Alvechurch Social Club – Surface Water Drainage Strategy

14th March 2023
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RAB: 3087

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Published by

RAB Consultants Limited
Second Floor
Cathedral House
Beacon Street
Lichfield
Staffordshire
WS13 7AA

Call: 01543 547 303
Email: enquiries@rabconsultants.co.uk
Visit: rabconsultants.co.uk

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Quality Control

Action	Name
Prepared	N. Parsons
Checked	T. Haskey
Approved	G. M. Wilson

Revision History

Version	Date	Amendments	Issued to
1.0	14/03/2023	First Issued	Caroline McIntyre

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1.0 Introduction

RAB Consultants has prepared this surface water drainage design report in support of the proposed change of use and minor extension development at Alvechurch Social Club.

2.0 Site details

2.1 Site location

TABLE 1: SITE LOCATION

Site address:	Alvechurch Social Club, Radford Road, Alvechurch, Birmingham B48 7LD
Site area:	0.187ha
Existing land use:	Social club and associated car park
OS NGR:	SP 02924 72595
Local Planning Authority:	Bromsgrove District Council

2.2 Site description

The site consists of a single two storey drinking establishment and associated parking. It is situated in the village of Alvechurch, and civil parish of Bromsgrove district, located in the northeast of Worcestershire.

The site is located near the main village square, towards the east extent of Alvechurch, near the River Arrow which flows south past the village. A mix of residential and commercial properties surround the site.

Access is direct from Radford Road along the north extent of the site.

2.3 Development proposal

A change of use development is proposed to convert the existing building on the site to a bed and breakfast accommodation. A 180m^2 extension to the existing building is also proposed as part of the development. The extension will be constructed onto a section of the existing car park.

28 guest bedrooms and a single manger bedroom will be created as a part of the development; 20 bedrooms in the proposed extension and 9 in the existing building.

Proposed plans and a topographic survey of the site are enclosed within Appendix A.

3.0 Drainage strategy

3.1 SuDS applicable policies

Worcestershire County Council's Sustainable Drainage Design and Evaluation Guide has been used to assist with this drainage strategy along with CIRIA's SUDS Manual and LASOO Non-Statutory Technical Standards for Sustainable Drainage, Practice Guidance.

3.2 SuDS feasibility

The SuDS Manual (2015), discusses the SuDS approach to managing surface water runoff which is intended to mimic the natural catchment process as closely as is possible. The approach sets out the design objectives in respect of SuDS:

- Use of surface water runoff as a resource;
- Manage rainwater close to where it falls (at source);
- Manage runoff on the surface (above ground);
- Allow rainwater to soak into the ground (infiltration);
- Promote evapotranspiration;
- Slow and store runoff to mimic natural runoff rates and volumes;
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source; and
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

Depending on the characteristics of the site and local requirements, these may be used in conjunction and to varying degrees. Table 2 presents the functions of the SuDS components (from which a management train can be created) and their feasibility in respect of the site.

TABLE 2: FEASIBILITY OF SUDS TECHNIQUES AT THE DEVELOPMENT SITE

Technique	Description	Feasibility Y / N / M (Maybe)
Good building design and rainwater harvesting	Components that capture rainwater and facilitate its use within the building or local environment.	**Y** – It is feasible to include water butts on downpipes for water reuse.
Porous and pervious surface materials	Structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system (green roofs, pervious paving).	**Y** – A small section of parking area can be made permeable. This would provide space for water storage and treatment.
Infiltration Systems	Components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.	**N** – Infiltration is unlikely to be appropriate according to available data – see Section 3.3.
Conveyance Systems	Components that convey flows to downstream storage systems (e.g. swales, watercourses).	**N** –SuDS conveyance systems are not possible within the site given the small urban nature and scale of development.
Storage Systems	Components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff (e.g., ponds, wetlands, and detention basins).	**Y** – The development has scope to utilise an underground attenuation storage system and small surface SuDS features such as rain gardens.
Treatment Systems	Components that remove or facilitate the degradation of contaminants present in the runoff.	**Y** – Small surface SuDS features and permeable paving will provide water quality benefits.

3.3 Existing drainage

The site lies close to (100m west of) the River Arrow and slopes steeply down towards Radford Road and down to the Arrow, with a typical gradient of 1:20 (freely available LiDAR data - 1m, DTM, 2021). Rain falling on to the site in its natural condition is therefore expected to contribute a high proportion of runoff, flowing quickly into the river. The Environment Agency's surface water risk map confirms this and also reveals a natural flow route (a natural valley) along Radford Road towards the River Arrow into which the proposed site would contribute flow.

The site has been developed such that the existing 0.187ha site is almost entirely impermeable except for a narrow strip around the east and a section of the north perimeter where well-established trees lie in a curbed off area.

A Severn Trent Water sewer map was obtained (Appendix B). It shows no surface water sewers but identifies a foul water sewer in Radford Road which flows around the site, first east then south through Mill Farm.

The topographic survey (Appendix A) identifies no drainage infrastructure across the car park. It is therefore assumed the 1500m^2 car park is undrained and simply runs off into Radford Road where it is picked up by the local highways system. Downpipes from the building roof appear to terminate below ground (Google Street View) which suggests the presence of a positive drainage system. Given the small urban site with a steep 1:20 gradient, and limited available easement from the building, it is unlikely a soakaway is currently utilised for rooftop discharge. Instead, surface water from the rooftops (370m^2) most likely discharges into the local highway's drainage network or the adjacent public foul sewer, or a private / unidentified surface water sewer located in Radford Road. A drainage tracing survey will be required to confirm the existing arrangement.

Equivalent greenfield runoff rates for the site have been calculated using the IH124 method (based on the interim code of practice of Sustainable Drainage systems given the small development area).

IH124 parameters:

Area = 0.187ha SOIL = 0.450

SAAR = 705mm Region = 4

TABLE 3: IH124 GREENFIELD PEAK RUNOFF RATES

Annual Exceedance Probability (AEP)	Peak Runoff Rate (l/s)
QBAR	0.8 (4.3 l/s/ha)
100% (1 year)	0.7 (3.7 l/s/ha)
3.33% (30 year)	1.6 (8.6 l/s/ha)
1% (100 year)	2.1 (11.2 l/s/ha)
1% (100 year) plus 21% for climate change*	2.6 (13.9 l/s/ha)

**21% increase on flow - Avon Warwickshire Catchment - 2080s - Central Allowance*

In reality, runoff from the site will be much higher than greenfield estimates given it is almost entirely impermeable.

While the ultimate below ground discharge location for the rooftops is unknown, a reasonable assumption and representation of its drainage arrangement has been made with Microdrainage Source Control[1] to estimate existing runoff rates from the site. As stated above the site is drained in two ways:

1. **'Undrained'** car park area – 1500m^2, running of into Radford Road.
    - Conservatively represented as a flat surface (tank), with a 10m weir set at the invert level of the tank to simulate overland runoff via the site entrance into Radford Road.
2. (Expected) **'Drained'** building rooftops – 370m^2, discharging below ground.
    - Final discharge manhole represented as a 1.5m deep, 1m^2 tank (representing a typical manhole chamber) with a 150mm outlet pipe (reasonable given the size of site).

