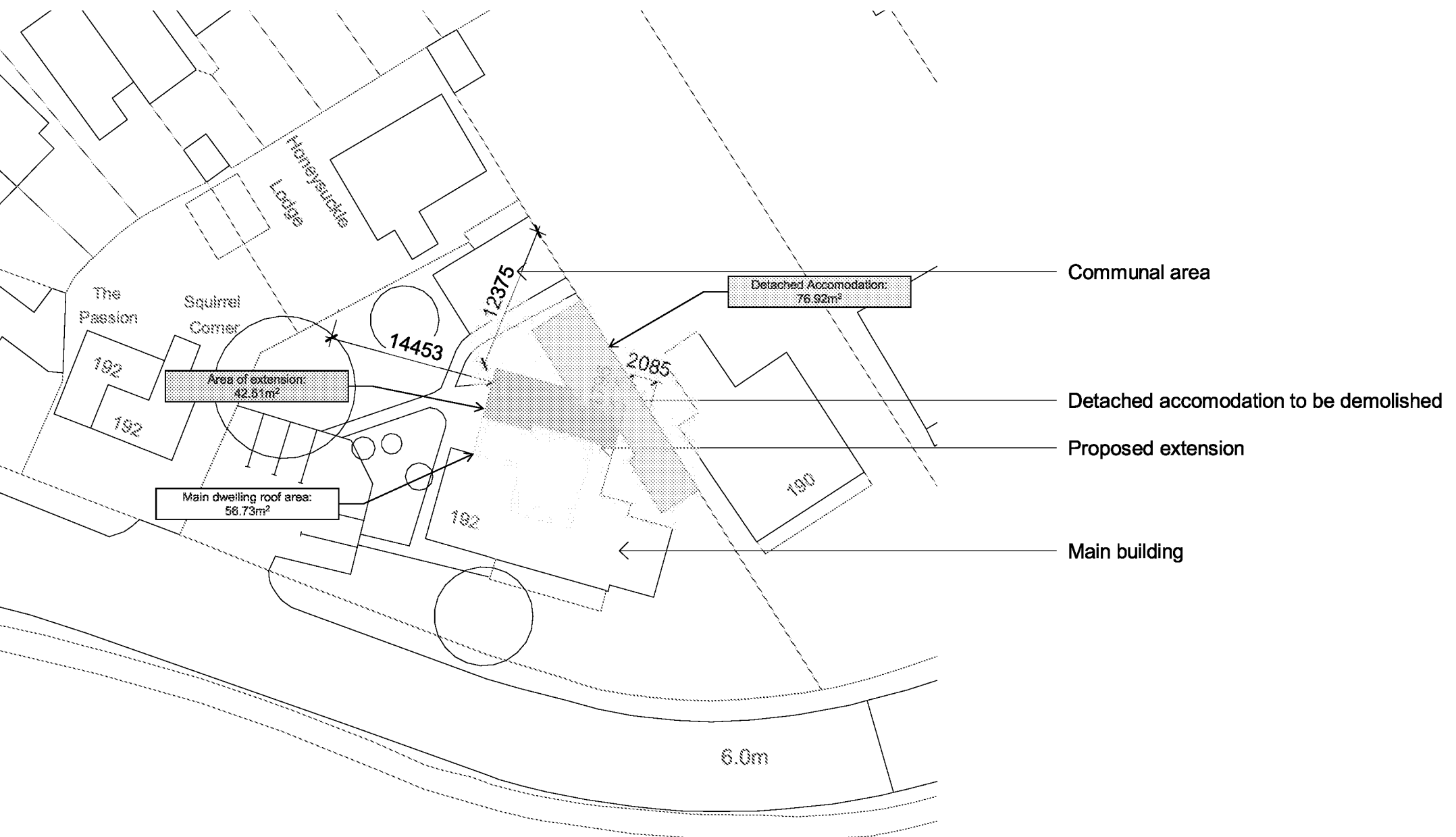


Appendix J

Southern Water Asset Location Plan

Appendix K

Areas of Site Undergoing Development and Change





Area of extension:
42.51m²

Main dwelling roof area:
58.73m²

Detached Accommodation:
76.82m²

Hawthorn Rd

Hawthorn Rd

Hawthorn Rd

Hawthorn Rd

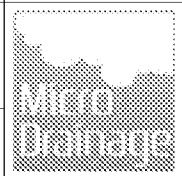
Hawthorn Rd

Larche UK

Jericho House

Appendix L
QMED Calculation

84 North Street
Guildford
Surrey GU1 4AU



Date 10/03/2025 15:33
File

Designed by commonuser
Checked by

Innovyze Source Control 2020.1.3

FEH Mean Annual Flood

Input

QMED Method		2008	URBEXT (1990)	0.5000
Site Location	GB 493250 99100 SZ 93250 99100		SPRHOST	29.750
Area (ha)		1.000	BFIHOST	0.693
SAAR (mm)		715	FARL	1.000

Results

QMED Rural (l/s) 2.7 QMED Urban (l/s) 5.4

Appendix M

Environment Agency Flood Map for Planning

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
492501/99607

Created
21 Feb 2025 12:00

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following:**

- bigger than 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2024 OS AC0000807064. <https://flood-map-for-planning.service.gov.uk/os-terms>



Flood map for planning








Your reference
<Unspecified>

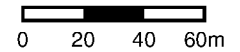
Location (easting/northing)
492501/99607

Scale
1:2500

Created
21 Feb 2025 12:00

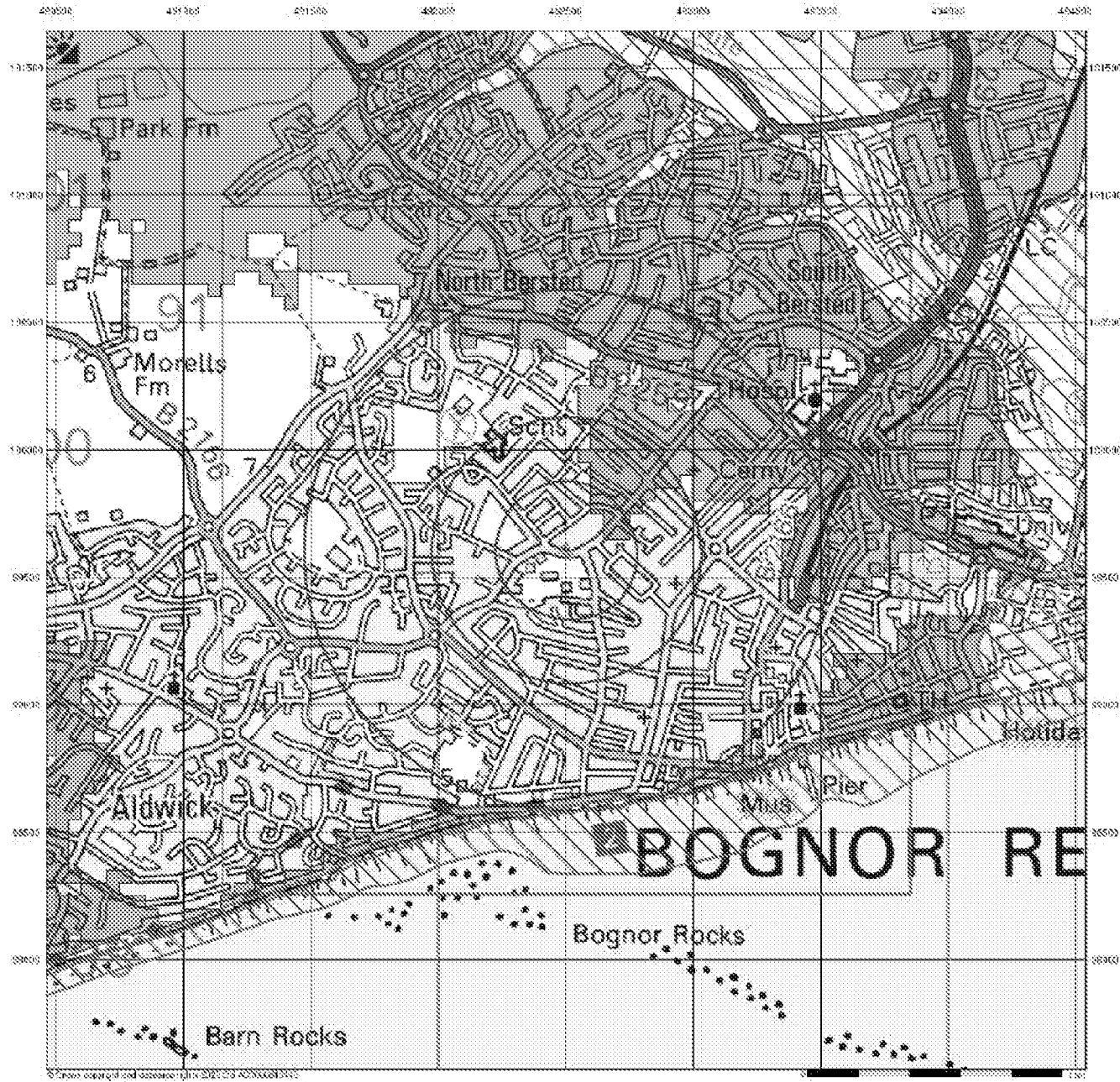


-  Selected area
-  Flood zone 3
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Water storage area



Appendix N

Groundwater susceptibility Mapping

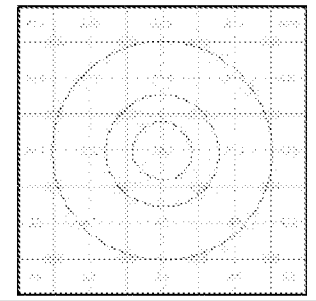


BGS Flood Data (1:50,000)

- General**
- Qualified Site
 - Specified Buffer/SD
 - Bearing Reference Point
 - Site
 - MUD/C

- BGS Geological Indicators of Flooding**
- Coastal
 - Island
 - Bodies of Water

BGS Flood Data Map - Slice A



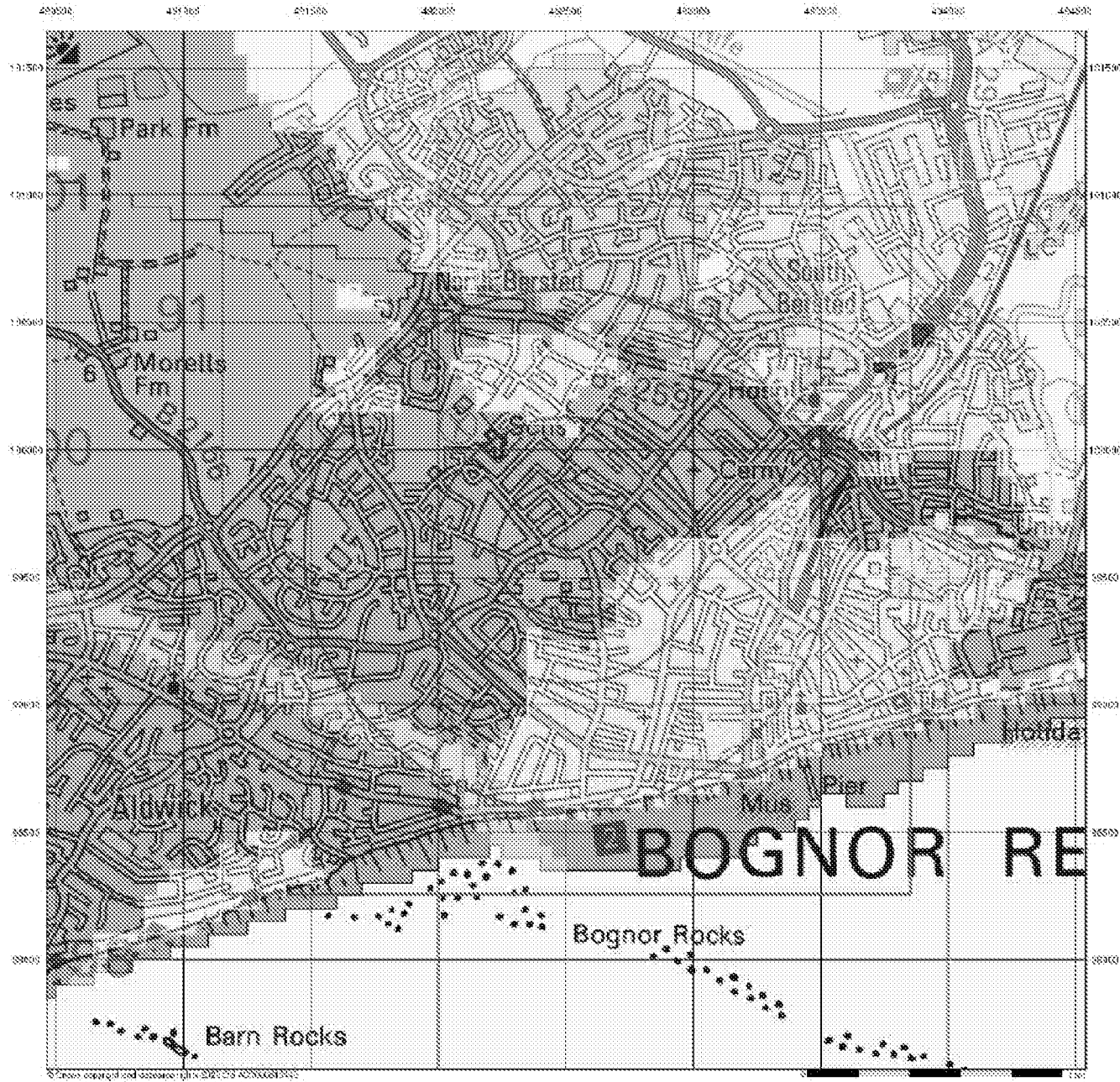
Order Details

Order Number: 371878281_1_1
 Customer Ref: 11pbog/2502082
 National Grid Reference: 492500, 99600
 Slice: A
 Site Area (Ha): 0.13
 Search Buffer (m): 1000

Site Details
 Site at, Bognor Regis, West Sussex



Tel: 0544 244 0333
 Fax: 0544 544 5661
 Web: www.ensochestr.co.uk

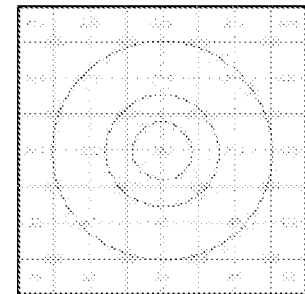


motion

BGS Flood Data (1:50,000)

- General**
- Qualified Data
 - Specified Buffer
 - Bearing Reference Point
 - Site
 - MUDIC
- BGS Groundwater Flooding Susceptibility**
- Potential for Groundwater Flooding to Occur at Surface
 - Potential for Groundwater Flooding of Property Sealed Below Ground Level
 - Limited Potential for Groundwater Flooding to Occur

BGS Flood Data Map - Slice A



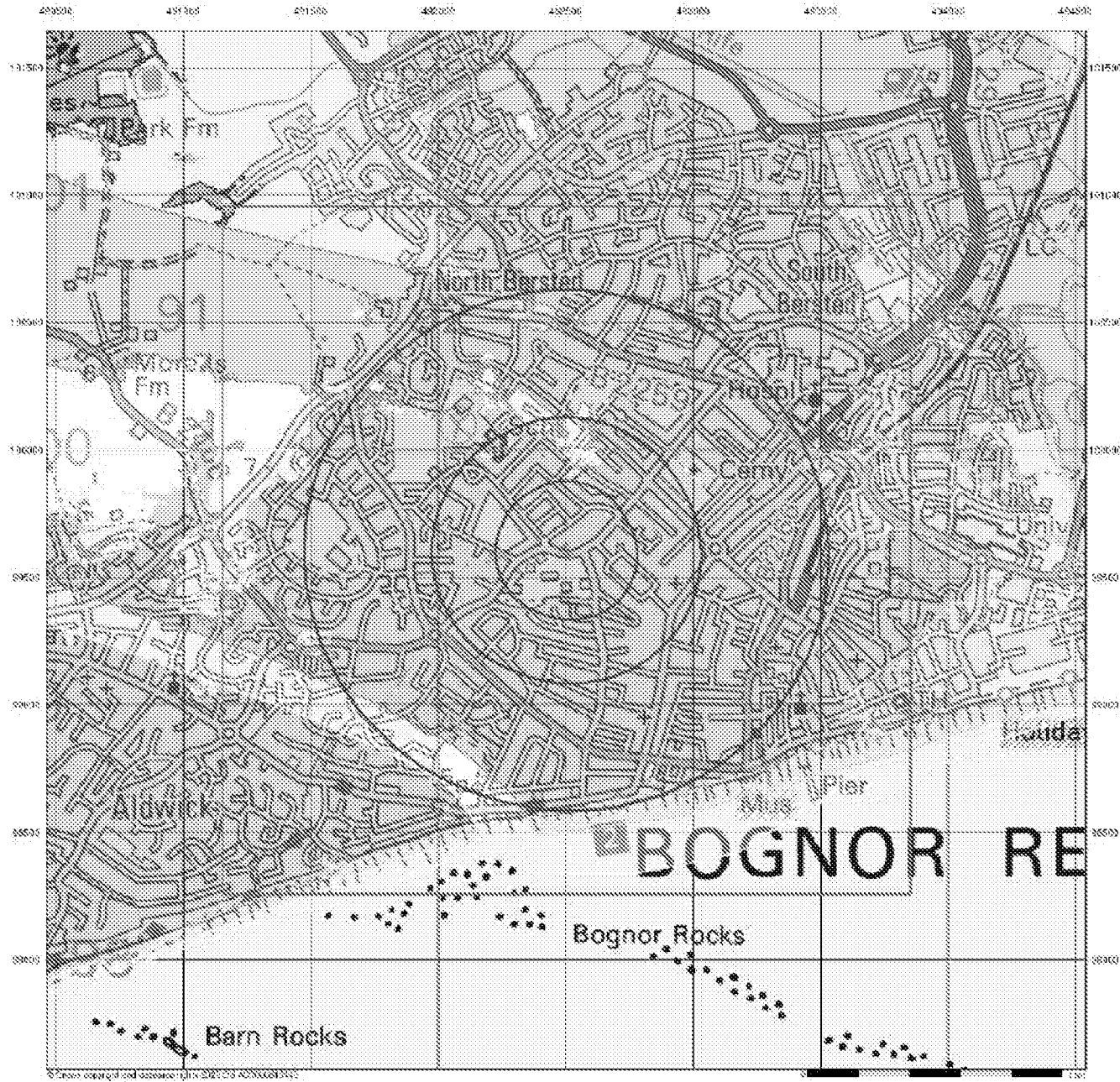
Order Details

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 Customer Ref: 11pbog/2502082
 National Grid Reference: 492500, 99600
 Slice: A
 Site Area (Ha): 0.13
 Search Buffer (m): 1000

Site Details
 Site at, Bognor Regis, West Sussex

Landmark
an information group service

Tel: 0544 244 2232
 Fax: 0544 544 5551
 Web: www.ensochess.com.uk



GeoSmart Information Groundwater Flood Map (1:50,000)

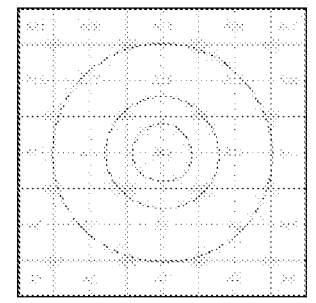
General

- Qualified Site
- Specified Features
- Bearing Reference Point
- Ditch

GeoSmart Information Groundwater Flooding Risk

- High Risk
- Moderate Risk
- Low Risk
- Negligible Risk

GeoSmart Information Groundwater Flood Map - Slice A



Order Details

Order Number: 371878281_1_1
 Customer Ref: 11pbog/2502082
 National Grid Reference: 492500, 99600
 Slice: A
 Site Area (Ha): 0.13
 Search Buffer (m): 1000

