waterbodies. In addition, we will identify additional flood storage areas which will be protected from development."

**G1 – Tackling and adapting to climate change** states the following in relation to the use of sustainable drainage to address the impacts of climate change:

the incorporation of appropriate water conservation and management measures such as Sustainable Drainage Systems (SuDS), including ensuring that the rate of run-off on 'Greenfield' sites not increase and on 'Brownfield ' sites is significantly reduced, and avoiding the use of impermeable surfaces

### 3 Site Details

#### 3.1 Site Location and Context

The site is located within the Sandbrook Retail Park in Rochdale and the site currently exists as a car park serving the existing retail units. Location data is shown below:

|                        |                |
|------------------------|----------------|
| Nearest postcode       | OL11 1RY       |
| Grid reference         | SD 89235 11765 |
| Grid reference 6-digit | SD892117       |
| Easting                | 389235         |
| Northing               | 411765         |

The site area available to our client for works (a smaller demise within the Planning 'red line') totals **0.17Ha** and is triangular in shape, indicated by the boundary in drawing 2404-09-DA01-A-DRAINAGE AREAS-A0 within section 12 Appendix E – Drainage & Hardstanding Drawings.

#### 3.2 Ground Conditions

An intrusive phase 1 and phase 2 site investigation exercise was carried out by Delta Simons (report reference 94776.604690\_REP\_Sandbrook Park\_Rochdale\_GEA\_24.02.15). This, along with the topographical survey that was undertaken by Survey Operations, summarises the superficial ground conditions on the site as follows:

- The existing site slopes around 800mm upward from east to west, from 123.130mAOD to 129.890mAOD
- The site is brownfield and comprises asphalt coverings to facilitate car parking spaces and running lanes
- A review of the site investigation reveals a variable thickness of made ground across the site, between 3.8m - 4.5m deep underlain by Glaciofluvial Deposits
- Perched groundwater was encountered in the standpipes in the made ground at levels between 1.39m – 2.0m BGL
- BRE365 infiltration testing was not undertaken at the site due to the thickness of made ground encountered, rendering it unsuitable for infiltration disposal of surface water

## 3.3 Flood Risk

The below screenshot is an extract from the available online EA flood maps:

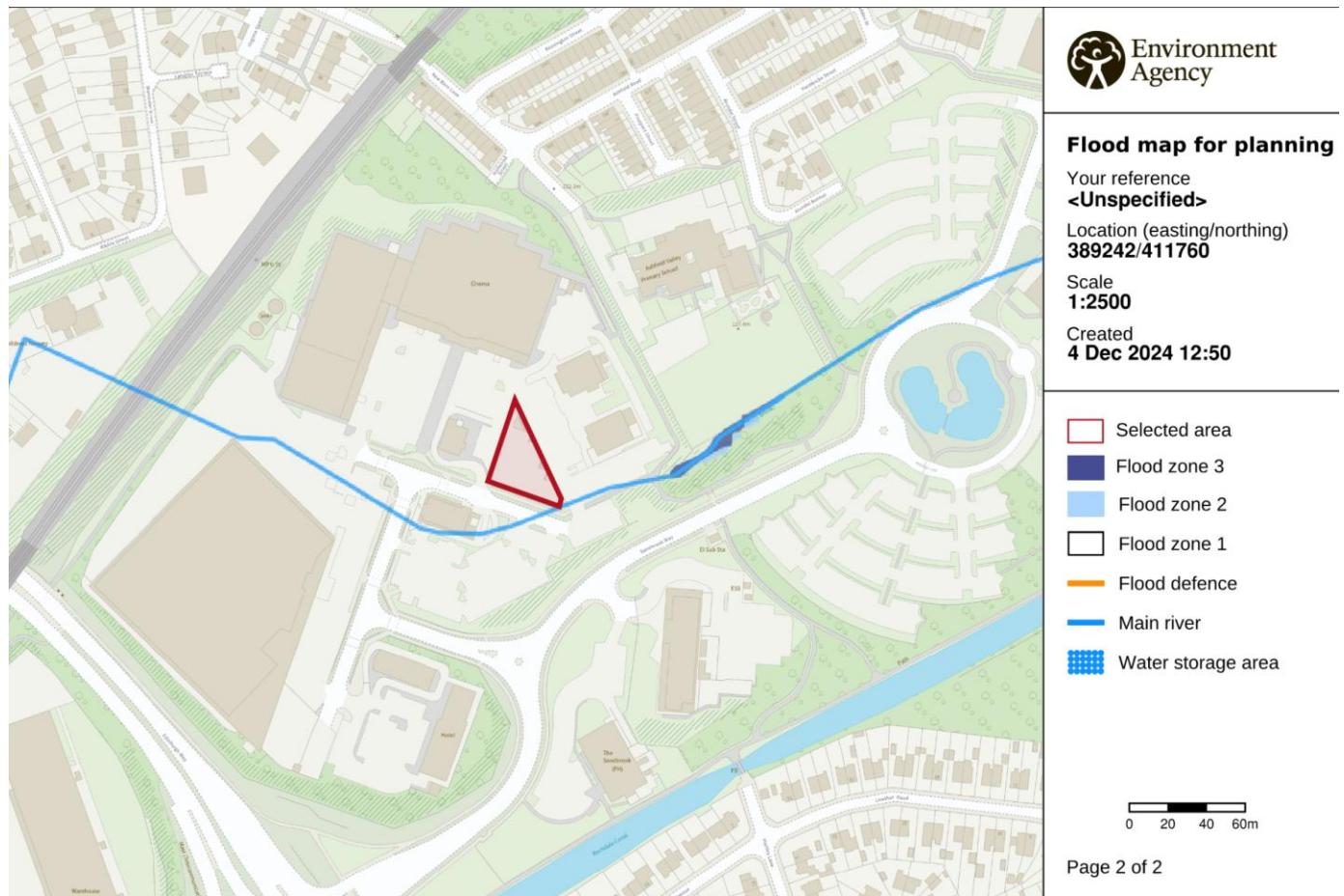


Figure 2 - Extract from EA flood maps

The proposed development lies within Flood Zone 1. Flood Zone 1 is a site which has less than 0.1% of flooding in any 1 year.

The proposed development does not result in any increase in additional hardstanding or roof areas compared with what exists at the moment. The SuDS being introduced reduces the rate of run off within the existing wider catchment.

Based on the above, no specific risks were identified local to this plot and that any surface water runoff will be mitigated by the positive surface water drainage system which collect, attenuate, and discharge surface water in a controlled manner.

### 3.4 Existing Drainage

There exists private foul and surface water drainage on site at the moment. The current car parking is drained by gullies tying into the private surface water system and a private foul water system exists within the retail park's curtilage.

It is proposed that the foul and surface water drainage from this site will be tied into the existing private systems on site which ultimately discharge to the public sewer system.

The screenshot below is an extract from United Utilities' asset map showing the nearby public sewers for information and a full plan extract is shown in section 10 Appendix C – United Utilities Asset Plans.

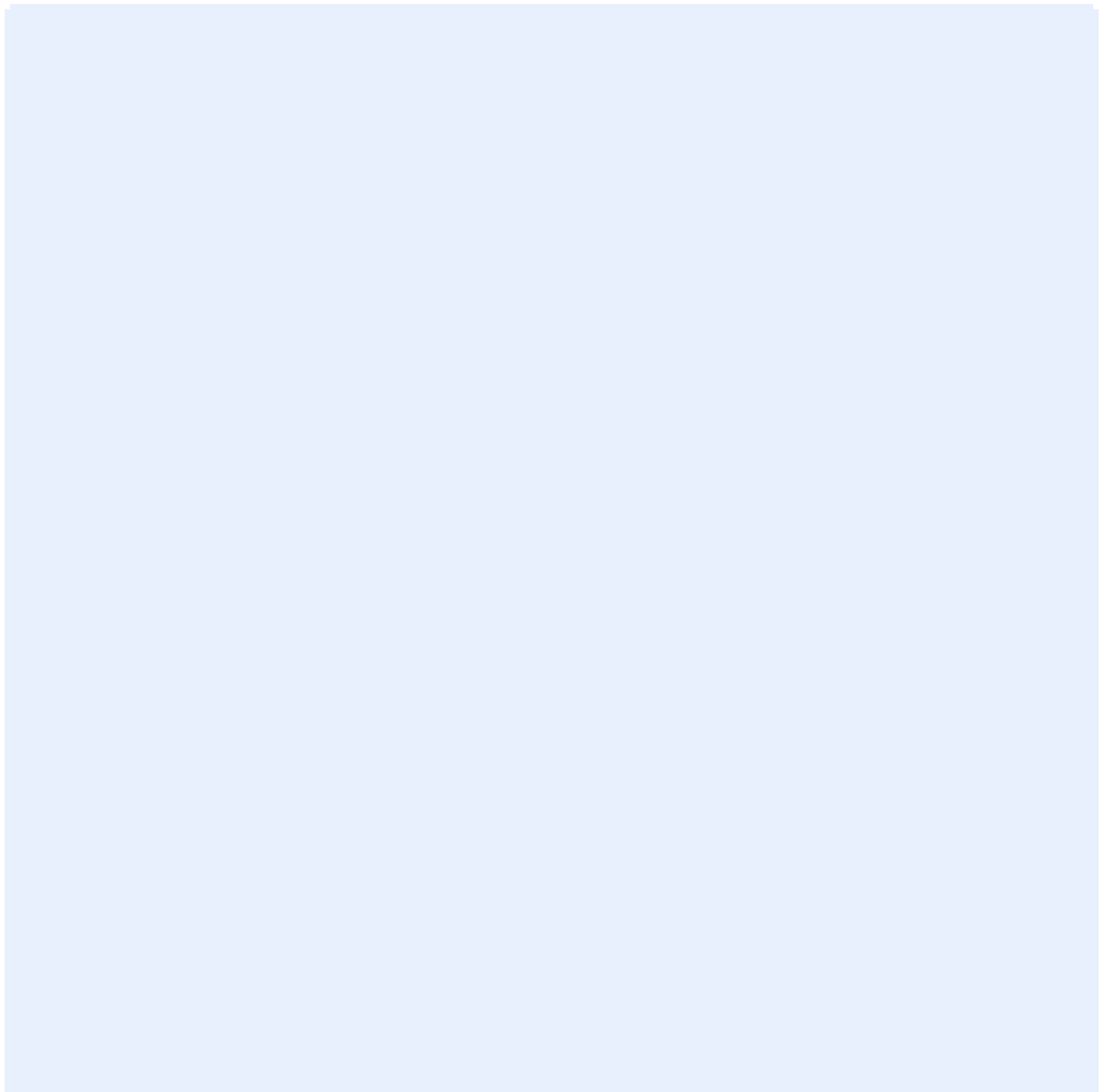


Figure 3-3 Extract from United Utilities asset plan for information

## 4 Foul Water

The following describes the foul water strategy for the retail unit.

It should be noted that the sewage discharge is domestic in nature – toilets, wash hand basins and sinks – no trade effluent is proposed to discharge through the system and will be dealt with separately.

### 4.1 Foul Water Drainage Design Criteria

The drainage within the site boundary is private although best practice guidelines will be applied including those outlined in the latest edition of Sewers for Adoption and BS EN 752.

The following design criteria will be adopted in the design of the foul drainage system:

|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Design Flow</b>              | Refer to section 4.3                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Pipe Size</b>                | The minimum diameter of the sewers on site is 110mm                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Network Layout</b>           | The maximum distance between access points is 100m. Access chambers shall generally be 1.2m in diameter                                                                                                                                                                                                                                                                                                                                                   |
| <b>Pipe self-cleansing</b>      | <p>Pipe flow velocities shall not be less than 0.75m/s for one third of the design flow<br/>Where this cannot be met, the criteria below would be considered to be satisfied by a 150mm gravity sewer having a gradient not flatter than:</p> <ul style="list-style-type: none"> <li>• 1 in 150 where there at least 10 connected dwelling units or equivalent flow</li> <li>• 1 in 60 for up to 9 connected dwelling units or equivalent flow</li> </ul> |
| <b>Pipe protection</b>          | All pipes below carriageways with less than 1.2m cover from finished road level or less than 0.9m in footways measured from finished footway level to pipe soffit shall be encased in a minimum of 100mm concrete                                                                                                                                                                                                                                         |
| <b>Coefficient of Roughness</b> | Colebrook-White ( $k_s$ ) carrier drain 1.5mm                                                                                                                                                                                                                                                                                                                                                                                                             |

### 4.2 Proposed Layout

The proposed drainage layout is included in section 12 Appendix D – Proposed Development Layout. The final form and point of discharge are subject to detailed design and consultation with United Utilities.

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#### 4.3 Foul Discharge Design Flows

The following is based on British Water Code of Practice - Flows and Loads 4 and BS EN 752.

6 No Staff @ 180L per day

200 No Customers @ 25 L per day

**Average** =  $(6 \times 180) + (200 \times 25) / 86400 = \mathbf{0.070 \text{ L/s}}$

Allow for double rate during busy periods

**Peak** =  $0.070 \times 2 = \mathbf{0.140 \text{ L/s}}$

These proposed flow rates are currently under consideration as part of a pre-development enquiry to United Utilities at the time of writing. The outcome of the PDE will be appended to this report as soon as received.

## 5 Surface Water

The following section considers the technical detail in terms of surface water drainage design which feeds into the hydraulic calculations.

### 5.1 Drainage Disposal Options

Consideration has been given to the drainage disposal options outlined in the NPPF Paragraph: 056 Reference ID: 7-056-20220825:

|                                                                                |                                                                                                                              |
|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| <b>1. into the ground (infiltration);</b>                                      | Infiltration to ground is not feasible due to ground conditions as per site investigation;<br><b><i>Move to option 2</i></b> |
| <b>2. to a surface water body;</b>                                             | There are no surface water bodies nearby that would provide a suitable tie-in;<br><b><i>Move to option 3</i></b>             |
| <b>3. to a surface water sewer, highway drain, or another drainage system;</b> | There are existing surface water sewers serving the retail park<br><b><i>Use this option</i></b>                             |
| <b>4. to a combined sewer</b>                                                  | N/A – surface water accommodated in previous stage                                                                           |

5.2 Climate Change Allowances

Consideration has been given to the recommendations of the Environment Agency’s Climate Change Allowances. This confirms the uplift in peak rainfall intensities for climate change to be 45% for the Irwell Management Catchment assuming the upper end allowance for the 1% annual exceedance rainfall event and assuming a 50-year design life.

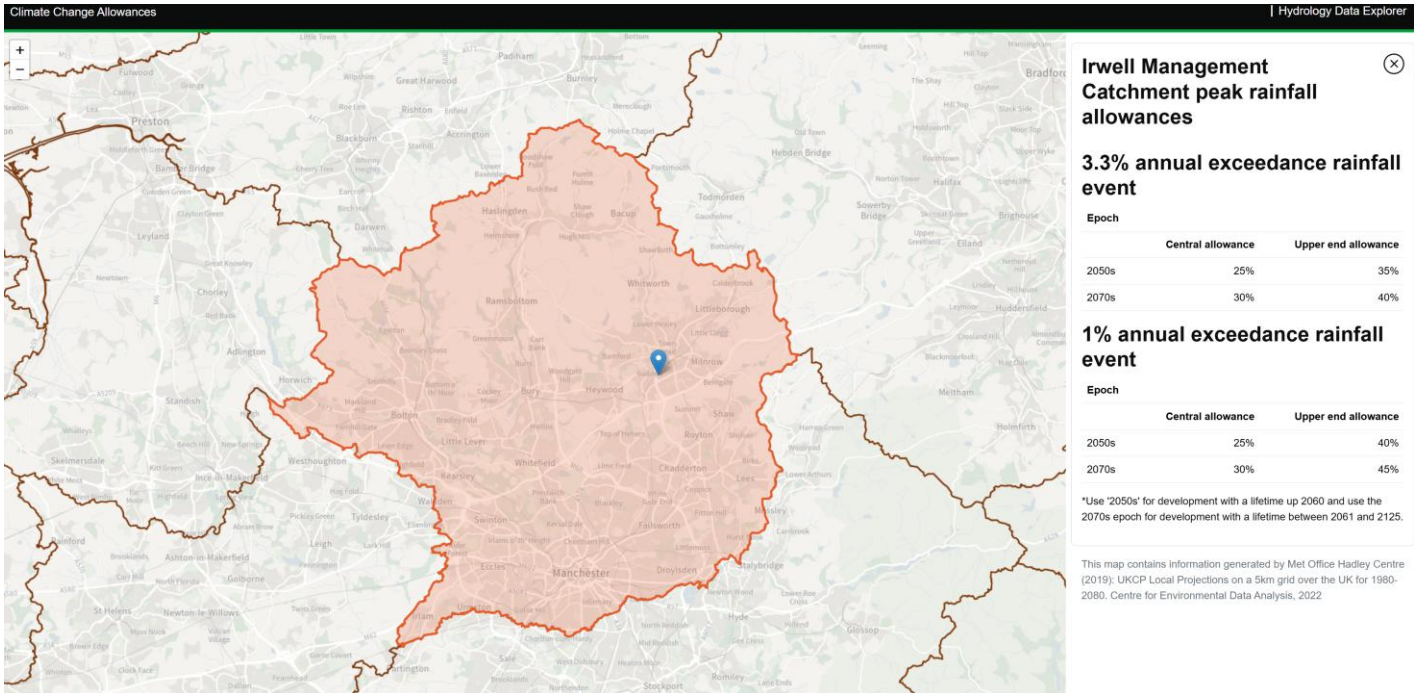


Figure 5-1 Recommended Climate Change allowances for Irwell Management Catchment (EA)

