Appendix F

Proposed Drainage Strategy Plan

A1

OSSULSTON STREET

R WALK

LOADING BAY

BL foul connection
Peak discharge flow rate 6l/s
Rising main Ø80mm

Basement extent. Top of basement level 16.9mAOD

Attenuation above the basement slab. IL of attenuation 16.9mAOD.

Roof Overhang

Combined manhole upstream of the TW connection. IL 16.75mAOD

New foul water manhole to receive pumped flows from basement. IL 16.81mAOD

New combined MH on the TW sewer. IL TBC.

Ø150mm

Ø225mm

BL foul connection
Peak discharge flow rate 6l/s
Rising main Ø80mm

Pumped surface water from the basement attenuation
Pumped flow rate 2.91l/s
Rising main Ø50mm

Vortex flow control (Hydrobrake or similar approved) chamber
Off-site surface water discharge rate 7.23l/s

IL16.81mAOD

Basement extent. Top of basement level 16.9mAOD

Basement extent. Top of basement level 16.9mAOD

BLCC foul connection
Peak discharge flow rate 1l/s

Proposed loading bay channel drain to connect to the existing drainage network of the loading bay. Location of the existing loading bay drainage network TBC by survey during next stage

0 5 10 20 Metres
Scale 1:360

Do not scale

NOTES

1. Existing Utility Survey Information is based on Groundwise information obtained 12/08/2020 and CTRL project proposed utilities information.
2. Do not scale off this drawing.
3.

LEGEND

- Site Boundary
- Existing Combined Sewer
- Existing Tunnel
- Proposed Utilities
- Surface Water Drainage Gravity Pipes
- Surface Water Pressurized Drainage Pipes
- Foul Drainage Pipes Pressurized Drainage Pipes
- Foul Drainage Pipes Gravity Drainage Pipes
- Surface Water Channel Drain
- Channel Drain Sump
- Channel Outlet
- Gully
- Surface Water Manhole
- Vortex Flow Control Manhole
- Foul Manhole
- Combined Manhole
- Below Ground Attenuation Tank
- Building
- Roof overhang
- Attenuation Tank Inspection Chamber

Rev	Date	By	Chkd	Appd
P04	09/09/21	RO	RO	TMcD
For Information				
P03	19/03/21	TC	RO	TMcD
For Information				
P02	07/12/20	RO	RO	TMcD
For Information				
P01	22/10/20	RO	RO	TMcD
For Information				

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www.arup.com

Client
Stanhope
Mitsui

Project Title
British Library

Key Plan

Drawing Title
Proposed Drainage
Combined
Plan

Scale at A1 1:250

Role Civil

Suitability **For Information**

Arup Job No **249622-00**

Rev **P04**

Name **BL-ARUP-ZZ-BG-DR-CU-001202**

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Appendix G

Camden Flood Risk Pro-Forma

Pro-forma for any schemes in flood risk areas & all major development - Camden LLFA

All yellow boxes **must** be completed on this and all relevant tabs
Complete peach cells with source document and section/page references, required to support/justify responses
Do not edit grey cells
Please note guidelines / notes in column M
Complete all relevant tabs

Introduction: This Proforma is intended to help you understand the Sustainable Drainage and Flood Risk considerations that the Lead Local Flood Authority (LLFA) and Local Planning Authority (LPA) will take into account when considering an application in Camden, as well as helping us to consider the application. This does not replace the need also to provide where required a Drainage Statement, Flood Risk Assessment, and GLA-Camden SuDS Pro-forma, and observe the detailed guidance in ' Camden Planning Guidance (CPG) Water & Flooding'. Any information provided should be referenced to the relevant section of submitted supporting documents. This summary page will help provide key details on the application. Note that certain cells on this and other tabs will be populated automatically from previous answers given.

A. Application details

Planning reference (if known)				
Scheme name	British Library Extension (BLE)			
Scheme address	Land to the North of the British Library, 96 Euston Road, London			
Postcode	NW1 2DB			
Scale of development as registered	Major			
Scale - policy subcategory		Residential parts	Minor - mediur	Non-residential parts
Type(s) of development	Non-residential	ificant refurbishment or change of		
Site area, hectares	1.4	*100%*		
Of which total permeable area, to nearest 0.0001 ha	1.4	100%		
Of which total impermeable area, to nearest 0.0001 ha	0	0%		

	Existing	Proposed				
	TOTAL pre-development	For demolition	New-build incl. infills, re-build, extensions	Retained (refurbished or change of use)	TOTAL post-development	Net UPLIFT post-development
Total floor area of development (GIA)					0	0
of which residential					0	0
of which non- residential	2703	2703	1006878		1006878	1004175
Number of residential units						
List all use class(es)						

Drainage Statement document details	BL-ARUP-ZZ-XX-RP-C-000001 Flood Risk Assessment & Drainage Strategy
Flood Risk Assessment document details	BL-ARUP-ZZ-XX-RP-C-000001 Flood Risk Assessment &Drainage Strategy

B. Flood Risk and SuDS - Policy & Documents Filter

Recommendation (Council to complete)			
	Site area 1 hectare or greater?	*Yes*	
	Major application?	*Yes*	
	In Critical Drainage Area?	Yes	
	In or bordering (<50m) Local Flood Risk Zone(s)?	Yes, partly	
	Name of LFRZ(s):	King's Cross	
	On Historically Flooded Street 1975 or 2002?	No	
	Name of HFS(s):	N/A	
	Area at risk of flooding (surface water)?	*CHECK SITE DETAILS*	
	Elevated groundwater susceptibility or <50m of GW in	No	
	In area with recorded sewer flooding incident?	No	
	In street with historical underground watercourse?	Yes	
	Area at risk of flooding (other relevant types)?	*Yes*	
	Basement proposed - new, enlarged or change of use	Yes	
	IF YES, list proposed basement uses (all spaces):	Technical spaces (including tank farm), Plant, Cross Rail2 spaces for future fit-out by TfL, cycle storage/cyclist amenities, HV substation	
Approve/Condition/Refuse	*IF YES, are habitable or vulnerable use(s) included?*	Yes	
Approve/Condition/Refuse	*IF NO, is other (non-basement) vulnerable developme*	Yes	
	Vulnerable development in flood-prone area?	*Yes*	
	Site-specific Flood Risk Assessment (FRA) required?	*CHECK SITE DETAILS*	
Approve/Condition/Refuse	Site-specific FRA submitted?	Yes	**If Yes, go to Flood Risk Proposals tab**
	Drainage Statement (DS) required?	*CHECK SITE DETAILS*	
Approve/Condition/Refuse	DS submitted?	Yes	**If Yes, go to Flood Risk Proposals tab**
	Sustainable drainage (SuDS) proposals required?	*CHECK SITE DETAILS*	
Approve/Condition/Refuse	SuDS proposals submitted?	Yes	**If Yes, go to SuDS Proposals tab**
	FRA/DS/SuDS supporting evidence required?	*CHECK SITE DETAILS*	
Approve/Condition/Refuse	Supporting evidence submitted?	Yes	**If Yes, go to Flood Risk Proposals &/or SuDS Proposals ta**

