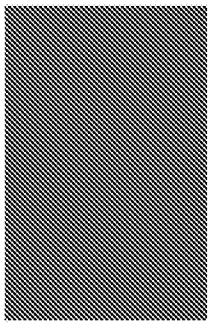
Proposed dwelling

at

86 Ancton Way
Bognor Regis
PO22 6JP

Flood Risk Assessment & Management of Surface Water Run-off

February 2025



HERBERT STUMPP
LIMITED

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Date	21st February 2025
Revisions	

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1. INTRODUCTION

Herbert Stumpp Limited have been appointed to prepare this document in respect of a proposed replacement dwelling at 86 Ancton Way, Bognor Regis, PO22 6JP.

The purpose of this document is to demonstrate:

(a) that flood risk to and from the development has been properly considered; and
(b) that a surface water drainage system to serve the proposed development has been designed to meet the requirements of the relevant statutory guidance and publications.

The site occupies an area of approximately 240m^2 (0.024Ha). A site location plan is shown in ***Figure 1.1*** below.

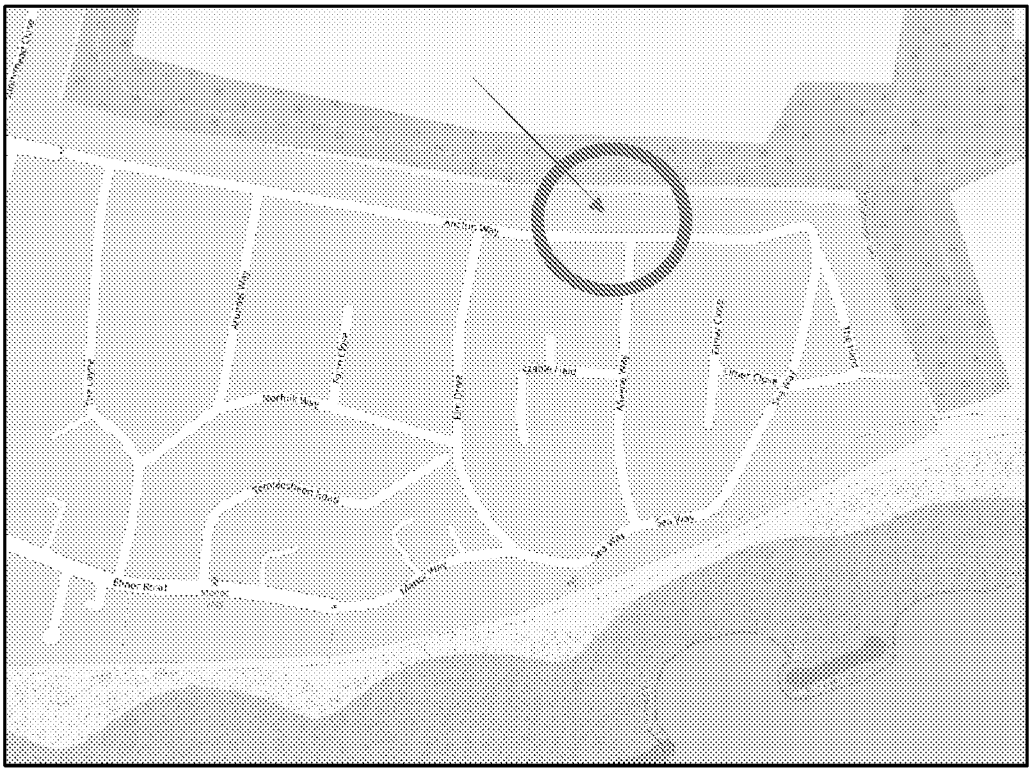


Figure 1.1: Site Location Plan © OpenStreetMap contributors

This document has been prepared in line with guidance found in the following:

- *Flood Risk Mapping*
- *Arun District Council Level 1 & Level 2 Strategic Flood Risk Assessments (SFRA)*
- *West Sussex LLFA policy for the management of surface water*
- *Supplementary requirements for surface water drainage proposals*

- *'Flood risk assessments: Climate change allowances' published by the Environment Agency*
- *Local Government Association (LGA) guidance on SuDS*
- *CIRIA Report C753F – The SUDs Manual*
- *Non-statutory technical guidance for sustainable drainage systems published by DEFRA March 2015*
- *BS 8582:2013. Code of practice for surface water management for development sites*
- *Tools for the design and evaluation of sustainable drainage systems (SuDS) published by UKSuDS (HR Wallingford)*
- *BS 7533-101:2021 Pavements constructed with clay, concrete or natural stone paving units. Code of practice for the structural design of pavements using modular paving units*

The proposed surface water drainage layout and associated construction details are shown on Drawing 006 included in **Appendix 1**.

2. FLOOD RISK

Interrogation of flood mapping (https://flood-map-for-planning.service.gov.uk) shows that the site is located in Flood Zone 3 and is at risk of flooding from the sea. Sites located in Flood Zone 3 have a 1 in 200 (0.5%) or greater chance of flooding each year. An extract from the mapping is shown in ***Figure 2.1***.

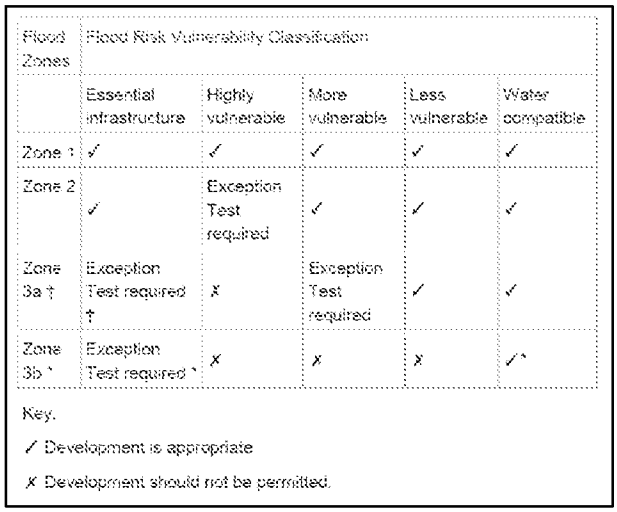
The proposed development is residential in nature and as can be seen in ***Figure 2.2***, is classed as 'More Vulnerable Development' (source: https://www.gov.uk/guidance/flood-risk-and-coastal-change).

Figure 2.1 – extract from flood zone mapping

More vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non-residential uses for health services, nurseries and educational establishments.
- Landfill* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Figure 2.2 – Development Classification



Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓*

Key.

✓ Development is appropriate

✗ Development should not be permitted.

Figure 2.3: Flood risk compatibility

More vulnerable developments placed in Flood Zone 3 are considered appropriate development (source: https://www.gov.uk/guidance/flood-risk-and-coastal-change) only if the exception test can be passed, as can be seen in ***Figure 2.3***. The Exception Test requires two additional elements to be satisfied (as set out in paragraph 164 of the National Planning Policy Framework) before allowing development to be allocated or permitted in situations where suitable sites at lower risk of flooding are not available following application of the sequential test. It should be demonstrated that:

- development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk;
- and the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

The following flood risks have been considered and are discussed in more detail in subsequent parts of this document:

- Flood risk from rivers or the sea
- Flood risk from surface water
- Flood risk from groundwater and reservoirs
- Flood risk from sewers
- Historic flood records
- Flood risk from the existing site
- Flood risk from the proposed development

The flood risks and their flood risk frequencies are set out in ***Table 2.1***

Risk of flooding	Yearly chance of flooding
Very low risk	<0.1% (less frequently than once in 1000 years)
Low risk	0.1% to 1% (once in every 100 – 1000 years)
Medium risk	1% to 3.3% (once in every 30 – 100 years)
High risk	>3.3% (more frequently than once in 30 years)

Table 2.1: Flood risk & flood risk frequency

2.1 Flood risk from rivers or the sea

Interrogation of flood mapping shows that the site is located in an area where there is very low yearly risk of flooding from rivers or the sea, and a low risk of flooding from rivers or sea between 2036 and 2069. This is shown in ***Figures 2.4 & 2.5***.

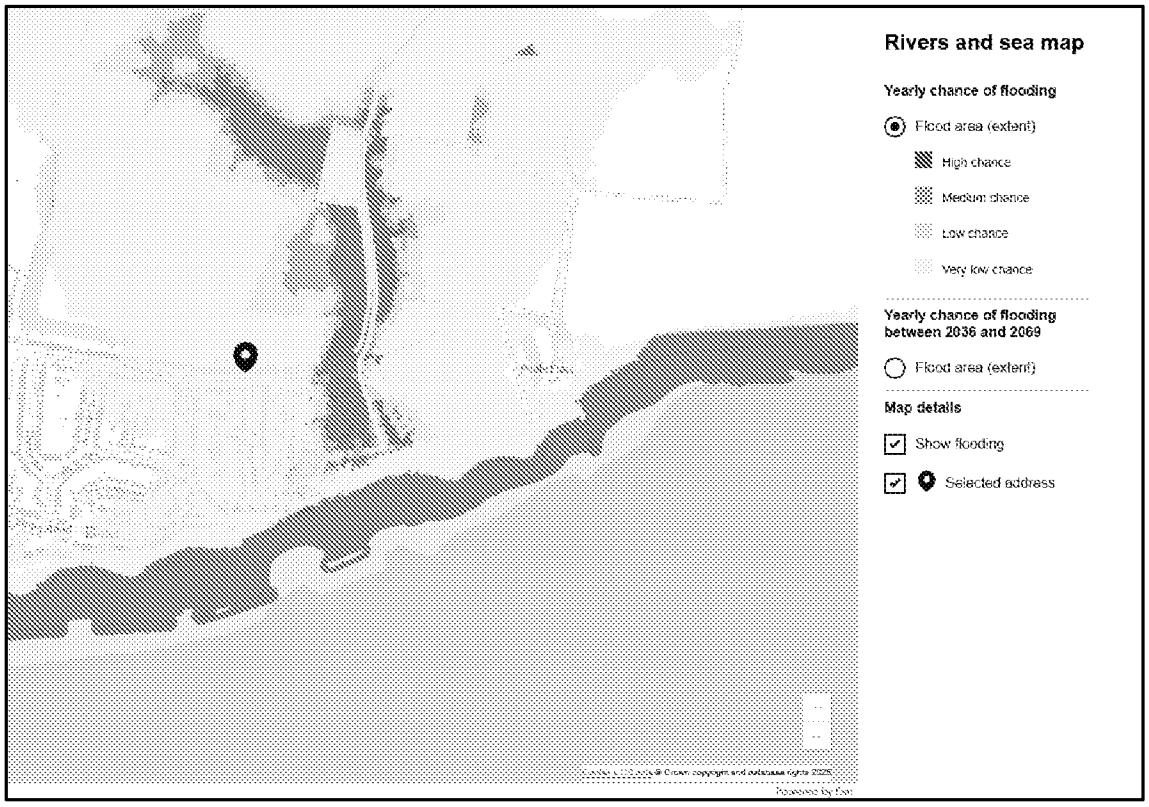


Figure 2.4 – Yearly chance of flooding (rivers and sea)

Figure 2.4 – Chance of flooding (rivers and sea) 2036-2069

2.2 Flood risk from surface water

Interrogation of flood mapping shows that the site is located in an area where there is very low yearly risk of flooding from surface water, and a low risk of flooding from surface water between 2036 and 2069. This is shown in ***Figures 2.6 & 2.7***.