Results are summarised in Table 4 below.

TABLE 4: ESTIMATE OF PRE-DEVELOPMENT BROWNFIELD 'FORMAL' RUNOFF RATES

Annual Exceedance Probability (AEP)	Critical Storm	Peak outflow rate from **'drained' building rooftops** (l/s)	Peak outflow rate from **'undrained' car park** (l/s)	Total rate leaving site (l/s)
100% (1 in 1)	15 min winter	5.1	5.6	10.7
3.3% (1 in 30)	15 min winter	12.6	19.0	31.6
1% (1 in 100) +CC (40%)	15 min winter	22.6	40.3	62.9

**40% increase on flow – Upper End – 2070s – Peak rainfall allowance*

[1] ***Summary of MicroDrainage Source Control test parameters:***
FSR rainfall – M5-60 = 19.800mm – Ratio R = 0.400
5-min Time of Concentration
Zero Infiltration

3.4 Proposed drainage strategy

It is proposed to convert the existing social club building into bed and breakfast accommodation. A 180m^2 extension to the existing building, over a section of the car park is also proposed as part of the development.

The recommended hierarchy for discharging surface water (ref. The SuDS Manual, CIRIA C753) is:

1. Infiltration to the maximum extent that is practical.
2. Discharge to surface waters.
3. Discharge to surface water sewer.
4. Discharge to combined sewers.

BGS online map reports the site is located on Mercia Mudstone Group with no superficial deposits. Soilscapes indicates that the proposed site is located on 'slightly acid loamy and clayey soils with impeded drainage'. Given the available information about ground conditions and given the steeply sloping nature of the site and nearby River Arrow, it seems highly unlikely that a strategy of discharging surface water to ground would be effective. Infiltration may be appropriate for low intensity storms, subject to the results of ground testing.

The River Arrow is located 100m east of the site. While creating a new discharge to the river would be the next best choice under the hierarchy, the route would require laying a sewer along Radford Road given third parties own adjacent land. The associated construction costs for this would render the small proposed development financially unviable.

As discussed earlier, Severn Trent Water sewer maps show no public surface water sewers within reasonable close proximity of the site. In the absence of a drainage tracing survey the existing site most likely discharges either into the local highway's drainage network or the adjacent public foul sewer, or a private / unidentified surface water sewer on Radford Road. It is therefore proposed to retain and adapt the existing surface water drainage provision from the site. A surface water drainage strategy is therefore proposed that meets the following site constraints and key design parameters:

- **Retained formal piped system (to be confirmed)**

No increase of drained area into the piped system – i.e. maintaining at most 370m^2 of drained area.

Provide significant betterment through the implementation of attenuation storage. The proposed development will create a bed and breakfast accommodation with 28 guest bedrooms which may increase foul load into the foul system compared with existing. Therefore, significant attenuation of flow provided to the 370m^2 of drained area will be particularly relevant if the existing surface water discharge in fact connects to the foul sewer.

- **Informal discharge onto Radford Road**

No increase of drained area that currently informally runs off onto Radford Road – i.e. maintaining at most 1500m^2 of informal discharge area.

Provide some betterment through the creation of boundary SuDS treatments to enhance retention, detention, water treatment and dispersal of outflow.

As such a drainage strategy is proposed that incorporates formal attenuation with flow control and small SuDS features proportionate to the scale of development to provide betterment from existing. To summarise the strategy:

- Surface water will be attenuated from the proposed extension, a section of existing rooftop and a section of parking spaces (**total 370m^2**) in a geocellular storage tank located beneath a section of permeable parking, with controlled outflow (3.0 l/s) into the existing piped system from the site.
- The remaining roof area will be disconnected from the existing underground system and instead managed as part of the element of informal site discharge into Radford Road (as existing). This will be done via a rain garden with check-dams to provide some retention, detention and water treatment.
- Minor landscaping works to allow a proportion of runoff from the car park to enter the kerbed-off tree perimeter areas, in order to create a perimeter rain garden – enhancing water quality benefits, evapotranspiration and infiltration potential prior to informally running off onto Radford Road as per existing.
- Provide a channel drain along the north perimeter (entrance) of the site to ensure diffuse informal runoff onto Radford Road.

This scheme will offer benefit to the **'formal'** piped system in restricting flow to a lower rate than existing as well as providing some volume and rate betterment to runoff from the **'informal'** section.

Consultation with the water company / LLFA may be required to agree the continued surface water discharge from the site and maximum rate.

Post-development runoff rates for the **'formal'** section of the site have been calculated using MicroDrainage Source Control[2] for the full range of storm events, with results included in Appendix C.

The attenuation system will manage all events up to and including the 1% AEP +40% climate change rainfall event without flooding, while discharging no greater than 3.0 l/s. This will provide at least a 41% rate betterment when compared to the existing **'formal'** piped system arrangement as shown in Table 5 below.

[2] ***Summary of MicroDrainage Source Control test parameters for the formal piped network section of site:***
22m^2 attenuation basin – 0.5m available storage depth – No Infiltration
Total drained area = 0.037ha
5 min time of concentration.
FSR Rainfall – M5-60 = 19.800mm – Ratio R = 0.400
Flow control = 0.090m diameter Hydrobrake set at the invert level of the attenuation basin.

TABLE 5: SUMMARY OF MICRODRAINAGE RESULTS – 'FORMAL' - 370M² SECTION OF SITE

Annual Exceedance Probability (AEP)	Critical Storm	Peak Water Depth in Attenuation unit (m)	Peak Outflow Rate (l/s)	Betterment from existing
1 in 1 (100%)	30-minute winter	0.079	2.2	41%
1 in 30 (3.33%)	30-minute winter	0.216	3.0	76%
1 in 100 +CC (1% +40% CC)	60-minute winter	0.488	3.0	87%

'Informal' runoff post-development has been conservatively assumed to be the same as existing – although it is considered the small perimeter SuDS features will provide some rate betterment. Nevertheless, the proposed drainage scheme is expected to have at least a 27% reduction in peak rate from the entire site when compared to existing.

TABLE 6: BETTERMENT FROM EXISTING – ENTIRE SITE

Annual Exceedance Probability (AEP)	Peak outflow rate from **'formal'** piped system (l/s)*	Peak outflow rate from **'informal'** section (l/s)*	Peak Outflow Rate from site (l/s)	Betterment from existing
1 in 1 (100%)	2.2	5.6	7.8	27%
1 in 30 (3.33%)	3.0	19.0	22.0	30%
1 in 100 +CC (1% +40% CC)	3.0	40.3	43.3	31%

The critical storm for the overall site runoff was the 15-min winter storm for all return periods tested. The rates shown in the table above are from the 15-min winter storm.