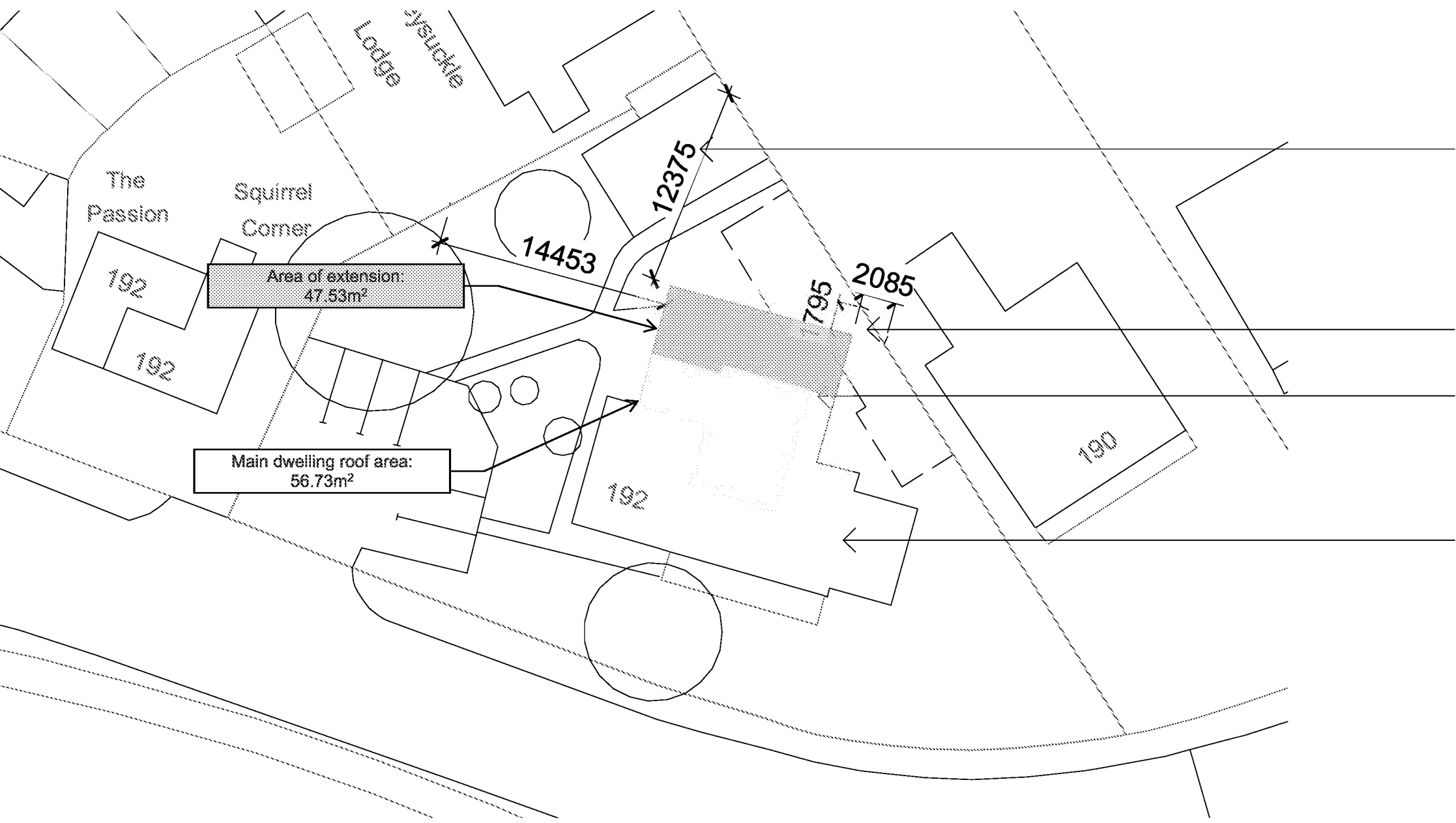
Site Details

Site at, Bognor Regis, West Sussex



Tel: 0544 544 0333
 Fax: 0544 544 5551
 Web: www.envirosearch.co.uk

Appendix O
Impermeable Area Plan



Area of extension:
47.53m²

Main dwelling roof area:
56.73m²

The
Passion

Squirrel
Corner

Lodge
Syluckle

14453

12375

795

2085

190

192

192

192

Appendix P

Drainage Strategy Plan and Details



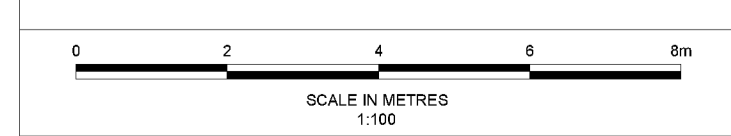
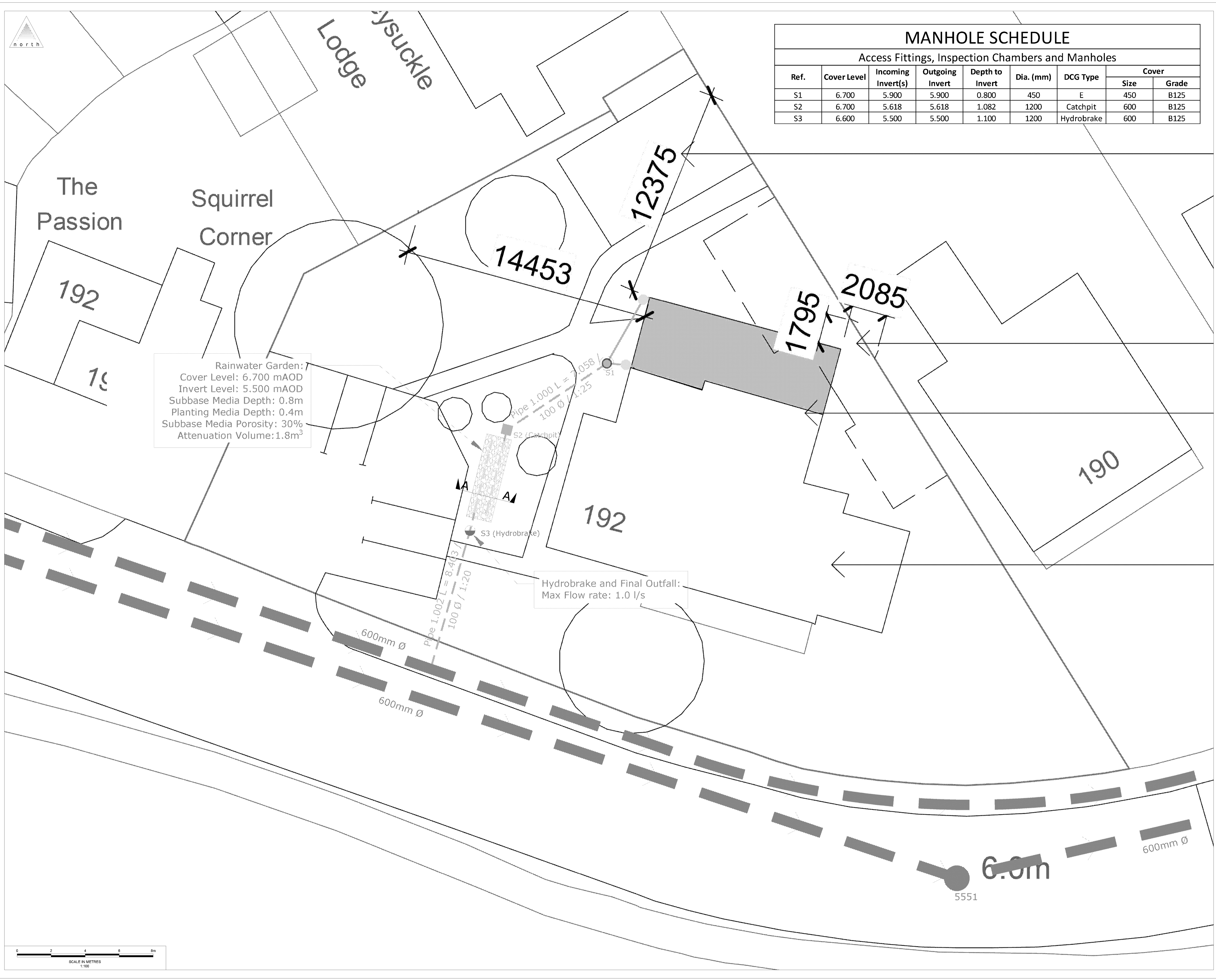
MANHOLE SCHEDULE								
Access Fittings, Inspection Chambers and Manholes								
Ref.	Cover Level	Incoming Invert(s)	Outgoing Invert	Depth to Invert	Dia. (mm)	DCG Type	Cover	
							Size	Grade
S1	6.700	5.900	5.900	0.800	450	E	450	B125
S2	6.700	5.618	5.618	1.082	1200	Catchpit	600	B125
S3	6.600	5.500	5.500	1.100	1200	Hydrobrake	600	B125

- Notes**
- All dimensions are in metres unless stated otherwise.
 - This drawing is for planning purposes only.
 - This drawing shall be read in conjunction with the drainage strategy report and any other drawings and specifications relevant to the site.
 - The exact location of all private rainwater pipes & internal foul soil pipes are to be confirmed.
 - All works to the adopted system are to be carried out in accordance with the Design and Construction Guidance ('The Code').
 - All works to the private drainage system to be in accordance with the Building Regulations Approved Document Part H 2015 edition.
 - 350mm min cover to be provided for private pipes laid in soft/paved areas. 900mm min cover to be provided for private pipes laid beneath roads/driveways unless not practicable. Where unachievable, shallow private drains may require protection using concrete surround or paving slabs bridging the trench, subject to the NHBC inspector's requirements.
 - All pipes shall be laid soffit to soffit with outgoing pipes unless otherwise stated.
 - Manholes situated within areas accessible to motor vehicles are to be fitted with suitable strength covers and frames. Please refer to the manhole schedule for guidance on this.

- Legend**
- New Surface Water Gravity Pipe
 - Existing Public Surface Water Sewer
 - New SW Inspection Chamber
 - New Hydrobrake
 - Rainwater Garden
 - Catchpit
 - 100mm Ø Polypropylene Linflex Filter Pipe
 - Water Butt

Rainwater Garden:
 Cover Level: 6.700 mAOD
 Invert Level: 5.500 mAOD
 Subbase Media Depth: 0.8m
 Planting Media Depth: 0.4m
 Subbase Media Porosity: 30%
 Attenuation Volume: 1.8m³

Hydrobrake and Final Outfall:
 Max Flow rate: 1.0 l/s



P01 First Issue	PA RW NO 13.03.2025
Rev. Description	Drn Chk App Date

Drawing Status: **FOR PLANNING**
 NOT FOR CONSTRUCTION



Client: Lamb Property Investments Ltd

Project: 192 Hawthorn Road, Bognor Regis

Title: Drainage Strategy Plan

Scale: 1:100 (@ A1)

Drawing: 2502082-0500 Revision: P01

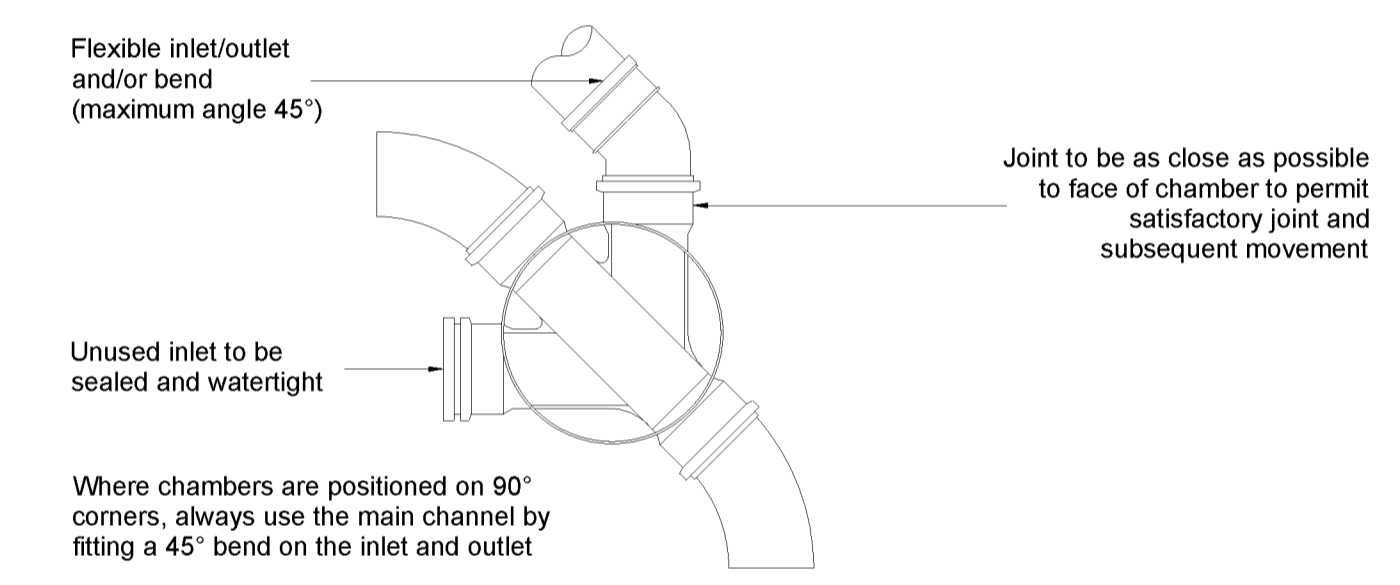
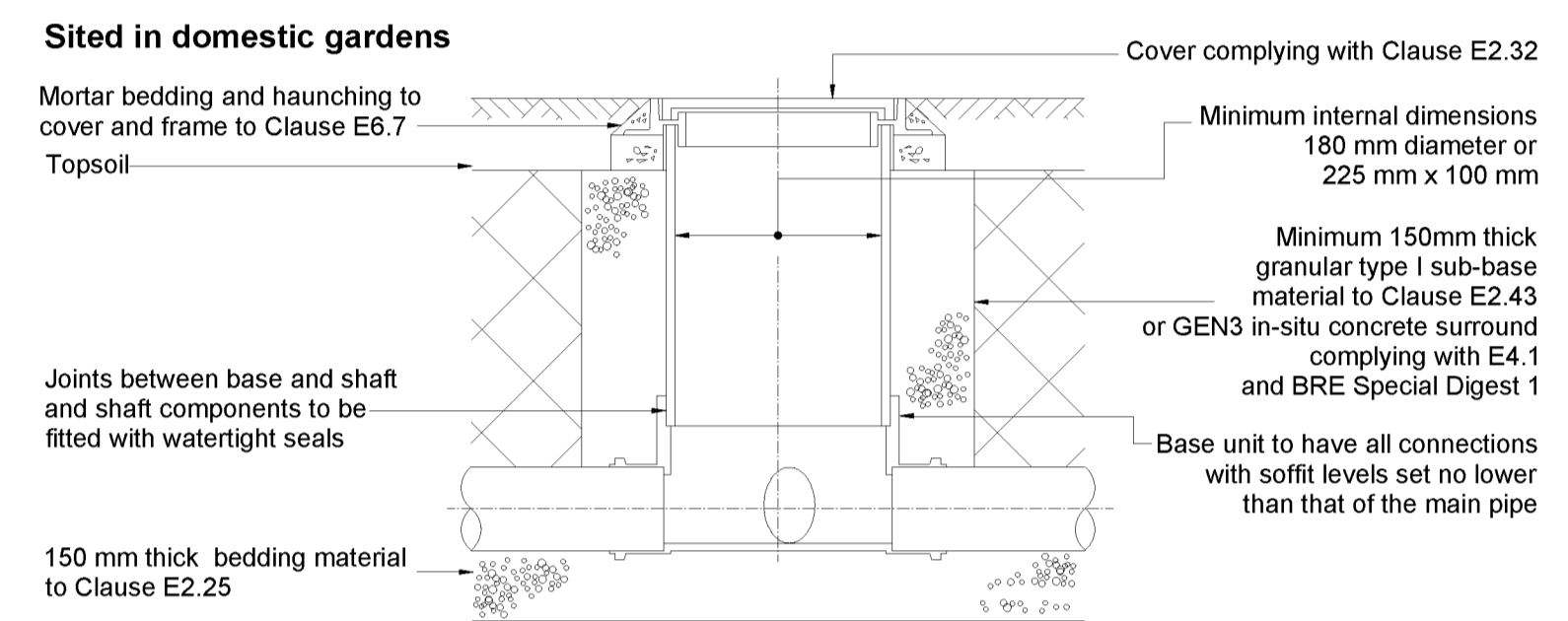
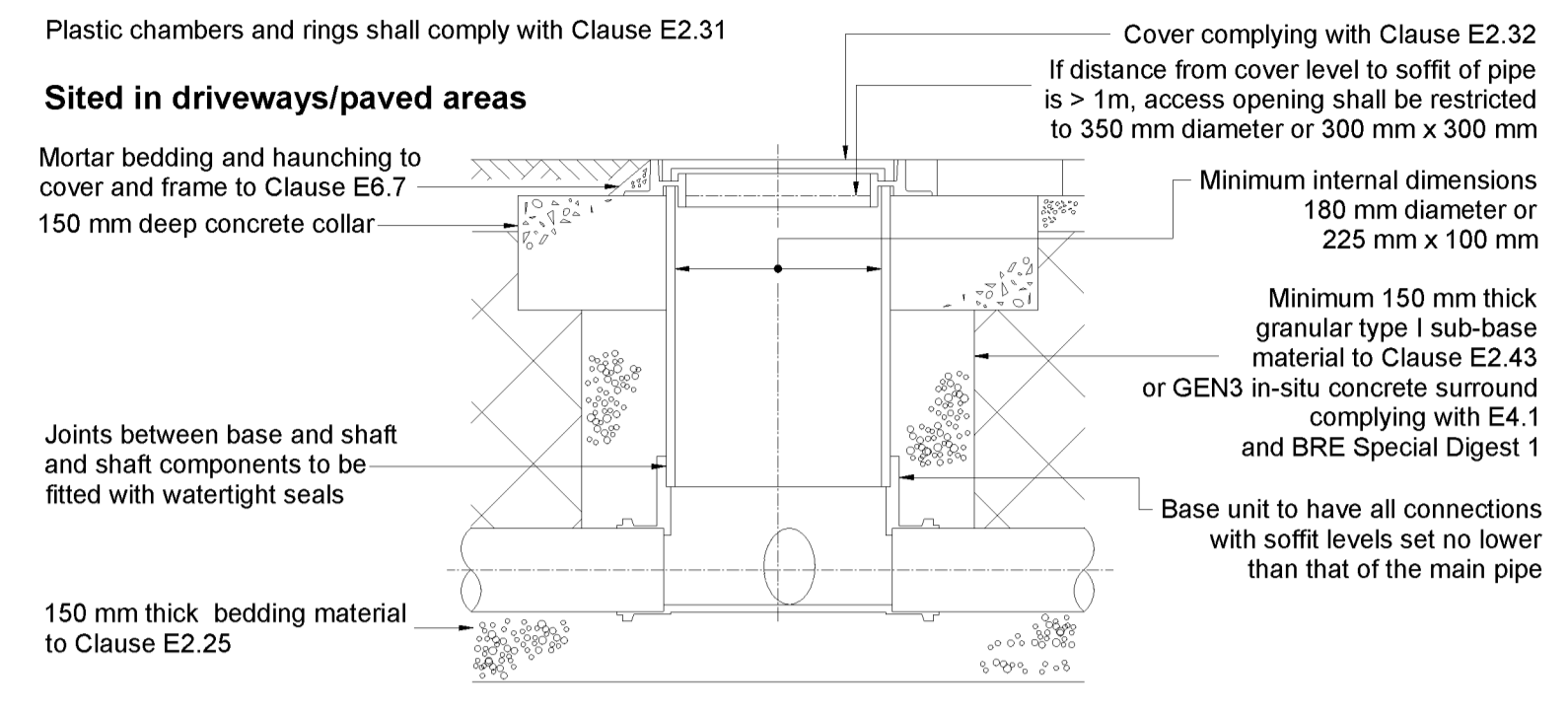
C:\Users\p\Documents\2502082\Drawings\DWG\2502082-0500-A.dwg

ARUN DISTRICT COUNCIL All rights reserved. Licence number 100043407

Notes

- All levels and dimensions are to be checked on site before any work commences. All dimensions are in millimetres unless stated otherwise.
- Any discrepancies shall be reported to the engineer immediately, so that clarification can be sought prior to the commencement of works.
- This drawing shall be read in conjunction with all other relevant engineering details, drawings and specification.