### 5.3 Land-Take Requirements

The following table highlights the land-take requirements that feed into the hydraulic calculations:

| Land use                               | Area (Ha)                            | Surface type |
|----------------------------------------|--------------------------------------|--------------|
| Coffee shop unit                       | 0.022                                | Impermeable  |
| Hardstanding (paving and road surface) | 0.114                                | Impermeable  |
| Soft landscaping                       | 0.032                                | Permeable    |
|                                        | <b>SUM = 0.17Ha (works red line)</b> |              |

## 5.4 Surface Water Drainage Design Criteria

The following criteria have been used to progress the drainage design and are in line with guidance and requirements set out by the local authority, CIRIA Report C753, DEFRA Guidance, Sewers for Adoption and United Utilities:

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>High-level requirement for network</b> | <p>Designed for conveyance for 2-year event.</p> <p>Designed so that flooding does not occur in any part of the site in a 1 in 30-year rainfall event</p> <p>Check for flooding during the 1 in 100-year event plus 45% for climate change (in accordance with EA guidance on uplift for peak rainfall intensity for the Irwell Management Catchment). If flooding occurs, provision of freeboard and an overland flood route to be identified to ensure no property or adjacent sites are at risk of flooding</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Pipe Size</b>                          | The minimum diameter of the sewers on site is 110mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Network Layout</b>                     | The maximum distance between access points is 100m. Access chambers shall generally be a minimum of 600mm in diameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Pipe self-cleansing</b>                | Pipe flow velocities shall not be less than 1.0m/s generally unless the receiving pipe is preceded by a SuDS system such as permeable paving or ponds, which generally do not pass forward sediment. Other alternatives suitable for private drainage systems would be to install catch pits along the surface water sewer lines                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Pipe protection</b>                    | All pipes below carriageways with less than 1.2m cover from finished road level or less than 0.9m in footways measured from finished footway level to pipe soffit shall be encased in a minimum of 100mm concrete                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Percentage runoff coefficients</b>     | <p>Roof areas = <b>100%</b></p> <p>Hardstanding areas = <b>100%</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Red Line Boundary</b>                  | The works 'red line' boundary is <b>0.17Ha</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Drained Area</b>                       | The positively drained area on site that will be accommodated by the new system, which includes the roof of the retail unit and associated hardstanding is approximately <b>0.138Ha</b> (81% of total red line area)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Coefficient of Roughness</b>           | Colebrook-White ( $k_s$ ) carrier drain 0.6mm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Attenuation</b>                        | <p>Based on maximum allowable discharge:</p> <ul style="list-style-type: none"> <li>The greenfield runoff rate for the site, assuming the civils works red line boundary of 0.17Ha using IH124 was incalculably small due to the SOIL type parameter in this instance (1) and small site size</li> <li>A brownfield runoff calculation was therefore carried out using IH124 assuming SOIL type 5 which generates a runoff for the 1 in 2 year event of 1.7l/s. We would propose a reduction of 35% on this, taking the allowable discharge to 1.1l/s. Any further decrease in the forward-flow rates would result in risk of blockage to the system</li> </ul> <p>It is therefore proposed to use the runoff rate of <b>1.1l/s</b> for the purposes of determining the required attenuation volume. This rate will be agreed with the LLFA as the authority responsible for flooding and United Utilities as the sewerage undertaker. This proposed flow rates are under consideration as part of a PDE to United Utilities at the time of writing. The outcome of the PDE will be appended to this report as soon as received.</p> |

## 5.5 Proposed Layout

The proposed drainage layout is included in section 12 Appendix E – Drainage & Hardstanding Drawings.

In line with local authority requirements, the proposed site stormwater drainage system will comprise of sustainable drainage features (SuDS) supplemented by pipes. The proposed system is described at high level:

- Runoff from the roof areas will be collected by rainwater pipes and conveyed through silt traps into permeable pavement stone below the parking bays outside
- Runoff from road and parking areas will be collected in filter trenches and permeable pavements
- Runoff from pedestrian hardstanding areas will be conveyed through sheet run-off to the road collection
- All water passes through a flow-control manhole limiting forward-flow of water

## 5.6 Hydraulic Modelling

The proposed drainage network has been hydraulically assessed using Causeway Flow. Flow is an industry standard sustainable drainage and flood hazard software, capable of incorporating surface water drainage design, including SuDS, with existing drainage networks and assessed in terms of design exceedance.

The model simulates inflow into a drainage network by routing runoff generated from a design rainfall event. The runoff generated is in part proportional to the percentage of impermeable area in the site.

A drainage network was constructed for the development site based on existing overland flow routes, site constraints and a site-specific topographic survey to estimate approximate manhole cover levels. To assess the proposed drainage network against the above design requirements, the model was run for a full range of return periods (2, 30 and 100 year plus 45% climate change) and multiple durations (15 minutes up to and including 10080 minutes).

## 5.7 Model Results

The drainage network has been assessed for conveyance design considering a 2-year (FEH) return period in line with design standards. Hydraulic simulations were considered for storms including 2, 30 and 100 plus 45% climate change. No flooding is predicted in any storm considered, up to and including the 1 in 100 year plus 45% climate change.

Hydraulic calculations are included in section 13 Appendix F – Drainage Calculations.

## 5.8 Exceedance

There is limited scope for exceedance whilst retaining overland flow routes within the boundary of the site therefore the on-site drainage has been designed to attenuate and discharge all events up to and including the 1 in 100 year plus 45% climate change event.

## 5.9 Urban Creep

Urban creep is the conversion of permeable surfaces to impermeable over time e.g. impermeable surfacing of front gardens to provide additional spaces, extensions to existing buildings, creation of patio areas.

No allowance has been made for urban creep on this site as there is very limited opportunity for this to happen given that the majority of the site is proposed to be hardstanding.

## 6 Water Quality

To ensure best practice treatment of surface water within the drainage network the Simple Index Approach, as described in the CIRA SuDS Manual, has been used to provide an indication of the suitability of the system in mitigation of water quality risks to receiving waters.

The proposed development can be considered as follows, based on Table 26.2 of the SuDS Manual – Pollution hazard indices for different land use classifications:

| Land Use                                                                                                                                                                                                                                                 | Pollution hazard level | Total suspended solids (TSS) | Metals | Hydrocarbons |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------------|--------|--------------|
| Other roofs (typically commercial/ industrial roofs), inert roofing material                                                                                                                                                                             | Low                    | 0.3                          | 0.2    | 0.05         |
| Individual property driveways, residential car parks, low traffic roads (e.g. cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) <i>i.e. &lt;300 traffic movements/day</i> | Low                    | 0.5                          | 0.4    | 0.4          |

The proposed drainage features include a series of silt traps, permeable pavements and filter drains. According to Table 26.3 of the SuDS Manual – Indicative SuDS mitigation indices for discharges to surface waters as shown below, the cumulative mitigation indices of these would exceed the respective pollution hazard indices shown above.

| Type of SuDS Component                                   | Total suspended solids (TSS) | Metals | Hydrocarbons |
|----------------------------------------------------------|------------------------------|--------|--------------|
| Filter trench / stone (with enhanced filter media layer) | 0.8                          | 0.8    | 0.8          |
| Permeable pavement                                       | 0.7                          | 0.6    | 0.7          |

The above individual mitigation indices can be combined to give a Total SuDS Mitigation index using the equation below:

$$\text{Total SuDS mitigation index} = \text{mitigation index}_1 + 0.5(\text{mitigation index}_2)$$

- New roof run-off enters filter trenches and permeable pavements prior to entering the below-ground piped network
- New pavement run-off is conveyed through the same treatment as the roads
- New road run-off passes through a filter trenches or permeable paving with with an enhanced filter media (D-Rainclean) at the base of the trench, prior to entering the below-ground piped network

By inspection, the proposed features are suitable for the nature of the development in terms of pollution risk mitigation.

## 7 SuDS Maintenance Requirements

Upon completion of the works and because the site is under private ownership, maintenance of the drainage system will fall to Starbucks Coffee Company (UK) Limited as the site operator.

The following maintenance schedule indicates the required activities for maintaining the drainage system.

### Inlets, Outlets, Pipework, Chambers and Cells

|                     |                                                                                                    |                                                                         |
|---------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Regular Maintenance | Inspect and identify any areas that are not operating correctly. If required, take remedial action | Monthly                                                                 |
|                     | Remove debris and sediment from chambers and cells                                                 | Monthly for first six months, then quarterly or after significant storm |
| Remedial actions    | Repair/rehabilitate where required                                                                 | As required                                                             |
| Monitoring          | Check all structures to ensure all is in good condition and operating as designed                  | Annually                                                                |
|                     | (Flow control) check for evidence of blockage                                                      | Monthly or after significant storm                                      |
|                     | (Flow control) check for damage to components                                                      | Annually or after significant storm                                     |

### Permeable Paving

|                     |                                                                                                                                 |                                     |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| Regular Maintenance | Inspect and identify any areas that are not operating correctly. If required, take remedial action                              | Monthly for 3 months, then annually |
|                     | Remove debris (where it may cause risks to performance) and brush down paving surface (where it may cause risks to performance) | Quarterly                           |
|                     | Remove weed or moss build-up on surface or in joints of blocks, fertilizer/weedkiller applications                              | As required                         |
| Remedial actions    | Repair/rehabilitate depressions or broken blocks                                                                                | As required                         |
|                     | Replacement of joint material (re-gritting)                                                                                     | Projected once every 20 years       |
| Monitoring          | Inspect/check all connection, chambers and flow controls to ensure that they are in good condition and operating as designed    | Annually                            |

**Filter Trench**

|                     |                                                                                                                                                                                                                                                                                                                                               |                             |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Regular Maintenance | Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices                                                                                                                                                                                                                         | Monthly (or as required)    |
|                     | Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage                                                                                                                                                                                                         | Monthly                     |
|                     | Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies                                                                                                                                                                                                       | Six monthly                 |
|                     | Remove sediment from pre-treatment devices                                                                                                                                                                                                                                                                                                    | Six monthly, or as required |
| Remedial actions    | Where there is no protective geotextile remove all stone and perforated pipe replacing as original Spec. and include separating geotextile as below. Where there is a separating geotextile (see Spec.) then remove surface stone layer and separating geotextile that protects the stone drain below. Replace geotextile and top stone layer | As required                 |
| Monitoring          | Inspect/check all connection, chambers and flow controls to ensure that they are in good condition and operating as designed                                                                                                                                                                                                                  | Annually                    |

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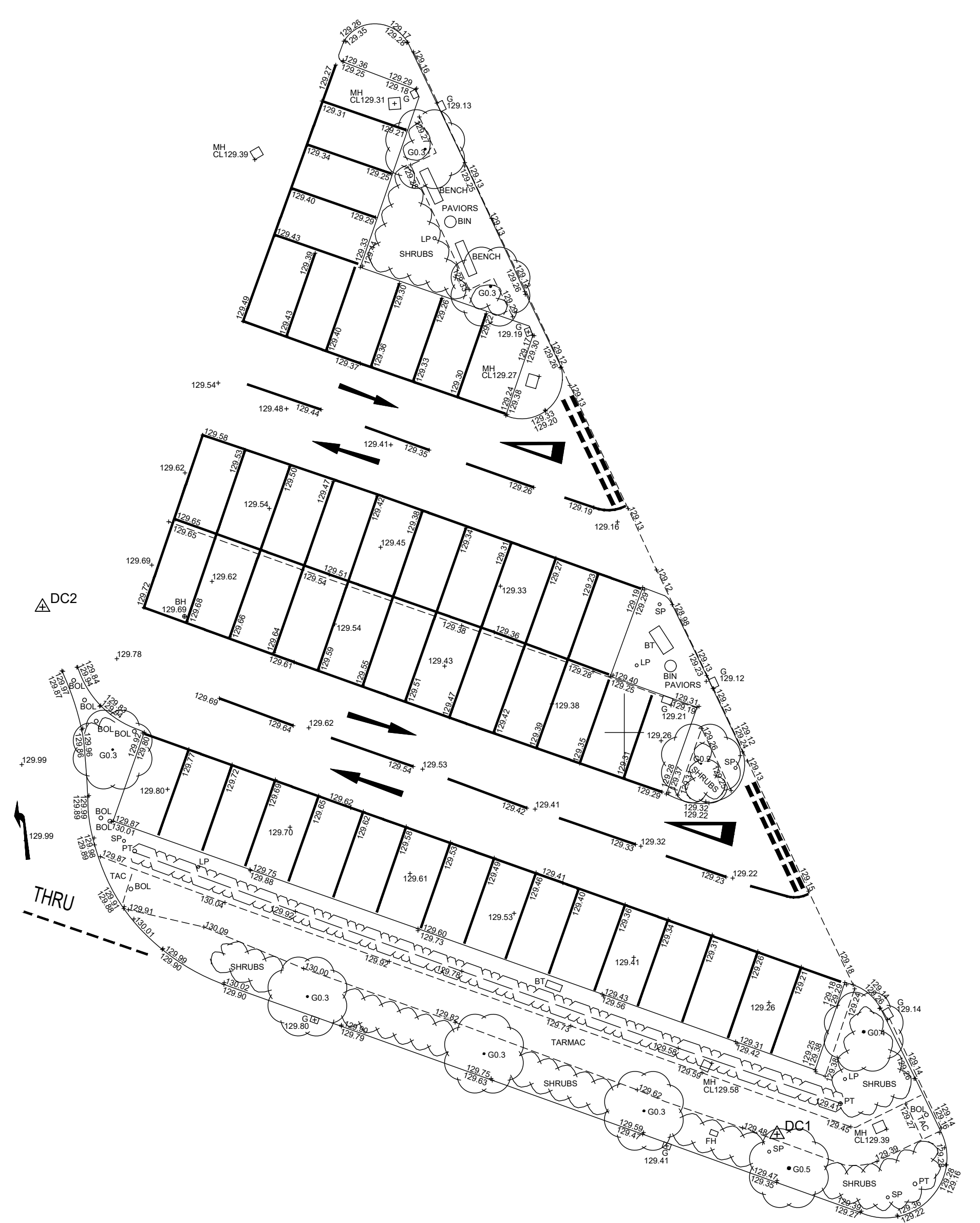
**8      Appendix A – Existing Topographical Survey**

411800N

411750N

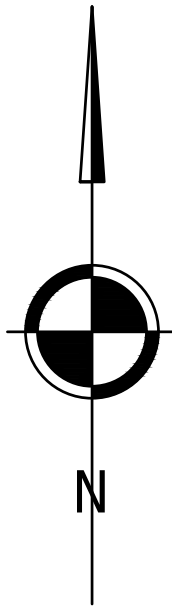
411800N

411750N



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Note:

The survey is plotted on a plane local Grid. Orientation to National Grid.

All levels relate to Ordnance Datum, achieved using the OS National GPS Network.

Survey Control Markers established for Mapping purposes only and should not be used for Construction without the written approval of Survey Operations Ltd.

| SURVEY STATIONS |           |           |        |
|-----------------|-----------|-----------|--------|
| Name            | Easting   | Northing  | Height |
| DC1             | 389257.86 | 411729.31 | 129.53 |
| DC2             | 389220.03 | 411756.46 | 129.94 |
| DC3             | 389243.68 | 411796.22 | 129.40 |



Smith Street, Skelmersdale, Lancs. WN8 8LN  
Tel: 01695 725662 Fax: 01695 51816  
Email: mail@survops.co.uk - www.survops.co.uk

|                                                                                        |                  |
|----------------------------------------------------------------------------------------|------------------|
| Client<br>Warrington Martin                                                            |                  |
| Drawing Title<br>Topographical Survey of Land at:<br>Sandbrook Retail Park<br>Rochdale |                  |
| Scale(s)<br>1:200                                                                      | Surveyor<br>DC   |
| Date<br>Jan 24                                                                         | Drawn<br>DS      |
| Job Number<br>23L193                                                                   | Checked<br>MH/SO |
| Sheet Size & Drg Number & Revision<br>A1 23L193/001                                    |                  |

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**9      Appendix B - Existing Retail Park Drainage**



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10      **Appendix C – United Utilities Asset Plans**

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**11      Appendix D – Proposed Development Layout**

 Site Ownership Boundary  
 Application Boundary

**DRAFT**



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**12      Appendix E – Drainage & Hardstanding Drawings**

ALL DRAWINGS SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS AND SPECIALISTS DRAWINGS. ALL SETTING-OUT AND DIMENSIONS TO ARCHITECTS' DRAWINGS ONLY. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CHECK ALL DIMENSIONS ON SITE AND ANY DIMENSIONS SHOWN ON THESE DRAWINGS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. DO NOT SCALE OFF ANY DRAWINGS.