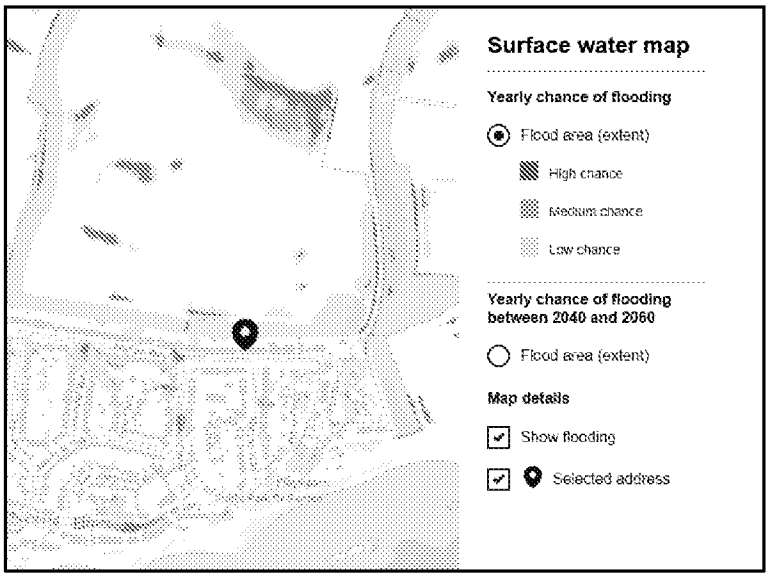


Figure 2.6 – Yearly chance of flooding from surface water

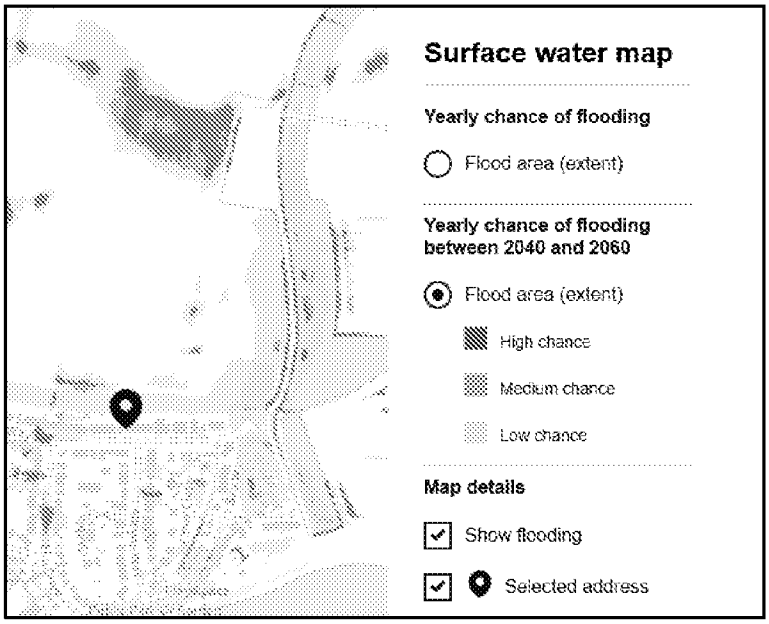


Figure 2.7 – Chance of flooding from surface water 2036-2069

2.3 Flood risk from groundwater and reservoirs

Interrogation of flood mapping shows that the site is located in an area flooding from either of these sources is unlikely. This is summarised in ***Figure 2.8***

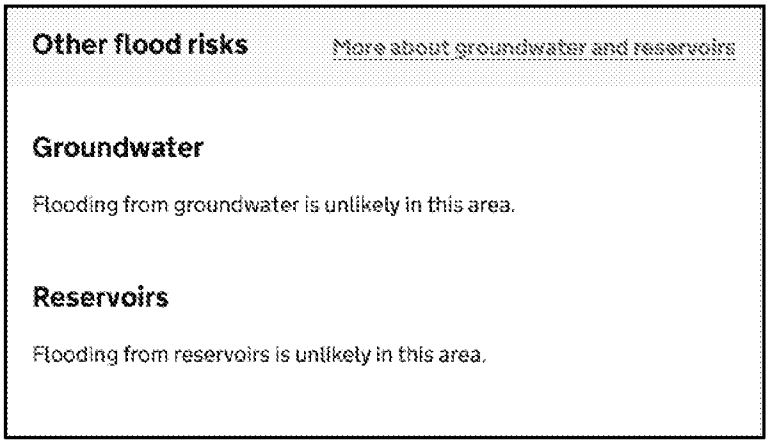


Figure 2.8 – summary of flood risk from other sources

2.4 Flood risk from sewers

The SFRA contains no record of any sewer flooding at the site. According to the landowner, there have been no records of sewer flooding in the past two years.

2.5 Historic flood records

Interrogation of the SFRA indicates that the site is located in an area where incidents of flooding have been recorded although not at the site address.

2.6 Flood risk from the existing site

The existing site comprises a single residential dwelling with the usual hard and soft landscaping. The total impermeable area (dwelling + outbuilding + hard landscaping) is approximately 150 sq.m.

The roof of the existing dwelling presently drains to a soakaway. The hardstanding at the front of the property drains to the road.

2.7 Flood risk from the proposed development

Following development of the site, the impermeable area will total approximately 95 sq.m. The increase in risk of overland (exceedance) flows reaching adjacent properties will be mitigated against by designing the surface water drainage system to cater for flows arising from the 1 in 100 year storm event plus an allowance for climate change, and the resultant risk of flooding to properties off-site will be low.

2.8 Impact of climate change

The site is located within an area influenced by tidal flooding, so climate change allowances for peak river flow and rainfall are not directly relevant to the assessment of flood risk from the sea.

2.9 Mitigation measures

It is important to recognise the effects of climate change and for the design of new developments to consider and to build in, resilience to flooding of all forms. ***Figure 2.9*** shows the approach to design, which is required by current guidance. It has been reproduced from *Improving the Flood Performance of New Buildings (flood resilient construction)*, published by Department for Communities and Local Government.

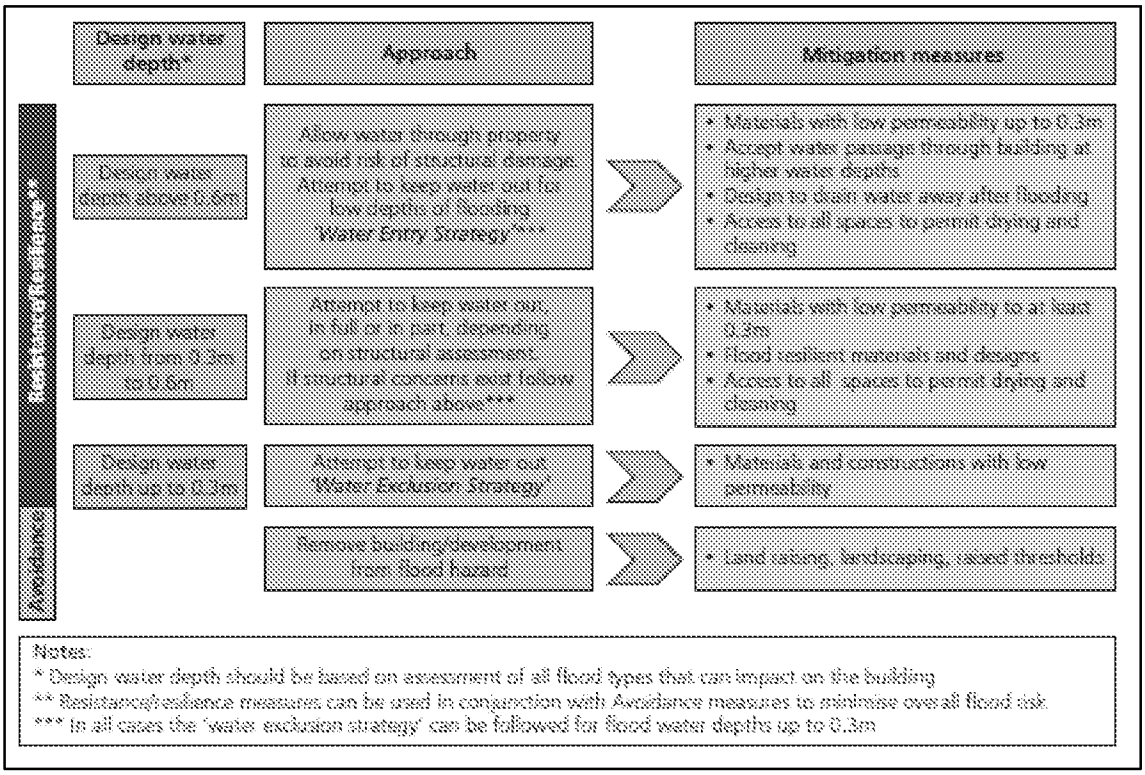


Figure 2.9 – Design Approach

The proposed development is classed as more vulnerable and the standing advice for such developments covers the following:

- floor levels
- flood resistance and resilience measures
- access and escape
- surface water management

2.9.1 Floor levels

Standing advice recommends that finished floor levels are set 300mm above the 0.5% AEP plus an allowance for climate change, and if this is not possible to raise the floor level as much as possible, consider moving vulnerable uses to upper floors and to include extra flood resistance and resilience measures.

The proposal is to construct a replacement dwelling, and the finished floor level of the proposed dwelling will be set at the same level as the existing finished floor level, reflecting the floor levels of the existing and adjacent properties.

2.9.2 Flood resistance and resilience measures

Standing advice requires that the design should be appropriately flood resistant and resilient by incorporating the following measures:

- using flood resistant materials that have low permeability to at least 600mm above the estimated flood level
- making sure any doors, windows or other openings are flood resistant to at least 600mm above the estimated flood level
- using flood resilient materials to at least 600mm above the estimated flood level by raising all sensitive electrical equipment, wiring and sockets to at least 600mm above the estimated flood level
- making it easy for water to drain away after flooding such as installing a sump and a pump
- making sure there is access to all spaces to enable drying and cleaning; ensuring that soil pipes are protected from back-flow such as by using non-return valve.

To protect the dwelling from the risk of flooding from fluvial sources, the intention is to adopt a water exclusion strategy. Flood resilient construction (masonry) will be used. There are two possible entry points for water into the extension and these are:

- Air vents
  Air vents will be fitted with covers to prevent water ingress which would be fixed in place to prevent water entering the sub floor voids. As an alternative, self-closing vents could be installed
- Doors.
  To prevent water ingress via the door openings, the doors will either be specialist manufactured flood-resistant doors, or a flood barrier will be provided, held in situ by channels fixed to the wall on each side of the door opening. The barrier would be dropped into place when needed.

2.9.3 Access and escape

The site is located within a flood zone and it is necessary to ensure that the occupants are fully aware of flood risk. The occupants will be advised to sign up to the Environment Agency's Flood Warning Service.

Standing advice requires details of emergency escape plans to be provided for any parts of a building that are below the estimated flood level. These plans should show that any single storey buildings or ground floors without access to upper floors can access a safe refuge above the estimated flood level; that any basement rooms have clear internal access (for example a staircase) to an upper floor above the estimated flood level; a safe route of access and escape which is set above the estimated flood level and connects the site to an area away from flood risk. The property has no basement and there is stair access from ground

floor level to the first floor. The first floor provides a safe refuge should it be required. There are two entry/exit points at the property: the front door (which gives access to Ancton Way) and the back door (which gives access into the rear garden).

2.9.4 Surface water management

Standing advice requires that Sustainable Drainage Systems (SuDS) should be provided for all developments involving surface water drainage in flood risk areas; and for major developments involving surface water drainage. The standing advice also states that in the event SuDS are not included, the local planning authority (LPA) should be provided with clear evidence of why their use would be inappropriate. The management of surface water is discussed in sections 3 & 4.