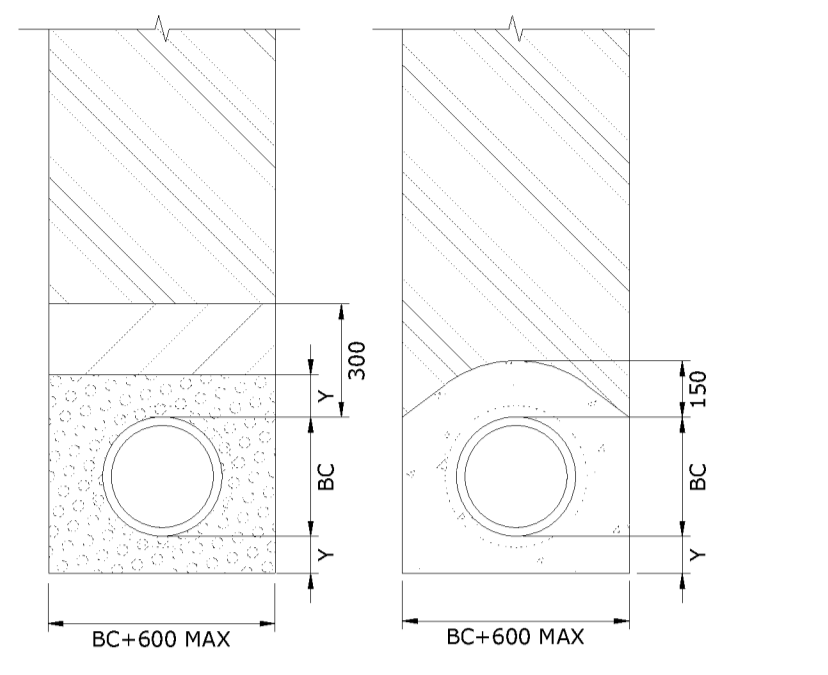
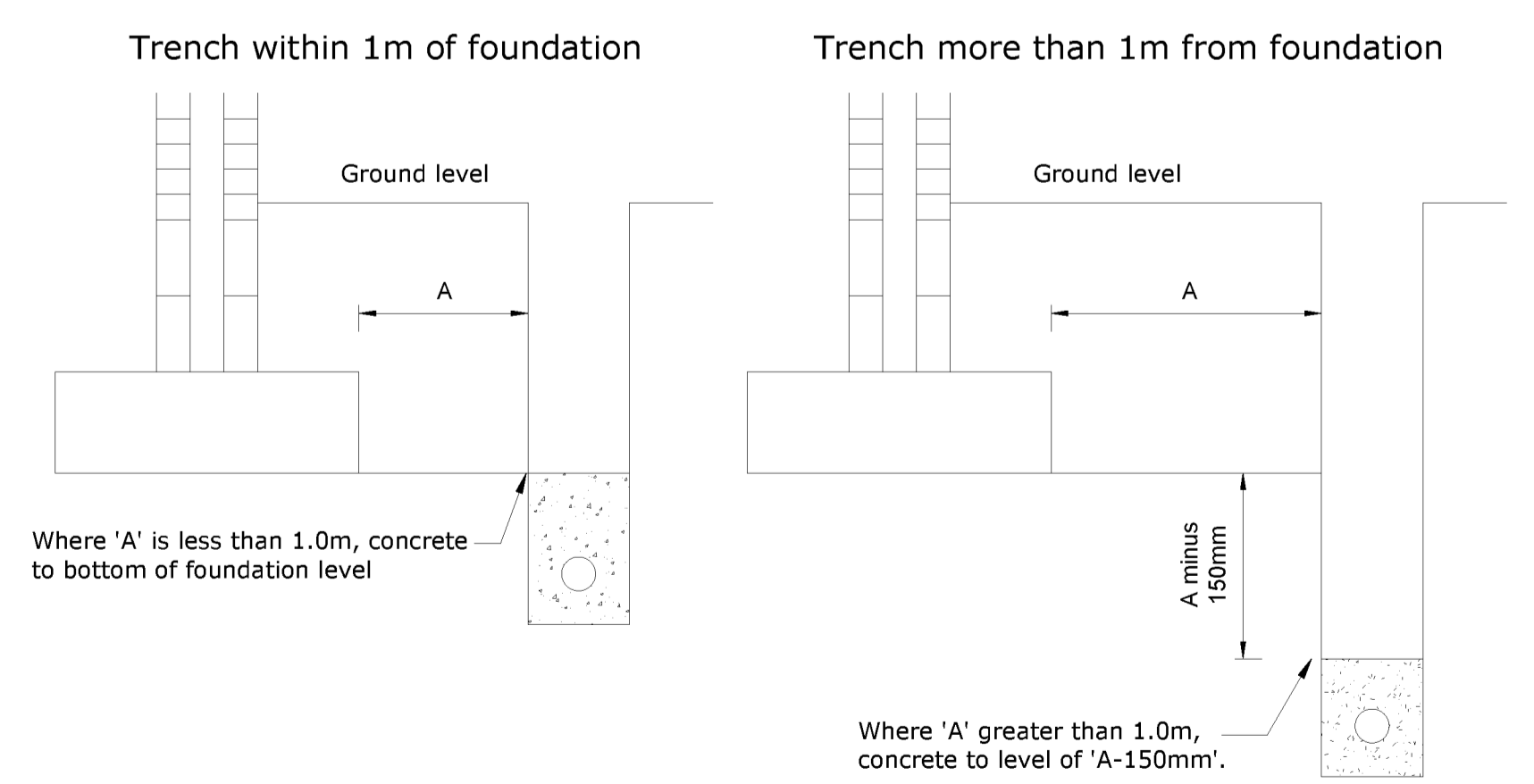
Figure B 23
Typical inspection chamber detail - Type E
 Depth from cover level to soffit of pipe up to 2 m
 Flexible material construction



Where chambers are positioned on 90° corners, always use the main channel by fitting a 45° bend on the inlet and outlet

Not to scale

Pipe runs near buildings



Key

- Suitable Backfill Material
- Selected Sidefill and Surround
- Single-size Granular Material
- ST2 Concrete Bed and Surround

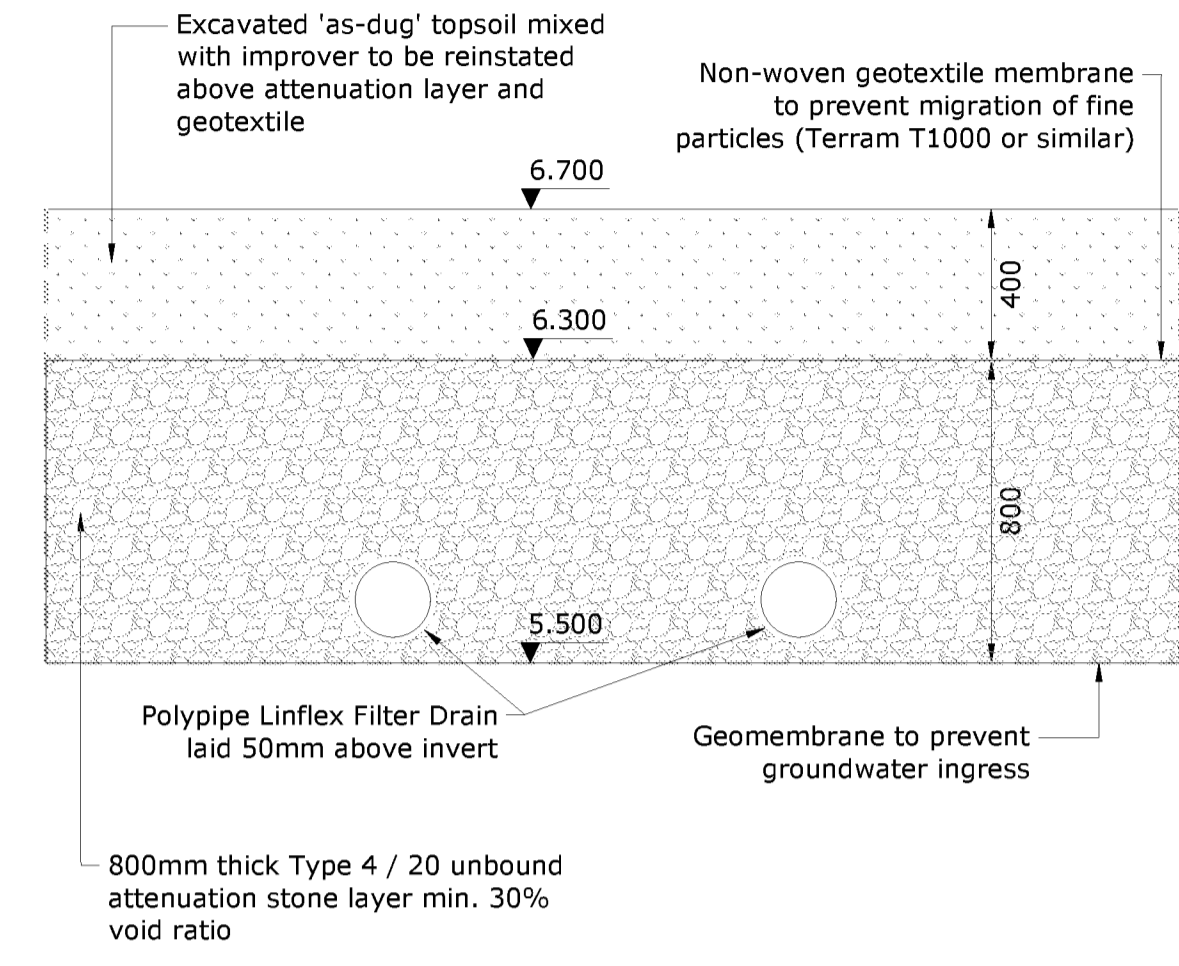
Dimension Y

CLASS	MACHINE DUG UNIFORM SOIL	ROCK OR HEAVY SOILS
S	NOTE (i)	NOTE (ii)
Z	NOTE (i)	NOTE (ii)

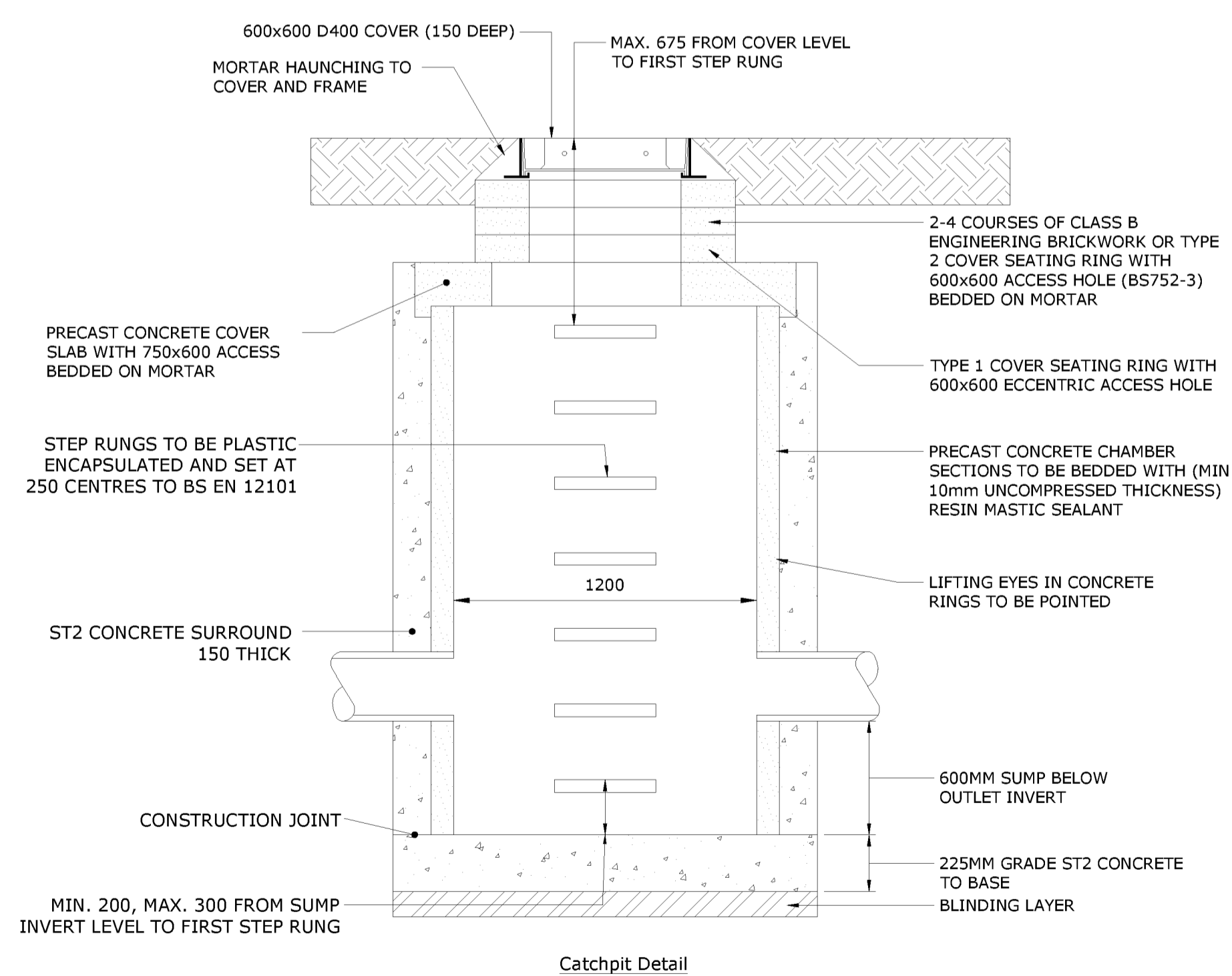
(i) Y=BC/6, with min 100 under Barrels (50 for Sleeve Joints) and min 50 under Sockets, whichever is the greater, with max of 400.
 (ii) Y=BC/4, with min 200 under Barrels (150 for Sleeve Joints) and min 150 under Sockets, whichever is the greater, with a max of 400.

DN = Nominal Internal Diameter of Pipe
 BC = Outside Diameter of Pipe

Pipe Bedding Detail



Section A - A: Rainwater Garden



Catchpit Detail

A	First Issue	PA	RW	NJ	13.03.2025
Revision Notes:		Dm	Chk	App	Date

Drawing Status: **DRAFT**
 NOT FOR CONSTRUCTION



Client:
 Lamb Property Investments Ltd

Project:
 192 Hawthorn Road, Bognor Regis

Title:
 Drainage Strategy Construction Details

Scale: NOT TO SCALE Size: A1 Project No: 2502082

Drawing: 2502082-0800 Revision: A

Appendix Q

Rainwater Garden Design and Management Guidance



RAIN GARDEN GUIDE

Bob Bray, Dusty Gedge, Gary Grant & Lani Leuthvilay

Principal Sponsor's Foreword



*Helen Newman
Head of Corporate
Responsibility and
Sustainability
Thames Water*

Everyone can help address the impact of climate change without making major lifestyle changes. This guide shows how changing the way you manage your outside space can help reduce localised flooding whilst at the same time providing an enjoyable area for the benefit of both wildlife and people.

Providing rain gardens is part of a growing desire to have more sustainable drainage systems. Other current initiatives include installing a "green roof" on top of buildings in urban spaces and reducing the amount of non permeable surfacing for example in car parks.

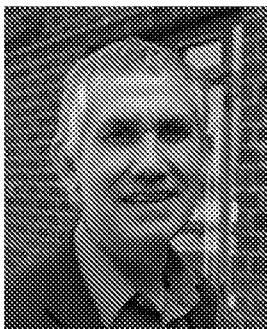
Thames Water is pleased to sponsor this guide. Our organisation is in favour of driving changes to the way we manage outdoor spaces to benefit both customers and wildlife that exists within our catchment. We are actively working on a number of projects to provide alternative routes for rainwater, reducing the burden on overloaded sewers in parts of our area. We believe this can have a real impact in terms of reducing flooding from overloaded sewers and makes better use of the water collected. In particular, rainwater gardens provide an altogether healthier alternative to enjoying our outside spaces.



Contents

What is a Rain Garden?	1
Why Rain Gardens?	2
Who is this Guide for?	2
Planning & Design	3
Construction	4
Planting	6
Planting Suggestions	7
Aftercare	8
Resources	8

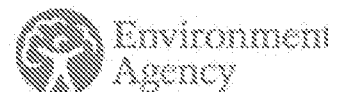
Statement of Support



*Dave Wardle
London Environment Team Manager
Environment Agency*

Water is a vital resource for people and wildlife. In the UK we expect to have enough water to meet our needs - having water readily available is something we often take for granted. Even in record breaking periods of prolonged summer rain, water is a precious resource, to be used and managed wisely.

The Environment Agency supports this guide which offers practical information on installing a small scale rain garden. It also reminds us how drains overwhelmed by a sudden downpour can affect water quality in the local river. Even one rain garden can make a small but positive difference in addressing localised flooding and the quality of the local water environment. Alongside other sustainable drainage systems and actions to tackle diffuse pollution, rain gardens can be an effective part of a bigger solution.



What is a RAIN GARDEN?

In its simplest form, a rain garden is a shallow depression, with absorbent, yet free draining soil and planted with vegetation that can withstand occasional temporary flooding. Rain gardens are designed to mimic the natural water retention of undeveloped land and to reduce the volume of rainwater running off into drains from impervious areas and treat low level pollution. In this guide, we also suggest establishing rain gardens in planters, which can receive water from a downpipe.

Rain gardens were first developed in the United States in the 1990s, where they have become increasingly popular. In the UK, the mimicking of natural drainage in urban areas is officially encouraged and known as Sustainable Drainage Systems (SuDS). This approach is part of a new philosophy to urban water management, developed in Australia, which is known as Water Sensitive Urban Design (WSUD).

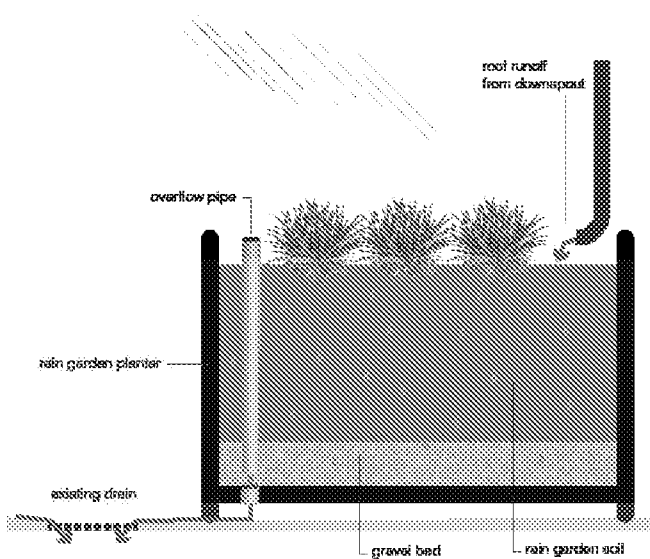
The term rain garden is wide ranging and has been used to describe a number of different features (see Why Rain Gardens? below). However, for the purposes of this guide a rain garden is a simple intervention designed to receive rainwater which has come from a downpipe or a large domestic paved area. The rainwater enters the soil and drains away into the ground or is taken up by the plants and lost back to the air by a process known as evapotranspiration.

Rain gardens usually absorb all the rainwater that flows into them, but when they do fill up following particularly heavy rainfall, any excess water is redirected to the existing drains. These simple rain gardens do not require any redesign of the existing drainage system and can be installed wherever space permits (see Planning and Design below) and in most soil types.