#### Hardstanding Legend

- Denotes area of proposed carriageway construction.
- 40mm Hot-rolled Asphalt
  - 160mm Dense Macadam combined roadbase & basecourse
  - 225mm Type 1 Sub-base
  - 6F2 Capping Layer (Refer Table 1.)
- Denotes area of monoblock/paving surface treatment.
- Monoblock/Paving to Architects spec.
  - 30mm Bedding layer of sharp sand/crushed rock.
  - Min. 225mm HA type 1 sub-base
- Denotes area of permeable block paving.
- 80mm Permeable Paving.
  - 50mm Deep Gravel (3-6mm)
  - 100mm Deep Gravel (3-20mm)
  - 400mm Deep Attenuation Crates
- Denotes area of landscaping to Architects spec.

#### Table 1.

| CBR Value | Capping Layer | Sub-Base |
|-----------|---------------|----------|
| < 2%      | 600mm         | 150mm    |
| 2% - 5%   | 350mm         | 150mm    |
| > 5%      | 0mm           | 225mm    |

#### Kerbing Legend

| Reference | Description           | Dimensions |
|-----------|-----------------------|------------|
| K1        | Half Batter Road Kerb | 125x255mm  |
| K2        | Bull Nose Road Kerb   | 125x150mm  |
| K3        | Square Road Kerb      | 125x255mm  |

|    |                         |                      |
|----|-------------------------|----------------------|
| K5 | Round Top Edging Kerb   | 50x200mm             |
| K7 | Wet Kerb                | 125x255mm            |
| K8 | Transition/Dropper Kerb | Varies to suit kerb. |
| K9 | ACO KerbDrain HB250     | 125x255mm            |

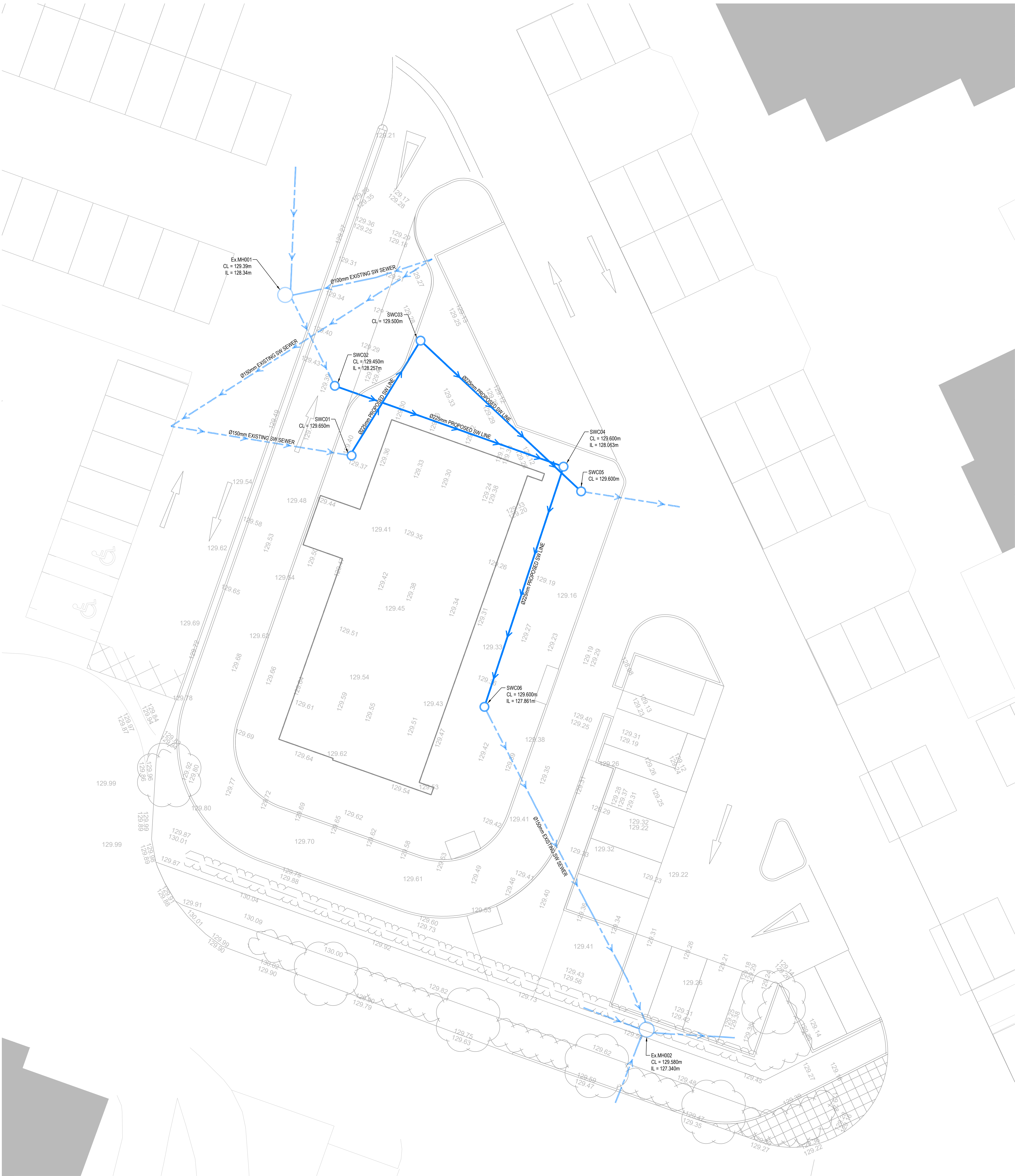
#### Drainage Legend

- Denotes Existing SW Drainage Line
- Denotes Existing FW Drainage Line
- Denotes Existing Combined Drainage Line
- Denotes Proposed SW Drainage Line
- Denotes Proposed FW Drainage Line
- Denotes Proposed Combined Drainage Line
- Denotes Existing SW Chamber
- Denotes Existing FW Chamber
- Denotes Existing Combined Chamber
- Denotes Proposed SW Chamber
- Denotes Proposed FW Chamber
- Denotes Proposed Combined Chamber
- Denotes Rodding Eye
- Denotes Rainwater Pipe
- Denotes Pop-Up
- Denotes area of proposed attenuation below permeable paving. Attenuation Crates - 11No. Layer 400mm Deep by Envirocrete or similar; bays lined w/ Permavoid geomembrane/similar
- Denotes area of proposed filter trench. 50mm D Rainclean over Type B filter material; trench lined w/ Permavoid geomembrane/similar



Existing Drainage - Areas to be Removed  
1:100

|                                 |             |            |    |            |
|---------------------------------|-------------|------------|----|------------|
| A                               | 08.12.24    | PLANNING   | SF | AF         |
| Rev                             | Date        | Revision   | By | CN         |
| Project                         |             |            |    |            |
| STARBUCKS                       |             |            |    |            |
| ROCHDALE                        |             |            |    |            |
| Drawing Title                   |             |            |    |            |
| EXISTING DRAINAGE TO BE REMOVED |             |            |    |            |
| PLANNING                        |             |            |    |            |
| Drawn by                        | SF          | Checked by | AF | Scale @ A0 |
| Drawing No                      | 2404-09-900 | Revision   | A  | 1:100      |



Proposed Diversion of Existing Drainage  
1:100

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Hardstanding Legend

- Denotes area of proposed carriageway construction.
  - 40mm Hot-rolled Asphalt
  - 150mm Dense Macadam combined roadbase & basecourse
  - 225mm Type 1 Sub-base
  - 6F2 Capping Layer (Refer Table 1.)
- Denotes area of monoblock/paving surface treatment.
  - Monoblock/Paving to Architects spec.
  - 30mm Bedding layer of sharp sand/crushed rock
  - Min. 225mm HA type 1 sub-base
- Denotes area of permeable block paving.
  - 80mm Permeable Paving
  - 50mm Deep Gravel (5-6mm)
  - 100mm Deep Gravel (5-20mm)
  - 400mm Deep Attenuation Crates
- Denotes area of landscaping to Architects spec.

Table 1.

| CBR Value | Capping Layer | Sub-Base |
|-----------|---------------|----------|
| < 2%      | 600mm         | 150mm    |
| 2% - 5%   | 350mm         | 150mm    |
| > 5%      | 10mm          | 225mm    |

Kerbing Legend

| Reference | Description           | Dimensions |
|-----------|-----------------------|------------|
| K1        | Half Batter Road Kerb | 125x255mm  |
| K2        | Bull Nose Road Kerb   | 125x150mm  |
| K3        | Square Road Kerb      | 125x255mm  |

|    |                         |                      |
|----|-------------------------|----------------------|
| K6 | Round Top Edging Kerb   | 50x200mm             |
| K7 | Weir Kerb               | 125x255mm            |
| K8 | Transition/Dropper Kerb | Varies to suit kerb. |
| K9 | ACO KerbDrain H8255     | 125x255mm            |

Drainage Legend

- Denotes Existing SW Drainage Line
- Denotes Existing FW Drainage Line
- Denotes Existing Combined Drainage Line
- Denotes Proposed SW Drainage Line
- Denotes Proposed FW Drainage Line
- Denotes Proposed Combined Drainage Line
- Ex.SWC Denotes Existing SW Chamber
- Ex.FWC Denotes Existing FW Chamber
- Ex.CC Denotes Existing Combined Chamber
- SWC Denotes Proposed SW Chamber
- FWC Denotes Proposed FW Chamber
- CC Denotes Proposed Combined Chamber
- RE Denotes Rodding Eye
- RWP Denotes Rainwater Pipe
- PU Denotes Pop-Up
- Denotes area of proposed attenuation below permeable paving. Attenuation Crates - 1160 Layer 400mm Deep by Grvicrete or similar; bays lined w/ Permeavoid geomembrane/similar
- Denotes area of proposed filter trench. 50mm D Rainclean over Type B filter material; trench lined w/ Permeavoid geomembrane/similar

|      |          |          |    |     |
|------|----------|----------|----|-----|
| A    | 08.12.24 | PLANNING | SF | AF  |
| Rev. | Date     | Revision | By | CHK |

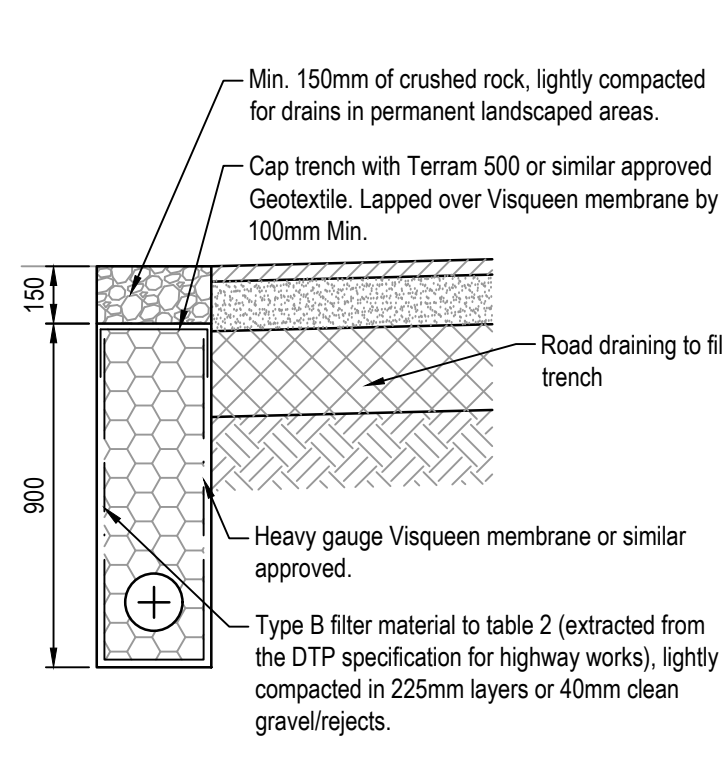
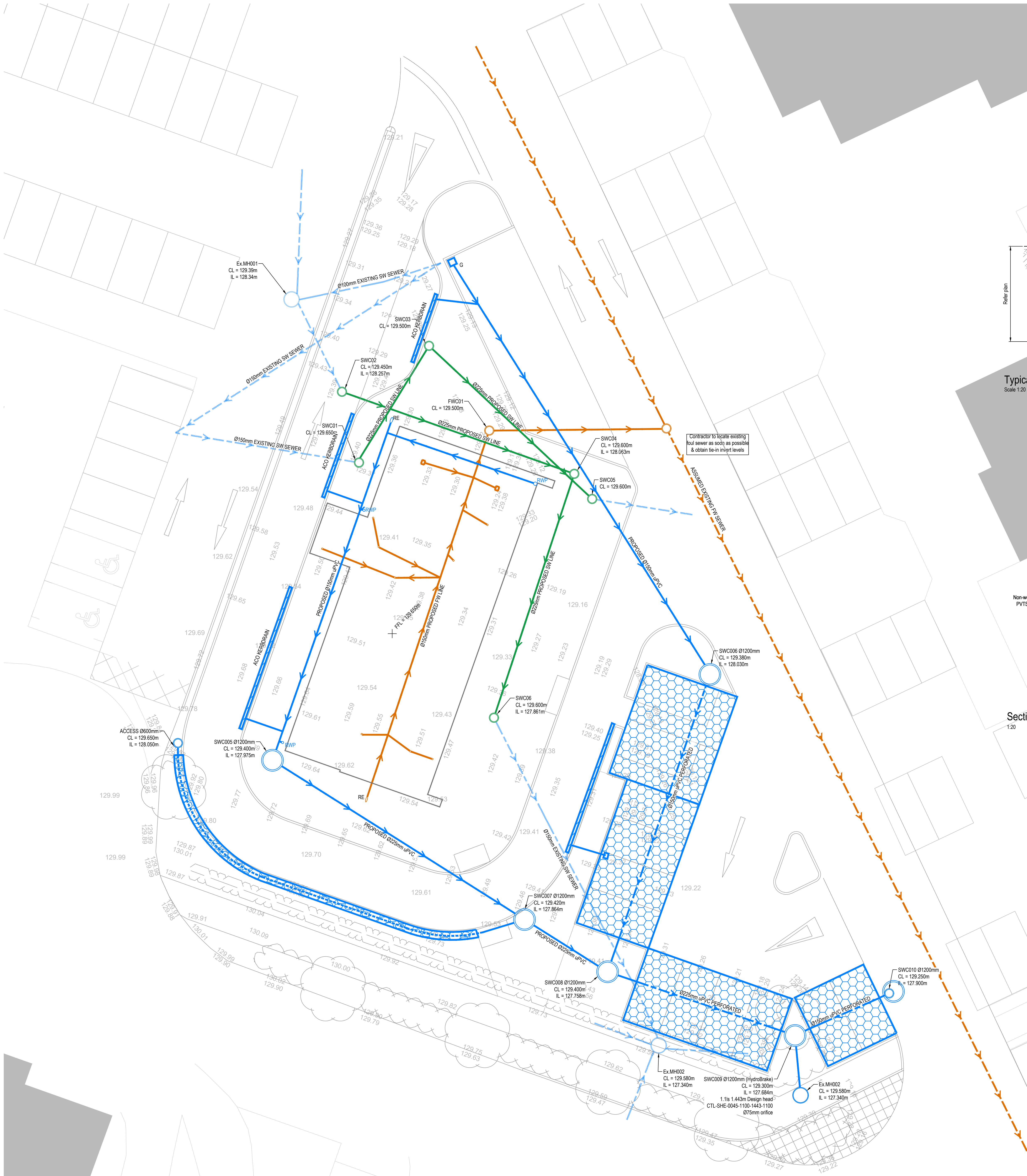
Project  
STARBUCKS  
ROCHDALE

Drawing Title  
PROPOSED DIVERTED ROUTE OF  
EXISTING DRAINAGE

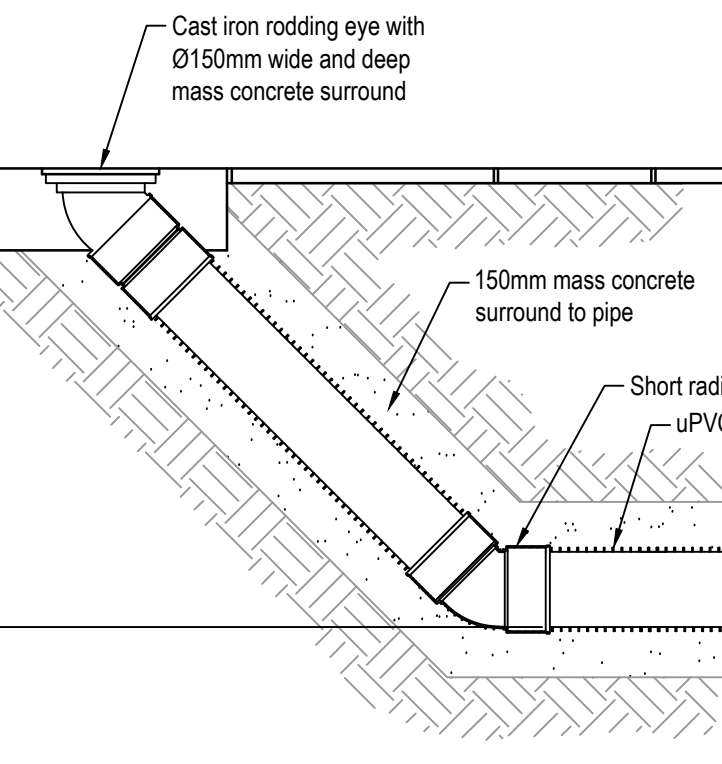
PLANNING

|          |            |            |
|----------|------------|------------|
| Drawn by | Checked by | Scale @ A0 |
| SF       | AF         | 1:100      |