3. SURFACE WATER DRAINAGE – DESIGN PRINCIPLES

CIRIA Report 753 – The SuDS Manual' sets out the design approach and the design criteria to be used when preparing the designs for a sustainable drainage system, and these have been applied when preparing the design for this development.

'Non-statutory technical guidance for sustainable drainage systems' published by DEFRA (March 2015) sets out non-statutory technical standards for sustainable drainage systems. These standards are used in conjunction with the National Planning Policy Framework (NPPF) and Planning Practice Guidance. These standards have been applied when preparing the design for this development.

In order to meet the requirements of planning policy and current best practice guidance and thus determine an appropriate and sustainable method of managing the surface water run-off from the site, the following have been considered and are discussed in the subsequent sections of this document:

- Underlying geology
- Climate change
- Sustainability and SuDS hierarchy
- Storm frequency
- Timetable for implementation
- Management and maintenance

3.1 Underlying geology

Interrogation of British Geological Survey Mapping indicates that the site is underlain by chalk (bedrock geology) with superficial deposits of river terrace deposits and raised beach deposits. An extract from the mapping is shown in ***Figure 3.1***.

Excavations carried out for foundations for the newly built adjacent property at No.88 Ancton Way confirmed that chalk is present at shallow depth. This can be seen in the photograph included in **Appendix 2**.

Soakage testing to BRE 365 was carried out for No.88 Ancton Way in January 2023. It is proposed to use the results from these tests. The location of the trial pit where these tests were undertaken is shown on Drawing 201 and is approximately 1m away from the site boundary. The results of the tests are included in **Appendix 3**.

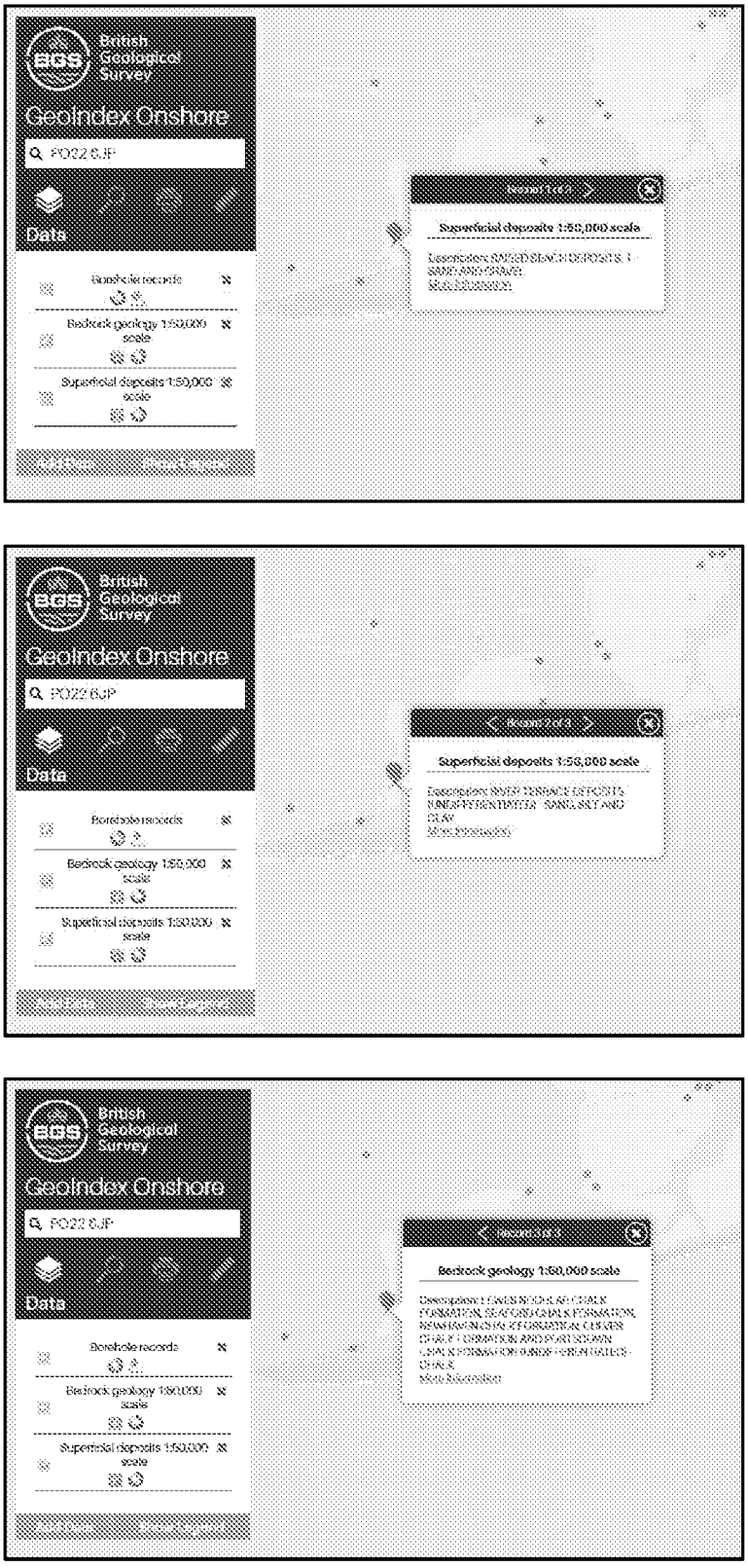


Figure 3.1 – extract from British Geological Survey mapping

© British Geological Survey

3.2 Climate change

'Flood risk assessments: climate change allowances' prepared by the Environment Agency recommends varying levels of allowance for climate change and requires that allowances for climate change are applied to the peak rainfall intensities used in the design storms to be considered.

The allowances to be used are obtained directly from that publication and it can be seen from the extract reproduced as ***Figure 3.1*** below that the allowances vary between 20% and 45%, depending upon the lifespan of the development and the exceedance rainfall event. It is considered that as the development is of a residential nature, a life span for the development of 100 years is appropriate, which means that the development will be in use until, say, 2125. The 1% annual exceedance rainfall event is appropriate and the central and upper end allowances for this event are 25% and 45%. An allowance of 45% will therefore be used.

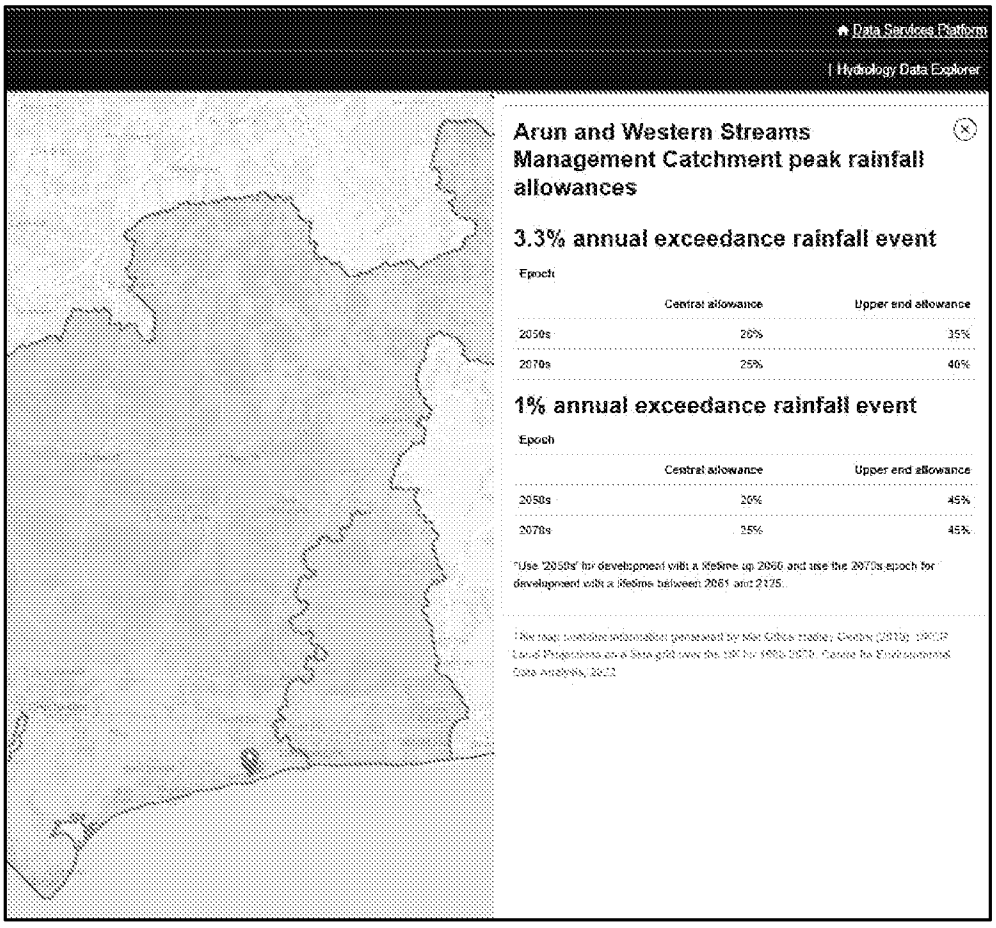


Figure 3.1 – peak rainfall allowances

3.3 Sustainability and SuDS hierarchy

In respect of surface water drainage, the policies of West Sussex LLFA and Arun District Council mirror the guidance set out in *'CIRIA Report 753 – The SuDS Manual'* and *'Non-statutory technical guidance for sustainable drainage systems'* published by DEFRA (March 2015).

CIRIA Report 753 – The SuDS Manual' sets out the design approach and the design criteria to be used when preparing the designs for a sustainable drainage system, and these have been applied when preparing the design for this development.

'Non-statutory technical guidance for sustainable drainage systems' published by DEFRA (March 2015) sets out non-statutory technical standards for sustainable drainage systems. These standards are used in conjunction with the National Planning Policy Framework (NPPF) and Planning Practice Guidance. These standards have been applied when preparing the design for this development. Sections s1, s2, s3, s4, s5 and s12 of the guidance do not apply. The publication states:

'…Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:

1. *into the ground (infiltration);*
2. *to a surface water body;*
3. *to a surface water sewer, highway drain, or another drainage system;*
4. *to a combined sewer.*

Particular types of sustainable drainage systems may not be practicable in all locations. It could be helpful therefore for local planning authorities to set out those local situations where they anticipate particular sustainable drainage systems not being appropriate….'

The items within the drainage hierarchy are now considered in turn:

- Rainwater use as a resource
  The storage of rainwater for re-use has been considered. A rainwater butt will be provided. This will receive surface water run-off from the roof. The butt will overflow into a drainage blanket beneath the rear patio.

- Rainwater infiltration to ground at or close to source
  The underlying geology of the site is chalk. Chalk is known to offer good soil infiltration rate and is compatible with infiltration drainage techniques. Surface water run-off from the existing site and the other properties in the area all presently drain to soakaways, although the locations of these soakaways are unknown. Infiltration drainage is the proposed method for the disposal of surface water run-off.

- Rainwater attenuation in green infrastructure features for gradual release
  Green walls, ponds, basins, swales and areas where run-off could accumulate or be attenuated at ground level have been discounted as they are considered unnecessary because infiltration techniques, which are higher up the hierarchy, are proposed.

- Rainwater discharge direct to a watercourse
  There is no nearby watercourse to discharge to, so this has been discounted. In any case,

this option is lower down the hierarchy than the proposed infiltration drainage techniques.