Flood Risk Assessment, Proposals & Evidence

Recommendation (Council to complete)	**Assessments**	Required?	Document submitted?	Document title	Page/ section reference
	Site-specific Flood Risk Assessment	*CHECK SITE DETAILS*	*Yes*		
	Drainage Statement	*CHECK SITE DETAILS*	*Yes*		
	SuDS Proposals tab completed	*CHECK SITE DETAILS*	Yes		
	SuDS Proposals	*CHECK SITE DETAILS*	*Yes*		
	SuDS Proposals tab completed	*CHECK SITE DETAILS*	Yes		

Recommendation (Council to complete)	**Policy compliance**	Required?	Requirement met?	Document title	Page/ section reference
	Assessments address local, regional & national policies	*CHECK SITE DETAILS*	Yes		
	include suitable research & quantification of site flood risks	*CHECK SITE DETAILS*	Yes		
	address cumulative impact of developments	*CHECK SITE DETAILS*	Yes		
	propose suitable flood ingress internal coping measures	*CHECK SITE DETAILS*	Yes		
	propose suitable flood risk mitigation measures	*CHECK SITE DETAILS*	Yes		
	Internal water consumption target 105 l/p/d (residential)	*No*	Yes		
	External water consumption target 5 l/p/d (residential)	*No*	Yes		
	BREEAM Excellent water consumption target (non-resi >500m2)	*Yes*	No		
	Will not locate vulnerable development in flood-prone area	*Yes*	*No*		
	Scheme does not increase flood risk on & off site	*CHECK SITE DETAILS*	Yes		
	Scheme reduces on&off-site flood risk where possible	*CHECK SITE DETAILS*	Yes		

Recommendation (Council to complete)	**Evidence supporting Assessments & Proposals**	Required?	Evidence submitted?	Document title	Page/ section reference
	Drawings showing site-specific flood risk up to 100yr+40%	*CHECK SITE DETAILS*	No		
	Drawings showing proposed internal coping measures	*CHECK SITE DETAILS*	No		
	Drawings showing proposed flood mitigation measures	*CHECK SITE DETAILS*	Yes		
	Drawings showing proposed basement/ground floor uses	*CHECK SITE DETAILS*	Yes		
	Building flood risk emergency evacuation plan		Yes		
	Drawings showing on&off-site overland exceedance flows	*CHECK SITE DETAILS*	No		
	Internal water calculations & proposals (resi)	*No*	No		
	External water calculations & proposals (resi)	*No*	No		
	BREEAM water calculations & proposals (non-resi >500m2)	*Yes*	No		

Guidelines / notes

Policy CC3 c. consider the impact of development in areas at risk of flooding
(including drainage) & d. incorporate flood resilient measures in areas prone to flooding; Where an assessment of flood risk is required, developments should consider surface water flooding in detail and groundwater flooding where applicable.

Policy CC3 c. consider the impact of development in areas at risk of flooding
(including drainage);

Policy CC3 b. avoid harm to the water environment and improve water quality
& e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible

including Local Plan CC3, CPG, new London Plan, National Planning Policy Framework
including Strategic Flood Risk Assessment, Update LFRZ Map & EA Mapping
Policy CC3 c. consider the impact of development in areas at risk of flooding
Policy CC3 d. incorporate flood resilient measures in areas prone to flooding;
Policy CC3 d. incorporate flood resilient measures in areas prone to flooding;

Policy CC3 a. incorporate water efficiency measures
Policy CC3 a. incorporate water efficiency measures
Policy CC3 a. incorporate water efficiency measures

Policy CC3 f. not locate vulnerable development in flood-prone areas.
Policy CC3 The Council will seek to ensure that development does not increase flood risk
Policy CC3 The Council will seek to ensure that development...reduces the risk of flooding where possible

allowing 300mm freeboard to potential water ingress points

Policy CC3 a. incorporate water efficiency measures
Policy CC3 a. incorporate water efficiency measures
Policy CC3 a. incorporate water efficiency measures

Sustainable Drainage (SuDS) Assessment, Evidence and Proposals

Recommendation (Council to complete)	**Assessments**	Document submitted?	Document title	Page/ section reference
	Drainage Statement (DS)	*Yes*	BL-ARUP-ZZ-XX-RP-C-000001	Section 7
	GLA-Camden SuDS Pro-forma (fully completed)	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Appendix H

Recommendation (Council to complete)	**Policy compliance**	Requirement met?	Document title	Page/ section reference
	DS must include identification of flood risk	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 6
	DS must include assessment of existing, greenfield & proposed runoff rates	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Sections 7.2.1 &7.2.2
	DS must include identification of measures, in line with the drainage hierarchy, to reduce runoff rates	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 7.3
	Achieve greenfield runoff rates wherever feasible, or as close as possible	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 7.2
	Constrain runoff volumes to greenfield for 100yr 6hr event where feasible	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Appendix I (Microdrainage results)
	Backstop target for unaltered buildings: >50% reduction in existing run-off	No	N/A	
	Developments must include SuDS unless inappropriate	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 7.3.2
	Development should follow the detailed London Plan drainage hierarchy	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 7.3.1
	EA climate change factor applied: 2080s upper rainfall intensity allowance (40%)	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 7.2 & Appendix I