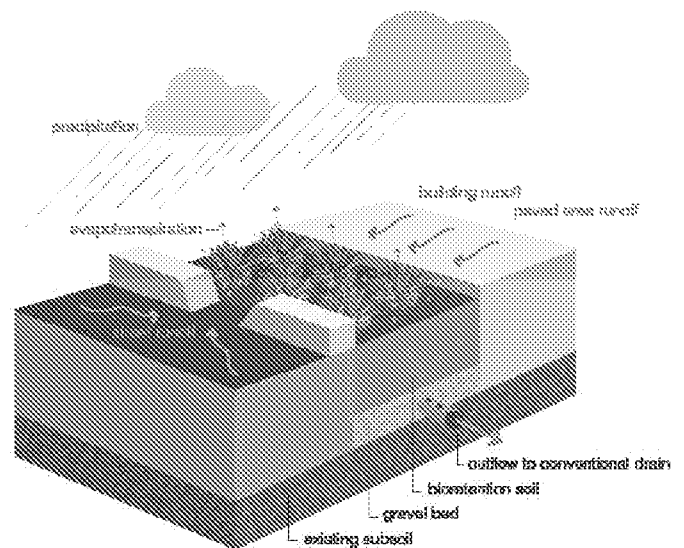


Typical domestic rain garden, Ashby Grove, London | CIRIA

Other features that may be described as rain gardens include bioretention strips, swales and specially designed tree-pits, which may receive the often more polluted surface water run-off from roads and other paved areas. These features usually include gravel layers, engineering soils and perforated drains and are normally installed in the street. Advice on the planning and design of these and other similar installations is outside of the scope of this guide. For more information see the CIRIA website in the Resources section.



Rain garden planter



Street rain garden



Why RAIN GARDENS?

The extensive areas of sealed surfaces, including roofs, pavements and roads, in our towns and cities, cause problems. When it rains, water is normally directed straight to drains, which can be overwhelmed during storms. When this happens, localised flooding can occur, damaging property and blocking streets. In some cities where surface water drains and foul sewers are interconnected, sewage can find its way into watercourses and streets.

Even when flooding does not occur, runoff may wash oil, heavy metals and other pollutants into watercourses, damaging the plants and animals that live in aquatic environments. Sealed surfaces can also cause problems during warm weather. When the sun shines, more heat is absorbed, causing urban areas to be hotter than the surrounding countryside – a phenomenon known as the Urban Heat Island Effect.

These problems have become worse as our towns and cities have grown and are expected to be exacerbated by climate change, which is likely to bring about more frequent and heavier downpours and stronger heat waves. One of the most effective ways of tackling these problems and adapting to climate change is to increase the quantity and quality of vegetation and soils in our towns and cities. All the green spaces and other environmental features, which include parks, gardens, green roofs and street trees, which are collectively known as green infrastructure, combine to provide various benefits at minimal cost, which are often described as ecosystem services.

Rain gardens help our gardens to deal more effectively with rainfall, but they also filter and clean runoff. By providing more and more rain gardens, we will be able to reduce our risk of flooding and curb urban heat islands.

The many benefits of green infrastructure include:

- Reduced risk of flood
- Reduction in water, air and noise pollution
- Better health through stress reduction and more places to exercise
- Space to relax and play
- Habitat for wildlife and space for people to enjoy nature
- Environmental education
- Local food production

Rain gardens can also be planted to attract wildlife (see Planting below) and can reduce the cost of maintenance, for example, where frequently mown lawns are replaced. They can be easily combined with schemes to harvest rainwater. By increasing the amount of water entering the soil, rain gardens help to reduce the effects of drought and help gardens to thrive without the need for irrigation.

Rain gardens work well by bringing about many small incremental improvements, which cumulatively can bring about huge beneficial change – each project, however small, makes a significant contribution towards the overall goal of making the city greener.

Who is this GUIDE for?

The rain gardens described in this guide are relatively simple and straightforward, suitable for establishment anywhere where local conditions are suitable and an adjacent downpipe can be intercepted or water from a paved area re-directed. This guide is intended to help the homeowner or property manager (or practical person working on behalf of others) to create a simple rain garden within their own property. Even in places without gardens, like many apartment blocks, offices or factories, there may be space to create container gardens or raised beds that receive water from downpipes and overflow into the drain. In some situations it may even be possible to remove paving or asphalt in order to create space for your rain garden.

We hope that this guide will encourage everyone to look for opportunities to establish rain gardens throughout our towns and cities. We should also consider how we can encourage managers of our parks and streets to restore more natural patterns of drainage in our neighbourhoods. For information on the various components of sustainable drainage systems and sources of professional advice see the Resources section at the end of this document or email us at: info@raingardens.info



Planning & Design

The first consideration is, if the rain garden overflows, where will the water go? This might be the existing drain, which the disconnected downpipe enters, but in some cases could be an alternative drain. If you are using the existing drain, you don't need to worry about drainage capacity, because the rain garden will be reducing the overall volume of water entering the drain. The rain garden will need to work in terms of levels, with the overflow point being higher than the receiving drain. If a suitable receiving drain cannot be identified, you should not proceed without taking professional advice.

You will usually site your rain garden in an existing flower bed or lawn. Rain gardens are usually situated some distance from buildings or site boundaries, although the exact location will depend on the local topography and available space. In order to reduce the likelihood of property damage to insignificant levels, authorities in the US recommend that rain gardens are situated at least 3m (10 feet) from any building. (Note that rain gardens as described here are not point soak-aways as described under Part H of the Building Regulations. However, if your property is situated in an area with chalk or other material that could be adversely affected by localised increases in the flow of ground water you should contact your local authority Building Control Officer for advice). If a rain garden is based on a planter, it will normally be most convenient to place it below the downpipe and close to the receiving drain.

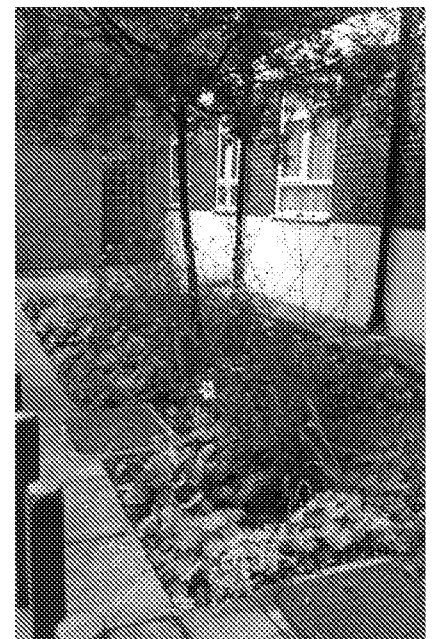
Most gardens slope away from buildings and it is usual to establish a rain garden on a gentle slope – the steeper it is, the more difficult it is to remodel the ground to create a level perimeter. Slopes of more than about 12% or 1:8 are difficult to work with and may require retaining structures. Seek professional advice if you would like to establish a rain

garden on a steeper slope than this. The downpipe should feed into the head of the rain garden. If the garden is some distance from the downpipe, create a swale (a small, shallow channel) or use a pipe to take the water to the rain garden.

It is possible to locate a rain garden in the shade of large trees, however the range of plants that will thrive will be limited to those that are shade tolerant and there could be problems with tree roots, which are best left alone. When planning the location of your rain garden, consider how it will relate to other existing and planned features and how it will look from various viewpoints both inside and out.

We recommend that you undertake a simple percolation test before building your rain garden. Dig a hole at least 250mm deep, fill with water and let it drain. Fill the pit with water again. If it drains away at the rate of 50mm per hour or more you have suitable conditions for a rain garden. Water will not drain away quickly enough if the water table is at or very close to the surface or if the soil is composed of a heavy clay. The soil can be improved (see Construction section over the page), so it will usually be possible to work on sites with almost any soil type, although again, if you have any concerns about ground conditions in the local area, contact your local authority Building Control Officer for advice.

If your soil is clay it will require much more improvement than a light, sandy soil. If you are unsure of the soil type at your site, you can run this simple test: take a handful of damp soil and squeeze it in the palm of your hand. If it holds its shape at first but easily crumbles you have a loamy soil, which is ideal for a rain garden. If it falls apart as soon as you open your hand, it is a sandy soil, which is also suitable for a rain garden. If your sample holds its shape and stays intact it is a clay soil, which will need to be improved.



Before, during and after the installation of a rain garden at Kingsmead Way, Hackney, London, led by Groundwork London's Green Team and Sanctuary Housing, and planted up by local residents
| Groundwork London

The next step is to consider the size of the rain garden. The bigger the rain garden the better. Experienced 'rain gardeners' in the US suggest that rain gardens are between 3m and 5m wide, with the length adjusted to suit the slope and area available. Although a rain garden of any size may bring some benefits, if it is very small, it may overflow too frequently and may become waterlogged and less effective in reducing run-off rates.

To calculate the volume of water that your rain garden may be receiving, measure the size of the roof that drains into the downpipe that you will be intercepting and consider how much rain may fall during a particular downpour or period. The volume of water that the rain garden will be receiving in litres, equals the area of the roof (in square metres) multiplied by the rainfall (in millimetres).

A rain garden 150mm deep and 20% of the area of the area of the roof that it serves will be able to intercept all of the run-off from a typical summer storm where 10-15mm of rain might fall. Rain gardens on more permeable soils will be even more effective. Over the course of an average year, a rain garden of this size will intercept most of the rainfall that it receives, only overflowing after several days of persistent rainfall.

Construction

Once you have determined the location, size and shape of your rain garden, you should mark the outline on the ground with rope or hose (or if it has straight sides, with pegs and string). You can reduce the effort of digging up existing turf by covering it with dark plastic for a few weeks, until it has died off.

Dig out your rain garden to create a saucer shaped profile, to create a flat base for infiltration. You may place the spoil around the margins to create a level berm or lip. At the centre, the base of the excavation for a typical rain garden will be between 150mm and 450mm below original ground level. You can check that the perimeter lip is level by using a series of wooden stakes, parallel sided board and spirit level or, on larger excavations, a length of hosepipe filled with water.

The berm will hold back water during a storm so will need to be approximately 300mm in width, approximately 100mm high and well compacted. The amount of material in the berm will be greater on the lower part of the slope. Berms are usually tapered off so that they blend in with the adjoining garden.

In order to allow excess water to flow out of the rain garden in the direction of the drain, create a permeable channel through the berm in the required location by making a 150mm wide slot and filling this with gravel. The lower level

of the outfall channel or pipe should be existing ground level. A shallow swale filled with gravel or pebbles can be created to channel the overflow towards the drain. In a similar way, if an inlet channel is required to direct water from the downpipe to the rain garden, this can be lined with clay and made with bricks, setts or pebbles (to ensure that the water reaches the rain garden and doesn't erode the soil).

Where a downpipe feeds water directly into a rain garden, stones or gravel should be used to dissipate the energy of the water and prevent heavy flows from washing away soil. Or alternatively, a pipe can be used to direct water to the rain garden.

You can redirect your downpipe towards the rain garden by adding bends and new sections or alternatively use a proprietary rainwater diverter of the type normally used to divert water from a downpipe to a water butt. The City of Toronto provides useful advice on the practicality of disconnecting downpipes (see Resources section on p10).

Once the rain garden is excavated to the required depth, the excavated soil should be improved to make it more water absorbent and free draining. The act of digging your soil will bring some improvement but it is also helpful to add organic matter. This could be in the form of your own home made compost, shredded paper, leaf mould, well-rotted bark or charcoal. If your soil is a heavy clay, the addition of sand, crushed brick, gravel, stones, as well as organic material will help.

Once your soil has been well mixed with any improver, backfill the excavation to the original ground level. This should leave a freeboard between the original ground level and the surrounding berm, an area that may flood for a few hours following particularly heavy rain.

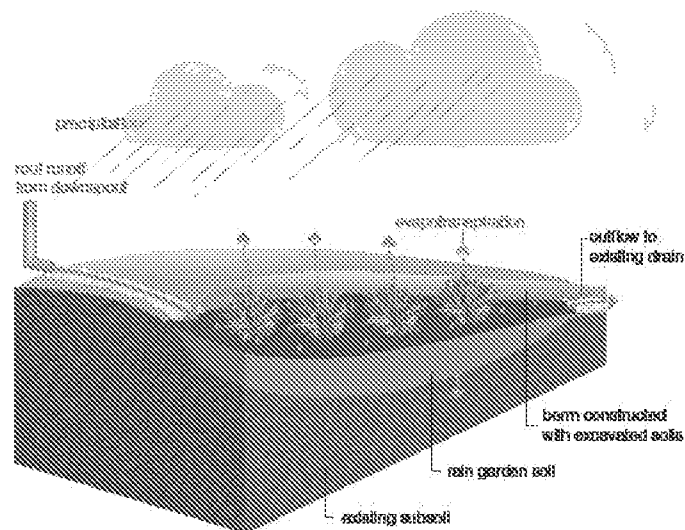


Rain gardens can be incorporated into conventional front gardens, keeping the ground permeable while allowing for car port and parking, as in this Hampton Court Flower Show Gold Medal winning design by Wendy Allen
| Wendy Allen Designs

Rain gardens that are created using stone, concrete or metal planters should have a drainage hole near the base, which is close to the receiving drain. The bottom of the planter should be filled with stones and gravel to a depth of at least 50mm, with a 'fleece' over the gravel, and the remainder filled with a water absorbent and free draining soil. Avoid the use of clay and include plenty of organic material.

An overflow pipe, set at the height of the rim of the planter allows water to run straight to the base of the planter when the planter is saturated. Where the down-pipe empties into the planter, stones should be used to dissipate the energy of the falling water and prevent the soil being washed away.

Once you have filled your rain garden with the improved soil, it is ready to plant!!



Section of a typical domestic rain garden



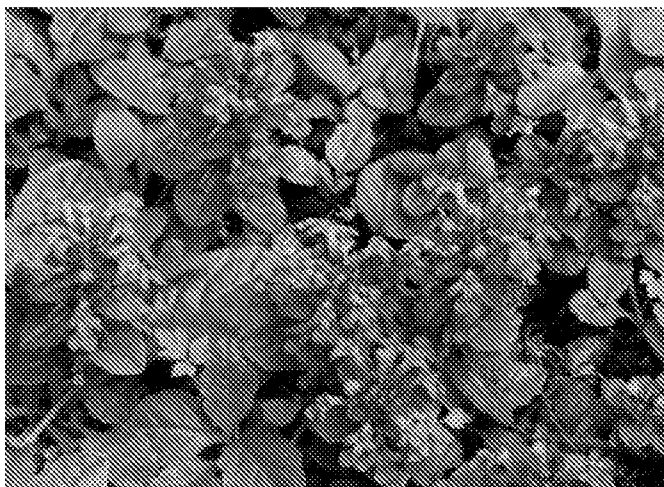
Ashby Grove rain garden, north London | CIRIA

Planting

Your rain garden is designed to slow surface water run-off and improve water quality. However it is a garden feature and should work for you in terms of the overall design of your property. Like any garden, there is range of possible planting styles: your rain garden might have ornamental, low maintenance ground cover, designed to provide a habitat for wildlife or quirky, perhaps, with stone, gravels or even sculpture – the choice is yours. The English cottage, American prairie or ornamental grass styles are particularly well suited to rain gardens. In larger planters, you may be able to grow fruit and vegetables.

When choosing plants you may want to consider height, colour and flowering period. Taller plants tend to be situated at the centre of the garden and shorter ones around the edges, so that all can be seen and so that deeper-rooted plants can benefit from the deeper soil in the middle of the bed. By grouping plants of various size and texture you will be able to create an interesting looking garden even when few flowers are in bloom. If you wish to create habitat for wildlife, plant native species or plants that are known to attract insects like bees and butterflies and other wildlife. For further information on plants for pollinators see the Royal Horticultural Society's list, and for general advice on wildlife gardening see the Wild About Gardens website (see the Resources section).

It is recommended that your rain garden is planted with a wide range of species in order to create a densely vegetated, stable and thriving bed with dense and thick root systems which will thrive without frequent maintenance. A typical rain garden is planted with about 10 species planted in 2 to 3 clumps per square metre. By planting several species, you will be creating a rain garden that can still succeed even if one or two species do not thrive. A typical planting density is 6-10 plants per square metre, but you may wish to vary this, depending on the size and nature of the plants chosen.



Bugle, *Ajuga reptans* | Bob Gibbons

Plant the rain garden with nursery-grown stock. Good results have been achieved with one or two year old plugs or potted

plants, which have a strong root system. Before you plant, it is advisable to have a good idea of what goes where, by preparing a planting plan. Excavate a hole for each plant about twice the size of the root ball, place the plant in the hole and press the soil firmly around the roots. The stem should be at the same level relative to the ground as it was in the growing container. Once the garden is planted, you may consider spreading bark mulch across bare soil to suppress weed growth.



Yellow flag iris, *Iris pseudocorus* | Bob Gibbons

The perimeter berm can be seeded with a general purpose wildflower grassland mix, which can be left to grow, or mown as required, in order to match the adjacent garden. Unless it rains, plants should be watered during establishment. During hot weather, the soil loses about 3 litres per square metre per day by evaporation, so it is advisable to replace this if possible. Once established, the plants will not need to be watered unless the weather has been exceptionally dry. Plants can be planted anytime during the growing season, as long as they are watered. If watering is difficult, it may be advisable to plant in autumn.

A very wide range of plants can be planted in rain gardens, however you should avoid using plants that do not withstand occasional flooding - for example species which are usually associated with dry Mediterranean style gardens, like Lavender. Other plants to avoid include those susceptible to root rot including Azalea, Juniper and Chinese privet.

The frequency that the rain garden is inundated will depend on the size of the rain garden and the weather, so it is important to keep an eye on the rain garden, replace any failures and adjust the planting palette to suit the actual conditions. A selection of suggested plants is included in the table. There are many others that will be suitable which are not listed, so feel free to experiment and apply your own plant knowledge if you are a keen gardener. If you have success or notice problems with particular species, please let us know at: www.raingardens.info.