- Controlled rainwater discharge to a surface water sewer or drain
  There is no nearby surface water sewer to discharge to, so this has been discounted. In any case, this option is lower down the hierarchy than the proposed infiltration drainage techniques.

- Controlled rainwater discharge to a combined sewer
  There is no nearby combined sewer to discharge to, so this has been discounted. In any case, this option is lower down the hierarchy than the proposed infiltration drainage techniques.

3.4 Storm frequency

Planning policies and current guidance require the surface water drainage system to be designed to receive flows from a 1 in 30 year +45% climate change event without flooding. The storage system and the below ground pipework leading to it have been designed to receive flows from a 1 in 100 year +45% climate change event without flooding.

3.5 Timetable for implementation

The proposed surface water drainage system will be constructed as part of the development of the site and will be operational prior to occupation. This is usual practice but is also a requirement of planning condition 6.

3.6 Management and maintenance

Responsibility for maintenance will rest with the owner of the proposed dwelling, and regular inspection and maintenance of the drainage system, its components and its contributing areas will be required.

The drainage system has been designed to comply with the requirements of *'Non-statutory technical guidance for sustainable drainage systems'*; current codes and guidance; as well as existing policies.

The construction details and the proposed drainage layout drawing show that the drainage system complies with the relevant requirements of Part H of the Building Regulations in respect of maintenance, access, pipe diameters and gradients; and they also show that the proposed materials are of a suitable nature for the intended use. Construction of the drainage system and installation of individual components will be tested where required in accordance with the Building Regulations, current codes of practice and manufacturer's recommendations.

The maintenance requirements for the drainage system are summarised as follows:

Gutters, channel drains & rainwater gullies

Materials:	Plastic/composite/steel gratings, plastic gutters and gullies, precast concrete channels
Maintenance requirements:	Monthly inspections to assess condition and to ensure no accumulations of debris or silt. Remove any debris and carry out jetting/flushing and repairs as necessary to ensure continued operation.

Manholes, inspection chambers and access fittings

Materials:	Steel covers, precast concrete and plastic inspection chambers and access fittings.
Maintenance requirements:	Twice annual inspections to monitor build-up of silt and to ensure chambers are free of excessive silt build-up and debris. Remove any debris and de-silt as necessary to ensure continued operation.

Below ground pipework

Materials:	Plastic, clay and concrete.
Maintenance requirements:	Ensure that gullies, manholes and channel drains are maintained free of debris and silt. In the event of silt accumulating in below ground pipework, carry out jetting as necessary and de-silt.

Permeable paving

Materials:	Clay/concrete pavers with stone media beneath
Maintenance requirements:	Sweeping of the surface 2 – 4 times per year, removal of any surface debris as it appears, and the removal of any weed and plant growth. Sweeping can be carried out manually or mechanically. Mechanical sweeping should only be carried out with the suction feature turned off to prevent the accidental removal of any surface grit.

4. DESIGN

The proposal is for surface water run-off from the proposed dwelling to drain into the ground via a drainage blanket located beneath the rear patio and via the permeable driveway/parking area to the front of the property.

The design has been broken down into the following sub-headings and these are subsequently discussed in detail:

- Groundwater monitoring
- Groundwater pollution
- Structural performance
- Hydraulic performance

4.1 Groundwater monitoring

A groundwater monitoring point was installed at the site in April 2023 and water levels were observed and recorded regularly. The monitoring point comprised a 1.5m length of perforated plastic pipe inserted into the ground to a depth of 1.45m and surrounded with shingle. A photographic record is included in **Appendix 4**. The results of the monitoring are tabulated in Table 4.1. Monitoring is ongoing and will cease at the end of April 2025.

Date	Depth of water above base
27.04.2024	95mm
16.05.2024	75mm
25.05.2024	Dry
07.06.2024	Dry
30.06.2024	Dry
20.07.2024	Dry
02.08.2024	Dry
08.08.2024	Dry
06.09.2024	Dry
11.10.2024	150mm
01.11.2024	Dry
15.11.2024	Dry
23.12.2024	Dry
18.01.2025	Dry
30.01.2025	220mm
14.02.2025	Dry

Table 4.1 – Groundwater levels

4.2 Groundwater pollution

The principal source of run-off is from the roof (75m^2) of the proposed dwelling. Run-off from this source will be uncontaminated and will thus present a very low risk of pollution.

The permeable driveway/parking to the front of the site is a potential source of pollutants such as hydrocarbons, phosphates, glycols, alcohols and heavy metals. Engines can leak, and accidental spillages can occur. The majority of silt and the pollutants that become attached to it are usually trapped within the top 30mm of the material, and organic pollutants such as petrol and diesel tend to biodegrade due to the length of time they are retained.

The risk of groundwater pollution is therefore considered to be low.

4.3 Structural performance

The proposed drainage blankets are present in four areas of the site:

- Rear patio
- Driveway/car parking area at the front

The rear patio will have pedestrian traffic only and fall within Traffic Category 1 of BS 7533. To meet the relevant structural performance requirements (CIRIA C753, BS 7533), this area should be constructed with a paver thickness of 50mm on a laying course of 50mm and should have a minimum depth of sub base of 100mm. A geotextile layer has also been specified for this area.

The driveway/parking area will be unbound stone contained in a cellular system such as Bodpave by Green-Tech or a Geoweb system. Examples are included in Appendix 5. The surface will require at least 200mm of aggregate beneath it in order to provide the necessary structural performance.

4.4 Hydraulic performance

The drainage blanket beneath the patio will be constructed using a coarse graded aggregate (4-20mm). The unbound stone for the driveway/parking area use the same aggregate.

The aggregate will have a void ratio of approximately 30% when laid, and these voids will provide the storage volume necessary to cater for the 1 in 100 year + 45% climate change event.

Surface water run-off will discharge into the aggregate via diffuser units.

Design calculations using the site-derived soil infiltration rate are included in **Appendix 6** and show that for the 1 in 100 year + 45% climate change event the drainage blanket beneath the patio is required to be a minimum of 270mm thickness which is in excess of that required for satisfactory structural performance. Formation level will be approximately 1m above the

highest recorded groundwater level.

The aggregate for the driveway/parking area is required to be a minimum of 130mm thickness. The structural design requires a greater depth of aggregate.

The pipework leading to each of these drainage blankets will be designed to convey flows up to and including in the 1 in 100 year + 45% climate change event without flooding. This is now demonstrated using the Modified Rational formula:

$$Q=3.61 \times C_v \times i \times A$$

(where Q = peak flow in litres/second, C_v is a dimensionless routing coefficient taken as 1.0 as required by WSCC LLFA policy (0.75 is the usual value), i is the rainfall intensity in mm/hr taken as 192mm/hr from Met Office data and A is the contributing area in hectares, being the drained area of the roof) the following result is achieved:

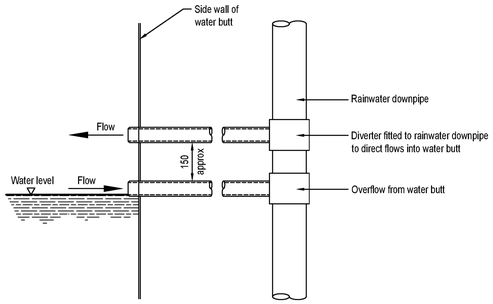
Q = 3.61 x 1.0 x (192mm/hr x 1.45) x (35/10000) = **3.52 litres/second**
($35m^2$ is the largest area contributing area to any drain run)

By referring to the *'Tables for the hydraulic design of pipes, sewers and channels'* by HR Wallingford & Barr to establish the relevant pipe capacities, it can be seen that a 100mm diameter uPVC pipe (k_s 0.6mm) laid at a 1 in 80 gradient has a capacity of 6.75 litres/second. This is greater than the calculated peak flow. The pipework will therefore be 100mm and will be laid not flatter than 1 in 80. This demonstrates that the design to complies with and exceeds the requirements of s7 of *'Non-statutory technical guidance for sustainable drainage systems'.*

The hydraulic design exceeds the requirements set out in current guidance and also exceeds the requirements of West Sussex County Council LLFA policy for the management of surface water.

The proposed ground levels within the site will remain largely as they are at present. Overland flows resulting from flooding of the drainage system in the event that the 1 in 100 year + 45% climate change event is exceeded would flow as they do at present (i.e. prior to development). Flows generated in this way will be rare and will present a very low risk.

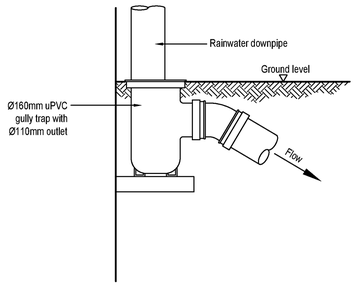
APPENDIX 1



TYPICAL SECTION THROUGH RAINWATER DIVERTER

TO BE FITTED TO EACH RAINWATER BUTT

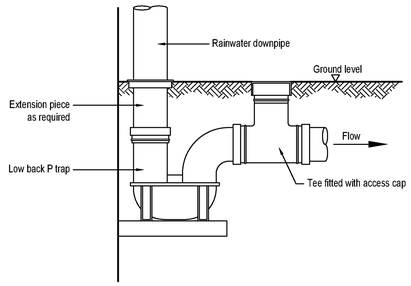
Scale 1:10



TYPICAL DETAIL AT BASE OF RAINWATER DOWNPIPES

FOR USE WHERE DOWNPIPES DO NOT DISCHARGE INTO WATER BUTTS FIRST

Scale 1:10



TYPICAL DETAIL AT BASE OF RAINWATER DOWNPIPES

FOR USE WHERE DOWNPIPES DO NOT DISCHARGE INTO WATER BUTTS FIRST

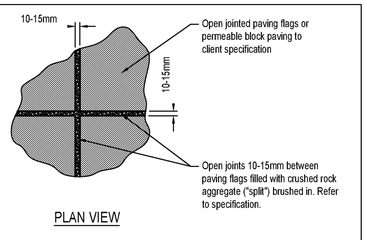
Scale 1:10

NOTES

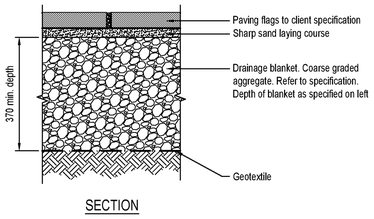
1. TAKE TIME TO READ AND UNDERSTAND THIS DRAWING AND FAMILIARISE YOURSELF WITH ITS CONTENT. DO THIS IN GOOD TIME BEFORE COMMENCING ANY WORK, AND IN THE EVENT OF ANY QUERY, REFER TO HERBERT STUMPP LTD IN A TIMELY MANNER.
2. Do not scale from this drawing for construction or fabrication. Work to figured dimensions only
3. This drawing is to be read in conjunction with all other relevant Architect's and Engineer's drawings
4. The contractor's attention is drawn to the drawing status and is to note the following:

   PLANNING (PL): The drawing is for planning only
   TENDER (T): The drawing is for pricing purposes only
   PRELIMINARY (P): The drawing has not received technical approval from the relevant approving authority
   CONSTRUCTION (C): The drawing is for construction

   THE CONTRACTOR MUST BE AWARE THAT ANY WORKS CARRIED OUT BASED UPON DRAWINGS MARKED TENDER OR PRELIMINARY ARE CARRIED OUT AT THE CONTRACTOR'S OWN RISK
5. The Construction (Design and Management) Regulations 2015 apply to this project. It is the client's responsibility to ensure that the requirements of the Regulations are satisfactorily addressed prior to commencement of any works.