An indicative drainage arrangement for the site is shown below in Figure 1.

Figure 1: Concept surface water drainage arrangement

In summary: Betterment will be provided for **water quality** as more water will pass through either a permeable paving sub-base or a planted SuDS rain garden feature prior to discharge which provides opportunity for the removal of solids.

Runoff **rate** from both the 'formal' and 'informal' sections of the site will be reduced through the use of either minor landscaping works to incorporate small SuDS features, or attenuation storage with flow control.

Incorporating the SuDS rain garden features provides the opportunity for enhanced evapotranspiration and infiltration, which will have some **volume** betterment for car park runoff, before it enters Radford Road.

The 'formal' attenuation scheme will manage **flood risk**, such that no flooding occurs for events up to the 1% AEP +40% CC. The scheme will also safely manage **exceedance** and system failure scenarios as exceedance would flow north away from buildings into Radford Road, where no vulnerable receptors are located.

The proposed drainage system (and site) also has potential to provide **amenity** and **biodiversity** enhancement within the local environment, complementing the local habitat given soft landscaped areas will be made into more formal SuDS rain garden features.

The system should be maintained in line with recommendations made in the CIRIA SuDS Manual.

4.0 Conclusion

RAB Consultants has prepared this Drainage Strategy to support the proposed change of use and extension to form a bed and breakfast accommodation at Alvechurch Social Club, Radford Road, Alvechurch, Birmingham B48 7LD.

A drainage strategy proportionate to the scale of development is proposed that aims to provide betterment from existing. The strategy includes maintaining the overall drainage provision as existing, by; providing betterment via attenuation that is designed to safely and suitably manage runoff for all events up to and including the 1%AEP plus climate change storm (40%); and incorporating small SuDS features into the site to provide water quality, rate and volume enhancement.

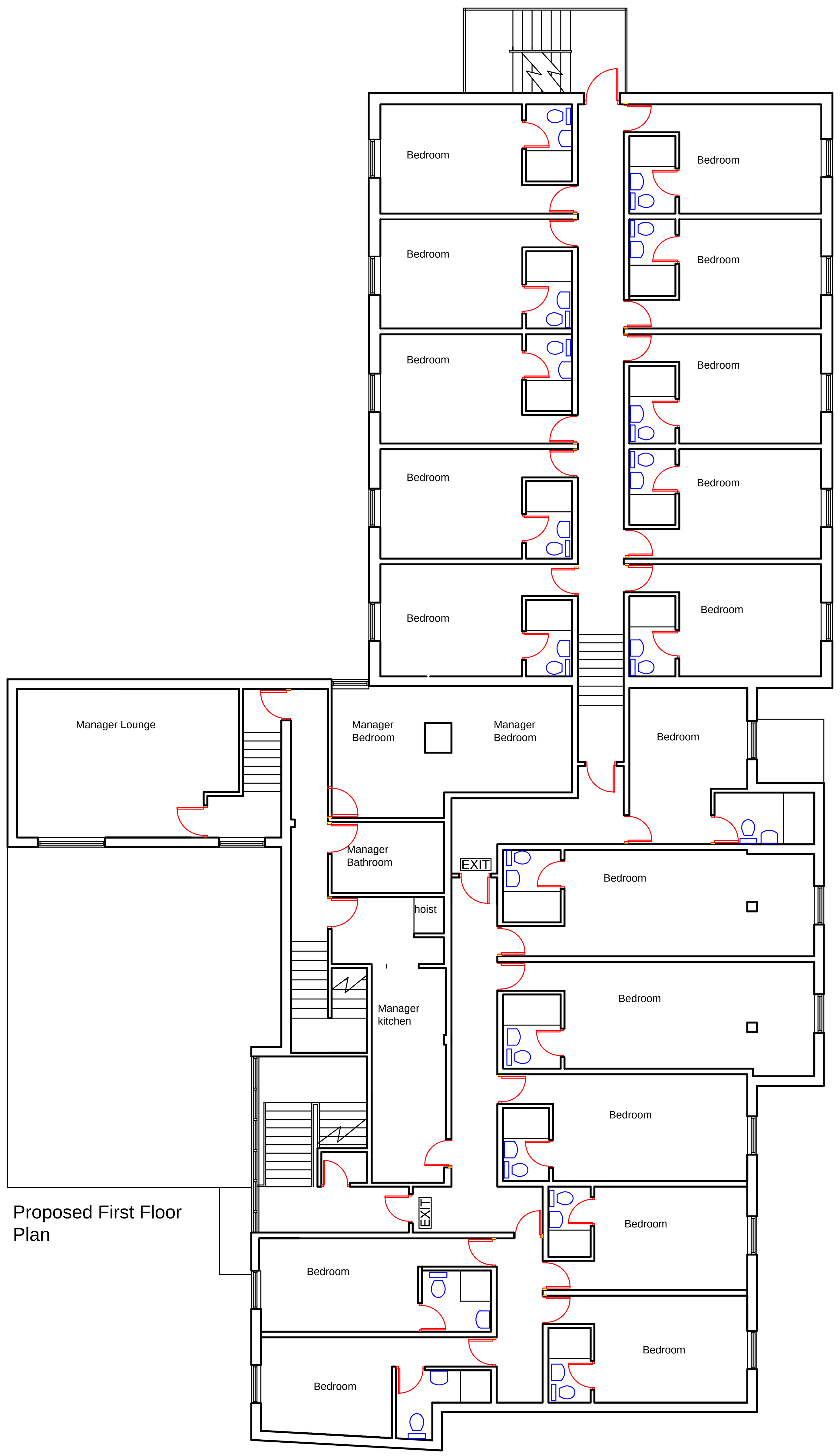
It is concluded that the proposed drainage scheme provides an integrated SuDS treatment train that meets the 4 pillars of SuDS and is in line with the Local Planning Authorities SuDS guidance.