Recommendation (Council to complete)	**Evidence supporting Assessments & Proposals**	Evidence submitted?	Document title	Page/ section reference
	Drawings detailing SuDS extent & position (incl. outfalls, control points, levels)	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Appendix F
	Blue-green roof details with area & minimum 150mm substrate for storage	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Appendix J
	Results of cross-site infiltration rate or similar tests to show soil (in)compatibility	No	N/A	
	Professional run-off calculations supporting rates & volumes reported in DS	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Appendix I
	Drawings showing on&off-site overland exceedance flows	Yes / No		
	Evidence of site surveys and investigations relating to drainage	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Appendix C
	Lifetime maintenance and adoption arrangements (and maintenance owner)	Yes	BL-ARUP-ZZ-XX-RP-C-000001	Section 7.5
	Management of health & safety risks related to SuDS design	Yes / No		
	Confirmation of discharge capacity (or correspondence) from relevant body eg TW	No	Ongoing consultation	Section 3

Guidelines / notes

Policy CC3 c. consider the impact of development in areas at risk of flooding (including drainage);

Download from www.london.gov.uk/what-we-do/environment/climate-change/surface-

Policy CC3 e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible
& Policy CC3 supporting text §8.67

Policy CC3 e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible
& Policy CC3 supporting text §8.66

Policy CC3 e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible
& Policy CC3 supporting text §8.68

Appendix H

GLA SuDS Pro-forma

Camden

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LoDEG

1. Project & Site Details		
	Project / Site Name (including sub-catchment / stage / phase where appropriate)	British Library Extension
	Address & post code	Land to the North of the British Library, 96 Euston Road, London, NW1 2DB
	OS Grid ref. (Easting, Northing)	E 529920
		N 182986
	LPA reference (if applicable)	
	Brief description of proposed work	The Proposed Development would involve extending the northern aspect of the existing British Library to provide library accommodation; commercial space designed to cater for knowledge quarter
	Total site Area	14437 m^2
	Total existing impervious area	5774.8 m^2
	Total proposed impervious area	14437 m^2
	Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	The site is located in an area considere "Low Risk" of floodin from surface water
	Existing drainage connection type and location	TBC
	Designer Name	Raluca Olariu
	Designer Position	Consultant
	Designer Company	Arup

2. Proposed Discharge Arrangements			
	2a. Infiltration Feasibility		
	Superficial geology classification	Superficial deposits are absent	
	Bedrock geology classification	London Clay	
	Site infiltration rate	0.00001	m/s
	Depth to groundwater level	2	m below ground level
	Is infiltration feasible?	No	
	2b. Drainage Hierarchy		
		Feasible (Y/N)	*Proposed (Y/N)*
	1 store rainwater for later use	Y	Y
	2 use infiltration techniques, such as porous surfaces in non-clay areas	N	N
	3 attenuate rainwater in ponds or open water features for gradual release	N	N
	4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
	5 discharge rainwater direct to a watercourse	N	N
	6 discharge rainwater to a surface water sewer/drain	N	N
	7 discharge rainwater to the combined sewer.	Y	
	2c. Proposed Discharge Details		
	Proposed discharge location	New Manhole in Midland Road	
	Has the owner/regulator of the discharge location been consulted?	Yes, Consultation is ongoing	

Camden

GREATERLONDONAUTHORITY

LoDEG

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	2.27			
1 in 1	1.93	76.03	231	7.23
1 in 30	5.21	171.25	607	7.23
1 in 100	7.23	236.79	822	7.23
1 in 100 + CC			1237	7.23
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Vortex flow control		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	1316	1845	128
Blue roofs	1316	1845	219
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	0	0	0
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	11805		609
Total	**14437**	**3690**	**956**

4. Supporting Information

4a. Discharge & Drainage Strategy	*Page/section of drainage report*
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Because the basement footprint cvers almost the entire site area infiltration is not feasible. The only area where there is no basement is the utilities corridor
Drainage hierarchy (2b)	Section 7.3.1 of the FRA
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Section 3 of the FRA
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	ppendix E and Appendix I of the FR
Proposed SuDS measures & specifications (3b)	Section 7.3.2 and Appendix J
4b. Other Supporting Details	*Page/section of drainage report*
Detailed Development Layout	
Detailed drainage design drawings, including exceedance flow routes	
Detailed landscaping plans	
Maintenance strategy	Section 7.4 of the FRA
Demonstration of how the proposed SuDS measures improve:	Appendix J of the FRA
a) water quality of the runoff?	N/A
b) biodiversity?	Green roof vegetation, rain gardens
c) amenity?	Raingardens and Story Garden

Appendix I

Modelling (Microdrainage) Results

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.900	Add Flow / Climate Change (%)	0
Ratio R	0.438	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	300	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm 2

« - Indicates pipe capacity < flow

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
S1.000	14.800	0.000	0.0	0.028	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S1.001	12.312	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S2.000	11.865	0.000	0.0	0.066	5.00	0.0	0.600	o	160	Pipe/Conduit	
S2.001	23.753	3.440	6.9	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S2.002	29.455	0.000	0.0	0.032	0.00	0.0	0.600	|_|	-76	Pipe/Conduit	
S2.003	2.504	0.000	0.0	0.005	0.00	0.0	0.600	|_|	-76	Pipe/Conduit	
S2.004	14.286	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S3.000	17.575	0.000	0.0	0.017	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S3.001	11.454	1.273	9.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	162.59	6.60	17.060	0.028	0.0	0.0	0.0	0.15	8.9«	12.3
S1.001	143.28	8.72	17.060	0.028	0.0	0.0	0.0	0.10	1.9«	12.3
S2.000	158.25	7.04	20.500	0.066	0.0	0.0	0.0	0.10	1.9«	28.5
S2.001	157.32	7.14	20.500	0.066	0.0	0.0	0.0	4.02	80.9	28.5
S2.002	135.15	9.79	17.060	0.098	0.0	0.0	0.0	0.19	18.9«	36.0
S2.003	133.57	10.02	17.060	0.103	0.0	0.0	0.0	0.19	18.9«	37.3
S2.004	118.74	12.47	17.060	0.103	0.0	0.0	0.0	0.10	1.9«	37.3
S3.000	159.60	6.90	18.330	0.017	0.0	0.0	0.0	0.15	8.9	7.2
S3.001	159.07	6.95	18.330	0.017	0.0	0.0	0.0	3.52	70.8	7.2