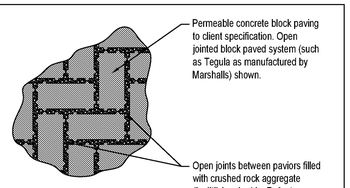
PLAN VIEW



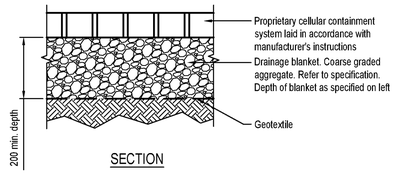
SECTION

DRAINAGE BLANKET BENEATH PATIO

Scale 1:10



PLAN VIEW



SECTION

PARKING/DRIVEWAY

Scale 1:10

SPECIFICATION FOR PERMEABLE SURFACING

1. Permeable paving: minimum thickness 50mm in pedestrian only areas and 65mm in driveway and vehicle crossover
2. Laying course and jointing aggregate: 2-6.3mm granite grit to BS EN 13242 lightly compacted. Re-grit 3 months after 3-4 months and upon final completion to allow for settlement.
3. Coarse graded aggregate: 4-20mm to BS EN 13242 lightly compated in 150mm layers
4. Geotextile: Needle punched polypropylene across base and taken up sides of excavation
5. Soft spots in formation to be removed and backfilled with SHW Clause 805 Type 3 material to BS EN 13242

GRANULAR BEDDING REQUIREMENTS - RIGID PIPES:

PIPE INTERNAL DIAMETER:

UP TO 100mm:	6 or 10 single size or 10 to 5 graded
100mm to 150mm:	10 or 14 nominal single size or 14 to 5 graded
225mm to 525mm:	10, 14 or 20 nominal single size or 14 to 5 graded or 20 to 5 graded
600mm and above:	10, 14, 20 or 40 nominal single sized crushed rock or 14 to 5 graded or 20 to 5 graded or 40 to 5 graded

GRANULAR BEDDING REQUIREMENTS - FLEXIBLE PIPES:

Either 6mm single size granular material or graded granular material 5mm minimum 10mm maximum size

PIPE STRENGTH AND BEDDING COMBINATIONS:

For concrete pipes with 0.9m to 1.2m cover to crown of pipe use Concrete Class M or Class H with Class A bedding
For concrete pipes with 1.2m to 2.5m cover to crown of pipe use Concrete Class M or Class H with Class B bedding
For clay pipes with 0.9m to 1.2m cover to crown of pipe use ESVC with Class A bedding
For clay pipes with 1.2m to 2.5m cover to crown of pipe use ESVC with Class B bedding

PIPE BEDDING NOTES:

Bc = Outside diameter of pipe
DN = Internal diameter of pipe

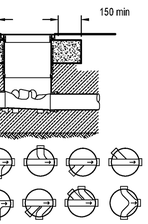
DIMENSION Y: EITHER: 1/6 of external pipe diameter OR 100mm under barrels and 50mm under sockets, whichever is greater. Maximum 400mm

Where a concrete surround is specified, Flexcell or equivalent compressible material is to be provided in the concrete surround at each pipe joint. Minimum thickness of compressible material 25mm

Selected as dug fill material or granular material free from stones larger than 40mm nominal size, lumps of clay over 100mm timber, frozen material and vegetable matter

Granular bed (refer to granular bedding requirements)

Concrete Grade ST4



Configurations for Shallow Access Bases

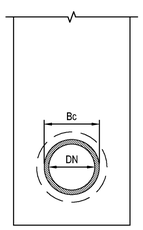
SHALLOW ACCESS FITTING (SAF)

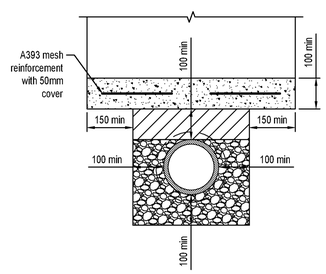
MAXIMUM DEPTH TO INVERT 600mm

(Scale 1:20)

NOTES FOR POLYPROYLENE INSPECTION CHAMBERS AND SHALLOW ACCESS FITTINGS:

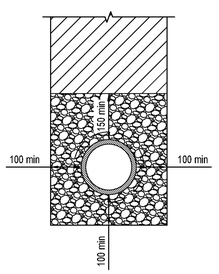
1. Provide a 100mm thick bed of selected as-dug or granular material. If ground conditions are unstable use a 150mm thick bed of either: ST4 or GEM4 designated mix in-situ concrete, placing the pre-formed polypropylene base of the chamber in position whilst the concrete is still wet so that it may adopt the shape of the base of the chamber
2. Polypropylene inspection chamber shaft sections are to provide set inverts using standard height shaft sections or are to provide inverts as specified by site cutting shaft sections to required height
3. 150mm minimum thickness of selected as-dug or granular material shall be placed and rammed firmly around pipes and fittings until adequate support is achieved
4. A 150mm minimum thickness grade ST4 concrete collar shall be provided around the top of the shaft to provide sealing for cover and frame where the chamber is located in non-adopted hard landscaped areas or in soft landscaped areas where there is access by construction traffic
5. A minimum 150mm thick grade ST4 concrete bed and surround is required where chambers are located in soft landscaped areas subject to construction traffic
6. Proprietary inlet adaptors are to be used to connect 100mm diameter pipes to 150mm diameter inlets
7. Unused inlets are to be sealed off using proprietary blanking-off plugs or plates





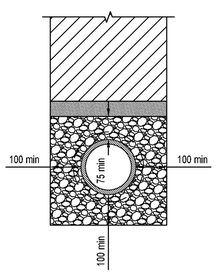
PIPE BEDDING FOR FLEXIBLE PIPES WITH LESS THAN 0.9m COVER BENEATH DRIVEWAYS AND VEHICULAR ACCESSES

(Scale 1:10)



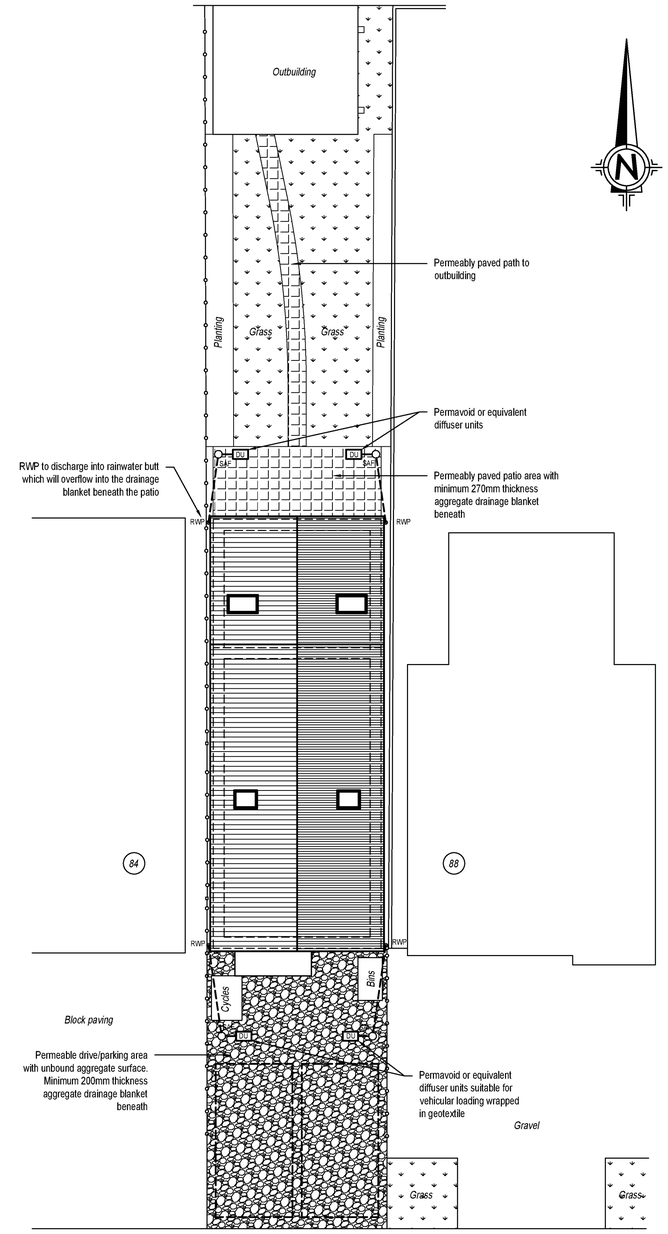
PIPE BEDDING FOR FLEXIBLE PIPES WITH MORE THAN 0.9m COVER BENEATH DRIVEWAYS AND VEHICULAR ACCESSES

(Scale 1:10)



PIPE BEDDING FOR FLEXIBLE PIPES WITH LESS THAN 0.6m COVER BENEATH AREAS WITHOUT VEHICULAR ACCESS

(Scale 1:10)



PROPOSED SURFACE WATER DRAINAGE

Scale 1:100

SCALE BAR 1:1250 SCALE DETAILS

0m 50 100 150 200 250m

SCALE BAR 1:100 SCALE DETAILS

0m 1 2 3 4 5 10 20m

ARUN DISTRICT COUNCIL M/2225/PL

Revisions:
PL1: Draft issue
PL2 19.02.2025: Issued for planning

ORIGINAL DRAWING SIZE: A1

HERBERT STUMPP LIMITED
Civil & Structural Engineers
Party Wall Surveyors
07921 214399
Email: info@herbertstumpp.co.uk

Project
86 ANCTON WAY, BOGNOR REGIS, WEST SUSSEX PO22 6JP

PROPOSED SURFACE WATER DRAINAGE

Drawing status: PLANNING
Drawn by: PP
Drawing Number: 006
Date: January 2025
Scale: As shown
Revision: PL 2

APPENDIX 2

APPENDIX 3

Calculations to determine Soil Infiltration Rate (f)

Site address

88 Ancton Way
Bognor Regis
PO22 6JP

Date January 2023

Soil Infiltration Rate (f) is given by f = Vp75-25/(As50 x Tp75-25 x 60)]

DETAILS OF TRIAL PIT

Trial pit dimensions			Outflow O = L x W x (Vp75-Vp25)			As50 = (L x 0.5 x D x 2) + (W x 0.5 x D x 2)		
Length (L)	0.500	m	O=	0.125	cu.m	As50=	1.000	sq.m
Width (W)	0.500	m						
Depth (D)	1.000	m						
Vp75	0.750	m						
Vp25	0.250	m						