5.0 Recommendations

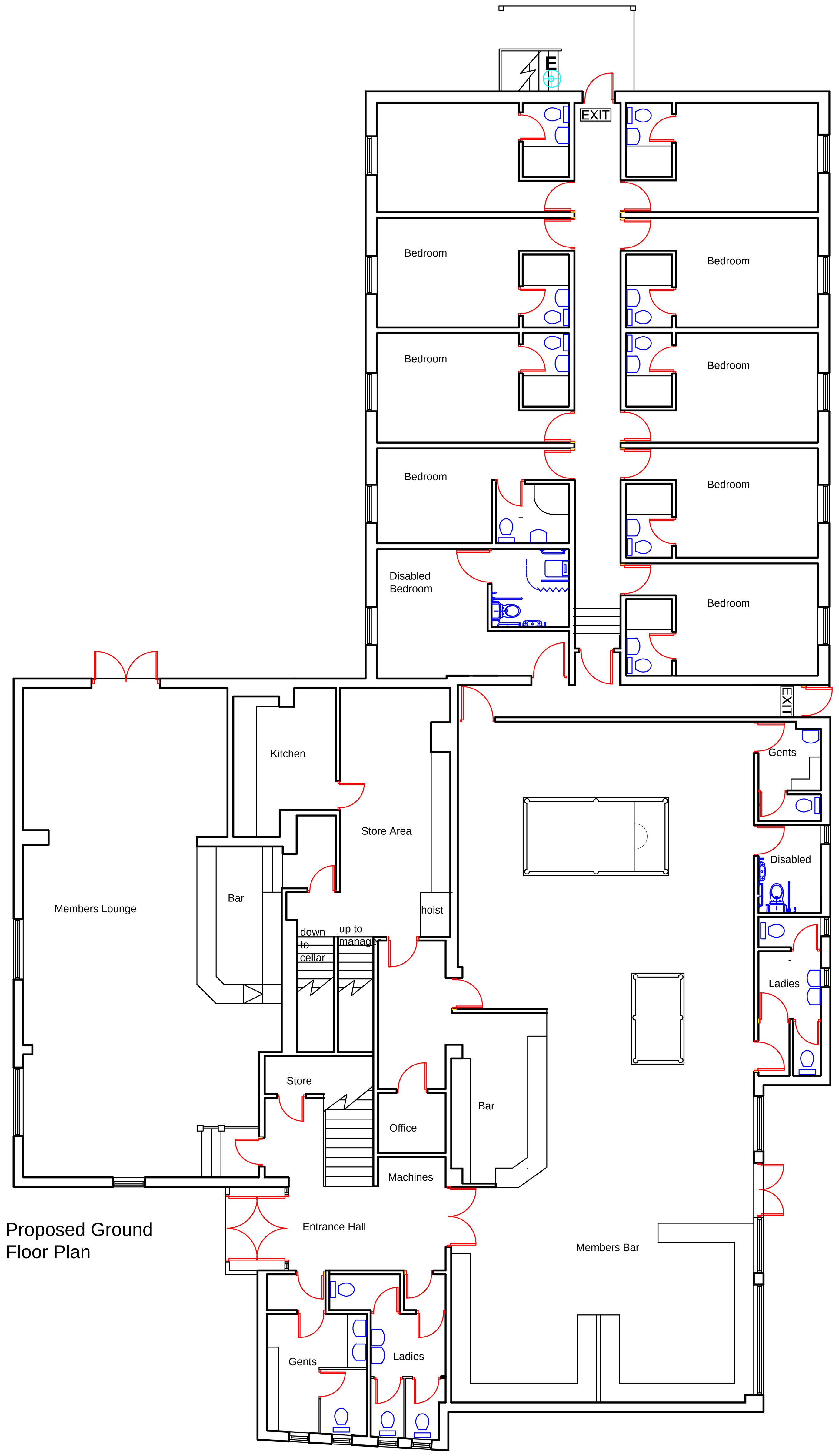
- Undertake a drainage tracing survey of existing to fully understand the formally drained arrangement.
- Implement a SuDS drainage scheme, in line with the strategy set out Section 3.4 of this report, which should integrate surface water risk management within the site and provide water quality improvements along with benefits to people and wildlife.
- Implement a regular maintenance schedule of the system, paying attention to the permeable pavement, flow control, debris / silt levels and blockage potential of the outflow – in line with the CIRIA SuDS Manual.
- Consult with the water company / LLFA to agree the continued surface water discharge from the site and maximum rate.
- *Construction (Design and Management) Regulations 2015*
    - *The revised CDM Regulations came into force in April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the Designer's responsibilities is to ensure that the Client organisation, in this instance Westbourne Leisure, is made aware of their duties under the CDM Regulations.*

Appendix A – Proposed Plan & Topographic Survey

REVISIONS	
13.07.2022	B Reduced extension size and revised layout



Proposed First Floor Plan



Proposed Ground Floor Plan

Upson & Co

A MEMBER OF
THE CHARTERED SOCIETY OF DESIGNERS

1 TREFEDDIAN BANK
ABERDOVEY
GWYNEDD LL35 0RU

TELEPHONE 07770 573 666
EMAIL upsonandco@btconnect.com

CLIENT
Westbourne Leisure
Strawberry Bank Hotel
72 Main Road
Meriden
Coventry CV7 7NF

PROJECT
Proposed Extension to form Bed and Breakfast Accommodation at:
Alvechurch Social Club
Radford Road
Alvechurch B48 7LD

DRG. TITLE
Proposed Layout Plans

DATE
December 2021

SCALE
1:100 @ A1

PROJECT NO. 1132
DRG.NO. 04B

Proposed Front Elevation

Proposed Rear Elevation

Proposed Elevation to Car Park

Proposed Side Elevation

REVISIONS

08.11.2022	C	Note Added regarding obscure glazing

Upson & Co

A MEMBER OF
THE CHARTERED SOCIETY OF DESIGNERS

1 TREFEDDIAN BANK
ABERDOVEY
GWYNEDD LL35 0RU

TELEPHONE 07770 573 666
Email : andrewupson4646@btinternet.com

CLIENT
Westbourne Leisure
Strawberry Bank Hotel
72 Main Road
Meriden
Coventry CV7 7NF

PROJECT
Proposed Extension to form Bed and Breakfast Accommodation at:
Alvechurch Social Club
Radford Road
Alvechurch B48 7LD