Planting Suggestions

Common name	Scientific name	Habit	Sunlight and Aspect	Origin
Guelder rose	<i>Viburnum opulus</i>	Perennial shrub	Any	Native. Flowers attract insects and berries are eaten by birds.
Dogwood	<i>Cornus sanguinea</i>	Perennial shrub	Any	Native. Leaves are larval food for vase bearer moth and berries eaten by birds. Often planted for attractive winter stems.
Culvers root	<i>Veronicastrum virginicum</i>	Herbaceous perennial	Full sun or partial shade	Non-native. Tall with long terminal blue flower spikes. On the RHS 'plants for pollinators' list.
Aster	<i>Aster spp.</i>	Herbaceous perennial	Full sun or partial shade	Non-native. Often late flowering. Clump forming. Several species on the RHS 'plants for pollinators' list.
Black eyed susan	<i>Rudbeckia hirta</i>	Herbaceous annual or biennial	Full sun or partial shade	Non-native. Spectacular yellow and black flowers. On RHS 'plants for pollinators' list.
Stinking hellebore	<i>Helleborus foetidus</i>	Herbaceous perennial	Full sun or partial shade	Native. Winter flowers.
Montbretia	<i>Crococsmia spp.</i>	Deciduous rhizomatous perennial	Partial shade	Naturalised. Red flowers. Thrives in most conditions.
Bugle	<i>Ajuga reptans</i>	Rhizomatous perennial	Partial shade	Native. Low growing and will form a mat.
Columbine	<i>Aquilegia spp.</i>	Herbaceous perennial	Full sun or partial shade	Non-native. Clump forming with tall flower spikes. On RHS 'plants for pollinators' list.
Inula	<i>Inula hookeri</i>	Herbaceous perennial	Partial shade	Tall clump forming with yellow flowers. On RHS 'plants for pollinators' list.
Hemp agrimony	<i>Eupatorium cannabinum</i>	Herbaceous perennial	Full sun or partial shade	Native. Sub-shrubs with pink flowers.
Bellflower	<i>Campanula glomerata</i>	Herbaceous perennial	Full sun or partial shade	Native. Clumps bearing violet-blue bell shaped flowers.
Sneezeweed	<i>Helenium sp.</i>	Herbaceous perennial	Full sun	Non-native. Clump forming with red flowers. On RHS 'plants for pollinators' list.
Lesser periwinkle	<i>Vinca minor</i>	Perennial sub-shrub	Any	Non-native. Ground cover with blue flowers.
Elephants ear	<i>Bergenia sp.</i>	Rhizomatous perennial	Full sun or partial shade	Non-native. Large leaves and pink flowers.
Plantain lilies	<i>Hosta spp.</i>	Herbaceous perennial	Part shade	Non-native. Attractive light coloured flowers.
Yellow flag	<i>Iris pseudocorus</i>	Rhizomatous perennial	Full sun or partial shade	Native. Likely to prefer wetter areas near inlet.
Siberian flag	<i>Iris sibirica</i>	Rhizomatous perennial	Full sun or partial shade	Non-native. Blue flowers. Prefers moist but well drained soil.
Garlic and onions	<i>Allium spp.</i>	Bulbous perennials	Full sun	Non-native. On RHS 'plants for pollinators' list.
Soft rush	<i>Juncus effusus</i>	Evergreen perennial	Full sun or partial shade	Native. Form tussocks – likely to prefer wetter areas.
Pendulous sedge	<i>Carex pendula</i>	Rhizomatous perennial	Full sun or partial shade	Native. Nodding flower spikes. Likely to prefer wetter areas near inlet.
Zebra grass	<i>Miscanthus sinensis</i>	Perennial, deciduous grass	Full sun	Non-native. Tussock forming ornamental grass with silky flowers.
Switch grass	<i>Panicum virgatum</i>	Deciduous perennial grass	Full sun	Non-native. Tussock forming ornamental grass.
Royal fern	<i>Osmunda regalis</i>	Deciduous fern	Any	Native. Large clump-forming plants.
Male fern	<i>Dryopteris felix-mas</i>	Deciduous or evergreen fern	Partial shade or full shade	Native. Large shuttlecock-like form.
Broad buckler fern	<i>Dryopteris dilatata</i>	Deciduous or evergreen fern	Partial shade or full shade	Native. Large shuttlecock-like form.

Maintenance

Occasional weeding may be required during the first two years of the life of the rain garden. Remove by hand any weeds, ensuring that you remove the whole plant, including the roots. As the plants in the beds mature, they will fill in any gaps and suppress weed growth.

During winter, you may want to remove any dead or untidy plants, although it is good to leave some dead stems and seed heads for wildlife.

Regular mowing is not required, but the bed may benefit from cutting occasionally. If required, cutting can be undertaken in late summer or autumn with a scythe or strimmer with particularly tough material cut by hand with secateurs. Remove cut material for composting.



*Rain garden, Hampton Court Flower Show
| Wendy Allen Designs*

Resources

This **Rain Garden Guide** is available for free download at the associated website:
www.raingardens.info

Low Impact Development
www.lowimpactdevelopment.org

Sustainable drainage systems
www.ciria.com/suds

Water sensitive urban design
www.wsud.melbournewater.com.au

London and the Urban Heat Island Effect
www.london.gov.uk/lccp/ourclimate/overheating.jsp

Defra Green Infrastructure Partnership
www.defra.gov.uk/environment/natural/green-infrastructure

Natural England on green infrastructure
www.naturalengland.org.uk/ourwork/planningtransport-localgov/greeninfrastructure/default.aspx

UK National Ecosystem Assessment
www.uknea.unep-wcmc.org

Regional climates: Meteorological Office
www.metoffice.gov.uk/climate/uk/regional

Soil and water
www.noble.org/ag/soils/soilwaterrelationships/index.htm

Building Regulations Part H – Drainage (Amended 2010)
www.planningportal.gov.uk/buildingregulations/approveddocuments/partH/approved

Disconnecting downpipes
www.toronto.ca/water/protecting_quality/downspout.htm

Depave Movement
www.depave.org

How to check levels using a hose
www.factsfacts.com/MyHomeRepair/WaterLevel.htm

Planting sources
www.rhs.org.uk/Gardening/Sustainable-gardening/pdfs/RHS_Pollinators_PlantList

www.wildaboutgardens.org.uk

Acknowledgements

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www.environment-agency.gov.uk



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Photographs

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Lani Leuthvilay

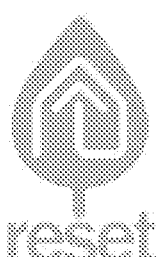
Design & Layout

Lani Leuthvilay, Blanche Cameron

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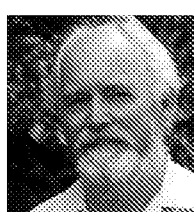
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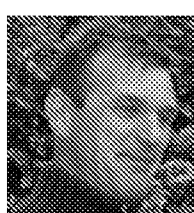
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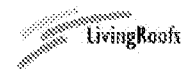
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Appendix R
FEH2022 Data

VERSION	"FEH CD-ROM"	Version	5.0.1	exported at	15:13:11 GMT	Mon	10-Mar-25
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11.00	0.46	30.20	40.38	47.42	54.47	58.85	64.73	69.84	73.75	79.73	84.37	101.13	115.06	162.01
11.25	0.47	30.35	40.56	47.62	54.69	59.08	64.99	70.12	74.06	80.07	84.74	101.59	115.56	162.60
11.50	0.48	30.51	40.74	47.81	54.90	59.31	65.24	70.40	74.36	80.41	85.11	102.03	116.05	163.18
11.75	0.49	30.66	40.91	48.00	55.11	59.54	65.49	70.67	74.65	80.74	85.46	102.47	116.53	163.74
12.00	0.50	30.80	41.08	48.18	55.32	59.76	65.73	70.94	74.94	81.06	85.81	102.89	116.99	164.29
12.25	0.51	30.95	41.24	48.36	55.52	59.97	65.97	71.20	75.22	81.38	86.15	103.30	117.44	164.80
12.50	0.52	31.10	41.40	48.54	55.71	60.18	66.21	71.46	75.50	81.69	86.48	103.70	117.88	165.30
12.75	0.53	31.24	41.56	48.71	55.91	60.39	66.44	71.71	75.77	81.99	86.81	104.09	118.30	165.79
13.00	0.54	31.38	41.72	48.88	56.10	60.60	66.66	71.96	76.04	82.29	87.13	104.47	118.72	166.27
13.25	0.55	31.52	41.87	49.05	56.28	60.80	66.88	72.21	76.30	82.58	87.44	104.84	119.12	166.75
13.50	0.56	31.66	42.02	49.21	56.46	60.99	67.10	72.45	76.56	82.87	87.75	105.21	119.52	167.21
13.75	0.57	31.79	42.17	49.37	56.64	61.19	67.32	72.68	76.81	83.15	88.05	105.56	119.91	167.66
14.00	0.58	31.93	42.31	49.53	56.82	61.38	67.53	72.91	77.06	83.43	88.34	105.91	120.29	168.11
14.25	0.59	32.06	42.46	49.69	56.99	61.57	67.73	73.14	77.30	83.70	88.63	106.26	120.67	168.55
14.50	0.60	32.19	42.60	49.85	57.17	61.75	67.94	73.36	77.54	83.96	88.92	106.60	121.03	168.98
14.75	0.61	32.31	42.74	50.00	57.34	61.93	68.14	73.58	77.78	84.23	89.20	106.93	121.39	169.40
15.00	0.63	32.44	42.88	50.15	57.50	62.11	68.34	73.80	78.01	84.48	89.47	107.25	121.75	169.82
15.25	0.64	32.56	43.02	50.30	57.67	62.29	68.53	74.01	78.24	84.74	89.74	107.57	122.09	170.23
15.50	0.65	32.68	43.15	50.45	57.83	62.46	68.72	74.22	78.46	84.98	90.00	107.89	122.43	170.63
15.75	0.66	32.80	43.29	50.59	57.99	62.64	68.91	74.42	78.68	85.23	90.27	108.19	122.76	171.03
16.00	0.67	32.92	43.42	50.73	58.15	62.81	69.09	74.62	78.90	85.47	90.52	108.50	123.09	171.42
16.25	0.68	33.04	43.55	50.88	58.30	62.97	69.28	74.82	79.11	85.70	90.77	108.79	123.41	171.80
16.50	0.69	33.16	43.68	51.02	58.46	63.14	69.46	75.02	79.32	85.94	91.02	109.09	123.73	172.19
16.75	0.70	33.27	43.81	51.16	58.61	63.30	69.64	75.21	79.52	86.16	91.27	109.37	124.04	172.56
17.00	0.71	33.38	43.93	51.29	58.76	63.46	69.81	75.40	79.73	86.39	91.51	109.66	124.34	172.93
17.25	0.72	33.50	44.06	51.43	58.91	63.62	69.98	75.59	79.93	86.61	91.74	109.94	124.64	173.30
17.50	0.73	33.61	44.18	51.56	59.05	63.78	70.16	75.77	80.12	86.83	91.98	110.21	124.93	173.66
17.75	0.74	33.72	44.31	51.69	59.20	63.94	70.32	75.96	80.32	87.04	92.21	110.48	125.22	174.02
18.00	0.75	33.83	44.43	51.83	59.34	64.09	70.49	76.13	80.51	87.25	92.43	110.75	125.51	174.37
18.25	0.76	33.93	44.55	51.96	59.49	64.24	70.65	76.31	80.69	87.45	92.65	111.00	125.79	174.74
18.50	0.77	34.04	44.68	52.09	59.63	64.39	70.81	76.48	80.87	87.65	92.86	111.26	126.06	175.11
18.75	0.78	34.14	44.80	52.22	59.77	64.54	70.97	76.64	81.04	87.85	93.07	111.51	126.33	175.48
19.00	0.79	34.24	44.92	52.35	59.91	64.69	71.13	76.81	81.22	88.04	93.28	111.76	126.60	175.84
19.25	0.80	34.34	45.04	52.48	60.05	64.84	71.28	76.97	81.39	88.23	93.49	112.00		


26.00	1.08	36.85	48.01	55.63	63.47	68.40	75.05	80.93	85.53	92.76	98.33	117.65	132.88	184.05
26.25	1.09	36.94	48.12	55.74	63.59	68.52	75.17	81.06	85.67	92.91	98.49	117.83	133.07	184.27
26.50	1.10	37.03	48.22	55.85	63.70	68.64	75.30	81.20	85.81	93.06	98.65	118.01	133.26	184.49
26.75	1.11	37.12	48.32	55.96	63.82	68.76	75.43	81.33	85.95	93.21	98.81	118.19	133.45	184.70
27.00	1.13	37.20	48.42	56.06	63.93	68.88	75.56	81.47	86.09	93.36	98.96	118.36	133.63	184.92
27.25	1.14	37.29	48.52	56.17	64.05	69.00	75.68	81.60	86.23	93.51	99.12	118.54	133.82	185.13
27.50	1.15	37.38	48.62	56.27	64.16	69.12	75.81	81.74	86.37	93.66	99.28	118.71	134.00	185.34
27.75	1.16	37.46	48.71	56.38	64.27	69.24	75.93	81.87	86.51	93.81	99.43	118.88	134.19	185.54
28.00	1.17	37.55	48.81	56.48	64.39	69.35	76.06	82.00	86.65	93.95	99.58	119.05	134.37	185.75
28.25	1.18	37.63	48.91	56.59	64.50	69.47	76.18	82.13	86.79	94.10	99.74	119.22	134.55	185.95
28.50	1.19	37.72	49.01	56.69	64.61	69.59	76.30	82.26	86.92	94.24	99.89	119.39	134.72	186.15
28.75	1.20	37.80	49.11	56.79	64.72	69.70	76.43	82.39	87.06	94.39	100.04	119.56	134.90	186.35
29.00	1.21	37.89	49.20	56.90	64.83	69.82	76.55	82.52	87.19	94.53	100.19	119.73	135.08	186.55
29.25	1.22	37.97	49.30	57.00	64.94	69.93	76.67	82.65	87.33	94.68	100.34	119.89	135.25	186.74
29.50	1.23	38.05	49.39	57.10	65.05	70.04	76.79	82.78	87.46	94.82	100.48	120.06	135.43	186.94
29.75	1.24	38.14	49.49	57.20	65.16	70.16	76.91	82.91	87.60	94.96	100.63	120.22	135.60	187.13
30.00	1.25	38.22	49.59	57.30	65.27	70.27	77.03	83.04	87.73	95.10	100.78	120.38	135.77	187.32
30.25	1.26	38.30	49.68	57.40	65.38	70.38	77.15	83.16	87.86	95.24	100.92	120.54	135.94	187.51
30.50	1.27	38.39	49.78	57.50	65.49	70.49	77.27	83.29	88.00	95.38	101.07	120.70	136.11	187.69
30.75	1.28	38.47	49.87	57.60	65.60	70.61	77.39	83.42	88.13	95.52	101.21	120.86	136.28	187.88
31.00	1.29	38.55	49.96	57.70	65.70	70.72	77.51	83.54	88.26	95.66	101.36	121.02	136.44	188.06
31.25	1.30	38.63	50.06	57.80	65.81	70.83	77.63	83.67	88.39	95.80	101.50	121.18	136.61	188.24
31.50	1.31	38.72	50.15	57.90	65.92	70.94	77.75	83.79	88.52	95.93	101.64	121.33	136.77	188.42
31.75	1.32	38.80	50.24	58.00	66.02	71.05	77.86	83.92	88.65	96.07	101.78	121.49	136.94	188.60
32.00	1.33	38.88	50.34	58.10	66.13	71.16	77.98	84.04	88.78	96.21	101.92	121.64	137.10	188.78
32.25	1.34	38.96	50.43	58.20	66.24	71.27	78.10	84.17	88.91	96.34	102.06	121.80	137.26	188.96
32.50	1.35	39.04	50.52	58.30	66.34	71.37	78.21	84.29	89.04	96.48	102.20	121.95	137.43	189.13
32.75	1.36	39.12	50.61	58.39	66.45	71.48	78.33	84.41	89.16	96.61	102.34	122.10	137.59	189.31
33.00	1.38	39.20	50.70	58.49	66.55	71.59	78.45	84.53	89.29	96.75	102.48	122.25	137.74	189.48
33.25	1.39	39.28	50.80	58.59	66.66	71.70	78.56	84.66	89.42	96.88	102.62	122.40	137.90	189.65
33.50	1.40	39.36	50.89	58.68	66.76	71.81	78.67	84.78	89.54	97.01	102.75	122.55	138.06	189.82
33.75	1.41	39.44	50.98	58.78	66.86	71.91	78.79	84.90	89.67	97.14	102.89	122.70	138.22	189.99
34.00	1.42	39.52	51.07	58.88	66.97	72.02	78.90	85.02	89.79	97.27	103.03	122.85	138.37	190.16
34.25	1.43	39.60	51.16	58.97	67.07	72.12	79.02	85.14	89.92	97.41	103.16	123.00	138.53	190.33
34.50	1.44	39.68	51.25	59.07	67.17	72.23	79.13	85.26	90.04	97.54	103.30	123.14	138.68	190.49
34.75	1.45	39.76	51.34	59.16	67.28	72.34	79.24	85.38	90.17	97.67	103.43	123.29	138.84	190.66
35.00	1.46	39.84	51.43	59.26	67.38	72.44	79.35	85.50	90.29	97.80	103.56	123.43	138.99	190.82
35.25	1.47	39.92	51.52	59.35	67.48	72.55	79.47	85.61	90.42	97.93	103.70	123.58	139.14	190.99
35.50	1.48	40.00	51.61	59.45	67.58	72.65	79.58	85.73	90.54	98.05	103.83	123.72	139.29	191.15
35.75	1.49	40.08	51.69	59.54	67.68	72.76	79.69	85.85	90.66	98.18	103.96	123.86	139.44	191.31
36.00	1.50	40.16	51.78	59.63	67.78	72.86	79.80	85.97	90.78	98.31	104.09	124.01	139.59	191.47
36.25	1.51	40.23	51.87	59.73	67.88	72.96	79.91	86.09	90.90	98.44	104.22	124.15	139.74	191.63
36.50	1.52	40.31	51.96	59.82	67.98	73.07	80.02	86.20	91.03	98.56	104.35	124.29	139.89	191.79
36.75	1.53	40.39	52.05	59.92	68.08	73.17	80.13	86.32	91.15	98.69	104.48	124.43	140.04	191.94
37.00	1.54	40.47	52.14	60.01	68.18	73.27	80.24	86.43	91.27	98.81	104.61	124.57	140.18	192.10
37.25	1.55	40.55	52.22	60.10	68.28	73.37	80.35	86.55	91.39	98.94	104.74	124.71	140.33	192.25
37.50	1.56	40.62	52.31	60.19	68.38	73.48	80.46	86.67	91.51	99.06	104.87	124.84	140.47	192.41
37.75	1.57	40.70	52.40	60.29	68.48	73.58	80.57	86.78	91.63	99.19	104.99	124.98	140.62	192.56
38.00	1.58	40.78	52.48	60.38	68.58	73.68	80.67	86.90	91.75	99.31	105.12	125.12	140.76	192.71
38.25	1.59	40.85	52.57	60.47	68.68	73.78	80.78	87.01	91.87	99.44	105.25	125.26	140.91	192.87
38.50	1.60	40.93	52.66	60.56	68.78	73.88	80.89	87.12	91.98	99.56	105.37	125.39	141.05	193.02
38.75	1.61	41.01	52.74	60.65	68.88	73.98	81.00	87.24	92.10	99.68	105.50	125.53	141.19	193.17
39.00	1.63	41.09	52.83	60.74	68.97	74.08	81.10	87.35	92.22	99.80	105.62	125.66	141.33	193.32
39.25	1.64	41.16	52.91	60.83	69.07	74.18	81.21	87.46	92.34	99.93	105.75	125.79	141.47	193.47
39.50	1.65	41.24	53.00	60.92	69.17	74.28	81.32	87.58	92.45	100.05	105.87	125.93	141.61	193.61
39.75	1.66	41.31	53.09	61.02	69.26	74.38	81.42	87.69	92.57	100.17	106.00	126.06	141.75	193.76
40.00	1.67	41.39	53.17	61.11	69.36	74.48	81.53	87.80	92.69	100.29	106.12	126.19	141.89	193.91
40.25	1.68	41.47	53.26	61.20	69.46	74.58	81.64	87.91	92.80	100.41	106.24	126.33	142.03	194.05
40.50	1.69	41.54	53.34	61.29	69.55	74.68	81.74	88.03	92.92	100.53	106.37	126.46	142.17	194.20
40.75	1.70	41.62	53.42	61.38	69.65	74.78	81.85	88.14	93.03	100.65	106.49	126.59	142.31	194.34
41.00	1.71	41.69	53.51	61.47	69.75	74.88	81.95	88.25	93.15	100.77	106.61	126.72	142.44	194.49
41.25	1.72	41.77	53.59	61.55	69.84	74.98	82.06	88.36	93.26	100.89	106.73	126.85	142.58	194.63
41.50	1.73	41.84	53.68	61.64	69.94	75.08	82.16	88.47	93.38	101.01	106.85	126.98	142.71	194.77
41.75	1.74	41.92	53.76	61.73	70.03	75.17	82.27	88.58	93.49	101.12	106.97	127.11	142.85	194.91
42.00	1.75	41.99	53.85	61.82	70.13	75.27	82.37	88.69	93.61	101.24	107.09	127.23	142.98	195.05
42.25	1.76	42.07	53.93	61.91	70.22	75.37	82.47	88.80	93.72	101.36	107.21	127.36	143.12	195.19
42.50	1.77	42.14	54.01	62.00	70.32	75.47	82.58	88.91	93.83	101.48	107.33	127.49	143.25	195.33
42.75	1.78	42.22	54.10	62.09	70.41	75.56	82.68	89.02	93.95	101.59	107.45	127.61	143.38	195.47
43.00	1.79	42.29	54.18	62.18	70.51	75.66	82.78	89.13	94.06	101.71	107.57	127.74	143.52	195.61
43.25	1.80	42.37	54.26	62.26	70.60	75.76	82.89	89.23	94.17	101.83	107.69	127.87	143.65	195.75
43.50	1.81	42.44	54.34	62.35	70.70	75.86	82.99	89.34	94.28	101.94	107.81	127.99	143.78	195.89
43.75	1.82	42.52	54.43	62.44	70.79	75.95	83.09	89.45	94.40	102.06	107.92	128.12	143.91	196.02
44.00	1.83	42.59	54.51	62.53	70.88	76.05	83.19	89.56	94.51	102.17	108.04	128.24	144.04	196.16
44.25	1.84	42.66	54.59	62.61	70.98	76.14	83.30	89.67	94.62	102.29	108.16	128.37	144.17	196.30
44.50	1.85	42.74	54.67	62.70	71.07	76.24	83.40	89.77	94.73	102.40	108.27	128.49	144.30	196.43
44.75	1.86	42.81	54.76	62.79	71.16	76.33	83.50	89.88	94.84	102.52	108.39	128.61	144.43	196.57
45.00	1.88	42.89	54.84	62.88	71.26	76.43	83.60	89.99	94.95	102.63	108.50	128.74	144.56	196.70
45.25	1.89	42.96	54.92	62.96	71.35	76.53	83.70	90.09	95.06	102.74	108.62	128.86	144.69	196.83
45.50														