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Network Design Table for Storm 2

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
S4.000	17.822	0.000	0.0	0.011	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S4.001	12.119	0.970	12.5	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.002	14.907	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S5.000	28.633	0.000	0.0	0.001	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S5.001	11.421	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.003	29.295	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S6.000	31.927	0.000	0.0	0.029	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S6.001	31.217	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S7.000	33.547	0.000	0.0	0.027	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S7.001	19.681	0.597	33.0	0.000	0.00	0.0	0.600	M22	-36	Pipe/Conduit	
S8.000	32.692	0.559	58.5	0.038	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S8.001	18.226	0.312	58.4	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S9.000	32.972	0.564	58.5	0.034	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S9.001	23.784	0.407	58.4	0.000	0.00	0.0	0.600	M22	-36	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S4.000	159.34	6.93	18.330	0.011	0.0	0.0	0.0	0.15	8.9	4.8
S4.001	158.69	6.99	18.025	0.011	0.0	0.0	0.0	2.99	60.1	4.8
S1.002	106.74	15.03	17.060	0.159	0.0	0.0	0.0	0.10	1.9«	45.9
S5.000	148.52	8.09	17.060	0.001	0.0	0.0	0.0	0.15	8.9	0.3
S5.001	133.28	10.06	17.060	0.001	0.0	0.0	0.0	0.10	1.9	0.3
S1.003	89.61	20.07	17.060	0.160	0.0	0.0	0.0	0.10	1.9«	45.9
S6.000	145.46	8.45	17.060	0.029	0.0	0.0	0.0	0.15	8.9«	11.4
S6.001	112.08	13.82	17.060	0.029	0.0	0.0	0.0	0.10	1.9«	11.4
S7.000	144.01	8.63	17.810	0.027	0.0	0.0	0.0	0.15	8.9«	10.5
S7.001	143.07	8.74	17.810	0.027	0.0	0.0	0.0	2.84	164.7	10.5
S8.000	177.94	5.26	17.460	0.038	0.0	0.0	0.0	2.13	123.5	18.1
S8.001	175.17	5.48	16.901	0.038	0.0	0.0	0.0	1.38	27.6	18.1
S9.000	177.91	5.26	17.260	0.034	0.0	0.0	0.0	2.13	123.5	16.6
S9.001	175.57	5.44	16.696	0.034	0.0	0.0	0.0	2.13	123.6	16.6

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Network Design Table for Storm 2

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
S1.004	24.889	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S10.000	5.702	0.000	0.0	0.016	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S10.001	6.466	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.005	24.889	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S11.000	26.003	0.000	0.0	0.032	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S11.001	8.256	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.006	37.113	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S12.000	35.495	0.000	0.0	0.046	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S12.001	4.375	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.007	37.113	0.000	0.0	0.000	0.00	4.3	0.600	o	160	Pipe/Conduit	
S13.000	34.841	0.000	0.0	0.035	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S13.001	1.747	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.008	9.154	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.004	79.23	24.35	17.060	0.287	0.0	0.0	0.0	0.10	1.9«	61.7
S10.000	173.47	5.62	17.060	0.016	0.0	0.0	0.0	0.15	8.9	7.4
S10.001	161.29	6.73	17.060	0.016	0.0	0.0	0.0	0.10	1.9«	7.4
S1.005	71.22	28.63	17.060	0.303	0.0	0.0	0.0	0.10	1.9«	61.7
S11.000	151.06	7.81	17.060	0.032	0.0	0.0	0.0	0.15	8.9«	12.9
S11.001	139.25	9.23	17.060	0.032	0.0	0.0	0.0	0.10	1.9«	12.9
S1.006	69.02	30.00	17.060	0.335	0.0	0.0	0.0	0.10	1.9«	62.6
S12.000	142.31	8.84	17.060	0.046	0.0	0.0	0.0	0.15	8.9«	17.7
S12.001	136.59	9.59	17.060	0.046	0.0	0.0	0.0	0.10	1.9«	17.7
S1.007	69.02	30.00	17.060	0.381	4.3	0.0	0.0	0.10	1.9«	75.4
S13.000	142.88	8.77	17.060	0.035	0.0	0.0	0.0	0.15	8.9«	13.7
S13.001	140.51	9.07	17.060	0.035	0.0	0.0	0.0	0.10	1.9«	13.7
S1.008	69.02	30.00	17.060	0.416	4.3	0.0	0.0	0.10	1.9«	82.1

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Network Design Table for Storm 2

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
S14.000	16.399	0.000	0.0	0.013	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S14.001	8.455	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.009	9.154	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S15.000	54.874	0.000	0.0	0.037	5.00	0.0	0.600	|_|	-75	Pipe/Conduit	
S15.001	25.378	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S16.000	6.234	0.000	0.0	0.009	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S16.001	10.545	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S17.000	13.216	0.000	0.0	0.053	5.00	0.0	0.600	o	160	Pipe/Conduit	
S17.001	17.894	3.441	5.2	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S17.002	33.326	0.000	0.0	0.001	0.00	0.0	0.600	|_|	-76	Pipe/Conduit	
S17.003	48.006	0.000	0.0	0.038	0.00	0.0	0.600	|_|	-76	Pipe/Conduit	
S17.004	19.498	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S18.000	22.591	0.000	0.0	0.032	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S18.001	18.046	0.309	58.4	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S15.002	15.519	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S14.000	160.85	6.77	17.060	0.013	0.0	0.0	0.0	0.15	8.9	5.9
S14.001	147.37	8.23	17.060	0.013	0.0	0.0	0.0	0.10	1.9«	5.9
S1.009	69.02	30.00	17.060	0.429	4.3	0.0	0.0	0.10	1.9«	84.6
S15.000	131.08	10.38	17.060	0.037	0.0	0.0	0.0	0.17	14.4	13.2
S15.001	107.95	14.75	17.060	0.037	0.0	0.0	0.0	0.10	1.9«	13.2
S16.000	172.79	5.67	17.060	0.009	0.0	0.0	0.0	0.15	8.9	4.1
S16.001	154.08	7.49	17.060	0.009	0.0	0.0	0.0	0.10	1.9«	4.1
S17.000	156.07	7.27	20.500	0.053	0.0	0.0	0.0	0.10	1.9«	22.4
S17.001	155.48	7.34	20.500	0.053	0.0	0.0	0.0	4.64	93.3	22.4
S17.002	131.39	10.34	17.060	0.054	0.0	0.0	0.0	0.19	18.9«	22.4
S17.003	108.32	14.66	17.060	0.092	0.0	0.0	0.0	0.19	18.9«	27.0
S17.004	95.81	18.01	17.060	0.092	0.0	0.0	0.0	0.10	1.9«	27.0
S18.000	154.51	7.44	17.060	0.032	0.0	0.0	0.0	0.15	8.9«	13.4
S18.001	152.44	7.66	17.060	0.032	0.0	0.0	0.0	1.38	27.7	13.4
S15.002	87.95	20.68	17.060	0.170	0.0	0.0	0.0	0.10	1.9«	40.5