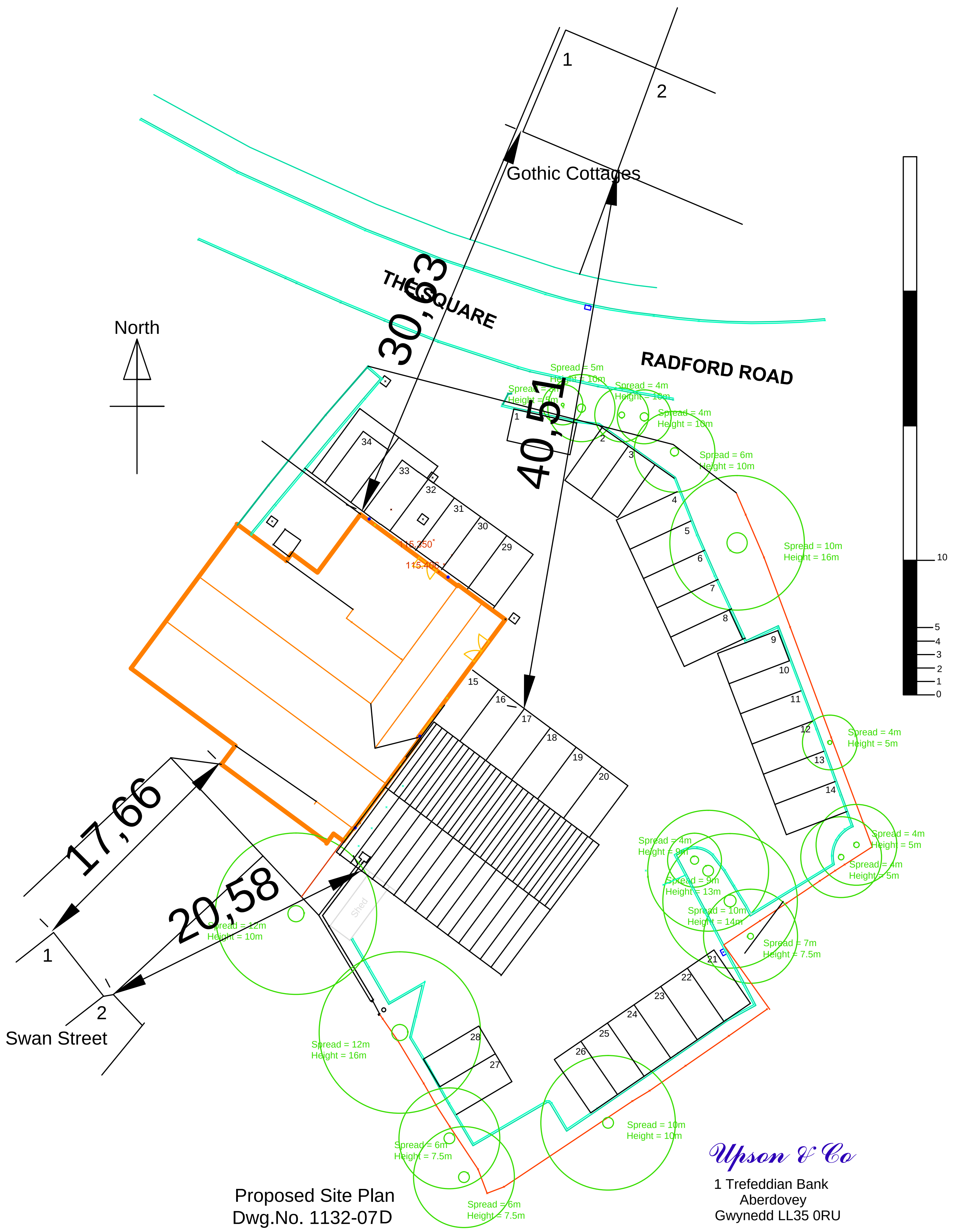
DRG. TITLE
Proposed Revised Elevations

DATE
October 2022

SCALE
1:100 @ A1

PROJECT NO. 1132

DRG.NO. 06C



North
Gothic Cottages
THE SQUARE
RADFORD ROAD
Swan Street
30,63
40,51
17,66
20,58
Spread = 12m
Height = 10m
Spread = 12m
Height = 16m
Spread = 6m
Height = 7.5m
Spread = 10m
Height = 10m
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Height = 16m
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Height = 7.5m
Spread = 4m
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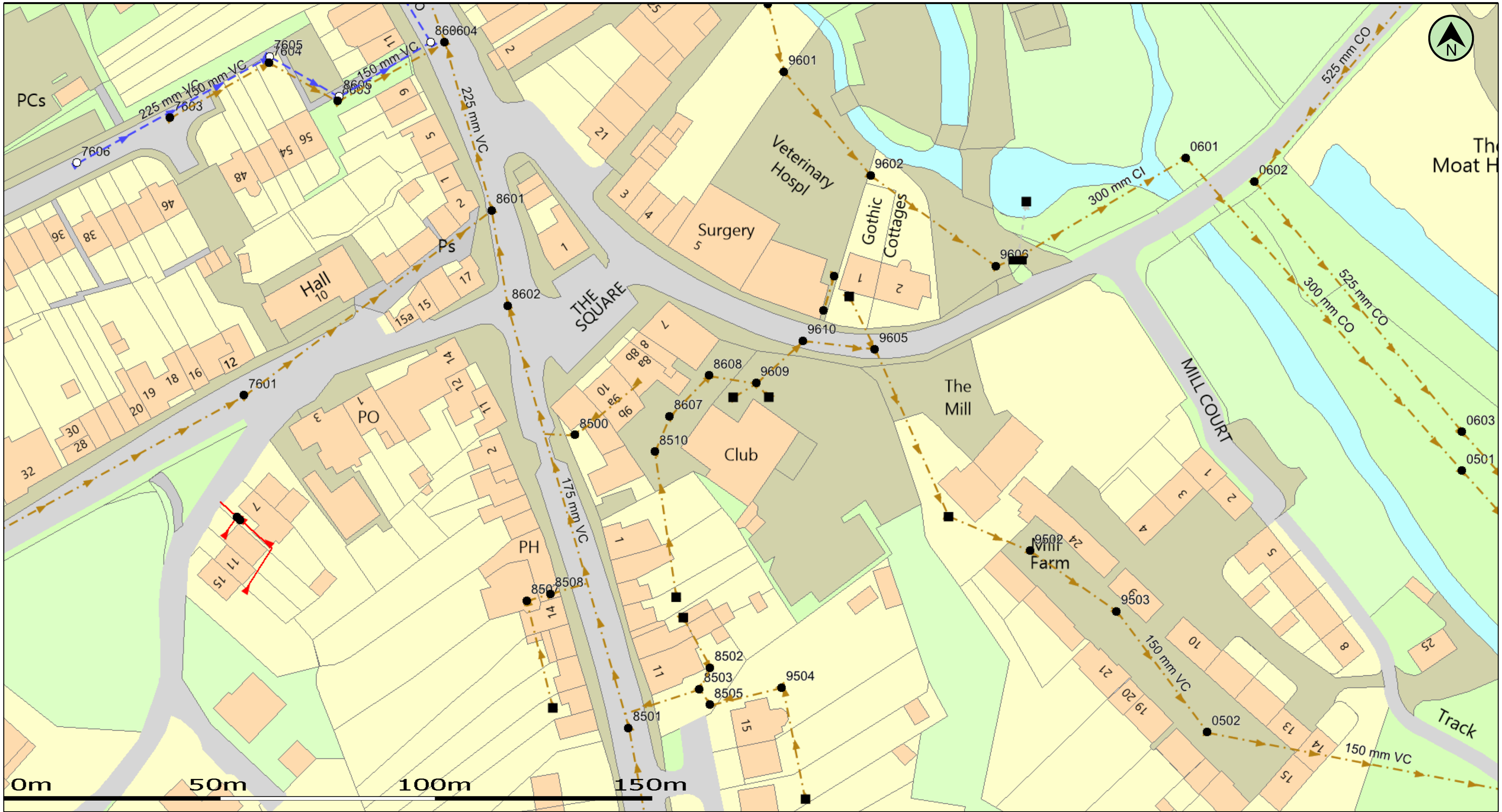
Spread = 6m
Height = 10m
Spread = 4m
Height = 10m
Spread = 5m
Height = 10m
Proposed Site Plan
Dwg.No. 1132-07D
Upson & Co
1 Trefeddian Bank
Aberdovey
Gwynedd LL35 0RU