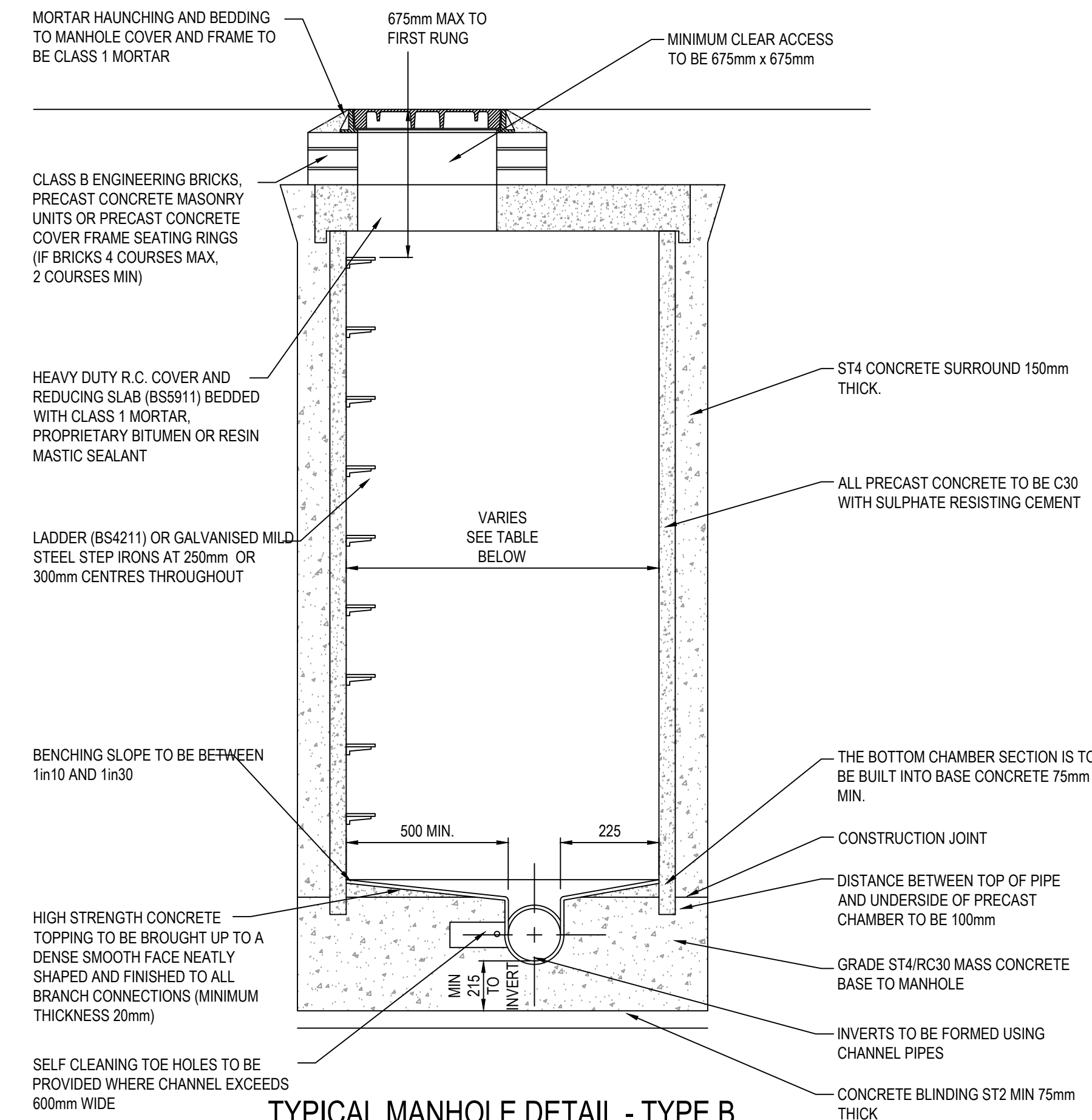
|             |          |
|-------------|----------|
| Drawing No. | Revision |
| 2404-09-901 | A        |



Filter Drain Detail  
Scale 1:20



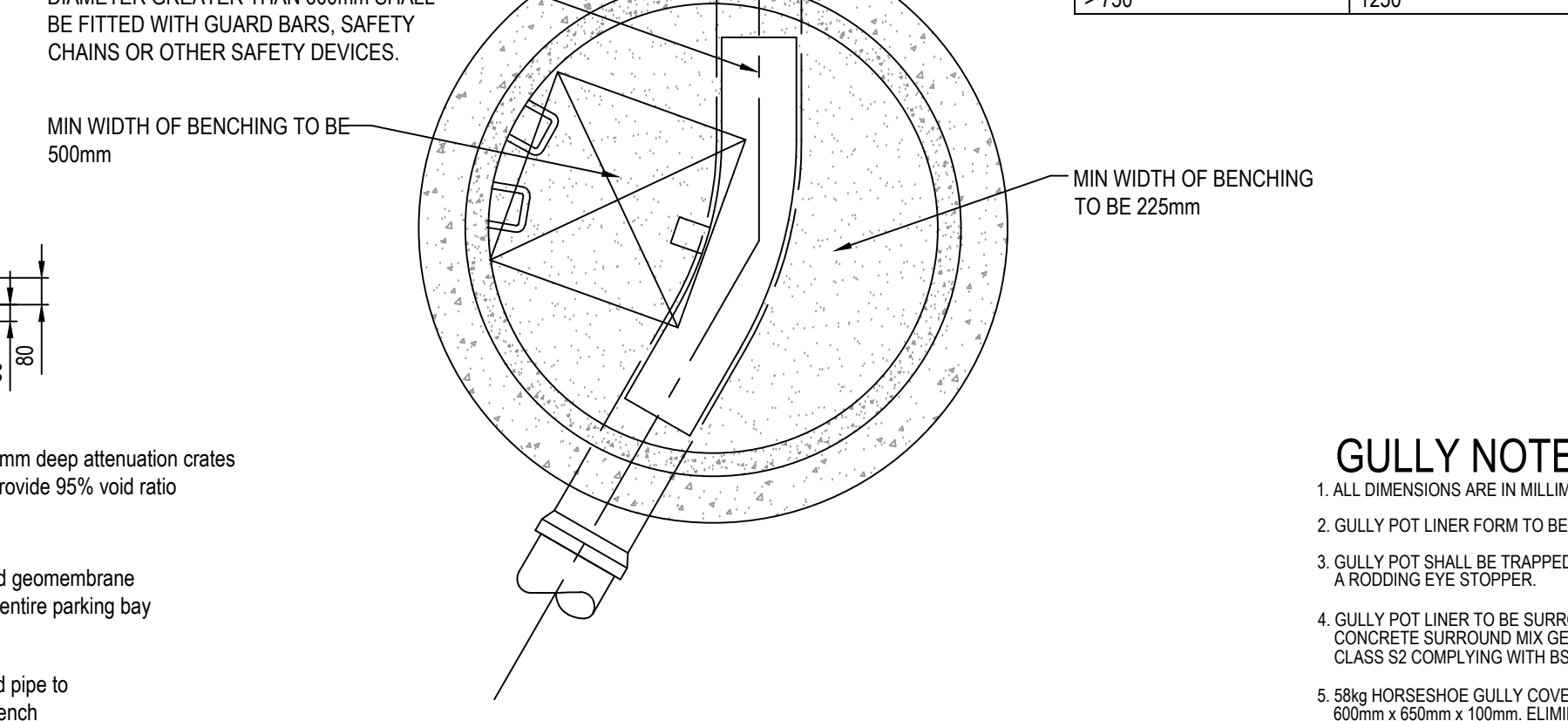
Typical Rodding Eye Detail  
Scale 1:20



TYPICAL MANHOLE DETAIL - TYPE B  
DEPTH TO SOFFIT 1.00m TO 3.00m  
(SCALE 1:20)

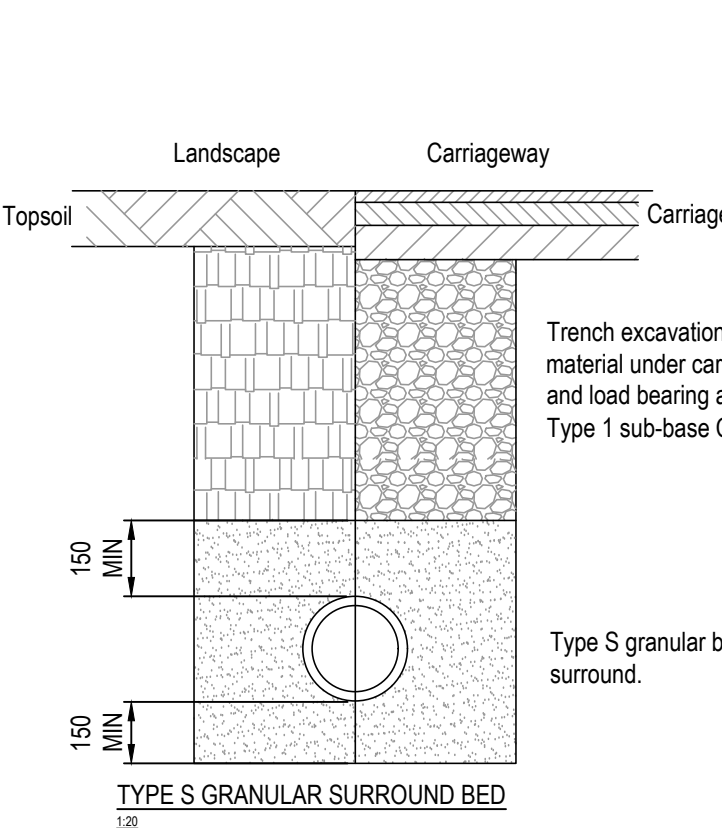
| DIAMETER OF LARGEST PIPE IN MANHOLE (mm) | CHAMBER SECTION DIAMETER (mm)                     |
|------------------------------------------|---------------------------------------------------|
| LESS THAN 375                            | 1200 (1050 WHERE DEPTH TO SOFFIT IS 1.35m - 1.5m) |
| 375 - 450                                | 1350                                              |
| 450 - 750                                | 1500                                              |
| 750 - 900                                | 1800                                              |

| ROCKER PIPE LENGTHS (mm) | PIPE DIA   | PIPE LENGTH |
|--------------------------|------------|-------------|
| 150 - 450                | 500 - 750  | 750 - 1000  |
| 450 - 750                | 750 - 1000 | 750 - 1000  |
| > 750                    | 1250       | 1250        |



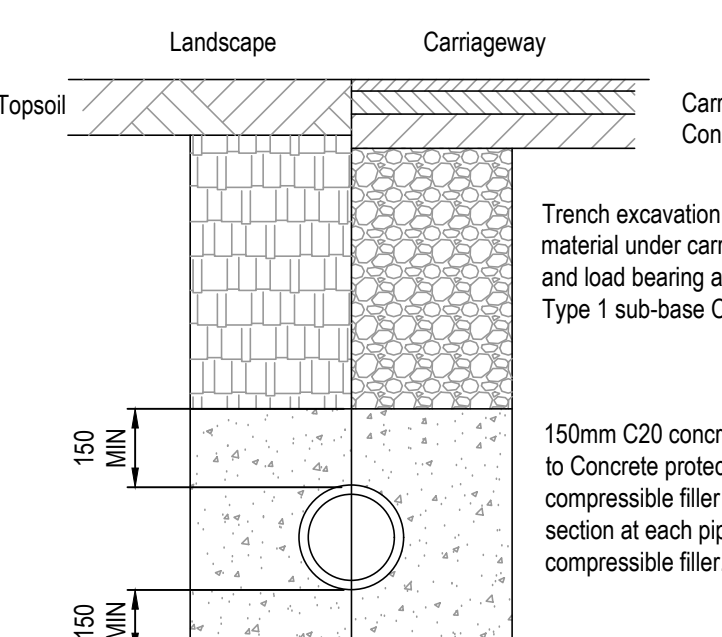
TYPICAL PLAN ON MH TYPE B

Section through parking bays  
1:20



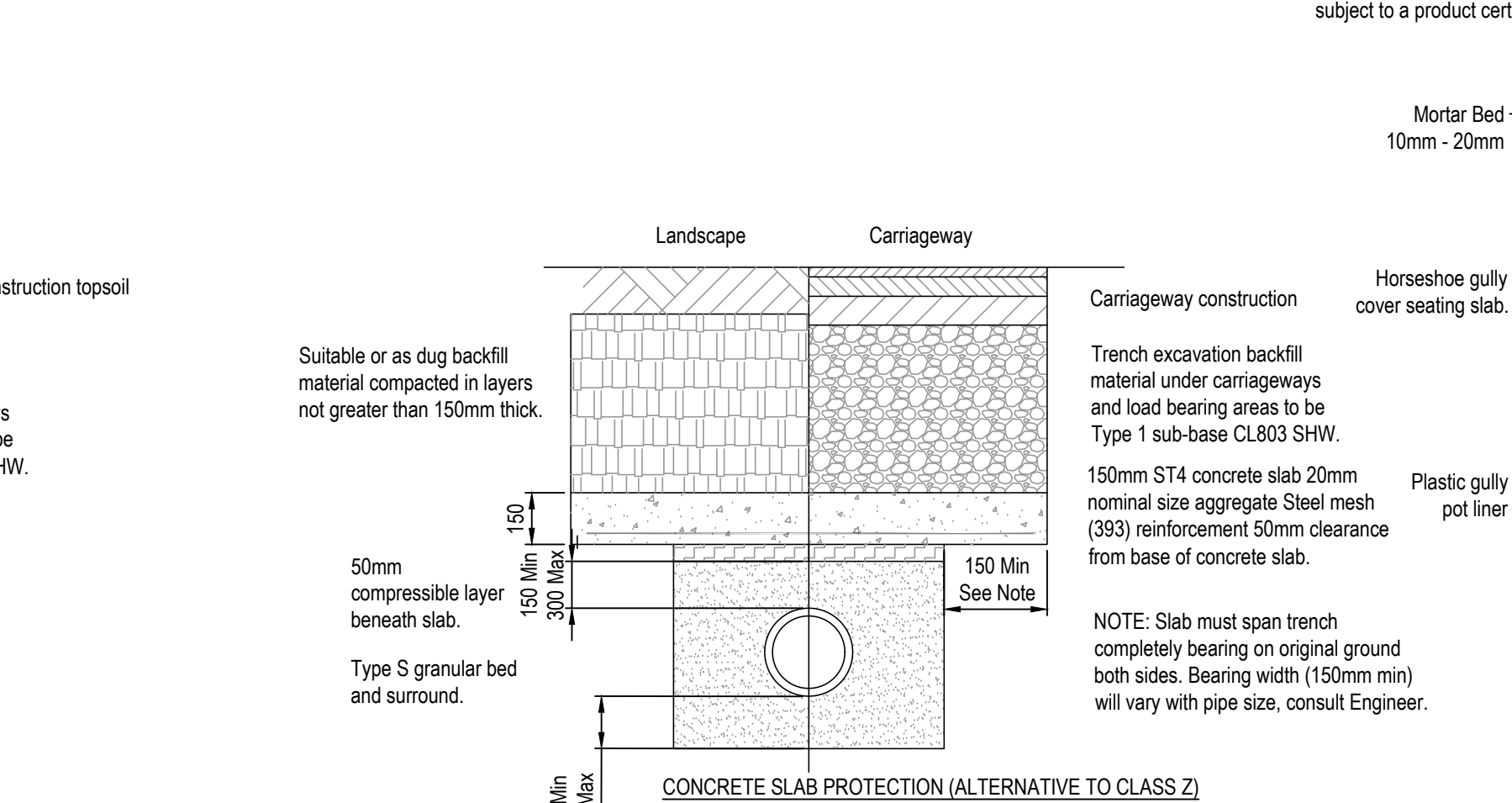
TYPE S GRANULAR SURROUND BED

To be used where cover pipe soffit is greater than 1200mm in vehicular areas and greater than 900mm in non traffic areas and greater than 900mm in non-trafficked areas (ie footpaths, verges etc.)