54.75	2.28	45.74	58.00	66.23	74.81	80.10	87.45	94.00	99.07	106.86	112.80	133.28	149.35	201.89
55.00	2.29	45.81	58.08	66.31	74.90	80.19	87.55	94.10	99.17	106.96	112.91	133.40	149.46	202.02
55.25	2.30	45.88	58.16	66.40	74.99	80.28	87.65	94.20	99.28	107.07	113.01	133.51	149.58	202.15
55.50	2.31	45.96	58.24	66.48	75.08	80.38	87.74	94.30	99.38	107.17	113.12	133.62	149.70	202.28
55.75	2.32	46.03	58.32	66.56	75.17	80.47	87.84	94.40	99.48	107.27	113.22	133.73	149.81	202.41
56.00	2.33	46.10	58.40	66.65	75.26	80.56	87.93	94.50	99.58	107.38	113.33	133.84	149.93	202.54
56.25	2.34	46.17	58.48	66.73	75.34	80.65	88.03	94.59	99.68	107.48	113.43	133.95	150.04	202.67
56.50	2.35	46.24	58.55	66.82	75.43	80.74	88.12	94.69	99.78	107.58	113.54	134.06	150.16	202.80
56.75	2.36	46.32	58.63	66.90	75.52	80.84	88.22	94.79	99.88	107.68	113.64	134.17	150.27	202.92
57.00	2.38	46.39	58.71	66.98	75.61	80.93	88.31	94.89	99.98	107.79	113.75	134.28	150.39	203.05
57.25	2.39	46.46	58.79	67.07	75.70	81.02	88.41	94.99	100.08	107.89	113.85	134.39	150.50	203.18
57.50	2.40	46.53	58.87	67.15	75.79	81.11	88.50	95.08	100.18	107.99	113.95	134.49	150.62	203.31
57.75	2.41	46.60	58.95	67.23	75.87	81.20	88.60	95.18	100.28	108.09	114.06	134.60	150.73	203.43
58.00	2.42	46.67	59.03	67.32	75.96	81.29	88.69	95.28	100.38	108.19	114.16	134.71	150.85	203.56
58.25	2.43	46.75	59.11	67.40	76.05	81.38	88.79	95.38	100.48	108.30	114.26	134.82	150.96	203.69
58.50	2.44	46.82	59.18	67.48	76.14	81.47	88.88	95.47	100.58	108.40	114.36	134.93	151.07	203.81
58.75	2.45	46.89	59.26	67.57	76.22	81.56	88.97	95.57	100.68	108.50	114.47	135.04	151.19	203.94
59.00	2.46	46.96	59.34	67.65	76.31	81.65	89.07	95.67	100.78	108.60	114.57	135.14	151.30	204.06
59.25	2.47	47.03	59.42	67.73	76.40	81.74	89.16	95.76	100.87	108.70	114.67	135.25	151.41	204.19
59.50	2.48	47.10	59.50	67.82	76.49	81.83	89.26	95.86	100.97	108.80	114.77	135.36	151.53	204.32
59.75	2.49	47.17	59.58	67.90	76.57	81.92	89.35	95.96	101.07	108.90	114.88	135.46	151.64	204.44
60.00	2.50	47.24	59.65	67.98	76.66	82.01	89.44	96.05	101.17	109.00	114.98	135.57	151.75	204.56
60.25	2.51	47.31	59.73	68.06	76.75	82.10	89.54	96.15	101.27	109.10	115.08	135.68	151.86	204.69
60.50	2.52	47.39	59.81	68.15	76.83	82.19	89.63	96.25	101.37	109.20	115.18	135.78	151.97	204.81
60.75	2.53	47.46	59.89	68.23	76.92	82.28	89.72	96.34	101.46	109.30	115.28	135.89	152.08	204.94
61.00	2.54	47.53	59.96	68.31	77.01	82.37	89.82	96.44	101.56	109.40	115.38	135.99	152.20	205.06
61.25	2.55	47.60	60.04	68.39	77.09	82.46	89.91	96.53	101.66	109.50	115.48	136.10	152.31	205.18
61.50	2.56	47.67	60.12	68.48	77.18	82.55	90.00	96.63	101.76	109.60	115.58	136.21	152.42	205.31
61.75	2.57	47.74	60.20	68.56	77.27	82.64	90.09	96.72	101.85	109.70	115.68	136.31	152.53	205.43
62.00	2.58	47.81	60.28	68.64	77.35	82.73	90.19	96.82	101.95	109.80	115.78	136.42	152.64	205.55
62.25	2.59	47.88	60.35	68.72	77.44	82.82	90.28	96.92	102.05	109.90	115.88	136.52	152.75	205.68
62.50	2.60	47.95	60.43	68.80	77.53	82.91	90.37	97.01	102.15	110.00	115.98	136.63	152.86	205.80
62.75	2.61	48.02	60.51	68.89	77.61	83.00	90.46	97.11	102.24	110.09	116.08	136.73	152.97	205.92
63.00	2.63	48.09	60.58	68.97	77.70	83.09	90.56	97.20	102.34	110.19	116.18	136.83	153.08	206.04
63.25	2.64	48.16	60.66	69.05	77.78	83.18	90.65	97.29	102.43	110.29	116.28	136.94	153.19	206.17
63.50	2.65	48.23	60.74	69.13	77.87	83.27	90.74	97.39	102.53	110.39	116.38	137.04	153.30	206.29
63.75	2.66	48.30	60.82	69.21	77.96	83.35	90.83	97.48	102.63	110.49	116.48	137.15	153.40	206.41
64.00	2.67	48.37	60.89	69.30	78.04	83.44	90.92	97.58	102.72	110.58	116.58	137.25	153.51	206.53
64.25	2.68	48.44	60.97	69.38	78.13	83.53	91.02	97.67	102.82	110.68	116.68	137.35	153.62	206.65
64.50	2.69	48.51	61.05	69.46	78.21	83.62	91.11	97.77	102.92	110.78	116.78	137.46	153.73	206.77
64.75	2.70	48.58	61.12	69.54	78.30	83.71	91.20	97.86	103.01	110.88	116.88	137.56	153.84	206.89
65.00	2.71	48.65	61.20	69.62	78.38	83.80	91.29	97.95	103.11	110.97	116.97	137.66	153.95	207.01
65.25	2.72	48.72	61.28	69.70	78.47	83.88	91.38	98.05	103.20	111.07	117.07	137.76	154.05	207.13
65.50	2.73	48.79	61.35	69.78	78.55	83.97	91.47	98.14	103.30	111.17	117.17	137.87	154.16	207.25
65.75	2.74	48.86	61.43	69.86	78.64	84.06	91.56	98.23	103.39	111.27	117.27	137.97	154.27	207.37
66.00	2.75	48.93	61.51	69.95	78.72	84.15	91.65	98.33	103.49	111.36	117.37	138.07	154.38	207.49
66.25	2.76	49.00	61.58	70.03	78.81	84.24	91.75	98.42	103.58	111.46	117.46	138.17	154.48	207.61
66.50	2.77	49.07	61.66	70.11	78.89	84.32	91.84	98.51	103.68	111.55	117.56	138.27	154.59	207.73
66.75	2.78	49.14	61.73	70.19	78.98	84.41	91.93	98.61	103.77	111.65	117.66	138.38	154.70	207.85
67.00	2.79	49.21	61.81	70.27	79.06	84.50	92.02	98.70	103.87	111.75	117.76	138.48	154.80	207.97
67.25	2.80	49.28	61.89	70.35	79.15	84.59	92.11	98.79	103.96	111.84	117.85	138.58	154.91	208.09
67.50	2.81	49.35	61.96	70.43	79.23	84.67	92.20	98.89	104.06	111.94	117.95	138.68	155.01	208.21
67.75	2.82	49.42	62.04	70.51	79.32	84.76	92.29	98.98	104.15	112.04	118.05	138.78	155.12	208.32
68.00	2.83	49.49	62.11	70.59	79.40	84.85	92.38	99.07	104.24	112.13	118.14	138.88	155.23	208.44
68.25	2.84	49.56	62.19	70.67	79.49	84.94	92.47	99.16	104.34	112.23	118.24	138.98	155.33	208.56
68.50	2.85	49.63	62.27	70.75	79.57	85.02	92.56	99.26	104.43	112.32	118.34	139.08	155.44	208.68
68.75	2.86	49.70	62.34	70.83	79.66	85.11	92.65	99.35	104.53	112.42	118.43	139.18	155.54	208.80
69.00	2.88	49.77	62.42	70.91	79.74	85.20	92.74	99.44	104.62	112.51	118.53	139.28	155.65	208.91
69.25	2.89	49.83	62.49	70.99	79.82	85.28	92.83	99.53	104.71	112.61	118.63	139.38	155.75	209.03
69.50	2.90	49.90	62.57	71.07	79.91	85.37	92.92	99.62	104.81	112.70	118.72	139.48	155.86	209.15
69.75	2.91	49.97	62.64	71.15	79.99	85.46	93.01	99.72	104.90	112.80	118.82	139.58	155.96	209.26
70.00	2.92	50.04	62.72	71.23	80.08	85.54	93.10	99.81	104.99	112.89	118.91	139.68	156.07	209.38
70.25	2.93	50.11	62.80	71.31	80.16	85.63	93.19	99.90	105.09	112.99	119.01	139.78	156.17	209.50
70.50	2.94	50.18	62.87	71.39	80.24	85.72	93.28	99.99	105.18	113.08	119.10	139.88	156.27	209.61
70.75	2.95	50.25	62.95	71.47	80.33	85.80	93.37	100.08	105.27	113.17	119.20	139.98	156.38	209.73
71.00	2.96	50.32	63.02	71.55	80.41	85.89	93.45	100.17	105.36	113.27	119.29	140.08	156.48	209.85
71.25	2.97	50.39	63.10	71.63	80.49	85.98	93.54	100.26	105.45	113.36	119.39	140.18	156.59	209.96
71.50	2.98	50.46	63.17	71.71	80.58	86.06	93.63	100.36	105.55	113.46	119.48	140.27	156.69	210.08
71.75	2.99	50.52	63.25	71.79	80.66	86.15	93.72	100.45	105.64	113.55	119.58	140.37	156.79	210.19
72.00	3.00	50.59	63.32	71.87	80.74	86.24	93.81	100.54	105.73	113.64	119.67	140.47	156.89	210.31
72.25	3.01	50.66	63.40	71.95	80.83	86.32	93.90	100.63	105.83	113.74	119.77	140.57	157.00	210.42
72.50	3.02	50.73	63.47	72.03	80.91	86.41	93.99	100.72	105.92	113.83	119.86	140.67	157.10	210.54
72.75	3.03	50.80	63.55	72.11	80.99	86.49	94.08	100.81	106.01	113.93	119.96	140.76	157.20	210.65
73.00	3.04	50.87	63.62	72.19	81.08	86.58	94.16	100.90	106.10	114.02	120.05	140.86	157.31	210.77
73.25	3.05	50.94	63.70	72.27	81.16	86.67	94.25	100.99	106.19	114.11	120.15	140.96	157.41	210.88
73.50	3.06	51.00	63.77	72.35	81.24	86.75	94.34	101.08	106.29	114.21	120.24	141.06	157.51	211.00
73.75	3.07	51.07	63.85	72.43	81.33	86.84	94.43	101.17	106.38	114.30	120.33	141.16	157.61	211.11
74.00	3.08	51.												

83.50	3.48	53.72	66.73	75.48	84.52	90.13	97.82	104.63	109.88	117.85	123.91	144.85	161.49	215.46
83.75	3.49	53.79	66.81	75.56	84.60	90.22	97.90	104.72	109.97	117.94	124.00	144.95	161.58	215.57
84.00	3.50	53.85	66.88	75.64	84.68	90.30	97.99	104.80	110.06	118.03	124.09	145.04	161.68	215.68
84.25	3.51	53.92	66.95	75.72	84.76	90.38	98.08	104.89	110.15	118.12	124.18	145.13	161.78	215.79
84.50	3.52	53.99	67.03	75.79	84.84	90.47	98.16	104.98	110.24	118.21	124.27	145.22	161.87	215.89
84.75	3.53	54.06	67.10	75.87	84.92	90.55	98.25	105.07	110.32	118.30	124.36	145.32	161.97	216.00
85.00	3.54	54.12	67.17	75.95	85.00	90.63	98.33	105.15	110.41	118.38	124.45	145.41	162.07	216.11
85.25	3.55	54.19	67.25	76.03	85.08	90.72	98.42	105.24	110.50	118.47	124.54	145.50	162.16	216.22
85.50	3.56	54.26	67.32	76.10	85.17	90.80	98.50	105.33	110.59	118.56	124.63	145.59	162.26	216.33
85.75	3.57	54.32	67.39	76.18	85.25	90.88	98.59	105.41	110.68	118.65	124.72	145.69	162.35	216.44
86.00	3.58	54.39	67.47	76.26	85.33	90.97	98.67	105.50	110.76	118.74	124.81	145.78	162.45	216.54
86.25	3.59	54.46	67.54	76.34	85.41	91.05	98.76	105.59	110.85	118.83	124.90	145.87	162.55	216.65
86.50	3.60	54.53	67.61	76.41	85.49	91.13	98.84	105.67	110.94	118.92	124.99	145.96	162.64	216.76
86.75	3.61	54.59	67.68	76.49	85.57	91.21	98.93	105.76	111.03	119.01	125.08	146.05	162.74	216.87
87.00	3.63	54.66	67.76	76.57	85.65	91.30	99.01	105.85	111.11	119.09	125.17	146.14	162.83	216.97
87.25	3.64	54.73	67.83	76.64	85.73	91.38	99.10	105.93	111.20	119.18	125.26	146.23	162.93	217.08
87.50	3.65	54.79	67.90	76.72	85.81	91.46	99.18	106.02	111.29	119.27	125.34	146.33	163.02	217.19
87.75	3.66	54.86	67.98	76.80	85.89	91.55	99.27	106.10	111.37	119.36	125.43	146.42	163.12	217.30
88.00	3.67	54.93	68.05	76.88	85.97	91.63	99.35	106.19	111.46	119.45	125.52	146.51	163.21	217.40
88.25	3.68	54.99	68.12	76.95	86.05	91.71	99.44	106.28	111.55	119.53	125.61	146.60	163.31	217.51
88.50	3.69	55.06	68.19	77.03	86.13	91.79	99.52	106.36	111.64	119.62	125.70	146.69	163.40	217.62
88.75	3.70	55.13	68.27	77.11	86.21	91.88	99.61	106.45	111.72	119.71	125.79	146.78	163.50	217.72
89.00	3.71	55.20	68.34	77.18	86.29	91.96	99.69	106.53	111.81	119.80	125.88	146.87	163.59	217.83
89.25	3.72	55.26	68.41	77.26	86.37	92.04	99.77	106.62	111.90	119.89	125.96	146.96	163.69	217.94
89.50	3.73	55.33	68.48	77.34	86.45	92.12	99.86	106.71	111.98	119.97	126.05	147.05	163.78	218.04
89.75	3.74	55.40	68.56	77.41	86.53	92.21	99.94	106.79	112.07	120.06	126.14	147.14	163.88	218.15
90.00	3.75	55.46	68.63	77.49	86.61	92.29	100.03	106.88	112.16	120.15	126.23	147.23	163.97	218.26
90.25	3.76	55.53	68.70	77.57	86.69	92.37	100.11	106.96	112.24	120.24	126.32	147.32	164.06	218.36
90.50	3.77	55.60	68.78	77.64	86.77	92.45	100.20	107.05	112.33	120.32	126.40	147.41	164.16	218.47
90.75	3.78	55.66	68.85	77.72	86.85	92.54	100.28	107.13	112.42	120.41	126.49	147.50	164.25	218.57
91.00	3.79	55.73	68.92	77.80	86.93	92.62	100.36	107.22	112.50	120.50	126.58	147.59	164.35	218.68
91.25	3.80	55.80	68.99	77.87	87.01	92.70	100.45	107.30	112.59	120.59	126.67	147.68	164.44	218.79
91.50	3.81	55.86	69.06	77.95	87.09	92.78	100.53	107.39	112.67	120.67	126.76	147.77	164.53	218.89
91.75	3.82	55.93	69.14	78.03	87.17	92.86	100.62	107.48	112.76	120.76	126.84	147.86	164.63	219.00
92.00	3.83	56.00	69.21	78.10	87.25	92.95	100.70	107.56	112.85	120.85	126.93	147.95	164.72	219.10
92.25	3.84	56.06	69.28	78.18	87.33	93.03	100.78	107.65	112.93	120.93	127.02	148.04	164.81	219.21
92.50	3.85	56.13	69.35	78.26	87.41	93.11	100.87	107.73	113.02	121.02	127.11	148.13	164.91	219.31
92.75	3.86	56.20	69.43	78.33	87.49	93.19	100.95	107.82	113.10	121.11	127.19	148.22	165.00	219.42
93.00	3.88	56.26	69.50	78.41	87.57	93.27	101.04	107.90	113.19	121.19	127.28	148.31	165.09	219.52
93.25	3.89	56.33	69.57	78.49	87.65	93.36	101.12	107.99	113.28	121.28	127.37	148.40	165.19	219.63
93.50	3.90	56.40	69.64	78.56	87.73	93.44	101.20	108.07	113.36	121.37	127.45	148.49	165.28	219.73
93.75	3.91	56.46	69.72	78.64	87.81	93.52	101.29	108.16	113.45	121.45	127.54	148.58	165.37	219.84
94.00	3.92	56.53	69.79	78.72	87.88	93.60	101.37	108.24	113.53	121.54	127.63	148.67	165.47	219.94
94.25	3.93	56.59	69.86	78.79	87.96	93.68	101.45	108.33	113.62	121.63	127.72	148.76	165.56	220.05
94.50	3.94	56.66	69.93	78.87	88.04	93.77	101.54	108.41	113.70	121.71	127.80	148.84	165.65	220.15
94.75	3.95	56.73	70.00	78.94	88.12	93.85	101.62	108.50	113.79	121.80	127.89	148.93	165.74	220.26
95.00	3.96	56.79	70.08	79.02	88.20	93.93	101.70	108.58	113.88	121.89	127.98	149.02	165.84	220.36
95.25	3.97	56.86	70.15	79.10	88.28	94.01	101.79	108.66	113.96	121.97	128.06	149.11	165.93	220.47
95.50	3.98	56.93	70.22	79.17	88.36	94.09	101.87	108.75	114.05	122.06	128.15	149.20	166.02	220.57
95.75	3.99	56.99	70.29	79.25	88.44	94.17	101.95	108.83	114.13	122.15	128.24	149.29	166.11	220.68
96.00	4.00	57.06	70.36	79.33	88.52	94.25	102.04	108.92	114.22	122.23	128.32	149.38	166.21	220.78