Appendix B – Severn Trent Water Sewer Map



(c) Crown copyright and database rights 2023 Ordnance Survey 100031673 | Date: 08/03/23 | Scale: 1:1250 | Map Centre: 402906,272606 | Data updated: 14/02/23 | Our Ref: 1105842 - 1 | Wastewater Plan A4

Public Foul Gravity/Lateral Drain
Public Combined Gravity/Lateral Drain
Public Surface Water Gravity/Lateral Drain
Pressure Foul
Pressure Combined
Pressure Surface Water
Highway Drain
Overflow Pipe
Disposal Pipe
Culverted Water Course
Pumping Station
Fitting
Manhole Foul
Manhole Surface
Abandoned Pipe
Chamber

Section 104 sewers are shown in green
Private sewers are shown in magenta

nathan.parsons@rabconsultants.co.uk

ALVECHURCH

SEVERN TRENT

GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on:
0800 783 4444 (24 hours)

a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.

b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.

c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.

d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.

e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).

f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.

2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).

3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.

4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.

5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.

6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.

7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.

8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.

9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.

10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.

11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.

12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.

13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,

14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.

16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.

17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May2014

18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.

19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
	C			
	C			
	F			
	F			
0501	F	113.17	109.62	3.55
0502	F	108.69	106.94	1.75
0601	F	111.51	109.93	1.58
0602	F	111.91	110.52	1.39
0603	F	112.7	110.32	2.38
7601	F	-	0	0
7603	F	-	115.4	0
7604	F	-	114.7	0
8500	F	-	0	0
8501	F	120.5	118.86	1.64
8502	F	0	0	0
8503	F	0	0	0
8505	F	0	0	0
8507	F	0	0	0
8508	F	0	0	0
8510	F	0	0	0
8601	F	115.98	113.72	2.26
8602	F	116.28	114.09	2.19
8603	F	-	114.2	0
8604	F	-	0	0
8607	F	0	0	0
8608	F	0	0	0
9502	F	109.74	108.3	1.44
9503	F	109.13	107.47	1.66
9504	F	0	0	0
9601	F	-	0	0
9602	F	-	0	0
9605	F	-	0	0

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
9606	F	111.63	110.23	1.4
9609	F	0	0	0
9610	F	0	0	0
9701	F	112.03	110.57	1.46
7605	S	-	113.04	0
7606	S	-	116.51	0
8605	S	-	112.94	0
8606	S	-	112.81	0

Appendix C – MicroDrainage Results

Summary of Results for 1 year Return Period

Half Drain Time : 11 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.069	0.069	0.0	1.8	1.8	1.4	O K
30 min Summer	0.075	0.075	0.0	2.0	2.0	1.6	O K
60 min Summer	0.073	0.073	0.0	2.0	2.0	1.5	O K
120 min Summer	0.064	0.064	0.0	1.7	1.7	1.3	O K
180 min Summer	0.057	0.057	0.0	1.4	1.4	1.2	O K
240 min Summer	0.053	0.053	0.0	1.2	1.2	1.1	O K
360 min Summer	0.046	0.046	0.0	1.0	1.0	1.0	O K
480 min Summer	0.042	0.042	0.0	0.8	0.8	0.9	O K
600 min Summer	0.039	0.039	0.0	0.7	0.7	0.8	O K
720 min Summer	0.036	0.036	0.0	0.6	0.6	0.8	O K
960 min Summer	0.033	0.033	0.0	0.5	0.5	0.7	O K
1440 min Summer	0.028	0.028	0.0	0.4	0.4	0.6	O K
2160 min Summer	0.024	0.024	0.0	0.3	0.3	0.5	O K
2880 min Summer	0.022	0.022	0.0	0.2	0.2	0.5	O K
4320 min Summer	0.019	0.019	0.0	0.2	0.2	0.4	O K
5760 min Summer	0.017	0.017	0.0	0.1	0.1	0.3	O K
7200 min Summer	0.015	0.015	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	30.668	0.0	2.1	14
30 min Summer	19.992	0.0	2.8	21
60 min Summer	12.656	0.0	3.5	38
120 min Summer	7.851	0.0	4.3	68
180 min Summer	5.909	0.0	4.9	98
240 min Summer	4.825	0.0	5.3	128
360 min Summer	3.606	0.0	6.0	190
480 min Summer	2.923	0.0	6.5	250
600 min Summer	2.484	0.0	6.9	310
720 min Summer	2.174	0.0	7.2	370
960 min Summer	1.762	0.0	7.8	492
1440 min Summer	1.311	0.0	8.7	736
2160 min Summer	0.976	0.0	9.7	1092
2880 min Summer	0.791	0.0	10.5	1460
4320 min Summer	0.588	0.0	11.7	2168
5760 min Summer	0.477	0.0	12.7	2936
7200 min Summer	0.406	0.0	13.5	3672

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	0.014	0.014	0.0	0.1	0.1	0.3	O K
10080 min Summer	0.014	0.014	0.0	0.1	0.1	0.3	O K
15 min Winter	0.075	0.075	0.0	2.1	2.1	1.6	O K
30 min Winter	0.079	0.079	0.0	2.2	2.2	1.6	O K
60 min Winter	0.072	0.072	0.0	2.0	2.0	1.5	O K
120 min Winter	0.060	0.060	0.0	1.5	1.5	1.2	O K
180 min Winter	0.052	0.052	0.0	1.2	1.2	1.1	O K
240 min Winter	0.047	0.047	0.0	1.0	1.0	1.0	O K
360 min Winter	0.040	0.040	0.0	0.8	0.8	0.8	O K
480 min Winter	0.036	0.036	0.0	0.6	0.6	0.8	O K
600 min Winter	0.033	0.033	0.0	0.5	0.5	0.7	O K
720 min Winter	0.031	0.031	0.0	0.5	0.5	0.6	O K
960 min Winter	0.028	0.028	0.0	0.4	0.4	0.6	O K
1440 min Winter	0.024	0.024	0.0	0.3	0.3	0.5	O K
2160 min Winter	0.020	0.020	0.0	0.2	0.2	0.4	O K
2880 min Winter	0.018	0.018	0.0	0.2	0.2	0.4	O K
4320 min Winter	0.016	0.016	0.0	0.1	0.1	0.3	O K
5760 min Winter	0.014	0.014	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.355	0.0	14.2	4400
10080 min Summer	0.318	0.0	14.8	5136
15 min Winter	30.668	0.0	2.4	14
30 min Winter	19.992	0.0	3.1	22
60 min Winter	12.656	0.0	3.9	38
120 min Winter	7.851	0.0	4.9	70
180 min Winter	5.909	0.0	5.5	100
240 min Winter	4.825	0.0	6.0	132
360 min Winter	3.606	0.0	6.7	192
480 min Winter	2.923	0.0	7.3	252
600 min Winter	2.484	0.0	7.7	312
720 min Winter	2.174	0.0	8.1	378
960 min Winter	1.762	0.0	8.8	492
1440 min Winter	1.311	0.0	9.8	736
2160 min Winter	0.976	0.0	10.9	1112
2880 min Winter	0.791	0.0	11.8	1468
4320 min Winter	0.588	0.0	13.2	2200
5760 min Winter	0.477	0.0	14.2	2856