DETAILS OF TESTS

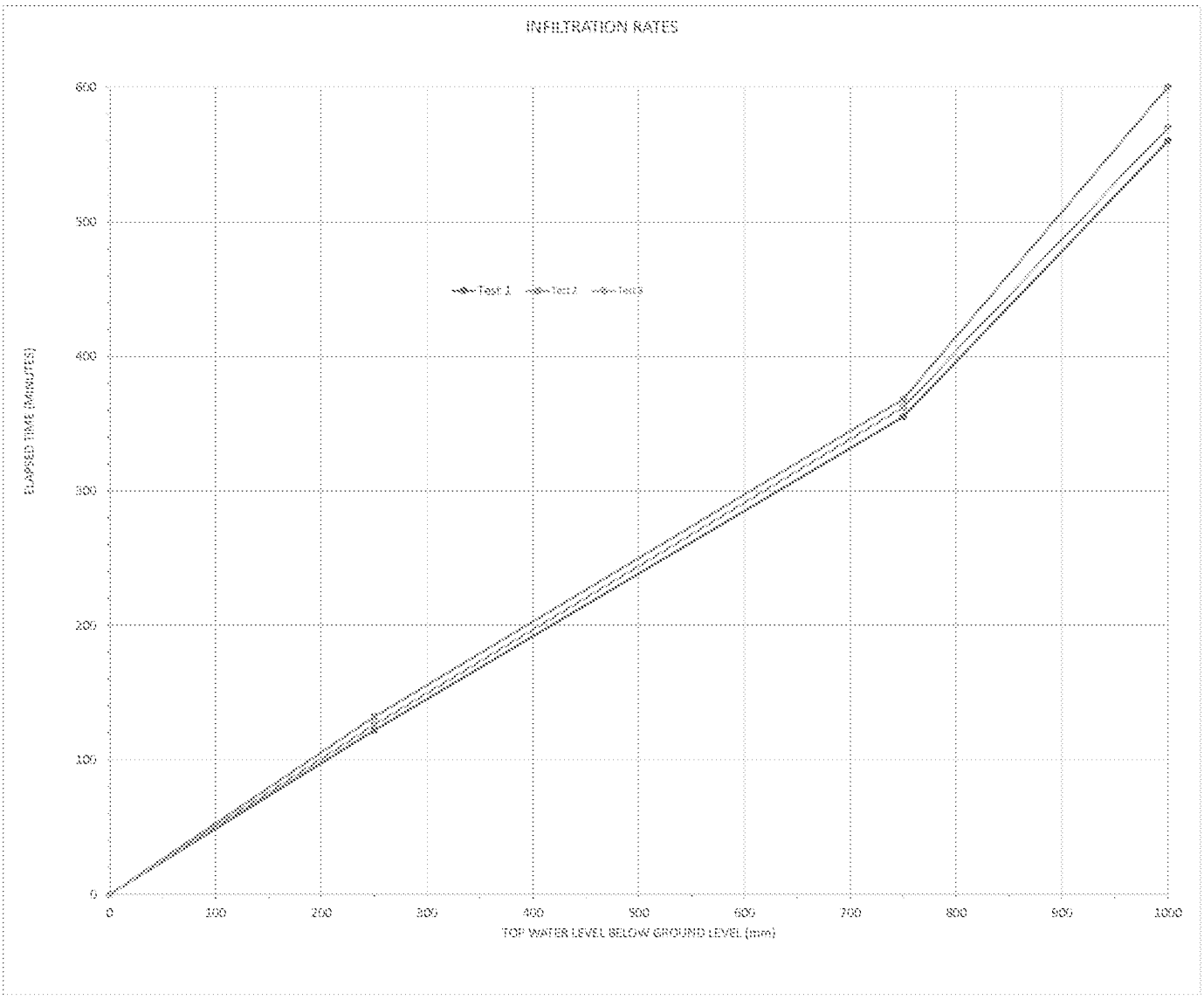
Test 1				Test 2				Test 3			
Time		Elapsed time		Time		Elapsed time		Time		Elapsed time	
Start	08:00	hh:mm	Minutes	Start	08:00	hh:mm	Minutes	Start	08:00	hh:mm	Minutes
75% full	10:02	02:02	122	75% full	10:12	02:12	132	75% full	10:06	02:06	126
25% full	13:55	05:55	355	25% full	14:08	06:08	368	25% full	14:02	06:02	362
Empty	17:20	09:20	560	Empty	18:00	10:00	600	Empty	17:30	09:30	570

	Time		
Depth	Test 1	Test 2	Test 3
0	0	0	0
250	122	132	126
750	355	368	362
1000	560	600	570

RESULTS OF TESTS (CALCULATED SOIL INFILTRATION RATE)

Test 1			Test 2			Test 3		
Tp75-25	233	min	Tp75-25	236	min	Tp75-25	236	min
f=	8.941E-06	m/second	f=	8.828E-06	m/second	f=	8.828E-06	m/second

SOIL INFILTRATION RATE TO USE (THE MINIMUM VALUE FROM THE THREE TESTS): **8.828E-06** **m/sec**



APPENDIX 4

APPENDIX 5

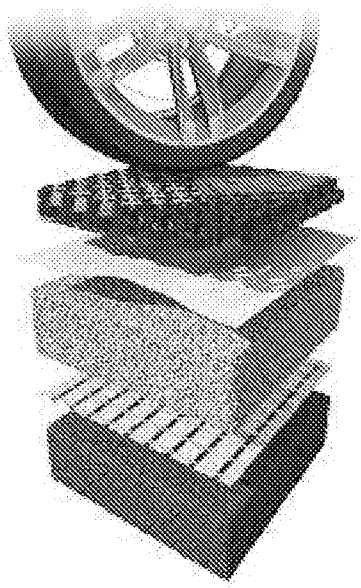
Technical Data Sheet

BODPAVE™ 85

GRASS SURFACES

Ground, Wind, Weed and Erosion Control

Bodpave™ is an interlocking cellular porous plastic paving grid system for ground surface stabilisation.



Applications

- Car and light vehicle parking
- Pedestrian walkways
- Golf buggy paths
- Cycle paths
- Driveways
- Residential parking
- Sustainable Drainage Systems (SuDS)

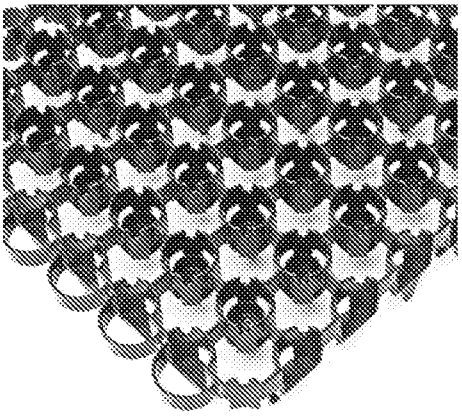
Design

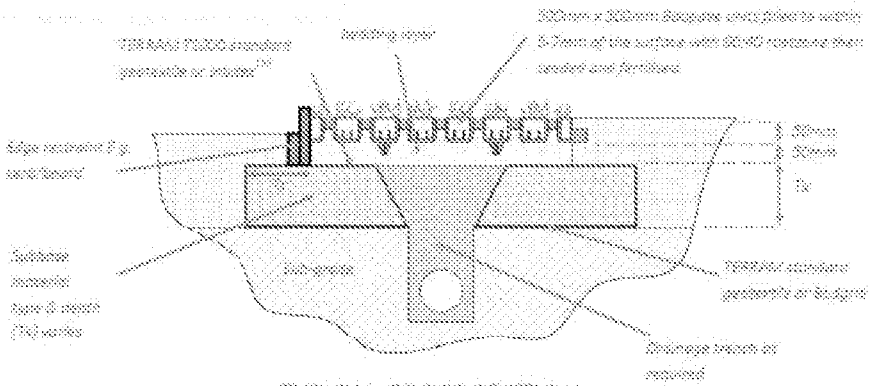
Most Bodpave™ installations will require a new sub-base (pavement foundation layer) to be constructed. The thickness and type of granular material used to form the sub-base will generally depend on the following factors;

- Strength of the underlying ground (sub-grade) measured in CBR* %
- Water permeability of the underlying ground (sub-grade) k measured in m/s
- Type of underlying ground (sub-grade) e.g. clay/silt/sand/gravel/rock
- Type of vehicle traffic (HGV/LGV/car/cycles/pedestrian)
- Frequency of traffic (occasional/regular)

*California Bearing Ratio Test

A comprehensive ground investigation survey with suitable testing is highly recommended to ensure the sub-base for a Bodpave™ surface is suitably strong and sufficiently durable for the anticipated use. **This design guide can be used for estimating ground conditions and producing preliminary pavement designs but it is not a substitute for site specific ground investigation works and a detailed pavement design by a suitably qualified civil engineer.**

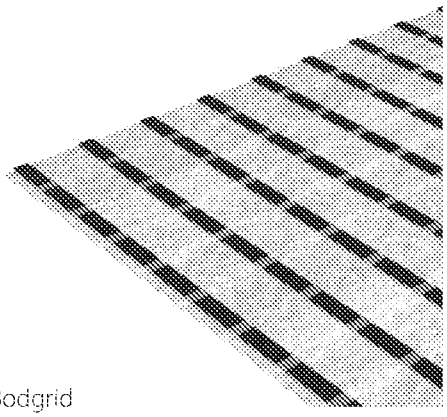




TYPICAL CROSS SECTION

Table 1 - Minimum Sub-base Thickness (Tx) with Bodgrid

Sub Grade	Cars/Light Vehicles (#)		Coaches/Heavy Goods/ Emergency Vehicles		Overlap
CBR* %	Thickness (mm)	Bodgrid	Thickness (mm)	Bodgrid	(mm)
1	300	GC30	400	GC30	600
2	150	GC30	250	GC30	500
3	125	GC30	175	GC30	450
4	125	GC30	150	GC30	400
5+	100	GC30	125	GC30	300

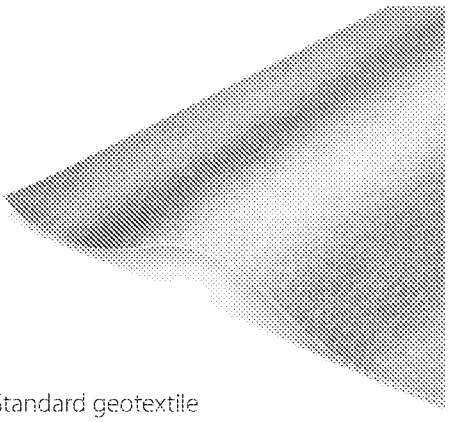


Bodgrid

Table 2 - Minimum Sub-base Thickness (Tx) without Bodgrid

Sub Grade	Cars/Light Vehicles (#)		Coaches/Heavy Goods/ Emergency Vehicles		Overlap
CBR* %	Thickness (mm)	Standard Geotextile	Thickness (mm)	Standard Geotextile	(mm)
1	450	T2000	600	T2000	600
2	225	T1500	375	T1500	500
3	200	T1000	300	T1000	450
4	200	T1000	225	T1000	400
5+	150	T1000	200	T1000	300

*California Bearing Ratio Test



Standard geotextile

Regular tight turning of vehicles and "dry" steering may cause damage to the Bodpave™ units and/or displace gravel infill; vehicle manoeuvring should be carefully considered at specification/design stage. Gravel filled units may require some maintenance when subjected to regular channelised and turning traffic loadings. Terram Bodpave™ 85 and Truckpave™ paviours are generally recommended for occasional overrun or regular HGV traffic respectively. If construction traffic axle load exceeds 60kN (6 tonnes), minimum sub-base thickness over Terram Bodgrid should be 200mm.