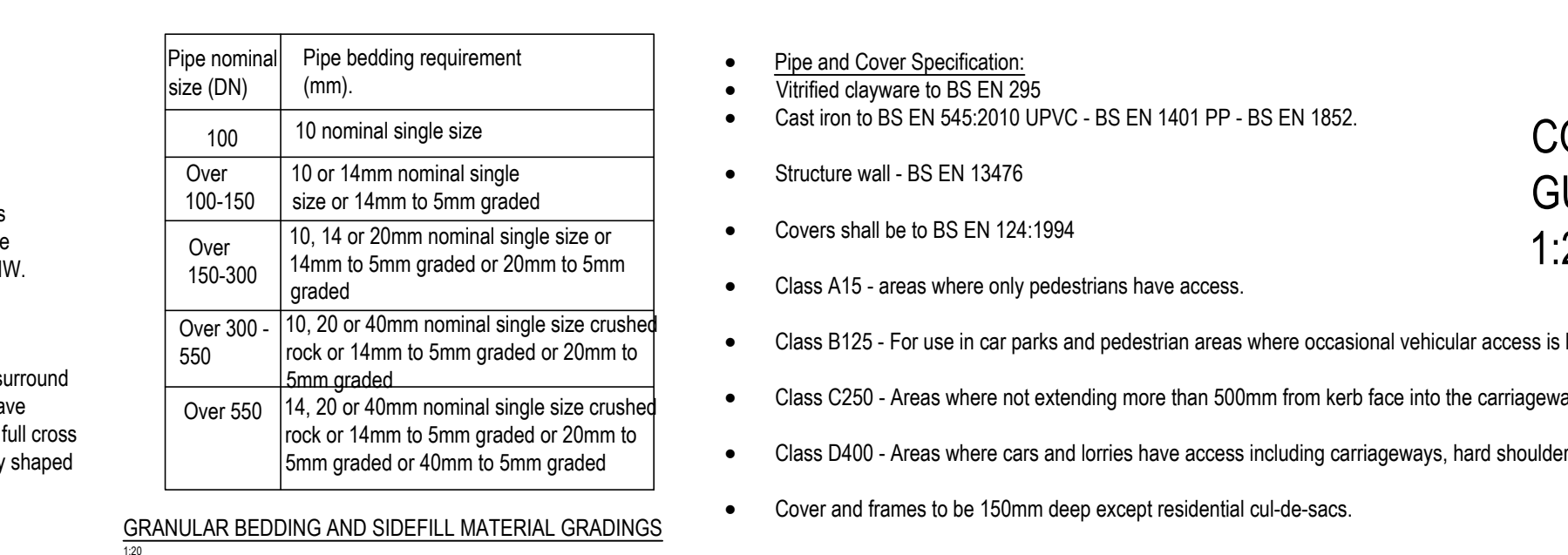
TYPE 2 CONCRETE BED AND SURROUND

To be used where cover pipe soffit is less than 1200mm in vehicular areas and less than 900mm in non traffic areas and greater than 900mm in non-trafficked areas (ie footpaths, verges etc.)



CONCRETE SLAB PROTECTION (ALTERNATIVE TO CLASS 2)

To be used where cover pipe soffit is less than 1200mm in vehicular areas and greater than 900mm in non traffic areas and less than 900mm in non-trafficked areas (ie footpaths, verges etc.)



TYPICAL PLAN ON INSITU CONCRETE TRAPPED ROAD GULLY 1:20

To be used where cover pipe soffit is less than 1200mm in vehicular areas and greater than 900mm in non traffic areas and less than 900mm in non-trafficked areas (ie footpaths, verges etc.)

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- ### Hardstanding Legend
- Denotes area of proposed carriageway construction.
    - 40mm Hot-rolled Asphalt
    - 160mm Dense Macadam combined roadbase & basecourse
    - 225mm Type 1 Sub-base
    - 6F2 Capping Layer (Refer Table 1.)
  - Denotes area of monoblock/paving surface treatment.
    - Monoblock/Paving to Architects spec.
    - 30mm Bedding layer of sharp sand/crushed rock.
    - Min. 225mm H4-type 1 sub-base
  - Denotes area of permeable block paving.
    - 80mm Permeable Paving
    - 50mm Deep Gravel (3-6mm)
    - 100mm Deep Gravel (5-20mm)
    - 400mm Deep Attenuation Crates
  - Denotes area of landscaping to Architects spec.

### Table 1.

| CBR Value | Capping Layer | Sub-Base |
|-----------|---------------|----------|
| < 2%      | 600mm         | 150mm    |
| 2% - 5%   | 300mm         | 150mm    |
| > 5%      | 0mm           | 225mm    |

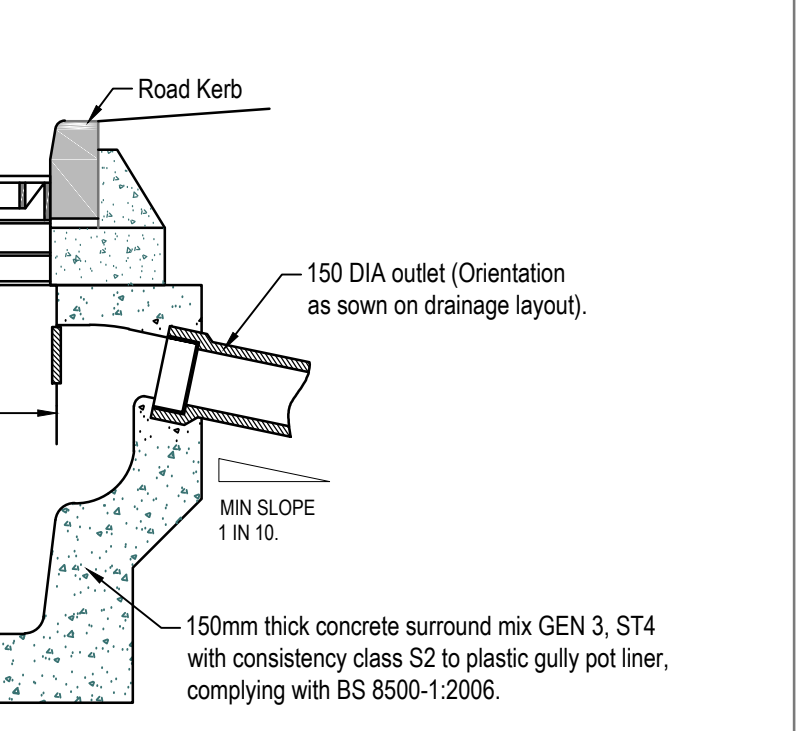
### Kerbing Legend

| Reference | Description           | Dimensions |
|-----------|-----------------------|------------|
| K1        | Half Batten Road Kerb | 125x255mm  |
| K2        | Bull Nose Road Kerb   | 125x150mm  |
| K3        | Square Road Kerb      | 125x255mm  |

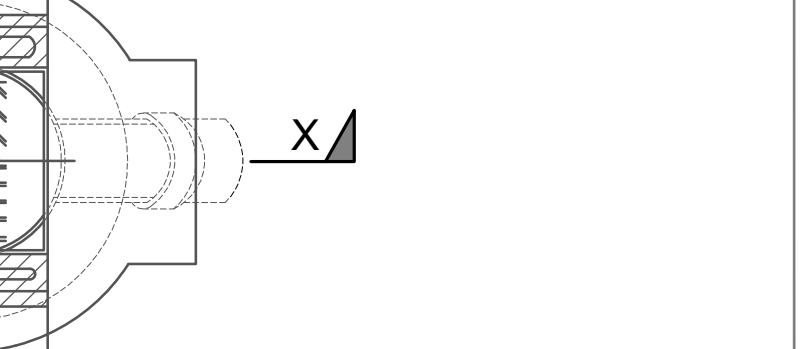
|    |                         |                      |
|----|-------------------------|----------------------|
| K5 | Round Top Edging Kerb   | 50x200mm             |
| K7 | Wet Kerb                | 125x255mm            |
| K8 | Transition/Dropper Kerb | Varies to suit kerb. |
| K9 | ACO Kerb/Drain YHB255   | 125x255mm            |

- ### Drainage Legend
- Denotes Existing SW Drainage Line
  - Denotes Existing FW Drainage Line
  - Denotes Existing Combined Drainage Line
  - Denotes Proposed SW Drainage Line
  - Denotes Proposed FW Drainage Line
  - Denotes Proposed Combined Drainage Line
  - Denotes Existing SW Chamber
  - Denotes Existing FW Chamber
  - Denotes Existing Combined Chamber
  - Denotes Proposed SW Chamber
  - Denotes Proposed FW Chamber
  - Denotes Proposed Combined Chamber
  - Denotes Rodding Eye
  - Denotes Rainwater Pipe
  - Denotes Pop-Up
  - Denotes area of proposed attenuation below permeable paving. Attenuation Crates - No Layer 400mm Deep by Envirocrate or similar, bays lined w/ Permavoid geomembrane/similar
  - Denotes area of proposed filter trench. 50mm D Rainclean over Type B filter material; trench lined w/ Permavoid geomembrane/similar

- ### GULLY NOTES:-
- ALL DIMENSIONS ARE IN MILLIMETRES.
  - GULLY POT LINER FORM TO BE PLASTIC.
  - GULLY POT SHALL BE TRAPPED AND BE PROVIDED WITH A RODDING EYE STOPPER.
  - GULLY POT LINER TO BE SURROUNDED WITH 150mm MINIMUM CONCRETE SURROUND MIX GEN 3 ST4 WITH CONSISTENCY CLASS S2 COMPLYING WITH BS 8500-1:2006.
  - 50mm HORSESHOE GULLY COVER BEARING SLAB 600mm x 600mm x 100mm. SUMMITER BRICKWORK WEAKSPOTS AND PROVIDES GREATER STABILITY.



SECTIONAL ELEVATION X-X  
1:20



TYPICAL PLAN ON INSITU CONCRETE TRAPPED ROAD GULLY 1:20

- ### Pipeline and Cover Specification:
- Vitrified clayware to BS EN 295
  - Cast iron to BS EN 545:2010 UPVC - BS EN 1401 PP - BS EN 1852
  - Structure wall - BS EN 13476
  - Covers shall be to BS EN 124-1994
  - Class A15 - areas where only pedestrians have access.
  - Class B125 - For use in car parks and pedestrian areas where occasional vehicular access is likely
  - Class C250 - Areas where not extending more than 500mm from kerb face into the carriageway.
  - Class D400 - Areas where cars and lorries have access including carriageways, hard shoulders.
  - Cover and frames to be 150mm deep except residential cul-de-sacs.

### GRANULAR BEDDINGS AND SIDEFILL MATERIAL GRADINGS

| Pipe nominal size (DN) | Pipe bedding requirement (mm)                                                                                     |
|------------------------|-------------------------------------------------------------------------------------------------------------------|
| 100                    | 10 nominal single size                                                                                            |
| Over 100-150           | 10 or 14mm nominal single size or 14mm to 5mm graded                                                              |
| Over 150-300           | 10, 14 or 20mm nominal single size or 14mm to 5mm graded or 20mm to 5mm graded                                    |
| Over 300-550           | 10, 20 or 40mm nominal single size crushed rock or 14mm to 5mm graded or 20mm to 5mm graded                       |
| Over 550               | 14, 20 or 40mm nominal single size crushed rock or 14mm to 5mm graded or 20mm to 5mm graded or 40mm to 5mm graded |

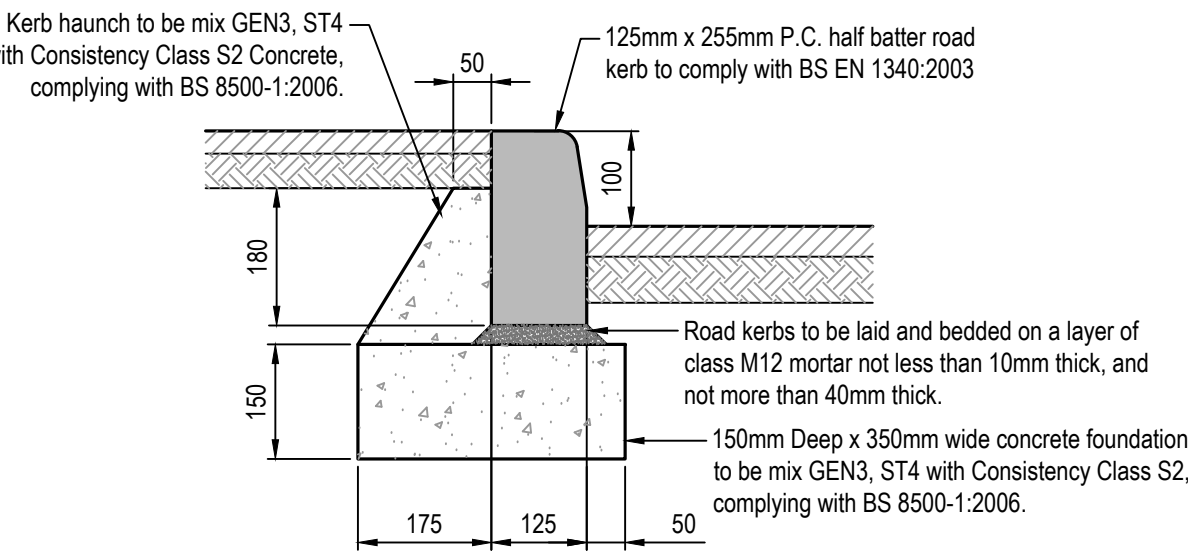
To be used where cover pipe soffit is less than 1200mm in vehicular areas and greater than 900mm in non traffic areas and less than 900mm in non-trafficked areas (ie footpaths, verges etc.)



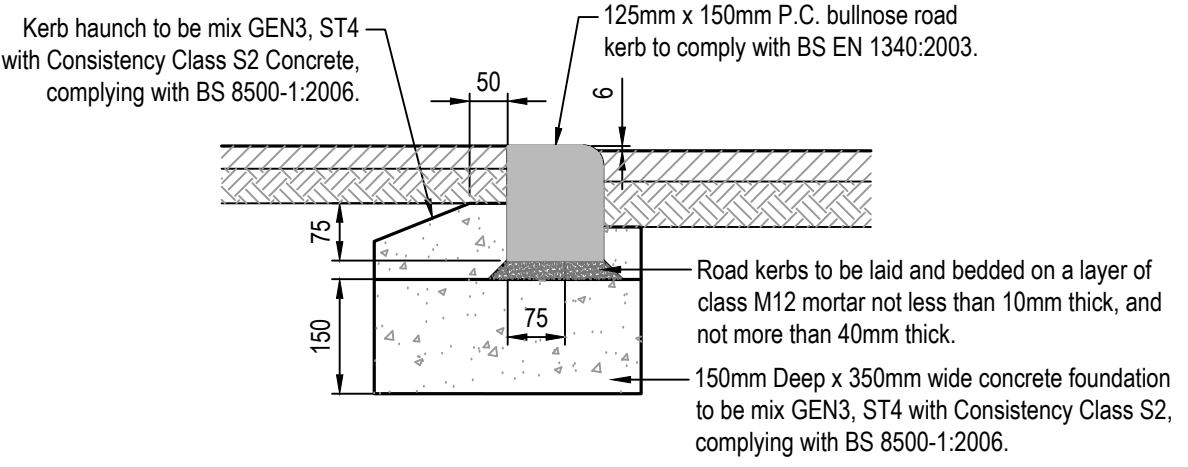
Hardstanding Layout  
1:100

Kerb Notes:

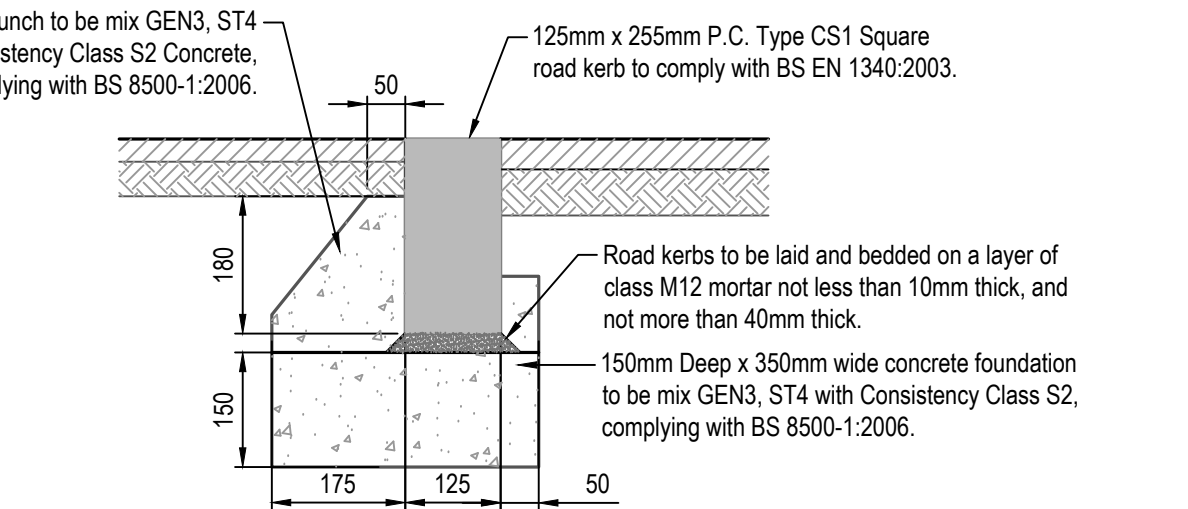
1. Road kerbs & edging kerbs may alternatively be laid directly on newly placed concrete foundation to be mix GEN3, ST4 with Consistency Class S1 complying with BS 8500-1:2006. (No mortar bed required with this alternative.)
2. All road kerbs and edging kerbs to be abutted, except kerbs laid to a radius of less than 40m, which shall be laid with an average gap of 6mm, and pointed with M12 mortar.