Appendix S

MicroDrainage Network Hydraulic Modelling Results

Motion		Page 1
84 North Street Guildford Surrey GU1 4AU		
Date 13/03/2025 09:47 File 1lpbog-MD-NW-10.03.2025...	Designed by commonuser Checked by	
Innovyze		Network 2020.1.3

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

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FEH Rainfall Model
Return Period (years)
FEH Rainfall Version
Site Location GB 493250 99100 SZ 93250 99100
Data Type Catchment
Maximum Rainfall (mm/hr) 550
Maximum Time of Concentration (mins) 30
Foul Sewage (l/s/ha) 0.000
Volumetric Runoff Coeff. 1.000
PIMP (%) 100
Add Flow / Climate Change (%) 0
Minimum Backdrop Height (m) 0.200
Maximum Backdrop Height (m) 1.500
Min Design Depth for Optimisation (m) 0.500
Min Vel for Auto Design only (m/s) 1.00
Min Slope for Optimisation (1:X) 500
  
```



Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.003	4-8	0.003	8-12	0.003	12-16	0.002

Total Area Contributing (ha) = 0.010

Total Pipe Volume (m³) = 0.128

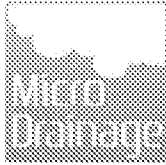
Network Design Table for Storm

- Indicates pipe length does not match coordinates

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section	Type	Auto Design
1.000	7.058	0.282	25.0	0.010	15.00	0.0	0.600	o	100	Pipe/Conduit		
1.001	1.833#	0.068	14.7	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit		
1.002	8.302	0.415	20.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit		

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	96.79	15.08	3.888	0.010	0.0	0.0	0.0	1.55	12.2	3.6
1.001	96.76	15.08	3.888	0.010	0.0	0.0	0.0	2.03	15.9	3.6
1.002	96.50	15.16	3.888	0.010	0.0	0.0	0.0	1.73	13.6	3.6

Motion		Page 2
84 North Street Guildford Surrey GU1 4AU		
Date 13/03/2025 09:47 File 1lpbog-MD-NW-10.03.2025...	Designed by commonuser Checked by	
Innovyze	Network 2020.1.3	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	0.005	0.005	0.005
	User	-	100	0.006	0.006	0.010
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.010	0.010	0.010

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002		6.500	5.085	0.000	0	0


Simulation Criteria for Storm

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	0.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH	FEH 2002	Summer Storms	Yes
Return Period (years)	100		Winter Storms	No
FEH Rainfall Version	2013		Cv (Summer)	1.000
Site Location	GB 493250 99100 SZ 93250 99100		Cv (Winter)	1.000
Data Type		Catchment	Storm Duration (mins)	30

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: 3 (Hydrobrake), DS/PN: 1.002, Volume (m³): 1.2

Unit Reference	MD-SHE-0048-1000-0900-1000
Design Head (m)	0.900
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	48
Invert Level (m)	5.500
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	1.0	Kick-Flo®	0.428	0.7
Flush-Flo™	0.212	0.9	Mean Flow over Head Range	-	0.8

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)	Depth (m)	Flow (l/s)
0.100	0.8	0.800	0.9	2.000	1.4	4.000	2.0	7.000	2.5
0.200	0.9	1.000	1.0	2.200	1.5	4.500	2.1	7.500	2.6
0.300	0.9	1.200	1.1	2.400	1.6	5.000	2.2	8.000	2.7
0.400	0.8	1.400	1.2	2.600	1.6	5.500	2.3	8.500	2.8
0.500	0.8	1.600	1.3	3.000	1.7	6.000	2.4	9.000	2.9
0.600	0.8	1.800	1.4	3.500	1.8	6.500	2.5	9.500	2.9

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Storage Structures for Storm

Filter Drain Manhole: 3 (Hydrobrake), DS/PN: 1.002

Infiltration Coefficient Base (m/hr)	0.00000	Pipe Diameter (m)	0.100
Infiltration Coefficient Side (m/hr)	0.00000	Pipe Depth above Invert (m)	0.050
Safety Factor	2.0	Number of Pipes	1
Porosity	0.30	Slope (1:X)	0.0
Invert Level (m)	5.500	Cap Volume Depth (m)	0.800
Trench Width (m)	1.5	Cap Infiltration Depth (m)	0.000
Trench Length (m)	5.0		

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	1	0.127	0.055	0.000	0.182
1.001	2 (Catchpit)	1.224	0.008	0.000	1.232
1.002	3 (Hydrobrake)	1.244	0.065	1.027	3.336
Total		2.595	0.128	1.027	4.550

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
 for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH
 FEH Rainfall Version 2013
 Site Location GB 493250 99100 SZ 93250 99100
 Data Type Catchment
 Cv (Summer) 1.000
 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
 Analysis Timestep Fine Inertia Status ON
 DTS Status OFF

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960,
 1440, 2160, 2880, 4320, 5760
 Return Period(s) (years) 2, 10, 30, 100
 Climate Change (%) 0, 20, 40, 45

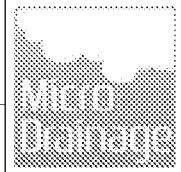
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	1	30 Summer	2	+0%	30/30 Summer				5.921	-0.079
1.001	2 (Catchpit)	30 Summer	2	+0%	10/15 Summer				5.644	-0.074
1.002	3 (Hydrobrake)	30 Summer	2	+0%	2/30 Summer				5.607	0.007

PN	US/MH Name	Flooded Volume (m ³)	Flow / Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.000	0.10		1.1	OK	
1.001	2 (Catchpit)	0.000	0.15		1.1	OK	
1.002	3 (Hydrobrake)	0.000	0.06	10	0.8	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 0.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH
 FEH Rainfall Version 2013
 Site Location GB 493250 99100 SZ 93250 99100
 Data Type Catchment
 Cv (Summer) 1.000
 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
 Analysis Timestep Fine Inertia Status ON
 DTS Status OFF

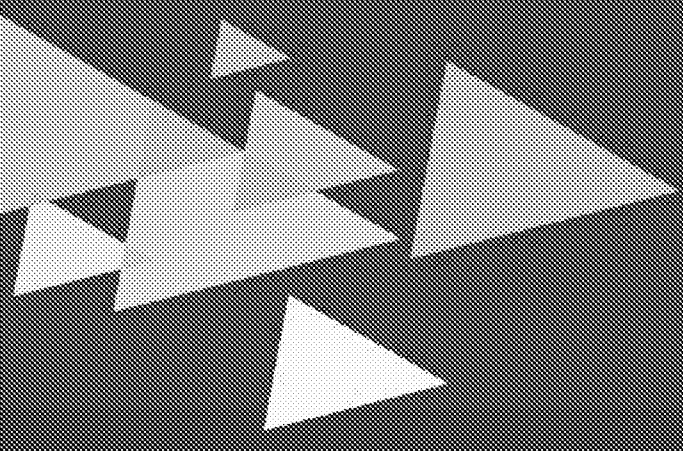
Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960,
 1440, 2160, 2880, 4320, 5760
 Return Period(s) (years) 2, 10, 30, 100
 Climate Change (%) 0, 20, 40, 45

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	1	60 Summer	100	+45%	30/30 Summer				6.339	0.339
1.001	2 (Catchpit)	60 Summer	100	+45%	10/15 Summer				6.332	0.614
1.002	3 (Hydrobrake)	60 Summer	100	+45%	2/30 Summer				6.331	0.731

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap. (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.000	0.38		4.1	SURCHARGED	
1.001	2 (Catchpit)	0.000	0.44		3.2	SURCHARGED	
1.002	3 (Hydrobrake)	0.000	0.08	52	1.0	FLOOD RISK	

Appendix T

Drainage Maintenance and Management Plan



192 Hawthorn Road, Bognor Regis

Drainage Management & Maintenance Plan

For

Lamb Property Investments Ltd

Document Control Sheet

192 Hawthorn Road, Bognor Regis

Lamb Property Investments Ltd

This document has been issued and amended as follows:

Date	Issue	Prepared by	Approved by
12 th March 2025	FINAL	Phil Allen MCIWEM C.WEM	Neil Jaques

Motion
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2.0	Maintenance Categories	2
3.0	The Surface Water Drainage System	3
4.0	General Maintenance Principles	4
5.0	Inspection and Maintenance Frequency of Components.....	6

1.0 Introduction

- 1.1 This document sets out the suggested principles for the long-term management and maintenance of the surface water drainage system on the proposed development at 192 Hawthorn Road, Bognor Regis.
- 1.2 The purpose of this document is to ensure that the site management company has a robust inspection and maintenance plan in place for the lifetime of the development. This ensures the optimum operation of the proposed surface water drainage system and that it will be maintained in perpetuity. This will contribute to reducing the risk of surface water flooding both on- and off-site.
- 1.3 All those responsible for maintenance should follow relevant health and safety legislation for all activities listed within this report (including lone working, if relevant). Method statements and risk assessments should always be undertaken and made available, if requested.
- 1.4 This document has been produced by Motion on behalf of their client, Lamb Property Investments Ltd. This document describes the typical management and maintenance tasks that are known at the design stage (maintenance frequencies and typical tasks, for example). These have been drawn from industry guidance such as CIRIA C753 - The SuDS Manual – and manufacturer’s own guidance.
- 1.5 Maintenance is considered as a construction activity under the CDM Regulations 2015. Under the CDM Regulations, it is a requirement that a competent person be appointed to carry out a required role. CDM defines a competent person as an individual with sufficient knowledge of the specific tasks to be undertaken, as well as sufficient experience and ability to carry out their duties in relation to the task in a way that secures health and safety on site.
- 1.6 In recognition of the requirements of the CDM Regulations 2015, this drainage management and maintenance plan expects that the maintenance work will be carried out by a competent person who must have prior knowledge of the drainage components and SuDS systems on site.
- 1.7 There are limitations on what this document can prescribe at the planning stage (outline or full). This document cannot name the specific company or individuals who will carry out the maintenance and what equipment is to be used. Related to this, this document is unable to provide method statements for exactly how maintenance practices will be carried out. These can only be determined at the time of the maintenance being carried out through the exact maintenance need and the safe systems of work held by the company carrying out the work. Therefore, this is to be the responsibility of the site management company and/or the individuals carrying out the work. We urge those who are carrying out the maintenance to record this information and make it available to the Local Planning Authority (LPA), if required to do so. This drainage management and maintenance plan needs to be a living document that is owned and maintained by the adopting site management company and should be adhered to for the lifetime of the development.

2.0 Maintenance Categories

2.1 There are three categories of maintenance activities referred to in this report. These are:

Inspection and Monitoring

- ✦ Inspection and monitoring tasks should be carried out frequently, nominally once a month, and should include a visual inspection of all components including all inlets and outlets.

Regular Maintenance (Monthly)

- ✦ Regular maintenance consists of basic tasks done on a frequent and predictable schedule, including vegetation management and litter removal.

Seasonal Maintenance (Quarterly)

- ✦ Seasonal maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (leaf litter and sediment removal is an example).

Remedial Maintenance

- ✦ Remedial maintenance comprises of intermittent tasks that may be required to rectify faults associated with the system that have been identified through visual inspections. The likelihood of faults can be minimised by correct installation, regular inspection and timely maintenance. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events and, as such, timings are difficult to predict.

3.0 The Surface Water Drainage System

- 3.1 The proposed surface water drainage system is made up of a number of components/structures. These include:
- ✧ Water butts
 - ✧ Pipes
 - ✧ Manholes
 - ✧ Catchpit manholes
 - ✧ Filter pipes
 - ✧ A rainwater garden
 - ✧ A Hydrobrake
- 3.2 All components should be installed in accordance with the manufacturer's instructions and to the levels/arrangement as defined on the designer's drawings. Not doing so will invalidate any warranty provided by the manufacturer.
- 3.3 All maintenance and cleaning must be carried out in accordance with manufacturer's recommendations and by competent and suitably qualified staff, as defined in the CDM regulations 2015.
- 3.4 This document should be read in conjunction with the 'As Built' drawings of the drainage system, so that the location and type of each feature can be recognised and understood.
- 3.5 Manufacturer's instructions should be added to this document once specific products have been selected and installed by the contractor. This document will subsequently form the basis for a drainage maintenance regime.

4.0 General Maintenance Principles

- 4.1 All surface water drainage systems, whether piped gravity systems, Sustainable Drainage Systems (SuDS), or flow control devices and pumps, require regular maintenance to keep them working at optimum efficiency and capacity. The maintenance of the surface water drainage system 192 Hawthorn Road should be carried out alongside other regular maintenance tasks on site.
- 4.2 Timely and adequate maintenance will increase the lifespan of all the drainage components. Inadequate maintenance will do the reverse. Therefore, the projected lifespan and anticipated replacement date of each drainage component cannot be forecast at the time of this document being produced.
- 4.3 The site management company are responsible for the maintenance of the surface water drainage system for the lifetime of the development.
- 4.4 Construction activities can create and discharge significant quantities of sediment that will quickly clog the surface water drainage system. Therefore, construction-stage sediment removal is required immediately post-construction. The construction site manager should assess this and carry out cleaning as necessary.
- 4.5 A catchpit manhole has been specified upstream of the rainwater garden. This will remove gross solids and the majority of silts. It is important that any debris build-up in the catchpit manhole is removed at regular intervals. This will reduce the risk of the filter pipes becoming silted up, which may also need jetting at regular intervals.
- 4.6 Cleaning should also take place after large storms when there have been increased surface water flows and visible entrainment and deposition of debris.
- 4.7 An increased frequency of inspection and maintenance should be programmed into the autumn and winter months in acknowledgement that:
- ✦ Leaf fall from deciduous trees in autumn will result in an increased amount of leaf litter and an elevated blockage risk of drainage infrastructure.
 - ✦ Increased rainfall during winter months will result in greater quantities of water moving through the drainage system and a greater input of silt and other debris.
- 4.8 Table 4.1, below, gives an overview of required maintenance tasks and the frequency at which they need to be undertaken. Section 5 – Inspection and Maintenance Frequency of Components – will assign typical maintenance frequencies and tasks to the specific components used within the surface water drainage system proposed for the development 192 Hawthorn Road.

Table 4.1: Typical maintenance tasks and frequencies

Activity	Indicative Frequency	Typical Tasks
Inspection and Monitoring	Monthly	<ul style="list-style-type: none"> ➤ Inspection of all inlets, outlets and control structures
Regular Maintenance	Monthly, for the lifetime of the development	<ul style="list-style-type: none"> ➤ Litter picking and debris removal ➤ Weed removal and invasive plant control
Seasonal Maintenance	Quarterly, for the lifetime of the development	<ul style="list-style-type: none"> ➤ Vegetation management around components ➤ Sweeping of pavement areas to remove surface silt ➤ Silt removal from system, including catchpits, cellular storage structures and control structures
Remedial maintenance	As required as a result of inspections, for the lifetime of the development.	<ul style="list-style-type: none"> ➤ Inlet/outlet repairs ➤ Erosion repairs ➤ Reinstatement of edgings ➤ Reinstatement following pollution incidents ➤ Removal of silt build-up and leaf litter after storms ➤ Repair of vandalism ➤ Replacement of any blocked filter membranes/materials

5.0 Inspection and Maintenance Frequency of Components

- 5.1 Table 5.1 below lists each of the components used within the development’s surface water drainage system. It suggests an indicative maintenance frequency for each component and ascribes typical maintenance tasks to them.
- 5.2 This list is not exhaustive, nor is it prescriptive. As mentioned in Section 3, additional, unscheduled maintenance may be required following adverse weather conditions or after autumn leaf falls. Additional maintenance tasks may be required to adequately clean and maintain individual components.
- 5.3 The list of components should be cross-referenced with the designer’s drawings so that the location of each component can be identified.
- 5.4 It is the responsibility of the adopting site management company (or their agents) to ensure that all necessary maintenance activities are carried out in a timely manner and that the design performance of each drainage component is preserved.
- 5.5 If there is any uncertainty regarding the correct and safe methods of cleaning, or what equipment should be used, the manufacturer should be consulted.

Table 5.1: Maintenance Frequency and Task for Drainage Components

Activity	Indicative Frequency	Anticipated Tasks
<p>Water Butts (not the responsibility of the adopting site management agency, but individual homeowners)</p>	<p>Annually in Autumn to Winter</p>	<ul style="list-style-type: none"> ✦ Remove falling leaves and seeds from guttering or those that have found their way into the water butt. ✦ Water may stagnate slightly. If so, use a water butt cleaning disc into the tank. ✦ In autumn and winter, drain water off every 10 days (or less) to make sure that water butts don’t overflow, and that water is kept moving. This will stop larvae and flies from using the water butt. ✦ Use safe products such as vinegar to clean the outside of the tank and the inside of the lid and be careful not to contaminate water with chemicals. ✦ At least once a year, completely empty the water butt and scrub it out with warm soapy water and then rinse thoroughly. This is best done at a time when the water butt is already nearly empty (end of summer) or when it can readily refill (winter).
<p>Pipes</p>	<p>As required</p>	<ul style="list-style-type: none"> ✦ Identify any pipes that may not be operating properly and employ a competent, qualified contractor to inspect using CCTV. ✦ If the pipe is blocked with silt or debris, the pipe should be jetted clean from an upstream access point. All silt and debris should be captured and removed at a downstream access point. ✦ Inspect once clean. ✦ If any other defects are encountered (cracks, displaced joints, root ingress), appropriate

		<p>solutions should be discussed with a competent and qualified contractor. These services are usually provided by the same companies that offer CCTV surveys and pipe jetting services.</p>
Manholes	Annually and as required, for the lifetime of the development.	<ul style="list-style-type: none"> ✧ Inspect/identify any damage or areas that are not operating correctly ✧ Remove silt, litter, leaves and other detritus. ✧ Inspect once clean.
Catchpit Manhole	Annually and as required, for the lifetime of the development.	<ul style="list-style-type: none"> ✧ Inspect/identify any damage or areas that are not operating correctly ✧ Remove silt, litter, leaves and other detritus. ✧ Inspect once clean.
Filter Pipes	Annually or as required	<ul style="list-style-type: none"> ✧ If the pipe is blocked with silt or debris, the pipe should be jetted clean from an upstream access point. All silt and debris should be captured and removed at downstream access point. ✧ Inspect once clean. ✧ If any other defects are encountered (cracks, displaced joints, root ingress), appropriate solutions should be discussed with a competent and qualified contractor. These services are usually provided by the same companies that offer CCTV surveys and pipe jetting services.
Rainwater Garden	<p>Rainwater gardens are a very low maintenance SuDS option.</p> <p>The porous subbase media is sealed and does not require maintenance.</p> <p>The rainwater garden's plants and planting media should be regularly maintained. It is suggested that maintenance takes place every 3 months in the winter, or every month in the summer when plants and weeds will be thriving.</p>	<ul style="list-style-type: none"> ✧ Whether the garden is draining properly after heavy rainfall should also be checked to avoid waterlogging. ✧ The plants should be observed and checked for any stress. Observe which plant species are thriving and which are not. Remove struggling plants and replace with hardier species that provide variety. ✧ Invasive plants and weeds must be regularly removed. A layer of mulch is recommended to help to keep these at bay. Mulch can also help retain moisture in drier months. ✧ Prune any dead vegetation to promote growth. ✧ If grasses are present in the garden, it's important to keep them trimmed because when they grow too long and then get wet, they can smother and crush the other plants. ✧ Although low maintenance, new plants that haven't established will need some extra water attention, especially during dry periods. ✧ Water inlets should be regularly cleared of any leaves or fallen debris, which will take place as part of the pipe and catchpit maintenance.

Hydrobrake chambers	Every three months for the first year, then annually thereafter for the lifetime of the development.	<ul style="list-style-type: none"> ✦ Contact manufacturer for instruction on approved and safe inspection and maintenance practices. ✦ Inspect Hydrobrake and check functionality. Remove any detritus as required. ✦ Inspect once clean.
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- 5.6 Upon completion of maintenance activities, a record should be kept of the work carried out. This should be retained and an annual maintenance report should be compiled, which should include the following:
- ✦ Observations resulting from inspections
 - ✦ Maintenance and operation activities undertaken during the year
 - ✦ Recommendations for inspections and maintenance programmes for the following year
- 5.7 On the next page is a table with suggested information should be recorded and included with the maintenance plan. As mentioned in the introduction to this document, this should be a living document and regularly updated, as required and should be kept for the lifetime of the development.
- 5.8 The Local Planning Authority (Arun District Council) may request to check and sign off any maintenance activities. Therefore, it is the recommendation that the LPA is contacted prior to any scheduled routine maintenance. The table mentioned above and on the next page, as well as the annual maintenance report, should be offered to the LPA for their records and approval.