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Winter	0.013	0.013	0.0	0.1	0.1	0.3	O K
8640 min Winter	0.012	0.012	0.0	0.1	0.1	0.3	O K
10080 min Winter	0.012	0.012	0.0	0.1	0.1	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.406	0.0	15.1	3640
8640 min Winter	0.355	0.0	15.9	4384
10080 min Winter	0.318	0.0	16.6	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.037

Time From:	(mins) To:	Area (ha)
0	5	0.037

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	22.0	0.0	0.501	0.0	0.0
0.500	22.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0090-3000-0500-3000
Design Head (m)	0.500
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	90
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	3.0	Kick-Flo®	0.355	2.6
Flush-Flo™	0.157	3.0	Mean Flow over Head Range	-	2.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	4.5	3.000	6.9	7.000	10.4
0.200	3.0	1.400	4.8	3.500	7.4	7.500	10.7
0.300	2.8	1.600	5.1	4.000	7.9	8.000	11.1
0.400	2.7	1.800	5.4	4.500	8.4	8.500	11.4
0.500	3.0	2.000	5.7	5.000	8.8	9.000	11.8
0.600	3.3	2.200	6.0	5.500	9.2	9.500	12.1
0.800	3.7	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.4	6.500	10.0		

Summary of Results for 30 year Return Period

Half Drain Time : 16 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.173	0.173	0.0	3.0	3.0	3.6	O K
30 min Summer	0.193	0.193	0.0	3.0	3.0	4.0	O K
60 min Summer	0.185	0.185	0.0	3.0	3.0	3.9	O K
120 min Summer	0.144	0.144	0.0	3.0	3.0	3.0	O K
180 min Summer	0.112	0.112	0.0	2.9	2.9	2.3	O K
240 min Summer	0.096	0.096	0.0	2.7	2.7	2.0	O K
360 min Summer	0.078	0.078	0.0	2.1	2.1	1.6	O K
480 min Summer	0.068	0.068	0.0	1.8	1.8	1.4	O K
600 min Summer	0.061	0.061	0.0	1.5	1.5	1.3	O K
720 min Summer	0.056	0.056	0.0	1.3	1.3	1.2	O K
960 min Summer	0.050	0.050	0.0	1.1	1.1	1.0	O K
1440 min Summer	0.042	0.042	0.0	0.8	0.8	0.9	O K
2160 min Summer	0.035	0.035	0.0	0.6	0.6	0.7	O K
2880 min Summer	0.031	0.031	0.0	0.5	0.5	0.6	O K
4320 min Summer	0.026	0.026	0.0	0.3	0.3	0.5	O K
5760 min Summer	0.023	0.023	0.0	0.3	0.3	0.5	O K
7200 min Summer	0.021	0.021	0.0	0.2	0.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.230	0.0	5.2	15
30 min Summer	48.981	0.0	6.8	23
60 min Summer	30.497	0.0	8.5	40
120 min Summer	18.434	0.0	10.2	72
180 min Summer	13.588	0.0	11.3	100
240 min Summer	10.896	0.0	12.1	130
360 min Summer	7.961	0.0	13.2	190
480 min Summer	6.370	0.0	14.1	250
600 min Summer	5.355	0.0	14.8	308
720 min Summer	4.645	0.0	15.5	370
960 min Summer	3.710	0.0	16.5	490
1440 min Summer	2.699	0.0	18.0	734
2160 min Summer	1.961	0.0	19.6	1104
2880 min Summer	1.563	0.0	20.8	1456
4320 min Summer	1.134	0.0	22.6	2164
5760 min Summer	0.902	0.0	24.0	2888
7200 min Summer	0.755	0.0	25.1	3656

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	0.020	0.020	0.0	0.2	0.2	0.4	O K
10080 min Summer	0.019	0.019	0.0	0.2	0.2	0.4	O K
15 min Winter	0.197	0.197	0.0	3.0	3.0	4.1	O K
30 min Winter	0.216	0.216	0.0	3.0	3.0	4.5	O K
60 min Winter	0.194	0.194	0.0	3.0	3.0	4.1	O K
120 min Winter	0.129	0.129	0.0	3.0	3.0	2.7	O K
180 min Winter	0.096	0.096	0.0	2.7	2.7	2.0	O K
240 min Winter	0.081	0.081	0.0	2.2	2.2	1.7	O K
360 min Winter	0.065	0.065	0.0	1.7	1.7	1.4	O K
480 min Winter	0.057	0.057	0.0	1.4	1.4	1.2	O K
600 min Winter	0.051	0.051	0.0	1.2	1.2	1.1	O K
720 min Winter	0.047	0.047	0.0	1.0	1.0	1.0	O K
960 min Winter	0.042	0.042	0.0	0.8	0.8	0.9	O K
1440 min Winter	0.035	0.035	0.0	0.6	0.6	0.7	O K
2160 min Winter	0.030	0.030	0.0	0.4	0.4	0.6	O K
2880 min Winter	0.026	0.026	0.0	0.3	0.3	0.5	O K
4320 min Winter	0.022	0.022	0.0	0.3	0.3	0.5	O K
5760 min Winter	0.020	0.020	0.0	0.2	0.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	0.653	0.0	26.1	4392
10080 min Summer	0.578	0.0	26.9	5120
15 min Winter	75.230	0.0	5.8	15
30 min Winter	48.981	0.0	7.6	25
60 min Winter	30.497	0.0	9.5	44
120 min Winter	18.434	0.0	11.4	74
180 min Winter	13.588	0.0	12.7	102
240 min Winter	10.896	0.0	13.5	132
360 min Winter	7.961	0.0	14.8	190
480 min Winter	6.370	0.0	15.8	250
600 min Winter	5.355	0.0	16.6	312
720 min Winter	4.645	0.0	17.3	372
960 min Winter	3.710	0.0	18.4	490
1440 min Winter	2.699	0.0	20.1	728
2160 min Winter	1.961	0.0	21.9	1120
2880 min Winter	1.563	0.0	23.3	1428
4320 min Winter	1.134	0.0	25.4	2136
5760 min Winter	0.902	0.0	26.9	2864

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Winter	0.018	0.018	0.0	0.2	0.2	0.4	O K
8640 min Winter	0.017	0.017	0.0	0.1	0.1	0.3	O K
10080 min Winter	0.016	0.016	0.0	0.1	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	0.755	0.0	28.2	3640
8640 min Winter	0.653	0.0	29.2	4368
10080 min Winter	0.578	0.0	30.2	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.037