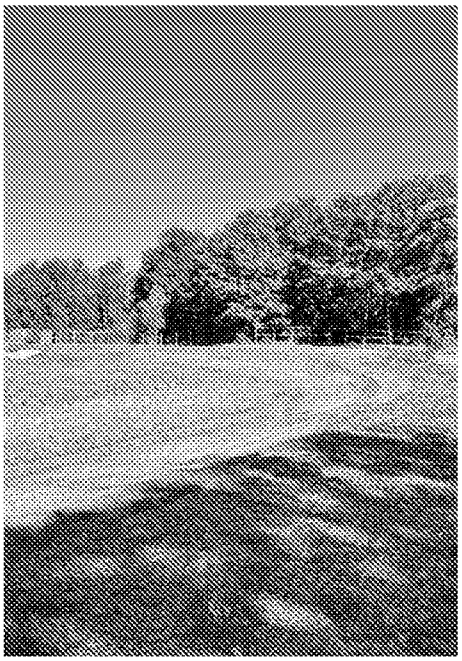
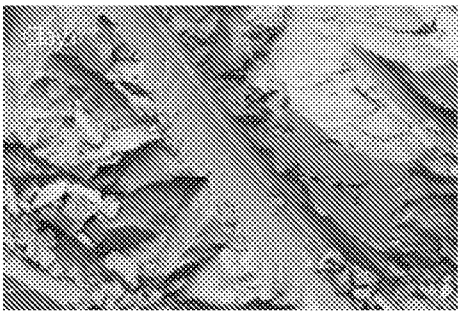


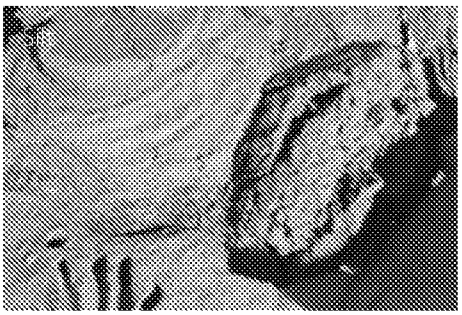
Table 3 - Field Guidance for Estimating Sub-grade Strength

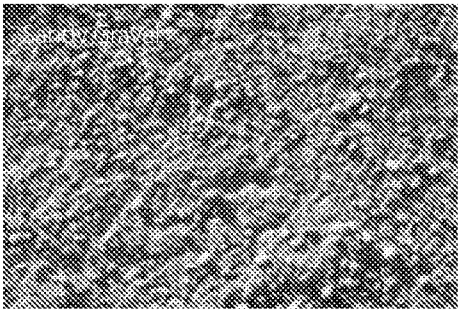
Consistency	Indicator		Mechanical (test) SPT	Strength	
	Tactile	Observation		CBR %	Cu Kn/SQM
Very Soft	Sample squeezes through fingers	Person standing will sink >75mm	<2	<1	<25
Soft	Easily moulded by finger pressure	Person walking sinks 50-70mm	2-4	~1	~25
Medium	Moulded moderate finger pressure	Person walking sinks 25mm	4-8	1-2	25-40
Firm	Moulded by strong finger pressure	Utility truck ruts 10-25mm	8-15	2-4	40-75
Stiff	Can be indented by thumb	Loaded construction vehicle ruts by 25mm	15-30	4-6	75-150

Table 4 - Typical Soil Types and Properties

Soil Type	Plasticity	CBR% Depth of Water Table Below Formation Level		Typical Range for Coefficient of Permeability K (m/s)	Infiltration
Heavy Clay	70 60 50 40	2 2 2.5 3	1 1.5 2 2	10^{-10} to 10^{-8}	No
Silty Clay	30	5	3	10^{-9} to 10^{-8}	No
Sandy Clay	20 10	6 7	4 5	10^{-9} to 10^{-6}	Partial
Silt	Non-plastic	2	1	10^{-8} to 10^{-6}	Partial
Poorly Graded Sand	Non-plastic	20	10	10^{-7} to 10^{-6}	Partial
Well Graded Sand	Non-plastic	40	15	10^{-6} to 10^{-4}	Total
Well Graded Sandy Gravel	Non-plastic	60	20	10^{-5} to 10^{-3}	Total







This field guide is provided as an aid to assessing the mechanical stabilisation requirements in commonly encountered site conditions.

1. Minimum sub-base thickness (Tx) can be selected from table 1 or 2 with ground strength and permeability estimated from tables 3 or 4 in the absence of any site specific ground investigation report.
2. If the Bodgrid layer is omitted, then the total sub-base layer thickness (Tx) must be increased by 50%. A standard geotextile separation layer should be specified with lower sub-grade strength (CBR value) requiring a more robust grade in accordance with BS8661:2019 (see table 2).
3. Bodpave™ units are an ideal surface for source control porous pavings SuDS with a permeable sub-base; DoT Type 3 (Type 1x) porous/open graded granular material as described in Specification for Highways Works clause 805. If a higher water storage (attenuation) capacity (void ratio) is required a hard crushed angular "clean stone" such as a course graded aggregate (CGA) type 4/20 (4mm minimum and 20mm maximum particle size) can be used. The type of SuDS design (attenuation, total or partial infiltration) will depend upon the underlying ground conditions and not all sites are suitable for infiltration. Weak and low-permeability cohesive sub-grades are generally unsuitable for infiltration (permeability coefficient k $<10^{-6}$ m/s). Clays with a low plasticity index (<20%) will reduce in strength when saturated; a full attenuation system with an impermeable membrane directly on top of the sub-grade is recommended (see table 4). Specific advice on suitable drainage and construction over very weak ground (CBR <1%) is available.
4. Alternatively traditional 'DoT Type 1' well graded granular material may be used for the sub-base provided that an adequate drainage system is installed. Typical drainage details; 100mm diameter perforated pipe drain laid at minimum gradient 1:100, bedded on gravel in trench backfilled with SHW Clause 505 'Type A' drainage aggregate (or CGA type 4/20), covered or wrapped with Terram T1000 standard non-woven geotextile and leading to a suitable outfall or soakaway. Drains placed down the centre

or along the edge of access routes up to 5m wide. Wider areas may require additional drainings at 5m - 10m centres.

5. The sub-base must be covered with a lyer of Terram T1000 standard or InbitexTM non-woven geotextile to prevent settlemen due to mixing of the bedding and sub-base layers and to provide filtration and pollution control.

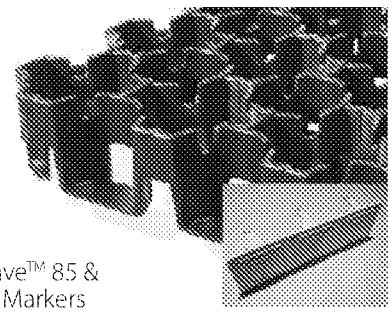
6. Bedding layer material should be either free-draining clean angular hard aggregate gravel chippings or course grit sand. Bodpave units should be filled with free-draining clean angular hard aggregate gravel chippings. **Rounded pea shingle is not suitable.** See table 6 for more details.

7. The final pavement and drainage design should be undertaken by a suitably qualified civil engineer and based on specific site conditions.

8. Maximum advised gradient for traffic applications is 12% (1:8) 7°, Bodpave units have specific fixing points for **steel u-pins** if required for steep slope applications.

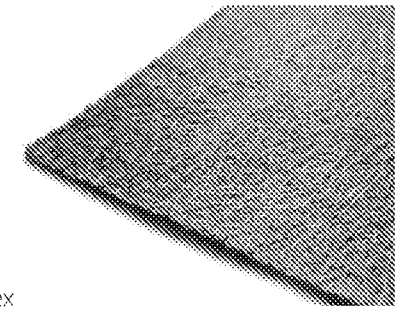
Table 5 - Products

Bodpave™ 85	
Dimensions	500mm x 500mm x 50mm + 35mm ground spike
Compressive Strength	<400 tonnes (400kN)/SQM (gravel filled)
Connection Strength	7kN/Lm
Material	100% recycled plastic
Coverage	4 units/SQM
White Markers	215mm x 70mm



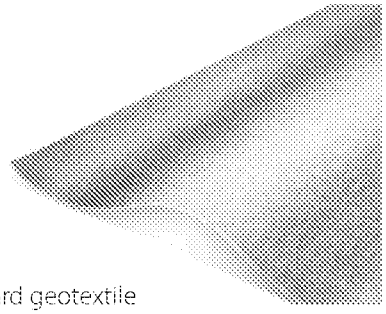
Bodpave™ 85 & White Markers

Inbitex™ Non-woven Geotextile	
Standard Roll Dimensions	4.5m wide x 100m long
Tensile Strength kN/m	8.5
Elongation	30%
CBR Puncture Resistance kN	1.6
Oil Absorption and Removal	<400g/SQM year



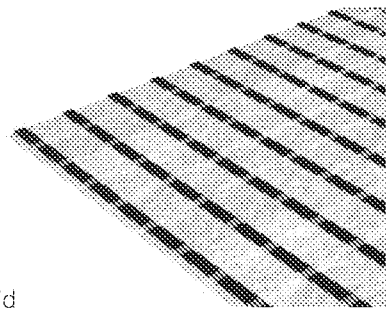
Inbitex

Non-woven Standard Geotextile	
Standard Roll Dimensions	4.5m x 100m long
Grades	T1000/T1500/T2000
BS8661 Classification	1/2/3
Tensile Strength kN/m	8.0/12.5/14.5
Elongation	60%
CBR Puncture Resistance kN	1.5/2.25/2.75



Standard geotextile

Bodgrid GC30	
Standard Roll Dimensions	4.8m wide x 50m long
Tensile Strength kN	30
Tensile Elongation	7%
Functions	Separation, filtration, stabilisation



Bodgrid

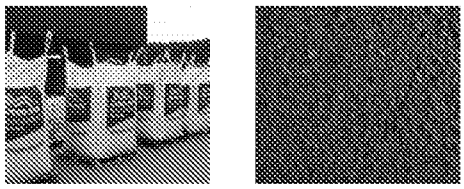
Table 6 - Fill Materials

Rootzone (Bodpave surface fill and bedding layer material)	
Description	Propriety mix of high quality, free draining sand and compost
Blend Ratio	60:40 or 70:30 sand:compost
Particle Size Range	0 to 2mm
Example	Green-tree Rootzone
Comments	Site won topsoil is not suitable

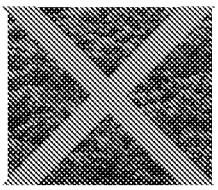
Grass Seed	
Description	Low maintenance hard wearing amenity mix
Varieties and Suggested Blend	50% amenity perennial rye grass (Turf PRG) 25% creeping red fescue 25% smooth stalked meadow grass
Application Rate	35-50g/sqm (new grass) 25g/sqm (overseeding)
Example	John Chambers Grass Seed Parks

Fertilisers	
Description	Pre-seeder fertiliser to encourage early grass growth to enhance seed establishment and improving root development
Example	Pre-seeder fertiliser 8-12-8+3MGO+ZN
Description	Spring Summer Fertiliser
Example	ICL Sportsmaster Spring Summer 9-7-7 Fertiliser

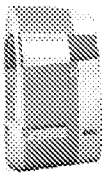
Sub-base (3 options)	
Description	Option 1 - well graded granular DoT Type 1 (with filter drains)
Aggregate Size	0 < 63mm
Grading to BS EN 13242 or 12620	GC 75/32 1/31.5 (SHW Clause 803)
Description	Opt 2 - permeable open graded granular DoT Type 3 (Type 1x)
Aggregate Size	0 to 40mm
Grading to BS EN 13242 or 12620	GC 80/25 1/40 (SHW Clause 805)
Description	Opt 3 - clean stone, course graded aggregate type 4/20
Aggregate Size	4 to 20mm
Grading to BS EN 13242 or 12620	GC 90/15 4/20