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Network Design Table for Storm 2

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
S19.000	21.435	0.000	0.0	0.000	5.00	0.0	0.600	M22	-36	Pipe/Conduit	
S19.001	21.584	0.000	0.0	0.000	0.00	0.0	0.600	o	160	Pipe/Conduit	
S1.010	7.811	0.078	100.1	0.000	0.00	0.0	0.600	o	310	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S19.000	155.66	7.32	17.060	0.000	0.0	0.0	0.0	0.15	8.9	0.0
S19.001	126.98	11.03	17.060	0.000	0.0	0.0	0.0	0.10	1.9	0.0
S1.010	69.02	30.00	16.910	0.600	4.3	0.0	0.0	1.60	121.1	116.4

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	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 Storage Structures	9
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.436
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.700	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	15 Winter	100	+40%				
S1.001	S2	15 Winter	100	+40%	30/15 Summer			
S2.000	S3	2160 Winter	100	+40%				
S2.001	S4	2160 Winter	100	+40%				
S2.002	S5	15 Winter	100	+40%				
S2.003	S6	15 Winter	100	+40%				
S2.004	S7	15 Winter	100	+40%	30/15 Summer			
S3.000	S8	15 Winter	100	+40%				
S3.001	S9	15 Winter	100	+40%				
S4.000	S10	15 Winter	100	+40%				
S4.001	S11	15 Winter	100	+40%				
S1.002	S12	2160 Winter	100	+40%	100/480 Winter			
S5.000	S13	2160 Winter	100	+40%				
S5.001	S14	2160 Winter	100	+40%	100/480 Winter			
S1.003	S15	2160 Winter	100	+40%	100/480 Winter			
S6.000	S16	15 Winter	100	+40%	100/15 Summer			

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	17.321	-0.049	0.000	0.81			17.7	FLOOD RISK*
S1.001	S2	17.301	0.081	0.000	2.67			17.4	FLOOD RISK*
S2.000	S3	20.597	-0.063	0.000	0.01			0.1	OK
S2.001	S4	20.597	-0.063	0.000	0.00			0.1	OK
S2.002	S5	17.366	-0.034	0.000	0.42			20.0	FLOOD RISK*
S2.003	S6	17.336	-0.064	0.000	0.18			19.2	FLOOD RISK*
S2.004	S7	17.334	0.114	0.000	3.18			19.1	FLOOD RISK*
S3.000	S8	18.432	-0.208	0.000	0.55			10.8	FLOOD RISK*
S3.001	S9	18.372	-0.118	0.000	0.15			11.0	FLOOD RISK*
S4.000	S10	18.405	-0.235	0.000	0.37			7.3	FLOOD RISK*
S4.001	S11	18.064	-0.121	0.000	0.14			7.3	OK
S1.002	S12	17.278	0.058	0.000	0.16			0.9	SURCHARGED
S5.000	S13	17.276	-0.094	0.000	0.00			0.0	FLOOD RISK*
S5.001	S14	17.276	0.056	0.000	0.00			0.0	FLOOD RISK*
S1.003	S15	17.276	0.056	0.000	0.11			0.6	SURCHARGED
S6.000	S16	17.389	0.019	0.000	0.71			16.6	FLOOD RISK*

PN	US/MH Name	Level Exceeded
S1.000	S1	
S1.001	S2	
S2.000	S3	
S2.001	S4	
S2.002	S5	
S2.003	S6	
S2.004	S7	
S3.000	S8	
S3.001	S9	
S4.000	S10	
S4.001	S11	
S1.002	S12	
S5.000	S13	
S5.001	S14	
S1.003	S15	
S6.000	S16	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S6.001	S17	15 Winter	100	+40%	30/15 Summer			
S7.000	S18	15 Winter	100	+40%				
S7.001	S19	15 Winter	100	+40%				
S8.000	S20	15 Winter	100	+40%				
S8.001	S21	15 Winter	100	+40%	1/15 Summer			
S9.000	S22	15 Winter	100	+40%				
S9.001	S23	2160 Winter	100	+40%	1/15 Summer			
S1.004	S18	2160 Winter	100	+40%	100/360 Winter			
S10.000	S19	2160 Winter	100	+40%				
S10.001	S20	2160 Winter	100	+40%	100/15 Summer			
S1.005	S21	2160 Summer	100	+40%				
S11.000	S22	15 Winter	100	+40%				
S11.001	S23	15 Winter	100	+40%	30/15 Winter			
S1.006	S24	2160 Winter	100	+40%	100/240 Winter			
S12.000	S25	15 Winter	100	+40%	100/15 Summer			
S12.001	S26	15 Winter	100	+40%	30/15 Winter			
S1.007	S27	720 Winter	100	+40%	100/240 Winter			
S13.000	S28	15 Winter	100	+40%				
S13.001	S29	15 Winter	100	+40%	100/15 Summer			
S1.008	S30	600 Winter	100	+40%	100/480 Winter			
S14.000	S31	15 Winter	100	+40%				
S14.001	S32	480 Winter	100	+40%				
S1.009	S33	480 Winter	100	+40%				
S15.000	S39	15 Winter	100	+40%				
S15.001	S40	15 Winter	100	+40%	30/15 Summer			
S16.000	S41	120 Winter	100	+40%				
S16.001	S42	120 Winter	100	+40%	100/120 Winter			
S17.000	S34	2160 Winter	100	+40%				
S17.001	S35	2160 Winter	100	+40%				
S17.002	S38	15 Winter	100	+40%				
S17.003	S45	15 Winter	100	+40%				
S17.004	S46	15 Winter	100	+40%	30/15 Winter			
S18.000	S51	15 Winter	100	+40%				
S18.001	S52	120 Winter	100	+40%	100/15 Winter			
S15.002	S43	120 Winter	100	+40%	100/120 Winter			
S19.000	S44	480 Winter	100	+40%				
S19.001	S45	480 Winter	100	+40%				
S1.010	S46	480 Winter	100	+40%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S6.001	S17	17.367	0.147	0.000	2.37			14.2	FLOOD RISK*
S7.000	S18	17.961	-0.159	0.000	0.72			17.4	FLOOD RISK*
S7.001	S19	17.878	-0.242	0.000	0.11			17.4	FLOOD RISK*
S8.000	S20	17.562	-0.208	0.000	0.20			24.9	FLOOD RISK*
S8.001	S21	17.304	0.243	0.000	0.83			23.0	SURCHARGED*