Time From:	(mins) To:	Area (ha)
0	5	0.037

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	22.0	0.0	0.501	0.0	0.0
0.500	22.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0090-3000-0500-3000
Design Head (m)	0.500
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	90
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	3.0	Kick-Flo®	0.355	2.6
Flush-Flo™	0.157	3.0	Mean Flow over Head Range	-	2.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	4.5	3.000	6.9	7.000	10.4
0.200	3.0	1.400	4.8	3.500	7.4	7.500	10.7
0.300	2.8	1.600	5.1	4.000	7.9	8.000	11.1
0.400	2.7	1.800	5.4	4.500	8.4	8.500	11.4
0.500	3.0	2.000	5.7	5.000	8.8	9.000	11.8
0.600	3.3	2.200	6.0	5.500	9.2	9.500	12.1
0.800	3.7	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.4	6.500	10.0		

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

Half Drain Time : 32 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.359	0.359	0.0	3.0	3.0	7.5	O K
30 min Summer	0.420	0.420	0.0	3.0	3.0	8.8	O K
60 min Summer	0.430	0.430	0.0	3.0	3.0	9.0	O K
120 min Summer	0.386	0.386	0.0	3.0	3.0	8.1	O K
180 min Summer	0.319	0.319	0.0	3.0	3.0	6.7	O K
240 min Summer	0.257	0.257	0.0	3.0	3.0	5.4	O K
360 min Summer	0.166	0.166	0.0	3.0	3.0	3.5	O K
480 min Summer	0.117	0.117	0.0	3.0	3.0	2.4	O K
600 min Summer	0.097	0.097	0.0	2.7	2.7	2.0	O K
720 min Summer	0.086	0.086	0.0	2.4	2.4	1.8	O K
960 min Summer	0.073	0.073	0.0	2.0	2.0	1.5	O K
1440 min Summer	0.059	0.059	0.0	1.4	1.4	1.2	O K
2160 min Summer	0.049	0.049	0.0	1.1	1.1	1.0	O K
2880 min Summer	0.042	0.042	0.0	0.8	0.8	0.9	O K
4320 min Summer	0.035	0.035	0.0	0.6	0.6	0.7	O K
5760 min Summer	0.031	0.031	0.0	0.5	0.5	0.7	O K
7200 min Summer	0.028	0.028	0.0	0.4	0.4	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	136.640	0.0	9.5	17
30 min Summer	89.730	0.0	12.4	28
60 min Summer	56.129	0.0	15.6	46
120 min Summer	33.920	0.0	18.8	80
180 min Summer	24.926	0.0	20.7	112
240 min Summer	19.911	0.0	22.1	144
360 min Summer	14.459	0.0	24.1	200
480 min Summer	11.523	0.0	25.6	254
600 min Summer	9.656	0.0	26.8	310
720 min Summer	8.354	0.0	27.8	370
960 min Summer	6.641	0.0	29.5	490
1440 min Summer	4.799	0.0	32.0	734
2160 min Summer	3.463	0.0	34.6	1096
2880 min Summer	2.744	0.0	36.5	1468
4320 min Summer	1.974	0.0	39.4	2200
5760 min Summer	1.561	0.0	41.6	2936
7200 min Summer	1.301	0.0	43.3	3656

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	0.026	0.026	0.0	0.3	0.3	0.5	O K
10080 min Summer	0.025	0.025	0.0	0.3	0.3	0.5	O K
15 min Winter	0.410	0.410	0.0	3.0	3.0	8.6	O K
30 min Winter	0.480	0.480	0.0	3.0	3.0	10.0	O K
60 min Winter	0.488	0.488	0.0	3.0	3.0	10.2	O K
120 min Winter	0.417	0.417	0.0	3.0	3.0	8.7	O K
180 min Winter	0.312	0.312	0.0	3.0	3.0	6.5	O K
240 min Winter	0.218	0.218	0.0	3.0	3.0	4.6	O K
360 min Winter	0.111	0.111	0.0	2.9	2.9	2.3	O K
480 min Winter	0.088	0.088	0.0	2.5	2.5	1.8	O K
600 min Winter	0.076	0.076	0.0	2.1	2.1	1.6	O K
720 min Winter	0.068	0.068	0.0	1.8	1.8	1.4	O K
960 min Winter	0.059	0.059	0.0	1.4	1.4	1.2	O K
1440 min Winter	0.049	0.049	0.0	1.1	1.1	1.0	O K
2160 min Winter	0.040	0.040	0.0	0.8	0.8	0.8	O K
2880 min Winter	0.036	0.036	0.0	0.6	0.6	0.7	O K
4320 min Winter	0.030	0.030	0.0	0.4	0.4	0.6	O K
5760 min Winter	0.026	0.026	0.0	0.3	0.3	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.120	0.0	44.7	4400
10080 min Summer	0.987	0.0	46.0	5048
15 min Winter	136.640	0.0	10.6	17
30 min Winter	89.730	0.0	13.9	30
60 min Winter	56.129	0.0	17.4	48
120 min Winter	33.920	0.0	21.1	86
180 min Winter	24.926	0.0	23.2	120
240 min Winter	19.911	0.0	24.7	150
360 min Winter	14.459	0.0	27.0	196
480 min Winter	11.523	0.0	28.6	252
600 min Winter	9.656	0.0	30.0	312
720 min Winter	8.354	0.0	31.1	372
960 min Winter	6.641	0.0	33.0	492
1440 min Winter	4.799	0.0	35.8	734
2160 min Winter	3.463	0.0	38.7	1112
2880 min Winter	2.744	0.0	40.9	1464
4320 min Winter	1.974	0.0	44.2	2192
5760 min Winter	1.561	0.0	46.6	2848

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
7200 min Winter	0.024	0.024	0.0	0.3	0.3	0.5	O K
8640 min Winter	0.022	0.022	0.0	0.3	0.3	0.5	O K
10080 min Winter	0.021	0.021	0.0	0.2	0.2	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.301	0.0	48.5	3640
8640 min Winter	1.120	0.0	50.1	4288
10080 min Winter	0.987	0.0	51.5	5184

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.037

Time From:	**(mins) To:**	**Area (ha)**
0	5	0.037

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	22.0	0.0	0.501	0.0	0.0
0.500	22.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0090-3000-0500-3000
Design Head (m)	0.500
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	90
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	3.0	Kick-Flo®	0.355	2.6
Flush-Flo™	0.157	3.0	Mean Flow over Head Range	-	2.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	4.5	3.000	6.9	7.000	10.4
0.200	3.0	1.400	4.8	3.500	7.4	7.500	10.7
0.300	2.8	1.600	5.1	4.000	7.9	8.000	11.1
0.400	2.7	1.800	5.4	4.500	8.4	8.500	11.4
0.500	3.0	2.000	5.7	5.000	8.8	9.000	11.8
0.600	3.3	2.200	6.0	5.500	9.2	9.500	12.1
0.800	3.7	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.4	6.500	10.0		