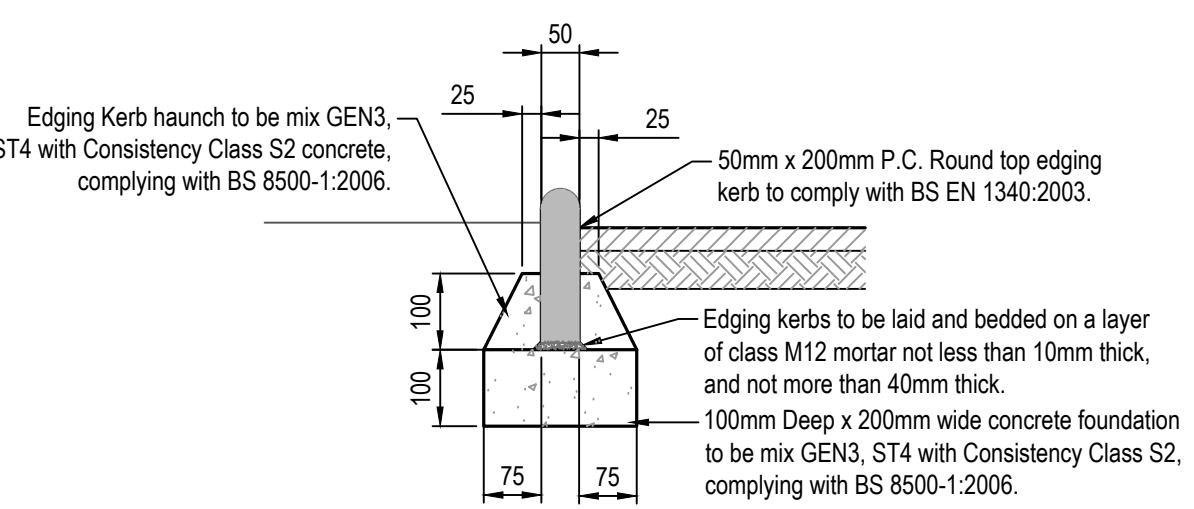
K1 - Typical Kerb Detail  
Half Batter Road Kerb  
Scale 1:10



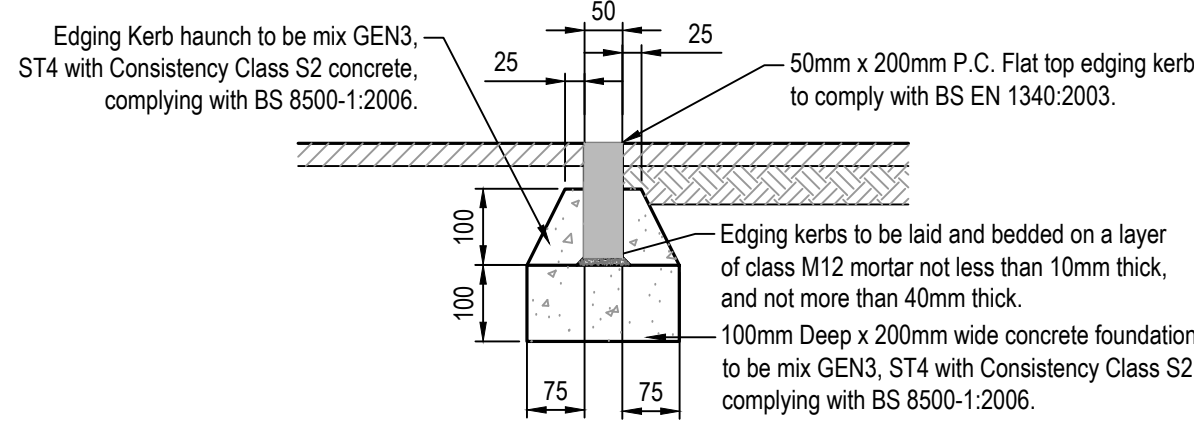
K2 - Typical Kerb Detail  
Bullnose Road Kerb  
Scale 1:10



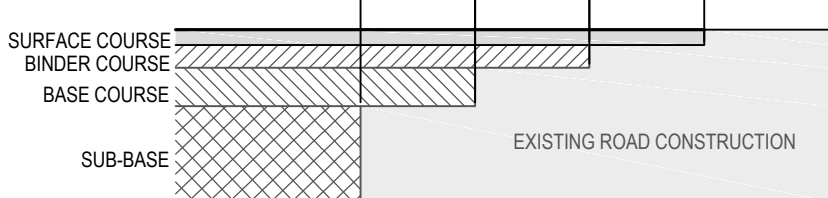
K3 - Typical Kerb Detail  
Square Road Kerb  
Scale 1:10



K6 - Typical Kerb Detail  
Round Top Edging Kerb  
Scale 1:10



K7 - Typical Kerb Detail  
Square Top Edging Kerb  
Scale 1:10



ROAD CONSTRUCTION TIE-IN DETAIL  
SCALE = 1:20

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Hardstanding Legend

- Denotes area of proposed carriageway construction.
  - 40mm Hot-rolled Asphalt
  - 150mm Dense Macadam combined roadbase & basecourse.
  - 225mm Type 1 Sub-base
  - 6F2 Capping Layer (Refer Table 1.)
- Denotes area of monoblock/paving surface treatment.
  - Monoblock/Paving to Architects spec.
  - 30mm Bedding layer of sharp sand/crushed rock
  - Min. 225mm HA type 1 sub-base
- Denotes area of permeable block paving.
  - 80mm Permeable Paving
  - 50mm Deep Gravel (3-6mm)
  - 100mm Deep Gravel (5-20mm)
  - 400mm Deep Attenuation Crates
- Denotes area of landscaping to Architects spec.

Table 1.

| CBR Value | Capping Layer | Sub-Base |
|-----------|---------------|----------|
| < 2%      | 150mm         | 150mm    |
| 2% - 5%   | 350mm         | 150mm    |
| > 5%      | 6mm           | 225mm    |

Kerbing Legend

| Reference | Description           | Dimensions |
|-----------|-----------------------|------------|
| K1        | Half Batter Road Kerb | 125x255mm  |
| K2        | Bull Nose Road Kerb   | 125x150mm  |
| K3        | Square Road Kerb      | 125x255mm  |

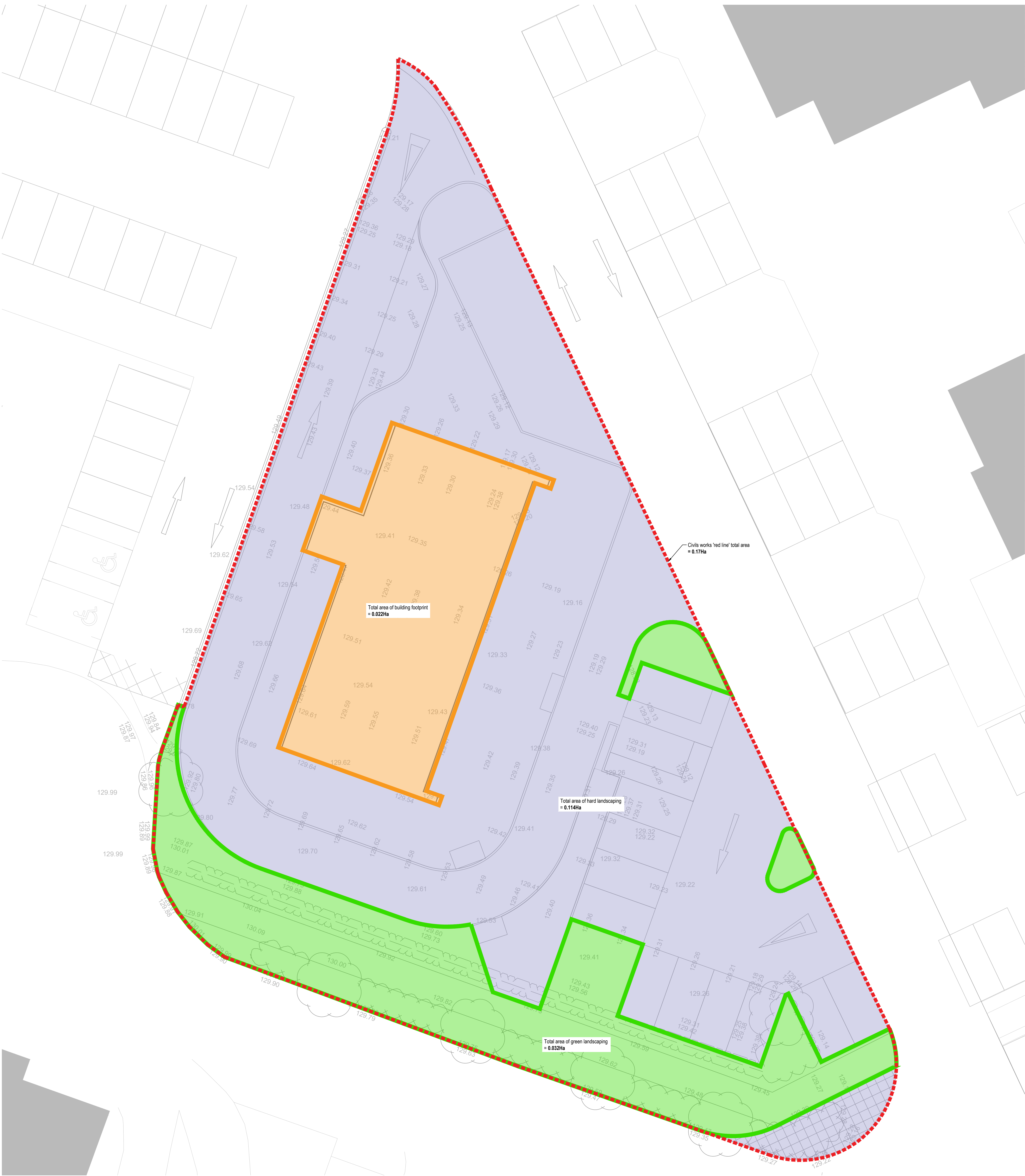
|    |                         |                      |
|----|-------------------------|----------------------|
| K6 | Round Top Edging Kerb   | 50x200mm             |
| K7 | Weir Kerb               | 125x255mm            |
| K8 | Transition/Dropper Kerb | Varies to suit kerb. |
| K9 | ACO KerbDrain HB255     | 125x255mm            |

Drainage Legend

- Denotes Existing SW Drainage Line
- Denotes Existing FW Drainage Line
- Denotes Existing Combined Drainage Line
- Denotes Proposed SW Drainage Line
- Denotes Proposed FW Drainage Line
- Denotes Proposed Combined Drainage Line
- Denotes Existing SW Chamber
- Denotes Existing FW Chamber
- Denotes Existing Combined Chamber
- Denotes Proposed SW Chamber
- Denotes Proposed FW Chamber
- Denotes Proposed Combined Chamber
- Denotes Rodding Eye
- Denotes Rainwater Pipe
- Denotes Pop-Up
- Denotes area of proposed attenuation below permeable paving. Attenuation Crates - 1No. Layer 400mm Deep by Envirocrete or similar; bays lined w/ Permacoid geomembrane/similar
- Denotes area of proposed filter trench. 50mm D Rainclean over Type B filter material; trench lined w/ Permacoid geomembrane/similar

|                     |          |            |              |
|---------------------|----------|------------|--------------|
| A                   | 05.12.24 | PLANNING   | SF           |
| Rev                 | Date     | Revision   | By           |
| Project             |          |            |              |
| STARBUCKS           |          |            |              |
| ROCHDALE            |          |            |              |
| Drawing Title       |          |            |              |
| HARDSTANDING LAYOUT |          |            |              |
| PLANNING            |          |            |              |
| Drawn by            | SF       | Checked by | Scale @ 1:10 |
| AF                  |          |            |              |
| Drawing No.         |          |            |              |
| 2404-09-903         |          |            |              |
| Revision            |          |            |              |
| A                   |          |            |              |

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Drainage Areas  
1:100

|                |  |              |  |             |  |    |  |            |  |
|----------------|--|--------------|--|-------------|--|----|--|------------|--|
| A              |  | 05.12.24     |  | INFORMATION |  | AF |  | AF         |  |
| Rev.           |  | Date         |  | Revision    |  | By |  |            |  |
| Project        |  |              |  |             |  |    |  |            |  |
| STARBUCKS      |  |              |  |             |  |    |  |            |  |
| ROCHDALE       |  |              |  |             |  |    |  |            |  |
| Drawing Title  |  |              |  |             |  |    |  |            |  |
| DRAINAGE AREAS |  |              |  |             |  |    |  |            |  |
| PLANNING       |  |              |  |             |  |    |  |            |  |
| Drawn by       |  | AF           |  | Checked by  |  | AF |  | Scale @ A0 |  |
| Drawing No.    |  | 2404-09-DA01 |  | Revision    |  | A  |  |            |  |

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**13      Appendix F – Drainage Calculations**

Design Settings

|                                      |        |                                    |               |
|--------------------------------------|--------|------------------------------------|---------------|
| Rainfall Methodology                 | FEH-22 | Minimum Velocity (m/s)             | 1.00          |
| Return Period (years)                | 2      | Connection Type                    | Level Soffits |
| Additional Flow (%)                  | 0      | Minimum Backdrop Height (m)        | 0.200         |
| CV                                   | 0.750  | Preferred Cover Depth (m)          | 1.200         |
| Time of Entry (mins)                 | 5.00   | Include Intermediate Ground        | ✓             |
| Maximum Time of Concentration (mins) | 30.00  | Enforce best practice design rules | ✓             |
| Maximum Rainfall (mm/hr)             | 50.0   |                                    |               |

Adoptable Manhole Type

| Max Width (mm) | Diameter (mm) | Max Width (mm) | Diameter (mm) |
|----------------|---------------|----------------|---------------|
| 374            | 1200          | 749            | 1500          |
| 499            | 1350          | 900            | 1800          |

>900 Link+900 mm

| Max Depth (m) | Diameter (mm) | Max Depth (m) | Diameter (mm) |
|---------------|---------------|---------------|---------------|
| 1.500         | 1050          | 99.999        | 1200          |

Circular Link Type

|       |          |         |   |                     |    |               |   |
|-------|----------|---------|---|---------------------|----|---------------|---|
| Shape | Circular | Barrels | 1 | Auto Increment (mm) | 75 | Follow Ground | x |
|-------|----------|---------|---|---------------------|----|---------------|---|

Available Diameters (mm)  
150

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1541 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1682 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1350 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1682 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1556 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1409 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

(Trench) Link Type

|         |             |                     |      |               |   |
|---------|-------------|---------------------|------|---------------|---|
| Shape   | Rectangular | Height (mm)         | 1567 | Follow Ground | x |
| Barrels | 1           | Auto Increment (mm) | 75   |               |   |

Available Diameters (mm)  
100

Nodes

| Name         | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|--------------|-----------|---------------|-----------------|---------------|-------------|--------------|-----------|
| SWC005       | 0.062     | 5.00          | 129.400         | 1200          | 389229.865  | 411750.798   | 1.425     |
| SWC006       |           | 5.00          | 129.380         | 1200          | 389257.424  | 411756.201   | 1.350     |
| SWC007       |           |               | 129.420         | 1200          | 389245.745  | 411740.760   | 1.556     |
| SWC008       |           |               | 129.400         | 1200          | 389250.980  | 411737.470   | 1.642     |
| SWC009       |           |               | 129.300         | 1200          | 389262.792  | 411733.455   | 1.616     |
| SWC010       |           | 5.00          | 129.250         | 1200          | 389268.721  | 411736.108   | 1.350     |
| Permeable 01 | 0.060     | 5.00          | 129.350         | 1200          | 389254.520  | 411747.733   | 1.409     |
| Permeable 02 | 0.008     | 5.00          | 129.400         | 1200          | 389257.354  | 411735.304   | 1.682     |
| Permeable 03 | 0.005     | 5.00          | 129.200         | 1200          | 389265.917  | 411734.859   | 1.350     |
| Ex. MH002    |           |               | 129.580         | 1200          | 389263.142  | 411729.688   | 1.919     |