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S9.000	S22	17.357	-0.213	0.000	0.18			22.8	FLOOD RISK*
S9.001	S23	17.273	0.267	0.000	0.01			0.7	SURCHARGED*
S1.004	S18	17.273	0.053	0.000	0.25			1.3	SURCHARGED
S10.000	S19	17.267	-0.103	0.000	0.01			0.3	FLOOD RISK*
S10.001	S20	17.267	0.047	0.000	0.03			0.3	FLOOD RISK*
S1.005	S21	17.220	0.000	0.000	0.17			0.9	FLOOD RISK*
S11.000	S22	17.321	-0.049	0.000	0.93			19.7	FLOOD RISK*
S11.001	S23	17.287	0.067	0.000	2.21			19.3	FLOOD RISK*
S1.006	S24	17.260	0.040	0.000	0.25			1.6	SURCHARGED
S12.000	S25	17.396	0.026	0.000	1.07			26.5	FLOOD RISK*
S12.001	S26	17.341	0.121	0.000	1.98			25.2	FLOOD RISK*
S1.007	S27	17.253	0.033	0.000	0.75			4.6	SURCHARGED
S13.000	S28	17.332	-0.038	0.000	0.86			21.1	FLOOD RISK*
S13.001	S29	17.291	0.071	0.000	1.57			20.0	FLOOD RISK*
S1.008	S30	17.226	0.006	0.000	0.68			4.7	SURCHARGED
S14.000	S31	17.215	-0.155	0.000	0.41			8.5	FLOOD RISK*
S14.001	S32	17.208	-0.012	0.000	0.10			0.9	FLOOD RISK*
S1.009	S33	17.207	-0.013	0.000	0.67			4.6	FLOOD RISK
S15.000	S39	17.388	-0.012	0.000	0.45			21.2	FLOOD RISK*
S15.001	S40	17.354	0.134	0.000	2.76			15.2	FLOOD RISK*
S16.000	S41	17.238	-0.132	0.000	0.03			1.7	FLOOD RISK*
S16.001	S42	17.238	0.018	0.000	0.23			1.7	FLOOD RISK*
S17.000	S34	20.600	-0.060	0.000	0.01			0.0	OK
S17.001	S35	20.600	-0.060	0.000	0.00			0.0	OK
S17.002	S38	17.317	-0.083	0.000	0.01			0.4	FLOOD RISK*
S17.003	S45	17.317	-0.083	0.000	0.31			18.6	FLOOD RISK*
S17.004	S46	17.302	0.082	0.000	2.75			13.9	FLOOD RISK*
S18.000	S51	17.271	-0.099	0.000	1.00			19.8	FLOOD RISK*
S18.001	S52	17.243	0.023	0.000	0.22			6.1	FLOOD RISK*
S15.002	S43	17.236	0.016	0.000	1.22			6.5	FLOOD RISK
S19.000	S44	17.194	-0.176	0.000	0.00			0.1	FLOOD RISK*
S19.001	S45	17.194	-0.026	0.000	0.05			0.2	FLOOD RISK*
S1.010	S46	17.194	-0.026	0.000	0.10			7.2	FLOOD RISK

PN	US/MH Name	Level Exceeded
S6.001	S17	
S7.000	S18	
S7.001	S19	
S8.000	S20	
S8.001	S21	
S9.000	S22	
S9.001	S23	
S1.004	S18	
S10.000	S19	
S10.001	S20	

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

PN	US/MH Name	Level Exceeded
S1.005	S21	
S11.000	S22	
S11.001	S23	
S1.006	S24	
S12.000	S25	
S12.001	S26	
S1.007	S27	
S13.000	S28	
S13.001	S29	
S1.008	S30	
S14.000	S31	
S14.001	S32	
S1.009	S33	
S15.000	S39	
S15.001	S40	
S16.000	S41	
S16.001	S42	
S17.000	S34	
S17.001	S35	
S17.002	S38	
S17.003	S45	
S17.004	S46	
S18.000	S51	
S18.001	S52	
S15.002	S43	
S19.000	S44	
S19.001	S45	
S1.010	S46	

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Appendix J

Drainage Details

Permavoid Modular Cell 150

Data Sheet

PRODUCT INFORMATION **P1** **ISSUE 4 - JUNE 2018**

Product code: PVPP150

Permavoid is a geocellular interlocking system designed for shallow ground water storage or infiltration, to be used in place of traditional aggregate sub-base, or to provide source control above ground at both roof and podium level, removing the need for heavier and less efficient systems. The system has an exceptionally high compressive and tensile strength and bending resistance with a proprietary jointing system to create a horizontal structural 'raft' within the pavement that is ideal for the shallow attenuation of surface water. The system can also be combined in layers using interlocking shear connectors to increase depth in 85mm and 150mm increments. This is particularly useful in designing infiltration systems, allowing flexibility in balancing the soil permeability/ infiltration area of the Permavoid storage units and residual temporary attenuation.

Applications

The Permavoid units are suitable for use as a stormwater attenuation and/or infiltration. The system comprises of single, interconnected cells which can be installed in the ground as part of sub-base formation, or above ground as part of roof or podium attenuation systems for source control. Permavoid is suitable for use in a range of applications including residential, industrial estates, car parks, sports pitches, roofs, basements, pedestrian areas and rainwater harvesting.