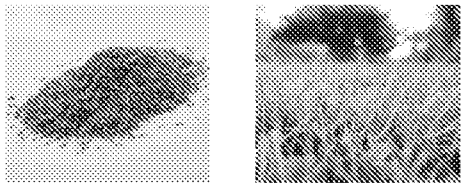
Rootzone



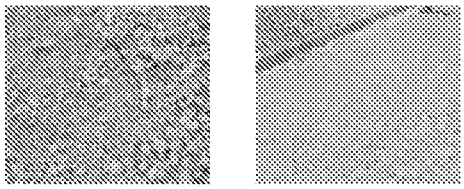
Site won topsoil



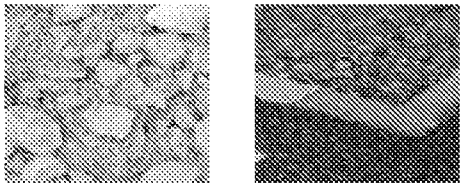
Fertiliser



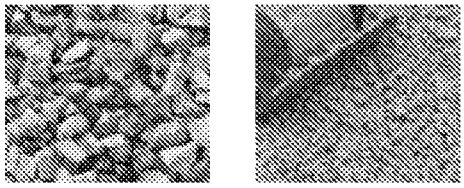
Grass Seed Mix



Type 1



Type 3 (1x) - permeable



CGA Type 4/20 (clean stone) - permeable

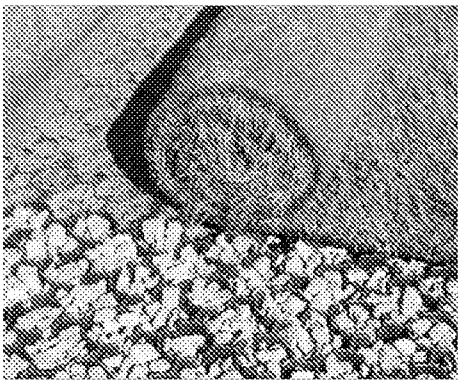
UNCOMPACTED COMPACTED

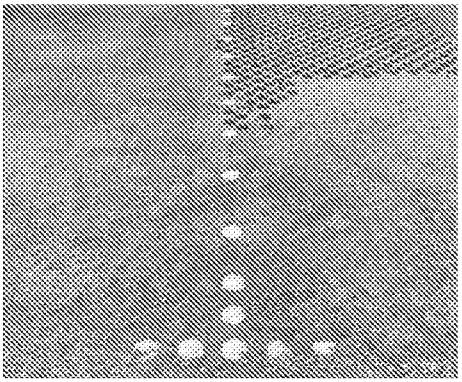
Installation

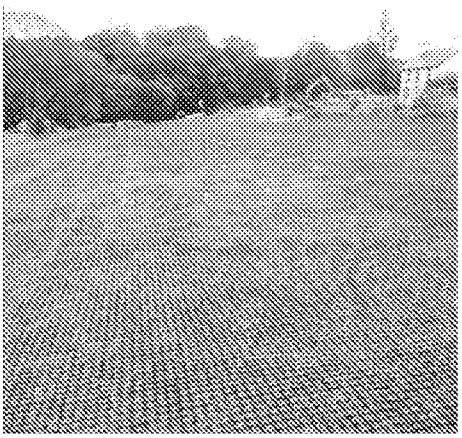
1. Excavate ground to the required formation level.
2. Unroll Terram all-in-one Bodgrid geocomposite (white geotextile below, black geogrid above) or Terram standard geotextile onto the prepared sub-grade with a minimum of 300mm overlap at the joints.
3. Place and compact type 3 (*) open graded granular material on top of the Terram layer to the required compacted thickness determind by the designer (minimum 100mm) to form a strong permeable sub-base layer.

* Type 3 is an open graded granular material as described in Specification for Highways Works clause 805. If a higher water storage (attenuation) capacity (void ratio) is required, a hard crushed angular "clean stone" such as a course graded aggregate (CGA) type 4/20 (4mm minimum and 20mm maximum particle size) can be used. Traditional well graded type 1 aggregate (with suitable drainage) may be used to form the sub-base layer as determind by the designer.

4. Install edge restriants as specified; traditional precast concrete kerbs, steel, plastic or treated timber boards/sleepers.
5. Install a second later of Terram standard geotextile on top of the sub-base with a minimum of 300mm overlap at the joints.
6. Place, compact and screed rootzone to a minimum uniform thickness of 50mm. See material specification section for more guidance on suitable bedding materials.
7. Start in the corner of the longest straight edge (kerb) leaving a 25mm expansion gap around the perimeter.
8. Place pre-connected set of four Bodpave units (1m x 1m) with the loop connectors facing outwards as a "leading edge" towards the remainder of the prepared bedding layer. Apply firm pressure so that the ground spikes are pressed fully into the bedding and the base of the units sit flat on the bedding layer surface.
9. Connect adjacent Bodpave units together by slotting the edge half cells down into the edge loops. Progress in rows (LOOPS ALWAYS LEAD) locking units in place with firm pressure over the snap-fit clips. If separation is required, clips can be dislocated using careful, firm hand or screwdriver pressure or by gently twisting the pavers.
10. Cut pavers to fit around obstructions and at the end of rows using a fine toothed hand or circular power saw. Partial units should be fixed using snap-fit clips and additional UV resistant nylon cable ties.
11. Install snap-fit markers as required before filling Bodpave units.
12. Once all Bodpave units have been installed, fill pavers with rootzone brushing away any surplus off the surface so that the tops of all the Bodpave units are visible. A single pass of a light vibrating plate compactor may be used to consolidate the pavers and settle the rootzone. Fill so the finished level is 5mm below the top of the units. Do not overfill or over compact.







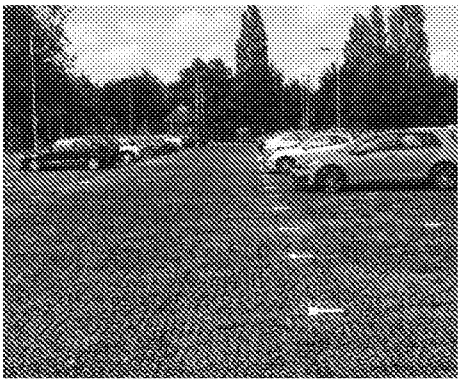
13. The rootzone infill should be seeded with a lawn mixture containing plenty of hard-wearing amenity perennial rye grass (Turf PRG) and some fescues to bind the sward and Bodpave units together, a pre-seeder fertiliser followed by frequent watering. A light top dressing may be applied to just cover the seed and to provide adequate germination conditions. Do not overfill the paver cells.

14. Once seeded, the area should be cordoned off to protect the young grass from traffic damage and allow the root sward to fully develop which may take 8+ weeks or 3-4 cuts during the growing season.

Maintenance

A grass filled Bodpave 85 porous surface should last for many years with very little maintenance. Maintaining a healthy grass filled Bodpave surface is dependent upon many factors including a successful initial installation, the frequency and intensity of traffic loading, sufficient irrigation, sunshine and regular growth recovery periods. The following maintenance should be considered:-

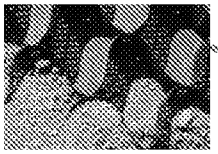
1. Regular mowing of the grass during the growing season (Spring/Summer/ Autumn) and removal of clippings.
2. Application of suitable fertiliser and Spring and Autumn.
3. Irrigation during hot and dry conditions.
4. Removal of fallen leaves, sticks and other debris from the surface as needed.
5. Weeds - ideally removed by hand or using a biodegradable weed killer once or twice a year.
6. Rotation of areas subject to seasonal traffic with frequent growth recovery periods. A minimum of 3 days per week without any traffic is recommended during the growing season, a longer recovery period may be required if the grass is in poor condition.
7. If Bodpave units are damaged consult us for advice on repair.



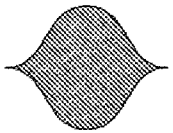
PRESTO GEOSYSTEMS

GEOWEB® 3D Solution Out-Performs Planar Geogrid System for Unpaved Roads and Platforms

1 Use Local Infill

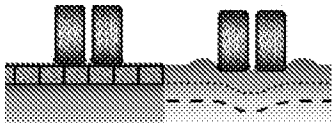


2 Confines Infill, Stabilizes Soils

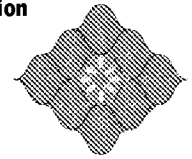


3 Reduces Rutting, Lowers Maintenance

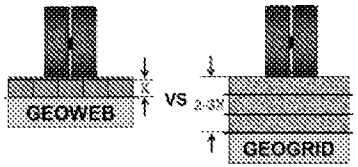
4 Decreases Rolling Resistance & Faster Cycle Times



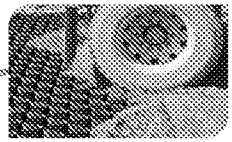
5 Delivers Instantaneous Protection



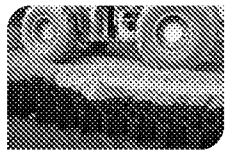
6 Bridges Soft Subgrades with Single Layer



7 Deploys Directly Over Poor Soils



8 Increases Speed of Construction



1. Use Local Infill.
The Geoweb system can use locally-available, or onsite fill. Geogrids require clean aggregate, increasing material cost plus added hauling costs.

2. Confines Infill, Stabilizes Soils.
Infill is confined in the Geoweb 3D structure, preventing it from movement under loading.

3. Reduces Rutting, Lowers Maintenance.
The Geoweb system is a full depth solution. Geogrids do nothing to protect surface translation. As a result, Geogrids require more maintenance to maintain road surfaces.

4. Decrease Rolling Resistance & Faster Cycle Times.
Geogrids only control lateral movement in thin layers. The Geoweb 3D system gives full depth protection, creating a firm, stable surface that increases cycle times and reduces tire wear, tire replacement and fuel consumption.

5. Delivers Instantaneous Protection.
Geogrids require tension to activate, initiated by partial deformation. The Geoweb system's affect is immediate and works on a principal of hoop strength.

6 Bridges Soft Subgrades with Single Layer.
A single layer of Geoweb performs well over soft subgrades. Geogrids require 2-3 layers for same benefit, adding cost and time to construction.

7. Deploys Directly Over Poor Soils.
On multi-layer Geogrid solutions, low pressure equipment must be used. The Geoweb system allows heavy equipment to deliver structural fill right to the edge of construction.

8. Increases Speed of Construction.
Installation of the Geoweb system is up to 3 times faster to deploy than multi-grid systems.

APPENDIX 6

< Back | Clear

INFILTRATION SYSTEMS DESIGN
Comparison

GEOMETRY

Trench 1		Trench 2		
Width (m)	2.5	Width (m)	5.5	
Length (m)	5.5	Length (m)	9	
Diameter (m)				
Trench base area (m2)	13.75	Trench base area (m2)	49.5	

PARAMETERS

Porosity	0.3	Porosity	0.3	
Effective porosity				
Infiltration coefficient (m/h)	0.03168	Infiltration coefficient (m/h)	0.03168	
Factor of safety	1.5	Factor of safety	1.5	

AREA TO BE DRAINED

Contributing area		**Contributing area**		
Rear Roof	25	Main roof	50	
Total area (m2)	25	**Total area (m2)**	50	

DESIGN RAINFALL

M5-60 rainfall depth (mm)	20	M5-60 rainfall depth (mm)	20	
Rainfall ratio r	0.4	Rainfall ratio r	0.4	
Climate change factor	1.45	Climate change factor	1.45	
FEH factor		FEH factor		
Return period (years)	100	Return period (years)	100	
Rainfall Duration (h)	**Intensity (mm/h)**	**Rainfall Duration (h)**	**Intensity (mm/h)**	
0.083333333	249.255	0.083333333	249.255	
0.166666667	174.479	0.166666667	174.479	
0.25	146.353	0.25	146.353	
0.5	92.798	0.5	92.798	
1	58.87	1	58.87	
2	35.12	2	35.12	
4	20.538	4	20.538	
6	15.187	6	15.187	
10	9.844	10	9.844	
24	5.111	24	5.111	

RESULTS

Maximum water depth (m)	0.27	**Maximum water depth (m)**	0.13	
Time for half-emptying (h)	1.55	**Time for half-emptying (h)**	0.87	