Links

| Name  | US Node      | DS Node      | Length (m) | ks (mm) / n | US IL (m) | DS IL (m) | Fall (m) | Slope (1:X) | Dia (mm) | T of C (mins) | Rain (mm/hr) |
|-------|--------------|--------------|------------|-------------|-----------|-----------|----------|-------------|----------|---------------|--------------|
| 1.000 | SWC005       | SWC007       | 18.787     | 0.600       | 127.975   | 127.864   | 0.111    | 169.2       | 225      | 5.31          | 44.8         |
| 1.001 | SWC007       | SWC008       | 6.183      | 0.600       | 127.864   | 127.758   | 0.106    | 58.3        | 225      | 5.37          | 44.7         |
| 1.002 | SWC008       | Permeable 02 | 6.732      | 0.600       | 127.758   | 127.718   | 0.040    | 168.3       | 225      | 5.48          | 44.3         |
| 1.003 | Permeable 02 | SWC009       | 5.744      | 0.600       | 127.718   | 127.684   | 0.034    | 168.9       | 225      | 5.58          | 44.0         |
| 1.004 | SWC009       | Ex. MH002    | 3.783      | 0.600       | 127.684   | 127.661   | 0.023    | 164.5       | 225      | 5.64          | 43.9         |
| 3.000 | SWC010       | Permeable 03 | 3.070      | 0.600       | 127.900   | 127.850   | 0.050    | 61.4        | 150      | 5.04          | 45.7         |
| 3.001 | Permeable 03 | SWC009       | 3.426      | 0.600       | 127.850   | 127.759   | 0.091    | 37.6        | 150      | 5.07          | 45.6         |
| 2.000 | SWC006       | Permeable 01 | 8.952      | 0.600       | 128.030   | 127.941   | 0.089    | 100.6       | 150      | 5.15          | 45.3         |
| 2.001 | Permeable 01 | SWC008       | 10.856     | 0.600       | 127.941   | 127.833   | 0.108    | 100.5       | 150      | 5.33          | 44.8         |

| Name  | Vel (m/s) | Cap (l/s) | Flow (l/s) | US Depth (m) | DS Depth (m) | Σ Area (ha) | Σ Add Inflow (l/s) | Pro Depth (mm) | Pro Velocity (m/s) |
|-------|-----------|-----------|------------|--------------|--------------|-------------|--------------------|----------------|--------------------|
| 1.000 | 1.002     | 39.8      | 7.5        | 1.200        | 1.331        | 0.062       | 0.0                | 66             | 0.775              |
| 1.001 | 1.715     | 68.2      | 7.5        | 1.331        | 1.417        | 0.062       | 0.0                | 51             | 1.141              |
| 1.002 | 1.005     | 39.9      | 14.7       | 1.417        | 1.457        | 0.122       | 0.0                | 94             | 0.930              |
| 1.003 | 1.003     | 39.9      | 15.5       | 1.457        | 1.391        | 0.130       | 0.0                | 97             | 0.940              |
| 1.004 | 1.016     | 40.4      | 16.1       | 1.391        | 1.694        | 0.135       | 0.0                | 99             | 0.961              |
| 3.000 | 1.286     | 22.7      | 0.0        | 1.200        | 1.200        | 0.000       | 0.0                | 0              | 0.000              |
| 3.001 | 1.645     | 29.1      | 0.6        | 1.200        | 1.391        | 0.005       | 0.0                | 15             | 0.654              |
| 2.000 | 1.002     | 17.7      | 0.0        | 1.200        | 1.259        | 0.000       | 0.0                | 0              | 0.000              |
| 2.001 | 1.002     | 17.7      | 7.3        | 1.259        | 1.417        | 0.060       | 0.0                | 67             | 0.954              |

Pipeline Schedule

| Link  | Length (m) | Slope (1:X) | Dia (mm) | Link Type | US CL (m) | US IL (m) | US Depth (m) | DS CL (m) | DS IL (m) | DS Depth (m) |
|-------|------------|-------------|----------|-----------|-----------|-----------|--------------|-----------|-----------|--------------|
| 1.000 | 18.787     | 169.2       | 225      | Circular  | 129.400   | 127.975   | 1.200        | 129.420   | 127.864   | 1.331        |
| 1.001 | 6.183      | 58.3        | 225      | Circular  | 129.420   | 127.864   | 1.331        | 129.400   | 127.758   | 1.417        |
| 1.002 | 6.732      | 168.3       | 225      | Circular  | 129.400   | 127.758   | 1.417        | 129.400   | 127.718   | 1.457        |
| 1.003 | 5.744      | 168.9       | 225      | Circular  | 129.400   | 127.718   | 1.457        | 129.300   | 127.684   | 1.391        |
| 1.004 | 3.783      | 164.5       | 225      | Circular  | 129.300   | 127.684   | 1.391        | 129.580   | 127.661   | 1.694        |
| 3.000 | 3.070      | 61.4        | 150      | Circular  | 129.250   | 127.900   | 1.200        | 129.200   | 127.850   | 1.200        |
| 3.001 | 3.426      | 37.6        | 150      | Circular  | 129.200   | 127.850   | 1.200        | 129.300   | 127.759   | 1.391        |
| 2.000 | 8.952      | 100.6       | 150      | Circular  | 129.380   | 128.030   | 1.200        | 129.350   | 127.941   | 1.259        |
| 2.001 | 10.856     | 100.5       | 150      | Circular  | 129.350   | 127.941   | 1.259        | 129.400   | 127.833   | 1.417        |

| Link  | US Node      | Dia (mm) | Node Type | MH Type   | DS Node      | Dia (mm) | Node Type | MH Type   |
|-------|--------------|----------|-----------|-----------|--------------|----------|-----------|-----------|
| 1.000 | SWC005       | 1200     | Manhole   | Adoptable | SWC007       | 1200     | Manhole   | Adoptable |
| 1.001 | SWC007       | 1200     | Manhole   | Adoptable | SWC008       | 1200     | Manhole   | Adoptable |
| 1.002 | SWC008       | 1200     | Manhole   | Adoptable | Permeable 02 | 1200     | Manhole   | Adoptable |
| 1.003 | Permeable 02 | 1200     | Manhole   | Adoptable | SWC009       | 1200     | Manhole   | Adoptable |
| 1.004 | SWC009       | 1200     | Manhole   | Adoptable | Ex. MH002    | 1200     | Manhole   | Adoptable |
| 3.000 | SWC010       | 1200     | Manhole   | Adoptable | Permeable 03 | 1200     | Manhole   | Adoptable |
| 3.001 | Permeable 03 | 1200     | Manhole   | Adoptable | SWC009       | 1200     | Manhole   | Adoptable |
| 2.000 | SWC006       | 1200     | Manhole   | Adoptable | Permeable 01 | 1200     | Manhole   | Adoptable |
| 2.001 | Permeable 01 | 1200     | Manhole   | Adoptable | SWC008       | 1200     | Manhole   | Adoptable |

Manhole Schedule

| Node         | Easting (m) | Northing (m) | CL (m)  | Depth (m) | Dia (mm) | Connections                                                                                  | Link  | IL (m)  | Dia (mm) |
|--------------|-------------|--------------|---------|-----------|----------|----------------------------------------------------------------------------------------------|-------|---------|----------|
| SWC005       | 389229.865  | 411750.798   | 129.400 | 1.425     | 1200     | <br>0      | 1.000 | 127.975 | 225      |
| SWC006       | 389257.424  | 411756.201   | 129.380 | 1.350     | 1200     | <br>0      | 2.000 | 128.030 | 150      |
| SWC007       | 389245.745  | 411740.760   | 129.420 | 1.556     | 1200     | <br>1<br>0 | 1.000 | 127.864 | 225      |
| SWC008       | 389250.980  | 411737.470   | 129.400 | 1.642     | 1200     | <br>1      | 2.001 | 127.833 | 150      |
|              |             |              |         |           |          | <br>2      | 1.001 | 127.758 | 225      |
|              |             |              |         |           |          | 0                                                                                            | 1.002 | 127.758 | 225      |
| SWC009       | 389262.792  | 411733.455   | 129.300 | 1.616     | 1200     | <br>1      | 3.001 | 127.759 | 150      |
|              |             |              |         |           |          | <br>2      | 1.003 | 127.684 | 225      |
|              |             |              |         |           |          | 0                                                                                            | 1.004 | 127.684 | 225      |
| SWC010       | 389268.721  | 411736.108   | 129.250 | 1.350     | 1200     | <br>0      | 3.000 | 127.900 | 150      |
| Permeable 01 | 389254.520  | 411747.733   | 129.350 | 1.409     | 1200     | <br>1      | 2.000 | 127.941 | 150      |
|              |             |              |         |           |          | 0                                                                                            | 2.001 | 127.941 | 150      |
| Permeable 02 | 389257.354  | 411735.304   | 129.400 | 1.682     | 1200     | <br>1     | 1.002 | 127.718 | 225      |
|              |             |              |         |           |          | 0                                                                                            | 1.003 | 127.718 | 225      |
| Permeable 03 | 389265.917  | 411734.859   | 129.200 | 1.350     | 1200     | <br>1    | 3.000 | 127.850 | 150      |
|              |             |              |         |           |          | 0                                                                                            | 3.001 | 127.850 | 150      |
| Ex. MH002    | 389263.142  | 411729.688   | 129.580 | 1.919     | 1200     | <br>1    | 1.004 | 127.661 | 225      |

Simulation Settings

|                      |          |                            |        |                         |     |
|----------------------|----------|----------------------------|--------|-------------------------|-----|
| Rainfall Methodology | FEH-22   | Analysis Speed             | Normal | Starting Level (m)      |     |
| Rainfall Events      | Singular | Skip Steady State          | x      | Check Discharge Rate(s) | ✓   |
| Summer CV            | 0.750    | Drain Down Time (mins)     | 240    | 2 year (l/s)            | 1.7 |
| Winter CV            | 0.840    | Additional Storage (m³/ha) | 20.0   | Check Discharge Volume  | x   |

Storm Durations

|    |     |     |     |     |      |      |      |      |       |
|----|-----|-----|-----|-----|------|------|------|------|-------|
| 15 | 60  | 180 | 360 | 600 | 960  | 2160 | 4320 | 7200 | 10080 |
| 30 | 120 | 240 | 480 | 720 | 1440 | 2880 | 5760 | 8640 |       |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|-----------------------|-----------------------|-----------------------|-----------------------|
| 2                     | 0                     | 0                     | 0                     |
| 30                    | 0                     | 0                     | 0                     |
| 100                   | 45                    | 0                     | 0                     |

Pre-development Discharge Rate

|                              |            |            |      |                      |      |
|------------------------------|------------|------------|------|----------------------|------|
| Site Makeup                  | Brownfield | SAAR (mm)  | 1105 | Growth Factor 2 year | 0.93 |
| Brownfield Method            | Greenfield | Soil Index | 5    | Betterment (%)       | 0    |
| Greenfield Method            | IH124      | SPR        | 0.53 | QBar                 | 1.8  |
| Positively Drained Area (ha) | 0.170      | Region     | 10   | Q 2 year (l/s)       | 1.7  |

Node SWC009 Online Hydro-Brake® Control

|                          |         |                         |                                |
|--------------------------|---------|-------------------------|--------------------------------|
| Flap Valve               | x       | Objective               | (HE) Minimise upstream storage |
| Replaces Downstream Link | ✓       | Sump Available          | ✓                              |
| Invert Level (m)         | 127.684 | Product Number          | CTL-SHE-0045-1100-1443-1100    |
| Design Depth (m)         | 1.443   | Min Outlet Diameter (m) | 0.075                          |
| Design Flow (l/s)        | 1.1     | Min Node Diameter (mm)  | 1200                           |

**Node Permeable 01 Depth/Area Storage Structure**

|                             |         |               |      |                           |         |
|-----------------------------|---------|---------------|------|---------------------------|---------|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0  | Invert Level (m)          | 128.720 |
| 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) | Depth (m) | Area (m²) | Inf Area (m²) |
|-----------|-----------|---------------|-----------|-----------|---------------|-----------|-----------|---------------|
| 0.000     | 158.0     | 0.0           | 0.400     | 158.0     | 0.0           | 0.401     | 0.0       | 0.0           |

**Node Permeable 02 Depth/Area Storage Structure**

|                             |         |               |      |                           |         |
|-----------------------------|---------|---------------|------|---------------------------|---------|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0  | Invert Level (m)          | 128.770 |
| 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) | Depth (m) | Area (m²) | Inf Area (m²) |
|-----------|-----------|---------------|-----------|-----------|---------------|-----------|-----------|---------------|
| 0.000     | 46.0      | 0.0           | 0.400     | 46.0      | 0.0           | 0.401     | 0.0       | 0.0           |

**Node Permeable 03 Depth/Area Storage Structure**

|                             |         |               |      |                           |         |
|-----------------------------|---------|---------------|------|---------------------------|---------|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0  | Invert Level (m)          | 128.570 |
| 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) | Depth (m) | Area (m²) | Inf Area (m²) |
|-----------|-----------|---------------|-----------|-----------|---------------|-----------|-----------|---------------|
| 0.000     | 23.0      | 0.0           | 0.400     | 23.0      | 0.0           | 0.401     | 0.0       | 0.0           |

**Node SWC009 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 3.001    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.759 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 600      |

**Node SWC009 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 1.003    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.684 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 600      |

**Node Permeable 03 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 3.000    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.850 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 600      |

**Node Permeable 02 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 1.002    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.718 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 600      |

**Node SWC007 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 1.000    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.864 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 500      |

**Node Permeable 01 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 2.000    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.941 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 600      |

**Node SWC008 Link Surround Storage Structure**

|                             |         |                           |         |                |          |
|-----------------------------|---------|---------------------------|---------|----------------|----------|
| Base Inf Coefficient (m/hr) | 0.00000 | Porosity                  | 0.30    | Link           | 2.001    |
| Side Inf Coefficient (m/hr) | 0.00000 | Invert Level (m)          | 127.833 | Surround Shape | (Trench) |
| Safety Factor               | 2.0     | Time to half empty (mins) |         | Diameter (mm)  | 600      |