Key Benefits

- High strength, high capacity, shallow, sub-base replacement system
- Stormwater attenuation and/or infiltration system
- Used as part of a sustainable drainage system (SuDS) scheme to offer stormwater storage at shallow construction depths
- 100% recyclable
- Units are manufactured from 90% recycled polypropylene (PP)

Performance

The structural load bearing capacity of the Permavoid units have been tested in accordance with the following European Standard: BS 7533-13:2009. The system's structural design life expectancy, based upon creep test data (tested in accordance with CIRIA guidelines) is as follows; for lightly loaded areas such as car parks a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank.

Installation

All calculations for Permavoid units are based upon site-specific load cases, pavement construction types and thicknesses, soil cover and ground conditions and the suitability must therefore be approved for each project.

Technical Support

Detailed guidance and assistance is available.
For further information, please contact our Technical Team on **+44 (0) 1509 615 100** or email **civils@polypipe.com** or visit **www.polypipe.com/civils-technical-hub**

ELEMENT	VALUE
PHYSICAL PROPERTIES	
Weight per unit	3kg
Weight per square metre	12kg
Length	708mm
Width	354mm
Depth	150mm
SHORT TERM COMPRESSIVE STRENGTH	
Vertical	715kN/m²
Lateral	156kN/m²
SHORT TERM DEFLECTION	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
TENSILE STRENGTH	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
OTHER PROPERTIES	
Volumetric void ratio	95%
Average effective perforated surface area	52%
Intrinsic permeability (k)	Minimum 1.0 x 10^{-5}
Ancillary	Permavoid Permatie Permavoid Shear Connector
Material	Polypropylene (PP)

HYDRAULIC PERFORMANCE						
3 units wide, 1 unit deep (1.06m x 0.15m)						
FREE DISCHARGE						
Gradient (%)	0	1	2	3	4	5
Flow Rate (l/m/s)	8	13	15	17	19	21

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Permavoid Modular Cell 150

Data Sheet

Permavoid Modular Cell 150 can be utilised in these SuDS techniques

TECHNIQUES													
Blue-Green roofs	Podium Decks	Trees	Sports Pitches	Cycle Paths	Permeable Paving (sub base & podium)	Bioretention & Rain Gardens	Attenuation Storage Tanks	Infiltration	Swales	Filter Drains	Detention Basins	Ponds & Wetlands	Filter Strips
	✓		✓	✓	✓	✓	✓	✓	✓	✓			

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Permavoid 150mm Podium Deck Roof Access Chamber

Data Sheet

PRODUCT INFORMATION **P1** **ISSUE 2 - JULY 2018**

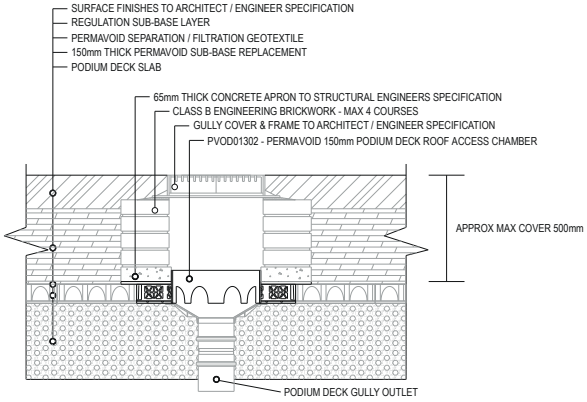
Product code: PVOD01302

The Permavoid 150mm Podium Deck Roof Access Chamber is engineered to provide access to an existing podium deck outlet, on a 150mm Permavoid sub-base replacement installation. It is set within 150mm Permavoid, providing a quick and easy connection to surrounding Permavoid. The chamber allows for easy access to an existing roof outlet for routine maintenance.

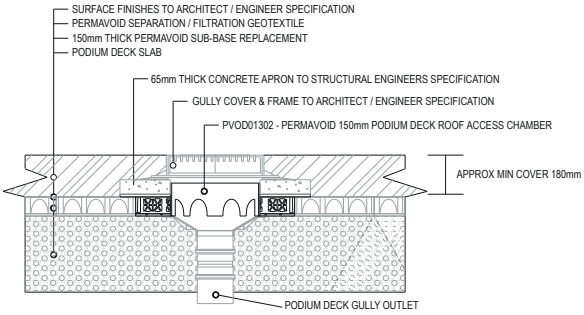
Key Benefits

- Engineered to provide access to an existing podium deck outlet
- Quick, easy connection to surrounding Permavoid
- Easy access for maintenance
- Designed to support the performance of existing outlet
- 100% recyclable

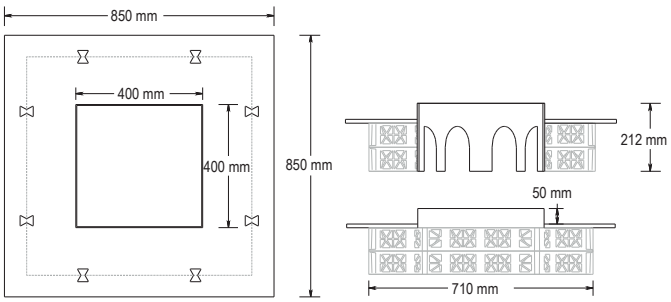
Application 1 - maximum cover approximately 500mm



Application 2 - minimum cover approximately 180mm



ELEMENT	VALUE
PHYSICAL PROPERTIES	
Length	850mm
Width	850mm
Depth	212mm
Outlet access length	400mm
Outlet access width	400mm
Unit weight	14kg
Material	HDPE/PP
PACKAGING DETAILS	
Packaging unit type	Double wall cardboard
Packaging unit dimension	872(L) x 872(W) x 234(H) mm
Packaging unit weight	14kg
Number of units per pallet	5
Pallet dimensions	1200(L) x 1200(W) x 1320(H) mm
Pallet weight	95kg



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Permavoid 150mm Podium Deck Roof Access Chamber

Data Sheet

Permavoid 150mm Podium Deck Roof Access Chamber can be utilised in these SuDS techniques