Date	Component requiring maintenance	Issues prompting maintenance	Scheduled maintenance (Y/N)	Maintenance carried out	Additional works required (Y/N). If yes, please detail	Next scheduled date of inspection and maintenance

Appendix U
Exceedance Plan

Appendix V

Compliance with Arun District Council Design Criteria

<input type="checkbox"/> Existing site drainage features are investigated – condition, performance, and ownership.	Provided through the CCTV survey
<input type="checkbox"/> Environmentally sensitive receiving water bodies are identified – for example groundwater source protection zones.	Source protection zones, and aquiferous category of bedrock and superficial geology discussed.
<input type="checkbox"/> Any appropriate easements to watercourses or other infrastructure are investigated.	N/A
<input type="checkbox"/> Existing and future flood risk from any source is detailed.	Yes - FRA provided.
It is suggested that the above is achieved with the following, which may be combined where appropriate:	It is suggested that the above is achieved with the following, which may be combined where appropriate:
<input type="checkbox"/> An existing topographical plan.	Yes, a LiDAR topographical and contour plan provided
<input type="checkbox"/> An existing drainage catchment plan.	Yes, the existing flowpaths and site drainage and where it goes is presented.
<input type="checkbox"/> An existing site surface water drainage plan (where applicable).	Yes, the CCTV survey covers this.
<input type="checkbox"/> Flood maps (fluvial, tidal, pluvial, groundwater, sewer, and reservoir) are supplied (or Flood Risk Assessment referred to).	Yes, this is in the FRA section of the report.
<input type="checkbox"/> Confirmation and surveys of any existing drainage infrastructure on the site.	Yes, this is in the CCTV survey
<input type="checkbox"/> Full details of any known flooding on the site.	No records of flooding known.
Proposed Design	Proposed Design
Essential	Essential
<input type="checkbox"/> Statement confirming the proposed design criteria including fixed design calculation inputs for the SuDS system. Examples include:	Yes, this is in the model and presented in the 'Design Criteria' section of the report.
<ul style="list-style-type: none"> • Climate change allowances, • Urban creep allowance, • CV values, • Rainfall data, • MADD factor or additional storage. 	Yes - NPPF climate change allowances applied to the 1 in 10, 1 in 30 and 1 in 100-year rainfall events. Urban creep discussed - but not applied as it is not applicable to blocks of flats CV value of '1' applied to all summer and winter storms FEH2022 Rainfall Data used and presented in Appendix R MADD Factor of zero applied.
<input type="checkbox"/> Natural catchments are followed.	No natural catchments as such. Existing misconnected drainage will be corrected in the drainage strategy
<input type="checkbox"/> Where phased construction is proposed, the phases correspond to natural catchments and can function independently from each other.	Phased construction not proposed
<input type="checkbox"/> The design is gravity based with no use of pumps.	Yes - Gravity drainage is used
<input type="checkbox"/> Natural systems that deliver specific hydrological function, such as watercourses or wetlands, are preserved.	N/A
<input type="checkbox"/> Where there is existing drainage infrastructure on the site it is clearly explained or illustrated what is being retained, upgraded, or removed.	Yes, and how the drainage strategy will remove surface water from the foul sewage system has been discussed. The CCTV survey shows what needs to be replaced/rerouted. However, because the CCTV survey plan is not to scale, this cannot be shown on the plan.
<input type="checkbox"/> Relevant restrictions relating to discharging to an environmentally sensitive receiving water body – for example a groundwater source protection zone - are investigated, reported and adhered to.	N/A
<input type="checkbox"/> Details of necessary off-site works and consents are provided.	N/A
<input type="checkbox"/> It is shown how a surface water drainage design will not conflict with additional areas of flood storage or compensation.	N/A - no existing areas of storage or compensation
<input type="checkbox"/> Surface water flow entering the site from elsewhere is conveyed safely around or through the site without compromising the SuDS system.	N/A - no flows from elsewhere
<input type="checkbox"/> Where runoff from elsewhere is drained together with the site runoff, the contributing catchment is modelled as part of the drainage system.	N/A
<input type="checkbox"/> If the surface water drainage is designed to flood in the 1% Annual Exceedance Probability [AEP] + Climate Change Allowance [CCA] event, then the flood volume is contained safely on site without flooding any part of a building or utility plant susceptible to water or affecting safe access or egress.	No flooding in the 1 in 100-year + 45% rainfall event
<input type="checkbox"/> The design provides and evidences interception drainage and is able to capture and retain on site the first 5mm of the majority of all rainfall events.	Yes - water butts are proposed for interception
<input type="checkbox"/> Water quality and treatment is adequately assessed – with an assessment appropriate for the scale and proposed use of the site.	Yes, surface water quality is discussed in Section 9 in the context of Chapter 26 of the SuDS manual
<input type="checkbox"/> Adequate freeboard is provided between the top water level of any open storage features and the top of the bank.	No open features, thus freeboard N/A
<input type="checkbox"/> There are no clashes with other infrastructure.	No
<input type="checkbox"/> Self-cleansing velocities are achieved where pipes are proposed.	Yes
<input type="checkbox"/> 1m freeboard is provided between peak groundwater levels and the base of any infiltration feature.	No infiltration features proposed due to very high groundwater levels. Rainwater garden has been designed as being tanked with geomembrane. There can be no buoyancy because the mass of the crushed stone and growth/planting media will offset this.
<input type="checkbox"/> The proposed discharge rate is explained and justified (for attenuation designs).	Yes. 1 l/s is the lowest practicable minimum
<input type="checkbox"/> Where discharge is proposed to a public surface water or combined sewer, a capacity check confirming that the sewer can receive the proposed flows is submitted.	No - but it is not anticipated that 1 l/s into a surface water system that has 2no. 600mm diameter culverts will be an issue.
<input type="checkbox"/> Adequate freeboard is provided between peak groundwater levels and the base of any attenuation feature (refer below if this is not possible).	N/A
<input type="checkbox"/> Where there is a risk that the base of an attenuation feature may penetrate peak groundwater levels, additional mitigation measures to prevent groundwater ingress are incorporated into the design and construction method statement.	As above, the rainwater garden is tanked with geomembrane and the mass of the crushed stone and planting media is enough to offset groundwater buoyancy. A construction method statement has not been produced at planning stage. A construction method statement can only be produced shortly prior to the construction stage when it is known who the contractor is, and what their systems of work are and how they propose to construct the development. Drainage engineers cannot prescribe this at the planning stage.
<input type="checkbox"/> Where there is a risk that the base of an attenuation feature may penetrate peak groundwater levels the effects of buoyancy have been considered in the design.	As above, this is not an issue.
<input type="checkbox"/> Amenity benefits are provided by the drainage system (assessed by others).	Yes
<input type="checkbox"/> Biodiversity benefits are provided by the drainage system (assessed by others).	Yes
<input type="checkbox"/> Landscaping has been designed to ensure ease of maintenance of drainage assets.	Yes
<input type="checkbox"/> The justification and criteria for tree root avoidance and mitigation measures is clear, referencing adopting body standards where applicable.	N/A
<input type="checkbox"/> Biodiversity and ecological enhancements do not impede the functionality, maintenance or capacity of the drainage system.	No
<input type="checkbox"/> It is confirmed what elements of the SuDS will be private.	All elements of the SuDS will be private as they are within private land ownership
<input type="checkbox"/> It is confirmed what the adoption arrangements for SuDS components will be.	No part of the drainage system is proposed for adoption
<input type="checkbox"/> A construction method statement for the SuDS system, appropriate to the scale of the development, is submitted.	No. As above, a construction method statement has not been produced at planning stage. A construction method statement can only be produced shortly prior to the construction stage when it is known who the contractor is, and what their systems of work are and how they propose to construct the development. Drainage engineers cannot prescribe this at the planning stage for contractors who will carry out the work.
<input type="checkbox"/> A maintenance plan for the SuDS system, appropriate to the scale of the development, is submitted. [Please refer to our SuDS Maintenance Checklist where this is stipulated by condition.]	Yes, included in Appendix T
<input type="checkbox"/> Any potential health and safety issues relating to SuDS implementation and management have been considered and managed.	Yes. No H&S implications to consider
Preferred	Preferred
<input type="checkbox"/> Ground raising is avoided where possible.	No ground raising proposed
<input type="checkbox"/> The drainage system is considered by and contributes to the biodiversity net gain statement (assessed by others).	Yes.
Impermeable Area/Catchment Plan	Motion Comment / Response
Essential	Essential
<input type="checkbox"/> Different drainage catchments are demarcated.	N/A
<input type="checkbox"/> Where phased construction is proposed, each phase is shown on a plan.	N/A
<input type="checkbox"/> An impermeable area plan is provided showing all positively drained areas including open surface water storage plan areas.	Yes - Appendix O
Preferred	Preferred
<input type="checkbox"/> Impermeable areas are shown in m ² on the impermeable areas plan(s).	Yes
<input type="checkbox"/> Demarcated impermeable areas correspond with the distribution of those areas in the supporting calculations.	Yes
Surface Water Drainage Calculations	Motion Comment / Response
General	General
<input type="checkbox"/> The most recently applicable, or previously agreed FEH rainfall data is used.	Yes - FEH 2022 used and data provided in Appendix R
<input type="checkbox"/> CV values for all events are set to 1. This includes summer, winter, design, and simulation events.	Yes
<input type="checkbox"/> The correct climate change allowances, appropriate for the full lifetime of the development, have been applied to all calculations.	Yes - NPPF climate change allowances applied to 1 in 10, 1 in 30 and 1 in 100-year rainfall events
<input type="checkbox"/> A 10% allowance for urban creep is applied to all residential roof areas.	No - Urban creep not applicable to blocks of flats or minor developments, as per ADC's guidance: "All major applications must also include a 10% allowance for urban creep applied to the design"
<input type="checkbox"/> 100% Annual Exceedance Probability [AEP] + Climate Change Allowance [CCA] (1 in 1 year) event calculations provided.	No - because FEH only considers the 1 in 2-year event.
<input type="checkbox"/> 10% AEP + CCA (1 in 10 year) event calculations provided showing that the incoming pipe to any infiltration feature is above this level.	Yes

<input type="checkbox"/> 3.33% AEP + CCA (1 in 30 year) event calculations provided showing that the full surface water volume is contained within the designed system without flooding.	Yes
<input type="checkbox"/> 1% AEP + CCA (1 in 100 year) event calculations provided showing that the full surface water volume is contained safely on site, without flooding any part of a building or utility plant susceptible to water or affecting safe access or egress.	Yes
Infiltration	Infiltration
<input type="checkbox"/> Half drain times do not exceed 24 hours for the 10% AEP + CCA and 1% AEP + CCA events.	Infiltration not used, but half drain times of system only 52 minutes
<input type="checkbox"/> If half drain times exceed 24 hours for the 1% AEP + CCA event, then advice and agreement from the LPA has been sought and submitted.	N/A
<input type="checkbox"/> The most precautionary design infiltration rate is used.	N/A
<input type="checkbox"/> Design infiltration rates are applied to the sides of soakaways only.	N/A
<input type="checkbox"/> Design infiltration rates are applied to the base of permeable paving, infiltration blankets or basins only.	N/A
<input type="checkbox"/> Where the design infiltration rate is applied to the base an appropriate factor of safety is applied.	N/A
Attenuation and Restricted Discharge	Attenuation and Restricted Discharge
<input type="checkbox"/> Greenfield run off rates are based upon the positively drained area of the site only.	Yes
<input type="checkbox"/> Discharge rates are restricted to QBAR or 2 l/s/ha, depending on whichever is higher, for all storms up to the 1% AEP + CCA event.	Discharge rate cannot be restricted to QMED as this is 0.0028 l/s for the positively drained areas of the site. Outflow restricted to 1 l/s as lowest practicable minimum for all rainfall events, up to and including the 1 in 100-year + 45% rainfall event.
<input type="checkbox"/> Half drain times and available capacity in the drainage system for subsequent storms are considered.	Yes. The maximum half drain time is 52 minutes
<input type="checkbox"/> Brownfield run off rates are based upon the positively drained area of the site only.	Yes
<input type="checkbox"/> Brownfield sites aspire to achieve greenfield runoff rates and volumes, where infiltration is not viable. If the proposed run off rate is higher than the greenfield run off rate, then an acceptable justification is provided, and the rate has been agreed with any relevant bodies.	Yes, all this evidence has been provided, and the overall benefit of the drainage strategy by removing surface water from the foul drainage system has been discussed.
<input type="checkbox"/> A surcharged outfall to a watercourse or sewer has been modelled. The surcharge level is the 1% AEP + CCA flood event for the receiving watercourse, or to the top of the bank if appropriate hydraulic modelling is not available.	N/A
<input type="checkbox"/> A surcharged outfall to a tidal waterbody has been modelled. The surcharge level is based upon present day extreme sea levels with an allowance for sea level rise applied.	N/A
Requested to aid assessment	Requested to aid assessment
<input type="checkbox"/> FEH22 point descriptors for the site are provided.	Yes, in Appendix R
Drainage Plans and Specifications	Motion Comment / Response
Essential	Essential
Plans are provided showing:	
<input type="checkbox"/> The proposed design within the proposed site layout.	Yes
<input type="checkbox"/> Existing site sections and levels.	The levels of the site are shown in Appendix D, and the existing site layout is in the plans in Appendix B
<input type="checkbox"/> Proposed site sections and levels.	Yes, the proposed development layout is in Appendix B. The site levels are not changing.
<input type="checkbox"/> Long and cross sections for the proposed drainage system including final finished floor levels.	Not necessary for an extension to an existing dwelling on a site with no level change and a simple drainage strategy
<input type="checkbox"/> Exceedance flow management routes.	Yes.
<input type="checkbox"/> Details of connections to watercourses and sewers.	Yes
<input type="checkbox"/> Maintenance access and any arisings storage and disposal arrangements.	No issues with maintenance access.
These plans must be of sufficient detail that a reviewer can be confident that the design can be constructed without flood risk being increased on site or elsewhere.	Reviewer has been provided with sufficient details to fully understand and assess this simple drainage strategy for a small-scale development of a single extension to an existing property.
Specifications are required for all materials used in the design. We suggest that this is best achieved and illustrated with site specific construction detail drawings. The combination of construction details, with plans and sections, ensure that the proposed standard of construction will facilitate adoption and maintenance by an appropriate body and have structural integrity.	Yes
The following checklist is designed to demonstrate the level of detail required:	
Easements	Easements
<input type="checkbox"/> 3m easements are shown from the top of the bank of all ordinary watercourses, and from the edge of all culverted watercourses on all plans.	N/A
<input type="checkbox"/> 8m easements are shown from the top of the bank of all main rivers on all plans - unless an alternative easement has been stipulated by the Environment Agency.	N/A
<input type="checkbox"/> Any appropriate easements as stipulated by any public or private utility provider shown on all plans.	N/A
<input type="checkbox"/> Infiltration features (aside from permeable paving that does not take any extra impermeable catchment such as a roof) are shown at least 5m from buildings or structures.	N/A
<input type="checkbox"/> Maintenance easements are shown from the top of the bank from all open SuDS features on all plans.	N/A
<input type="checkbox"/> Existing trees and their root protection zones are shown on any drainage layout.	N/A
<input type="checkbox"/> Proposed trees and appropriate easements are shown on any drainage layout.	N/A
Detail	Detail
<input type="checkbox"/> It can be clearly determined what a pipe's diameter, pipe materials, gradients, flow directions and invert levels are from the plans.	Yes
<input type="checkbox"/> It can be clearly determined what an inspection chamber or manhole's cover level, invert level, cover loading grade and sump depth (where applicable) are from the plans.	Yes
<input type="checkbox"/> All infiltration or attenuation features (including permeable paving) are clearly labelled with their dimensions, invert/base levels and cover levels.	Yes, and this is also detailed in the report
<input type="checkbox"/> Control structures are labelled with discharge rates, hydraulic head, invert and cover levels and ideally model number.	Yes, and this is also detailed in the report
<input type="checkbox"/> Operational characteristics of any other mechanical features are detailed.	N/A
<input type="checkbox"/> Measures to protect drainage from tree root damage are clearly shown on any drainage layout.	N/A - no RPZ's in close proximity
<input type="checkbox"/> Any areas of necessary ground raising are clearly justified and demarked on a plan, with depths and levels.	N/A
<input type="checkbox"/> If the 1% AEP + CCA event floods, then the extent and depth of the flooding is shown on a site plan. This plan includes proposed external ground levels and finished floor levels of buildings.	No flooding in the 1 in 100-year + 45% rainfall event
<input type="checkbox"/> Potential flow routes off site are shown. The plan also includes proposed external ground levels, finished floor levels of buildings and designed slopes on all impermeable surfaces such as highways or car parks.	Yes, exceedance plan provided
<input type="checkbox"/> Cross sections and long sections of all open features are provided.	No open features
<input type="checkbox"/> Construction detail drawings are site specific.	No construction detail drawings - currently at planning stage (RIBA Stage 2/3). Construction issue drawings (RIBA Stage 5) will follow Tender Design Stage (RIBA Stage 4).
<input type="checkbox"/> Construction detail drawings are provided for all components including but not limited to:	No construction detail drawings - currently at planning stage (RIBA Stage 2/3). Construction issue drawings (RIBA Stage 5) will follow Tender Design Stage (RIBA Stage 4).
• <input type="checkbox"/> Infiltration structures	N/A
• <input type="checkbox"/> Attenuation structures	N/A
• <input type="checkbox"/> Manholes/inspection chambers	N/A
• <input type="checkbox"/> Catchpits/silt traps	N/A
• <input type="checkbox"/> Flow control devices	N/A
• <input type="checkbox"/> Permeable paving	N/A
• <input type="checkbox"/> Headwalls	N/A
• <input type="checkbox"/> Channel drains	N/A
• <input type="checkbox"/> Gullies	N/A
• <input type="checkbox"/> Pipe bed and surround	N/A
• <input type="checkbox"/> Pipe to pipe connections	N/A
• <input type="checkbox"/> Filter strips or drains	N/A
• <input type="checkbox"/> Swales	N/A
• <input type="checkbox"/> Bio-retention systems	N/A
• <input type="checkbox"/> Ponds and wetlands	N/A
• <input type="checkbox"/> Tree pits and measures to protect drainage from root incursion	N/A
• <input type="checkbox"/> Water treatment features	N/A
• <input type="checkbox"/> Green roofs	N/A
• <input type="checkbox"/> Measures to protect drainage from tree roots.	N/A
• <input type="checkbox"/> Water butts or alternative methods of water reuse – also to be shown on plans.	N/A
The following items are requested to aid assessment or confidence in construction:	The following items are requested to aid assessment or confidence in construction:
<input type="checkbox"/> Where features have a non-uniform plan area, a plan showing the coordinates of the perimeter is provided.	N/A
<input type="checkbox"/> All drainage infrastructure is labelled to correspond with the supporting calculations.	Yes
Other	Other
<input type="checkbox"/> Open feature planting specification is provided (to be assessed by others).	Planting recommendation is provided, but final specification needs to be provided by others