**Rainfall**

| Event                      | Peak<br>Intensity<br>(mm/hr) | Average<br>Intensity<br>(mm/hr) | Event                                | Peak<br>Intensity<br>(mm/hr) | Average<br>Intensity<br>(mm/hr) |
|----------------------------|------------------------------|---------------------------------|--------------------------------------|------------------------------|---------------------------------|
| 2 year 15 minute summer    | 96.792                       | 27.389                          | 30 year 720 minute winter            | 13.437                       | 5.359                           |
| 2 year 15 minute winter    | 67.924                       | 27.389                          | 30 year 960 minute summer            | 16.670                       | 4.390                           |
| 2 year 30 minute summer    | 65.026                       | 18.400                          | 30 year 960 minute winter            | 11.043                       | 4.390                           |
| 2 year 30 minute winter    | 45.632                       | 18.400                          | 30 year 1440 minute summer           | 12.399                       | 3.323                           |
| 2 year 60 minute summer    | 45.659                       | 12.066                          | 30 year 1440 minute winter           | 8.333                        | 3.323                           |
| 2 year 60 minute winter    | 30.335                       | 12.066                          | 30 year 2160 minute summer           | 9.164                        | 2.533                           |
| 2 year 120 minute summer   | 31.875                       | 8.424                           | 30 year 2160 minute winter           | 6.314                        | 2.533                           |
| 2 year 120 minute winter   | 21.177                       | 8.424                           | 30 year 2880 minute summer           | 7.781                        | 2.085                           |
| 2 year 180 minute summer   | 26.011                       | 6.694                           | 30 year 2880 minute winter           | 5.229                        | 2.085                           |
| 2 year 180 minute winter   | 16.908                       | 6.694                           | 30 year 4320 minute summer           | 5.997                        | 1.568                           |
| 2 year 240 minute summer   | 21.361                       | 5.645                           | 30 year 4320 minute winter           | 3.949                        | 1.568                           |
| 2 year 240 minute winter   | 14.192                       | 5.645                           | 30 year 5760 minute summer           | 4.998                        | 1.279                           |
| 2 year 360 minute summer   | 17.086                       | 4.397                           | 30 year 5760 minute winter           | 3.235                        | 1.279                           |
| 2 year 360 minute winter   | 11.106                       | 4.397                           | 30 year 7200 minute summer           | 4.285                        | 1.093                           |
| 2 year 480 minute summer   | 13.831                       | 3.655                           | 30 year 7200 minute winter           | 2.766                        | 1.093                           |
| 2 year 480 minute winter   | 9.189                        | 3.655                           | 30 year 8640 minute summer           | 3.776                        | 0.963                           |
| 2 year 600 minute summer   | 11.541                       | 3.157                           | 30 year 8640 minute winter           | 2.437                        | 0.963                           |
| 2 year 600 minute winter   | 7.886                        | 3.157                           | 30 year 10080 minute summer          | 3.398                        | 0.867                           |
| 2 year 720 minute summer   | 10.431                       | 2.796                           | 30 year 10080 minute winter          | 2.193                        | 0.867                           |
| 2 year 720 minute winter   | 7.010                        | 2.796                           | 100 year +45% CC 15 minute summer    | 457.678                      | 129.507                         |
| 2 year 960 minute summer   | 8.740                        | 2.302                           | 100 year +45% CC 15 minute winter    | 321.178                      | 129.507                         |
| 2 year 960 minute winter   | 5.790                        | 2.302                           | 100 year +45% CC 30 minute summer    | 318.880                      | 90.232                          |
| 2 year 1440 minute summer  | 6.524                        | 1.748                           | 100 year +45% CC 30 minute winter    | 223.775                      | 90.232                          |
| 2 year 1440 minute winter  | 4.384                        | 1.748                           | 100 year +45% CC 60 minute summer    | 228.173                      | 60.299                          |
| 2 year 2160 minute summer  | 4.843                        | 1.338                           | 100 year +45% CC 60 minute winter    | 151.592                      | 60.299                          |
| 2 year 2160 minute winter  | 3.337                        | 1.338                           | 100 year +45% CC 120 minute summer   | 134.975                      | 35.670                          |
| 2 year 2880 minute summer  | 4.156                        | 1.114                           | 100 year +45% CC 120 minute winter   | 89.674                       | 35.670                          |
| 2 year 2880 minute winter  | 2.793                        | 1.114                           | 100 year +45% CC 180 minute summer   | 102.333                      | 26.334                          |
| 2 year 4320 minute summer  | 3.325                        | 0.869                           | 100 year +45% CC 180 minute winter   | 66.519                       | 26.334                          |
| 2 year 4320 minute winter  | 2.189                        | 0.869                           | 100 year +45% CC 240 minute summer   | 80.565                       | 21.291                          |
| 2 year 5760 minute summer  | 2.875                        | 0.736                           | 100 year +45% CC 240 minute winter   | 53.525                       | 21.291                          |
| 2 year 5760 minute winter  | 1.861                        | 0.736                           | 100 year +45% CC 360 minute summer   | 61.669                       | 15.869                          |
| 2 year 7200 minute summer  | 2.553                        | 0.651                           | 100 year +45% CC 360 minute winter   | 40.086                       | 15.869                          |
| 2 year 7200 minute winter  | 1.648                        | 0.651                           | 100 year +45% CC 480 minute summer   | 49.004                       | 12.950                          |
| 2 year 8640 minute summer  | 2.323                        | 0.593                           | 100 year +45% CC 480 minute winter   | 32.557                       | 12.950                          |
| 2 year 8640 minute winter  | 1.499                        | 0.593                           | 100 year +45% CC 600 minute summer   | 40.560                       | 11.094                          |
| 2 year 10080 minute summer | 2.154                        | 0.549                           | 100 year +45% CC 600 minute winter   | 27.713                       | 11.094                          |
| 2 year 10080 minute winter | 1.390                        | 0.549                           | 100 year +45% CC 720 minute summer   | 36.554                       | 9.797                           |
| 30 year 15 minute summer   | 249.551                      | 70.614                          | 100 year +45% CC 720 minute winter   | 24.566                       | 9.797                           |
| 30 year 15 minute winter   | 175.123                      | 70.614                          | 100 year +45% CC 960 minute summer   | 30.700                       | 8.084                           |
| 30 year 30 minute summer   | 171.872                      | 48.634                          | 100 year +45% CC 960 minute winter   | 20.336                       | 8.084                           |
| 30 year 30 minute winter   | 120.612                      | 48.634                          | 100 year +45% CC 1440 minute summer  | 23.039                       | 6.175                           |
| 30 year 60 minute summer   | 121.846                      | 32.200                          | 100 year +45% CC 1440 minute winter  | 15.484                       | 6.175                           |
| 30 year 60 minute winter   | 80.952                       | 32.200                          | 100 year +45% CC 2160 minute summer  | 17.038                       | 4.709                           |
| 30 year 120 minute summer  | 73.784                       | 19.499                          | 100 year +45% CC 2160 minute winter  | 11.739                       | 4.709                           |
| 30 year 120 minute winter  | 49.020                       | 19.499                          | 100 year +45% CC 2880 minute summer  | 14.402                       | 3.860                           |
| 30 year 180 minute summer  | 56.476                       | 14.533                          | 100 year +45% CC 2880 minute winter  | 9.679                        | 3.860                           |
| 30 year 180 minute winter  | 36.711                       | 14.533                          | 100 year +45% CC 4320 minute summer  | 10.978                       | 2.870                           |
| 30 year 240 minute summer  | 44.633                       | 11.795                          | 100 year +45% CC 4320 minute winter  | 7.230                        | 2.870                           |
| 30 year 240 minute winter  | 29.653                       | 11.795                          | 100 year +45% CC 5760 minute summer  | 9.050                        | 2.317                           |
| 30 year 360 minute summer  | 34.135                       | 8.784                           | 100 year +45% CC 5760 minute winter  | 5.858                        | 2.317                           |
| 30 year 360 minute winter  | 22.189                       | 8.784                           | 100 year +45% CC 7200 minute summer  | 7.683                        | 1.960                           |
| 30 year 480 minute summer  | 27.026                       | 7.142                           | 100 year +45% CC 7200 minute winter  | 4.958                        | 1.960                           |
| 30 year 480 minute winter  | 17.955                       | 7.142                           | 100 year +45% CC 8640 minute summer  | 6.704                        | 1.710                           |
| 30 year 600 minute summer  | 22.277                       | 6.093                           | 100 year +45% CC 8640 minute winter  | 4.327                        | 1.710                           |
| 30 year 600 minute winter  | 15.221                       | 6.093                           | 100 year +45% CC 10080 minute summer | 5.978                        | 1.525                           |
| 30 year 720 minute summer  | 19.994                       | 5.359                           | 100 year +45% CC 10080 minute winter | 3.858                        | 1.525                           |

**Results for 2 year Critical Storm Duration. Lowest mass balance: 96.26%**

| Node Event        | US Node      | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status     |
|-------------------|--------------|-------------|-----------|-----------|--------------|---------------|------------|------------|
| 360 minute winter | SWC005       | 272         | 128.539   | 0.563     | 1.6          | 1.1275        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC006       | 272         | 128.539   | 0.509     | 0.2          | 0.5751        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC007       | 272         | 128.539   | 0.674     | 1.4          | 2.2822        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC008       | 272         | 128.539   | 0.780     | 1.8          | 2.0983        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC009       | 272         | 128.538   | 0.854     | 1.3          | 2.1979        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC010       | 272         | 128.538   | 0.638     | 0.1          | 0.7220        | 0.0000     | SURCHARGED |
| 360 minute winter | Permeable 01 | 272         | 128.539   | 0.598     | 1.6          | 2.0282        | 0.0000     | SURCHARGED |
| 360 minute winter | Permeable 02 | 272         | 128.538   | 0.820     | 1.6          | 1.8956        | 0.0000     | SURCHARGED |
| 360 minute winter | Permeable 03 | 272         | 128.538   | 0.688     | 0.4          | 1.1799        | 0.0000     | SURCHARGED |
| 15 minute summer  | Ex. MH002    | 1           | 127.661   | 0.000     | 0.8          | 0.0000        | 0.0000     | OK         |

| Link Event (Upstream Depth) | US Node      | Link         | DS Node      | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|-----------------------------|--------------|--------------|--------------|---------------|----------------|----------|---------------|--------------------|
| 360 minute winter           | SWC005       | 1.000        | SWC007       | 1.4           | 0.441          | 0.034    | 0.7472        |                    |
| 360 minute winter           | SWC006       | 2.000        | Permeable 01 | -0.2          | -0.041         | -0.013   | 0.1576        |                    |
| 360 minute winter           | SWC007       | 1.001        | SWC008       | 0.9           | 0.300          | 0.013    | 0.2459        |                    |
| 360 minute winter           | SWC008       | 1.002        | Permeable 02 | 1.4           | 0.356          | 0.036    | 0.2677        |                    |
| 360 minute winter           | SWC009       | Hydro-Brake® | Ex. MH002    | 0.9           |                |          |               | 25.6               |
| 360 minute winter           | SWC010       | 3.000        | Permeable 03 | -0.1          | -0.013         | -0.006   | 0.0540        |                    |
| 360 minute winter           | Permeable 01 | 2.001        | SWC008       | 1.1           | 0.482          | 0.061    | 0.1911        |                    |
| 360 minute winter           | Permeable 02 | 1.003        | SWC009       | 1.3           | 0.300          | 0.033    | 0.2284        |                    |
| 360 minute winter           | Permeable 03 | 3.001        | SWC009       | -0.3          | 0.019          | -0.009   | 0.0603        |                    |

Results for 30 year Critical Storm Duration. Lowest mass balance: 96.26%

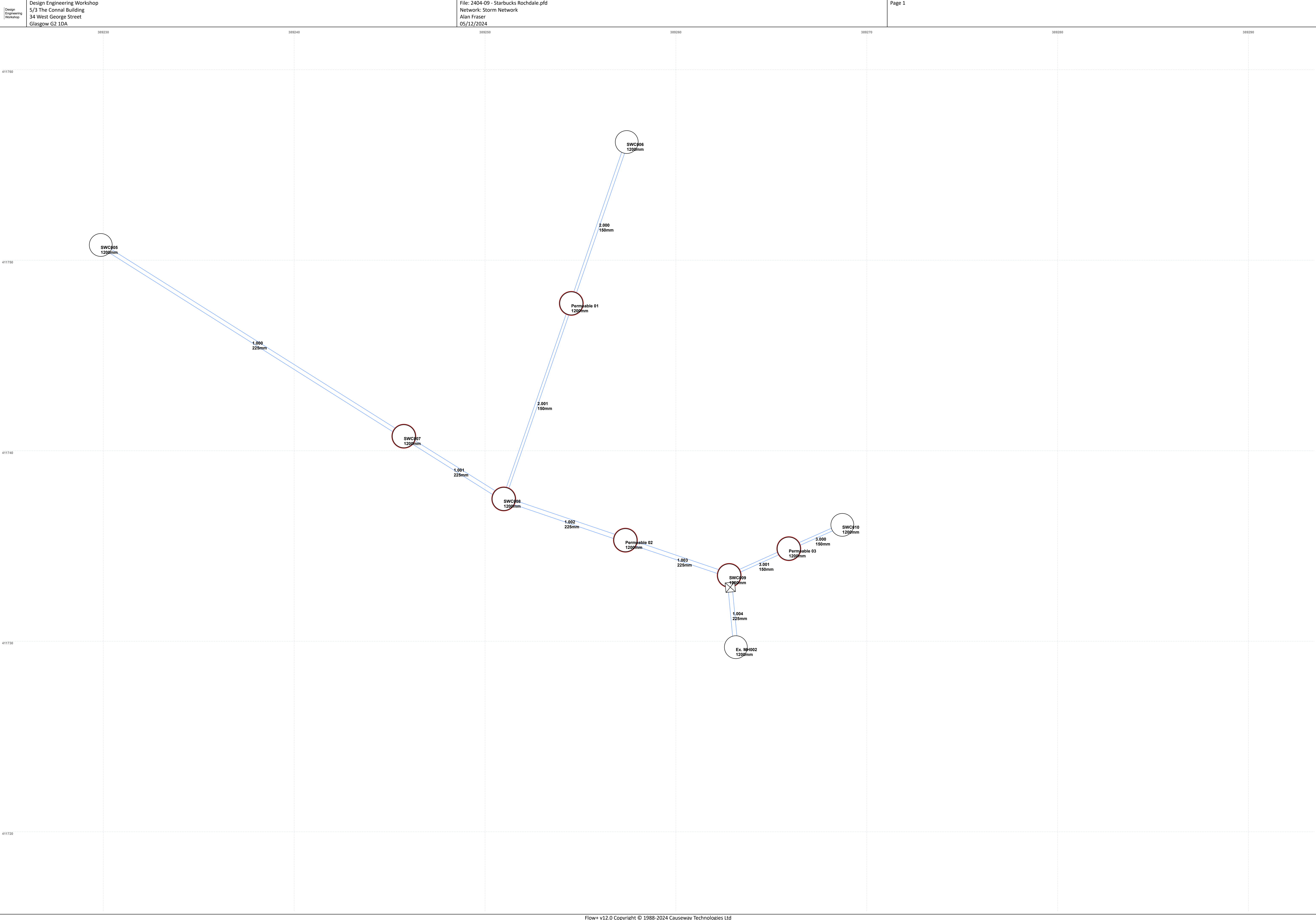
| Node Event        | US Node      | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status     |
|-------------------|--------------|-------------|-----------|-----------|--------------|---------------|------------|------------|
| 360 minute winter | SWC005       | 344         | 128.807   | 0.832     | 3.2          | 1.6651        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC006       | 344         | 128.807   | 0.777     | 0.3          | 0.8790        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC007       | 344         | 128.807   | 0.943     | 3.1          | 3.3446        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC008       | 344         | 128.807   | 1.049     | 4.8          | 2.9267        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC009       | 344         | 128.807   | 1.123     | 4.5          | 2.9453        | 0.0000     | SURCHARGED |
| 360 minute winter | SWC010       | 344         | 128.807   | 0.907     | 0.3          | 1.0259        | 0.0000     | SURCHARGED |
| 360 minute winter | Permeable 01 | 344         | 128.807   | 0.866     | 4.7          | 16.1546       | 0.0000     | SURCHARGED |
| 360 minute winter | Permeable 02 | 344         | 128.807   | 1.089     | 4.8          | 4.1926        | 0.0000     | SURCHARGED |
| 360 minute winter | Permeable 03 | 344         | 128.807   | 0.957     | 3.4          | 6.8421        | 0.0000     | SURCHARGED |
| 15 minute summer  | Ex. MH002    | 1           | 127.661   | 0.000     | 0.9          | 0.0000        | 0.0000     | OK         |

| Link Event (Upstream Depth) | US Node      | Link         | DS Node      | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|-----------------------------|--------------|--------------|--------------|---------------|----------------|----------|---------------|--------------------|
| 360 minute winter           | SWC005       | 1.000        | SWC007       | 3.1           | 0.420          | 0.077    | 0.7472        |                    |
| 360 minute winter           | SWC006       | 2.000        | Permeable 01 | -0.3          | -0.020         | -0.016   | 0.1576        |                    |
| 360 minute winter           | SWC007       | 1.001        | SWC008       | 3.0           | 0.316          | 0.044    | 0.2459        |                    |
| 360 minute winter           | SWC008       | 1.002        | Permeable 02 | 4.4           | 0.346          | 0.110    | 0.2677        |                    |
| 360 minute winter           | SWC009       | Hydro-Brake® | Ex. MH002    | 1.0           |                |          |               | 31.8               |
| 360 minute winter           | SWC010       | 3.000        | Permeable 03 | -0.3          | -0.018         | -0.014   | 0.0540        |                    |
| 360 minute winter           | Permeable 01 | 2.001        | SWC008       | 2.4           | 0.438          | 0.137    | 0.1911        |                    |
| 360 minute winter           | Permeable 02 | 1.003        | SWC009       | 4.5           | 0.293          | 0.112    | 0.2284        |                    |
| 360 minute winter           | Permeable 03 | 3.001        | SWC009       | -3.1          | -0.179         | -0.108   | 0.0603        |                    |

Results for 100 year +45% CC Critical Storm Duration. Lowest mass balance: 96.26%

| Node Event         | US Node      | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status     |
|--------------------|--------------|-------------|-----------|-----------|--------------|---------------|------------|------------|
| 1440 minute winter | SWC005       | 1110        | 129.045   | 1.070     | 2.2          | 2.1402        | 0.0000     | SURCHARGED |
| 1440 minute winter | SWC006       | 1110        | 129.045   | 1.015     | 0.1          | 1.1476        | 0.0000     | SURCHARGED |
| 1440 minute winter | SWC007       | 1110        | 129.045   | 1.181     | 2.2          | 4.2818        | 0.0000     | SURCHARGED |
| 1440 minute winter | SWC008       | 1110        | 129.045   | 1.287     | 2.4          | 3.6593        | 0.0000     | SURCHARGED |
| 1440 minute winter | SWC009       | 1110        | 129.045   | 1.360     | 2.3          | 3.6057        | 0.0000     | FLOOD RISK |
| 1440 minute winter | SWC010       | 1110        | 129.045   | 1.144     | 0.1          | 1.2944        | 0.0000     | FLOOD RISK |
| 1440 minute winter | Permeable 01 | 1110        | 129.045   | 1.104     | 2.7          | 52.6550       | 0.0000     | SURCHARGED |
| 1440 minute winter | Permeable 02 | 1110        | 129.045   | 1.327     | 2.4          | 15.1475       | 0.0000     | SURCHARGED |
| 1440 minute winter | Permeable 03 | 1110        | 129.045   | 1.194     | 1.3          | 10.8310       | 0.0000     | FLOOD RISK |
| 15 minute summer   | Ex. MH002    | 1           | 127.661   | 0.000     | 1.0          | 0.0000        | 0.0000     | OK         |

| Link Event (Upstream Depth) | US Node      | Link         | DS Node      | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|-----------------------------|--------------|--------------|--------------|---------------|----------------|----------|---------------|--------------------|
| 1440 minute winter          | SWC005       | 1.000        | SWC007       | 2.2           | 0.374          | 0.054    | 0.7472        |                    |
| 1440 minute winter          | SWC006       | 2.000        | Permeable 01 | -0.1          | -0.008         | -0.006   | 0.1576        |                    |
| 1440 minute winter          | SWC007       | 1.001        | SWC008       | 2.1           | 0.288          | 0.031    | 0.2459        |                    |
| 1440 minute winter          | SWC008       | 1.002        | Permeable 02 | 2.2           | 0.329          | 0.056    | 0.2677        |                    |
| 1440 minute winter          | SWC009       | Hydro-Brake® | Ex. MH002    | 1.1           |                |          |               | 92.1               |
| 1440 minute winter          | SWC010       | 3.000        | Permeable 03 | -0.1          | -0.006         | -0.005   | 0.0540        |                    |
| 1440 minute winter          | Permeable 01 | 2.001        | SWC008       | 1.2           | 0.410          | 0.070    | 0.1911        |                    |
| 1440 minute winter          | Permeable 02 | 1.003        | SWC009       | 2.3           | 0.144          | 0.058    | 0.2284        |                    |
| 1440 minute winter          | Permeable 03 | 3.001        | SWC009       | -1.2          | -0.071         | -0.043   | 0.0603        |                    |



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