TECHNIQUES													
Blue-Green roofs	Podium Decks	Trees	Sports Pitches	Cycle Paths	Permeable Paving (sub base & podium)	Bioretention & Rain Gardens	Attenuation Storage Tanks	Infiltration	Swales	Filter Drains	Detention Basins	Ponds & Wetlands	Filter Strips
✓	✓												

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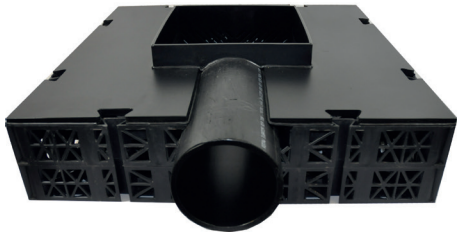
Permavoid 150mm Podium Deck Roof Diffuser Chamber with 160mm Inlet

Data Sheet

PRODUCT INFORMATION **P1** **ISSUE 2 - JULY 2018**

Product code: PVOD01403

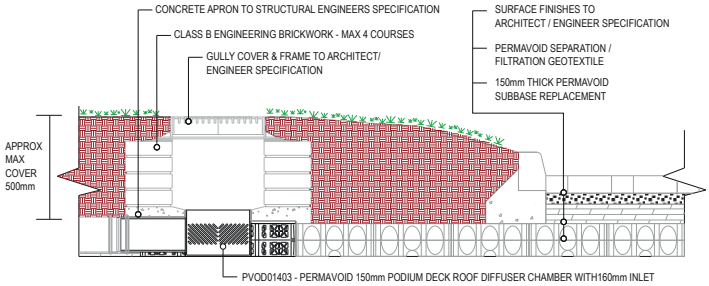
Designed for use in shallow Permavoid podium deck constructions, the Permavoid 150mm Podium Deck Roof Diffuser Chamber with 160mm Inlet collects rainwater via the 160mm Ø inlet pipe, filters through the perforated walls and is dispersed into the surrounding 150mm Permavoid storage system. It has an integral 50mm sump to effectively trap silt, and is compatible with standard 160mm Ø push fit couplings.



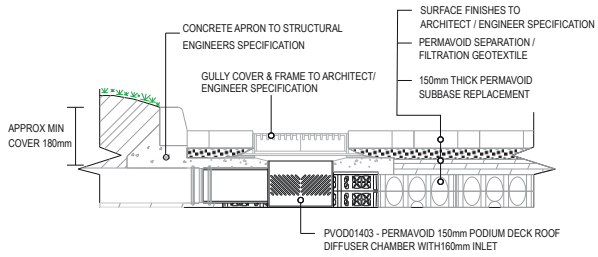
Key Benefits

- 20l/s controlled inlet water flow
- Passive flow control
- Easy access for routine maintenance
- Effective water dispersal
- Integrates with surrounding Permavoid
- Compatible with 160mm Ø standard couplings
- 100% recyclable

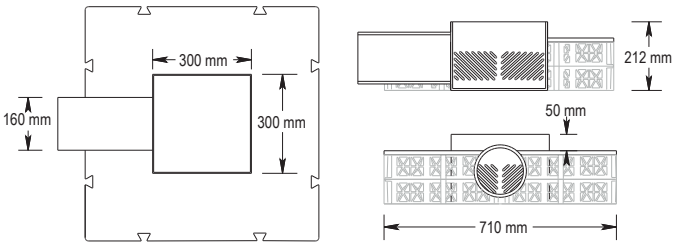
Application 1 - maximum cover approximately 500mm



Application 2 - minimum cover approximately 180mm



ELEMENT	VALUE
PHYSICAL PROPERTIES	
Length	800mm
Width	710mm
Depth	212mm
Sump depth	50mm
Inlet spigot Ø OD	160mm
Inlet spigot length	90mm
Maximum flow	20l/s
Unit weight	12.4kg
Material	HDPE/PP
PACKAGING DETAILS	
Packaging unit type	Double wall cardboard
Packaging unit dimension	822(L) x 732(W) x 237(H) mm
Packaging unit weight	12.4kg
Number of units per pallet	12
Pallet dimensions	1200(L) x 1200(W) x 1614(H) mm
Pallet weight	176.2kg



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Permavoid 150mm Podium Deck Roof Diffuser Chamber with 160mm Inlet

Data Sheet

Permavoid 150mm Podium Deck Roof Diffuser Chamber with 160mm Inlet can be utilised in these SuDS techniques

TECHNIQUES													
Blue-Green roofs	Podium Decks	Trees	Sports Pitches	Cycle Paths	Permeable Paving (sub base & podium)	Bioretention & Rain Gardens	Attenuation Storage Tanks	Infiltration	Swales	Filter Drains	Detention Basins	Ponds & Wetlands	Filter Strips
✓	✓												

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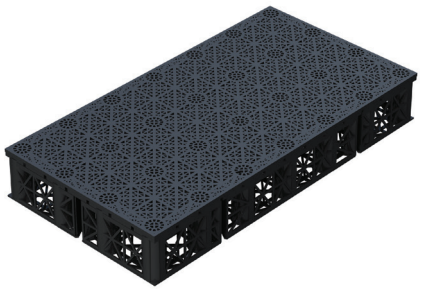
Permavoid Modular Cell 85

Data Sheet

PRODUCT INFORMATION **P1** **ISSUE 4 - JUNE 2018**

Product code: PVPP85

Permavoid is a geocellular interlocking system designed for shallow ground water storage or infiltration, to be used in place of traditional aggregate sub-base or can provide source control at both roof and podium level, removing the need for heavier and less efficient systems. The system has an exceptionally high compressive and tensile strength and bending resistance with a proprietary jointing system to create a horizontal structural 'raft' within the pavement that is ideal for the shallow attenuation of surface water. The system can also be combined in layers using interlocking shear connectors to increase depth in 85mm and 150mm increments. This is particularly useful in designing infiltration systems, allowing flexibility in balancing the soil permeability/infiltration area of the Permavoid storage units and residual temporary attenuation.



Applications

The Permavoid units are suitable for use as a stormwater attenuation and/or infiltration system. The system comprises of single, interconnected cells which can be installed in the ground as part of sub-base formation, or above ground as part of roof or podium attenuation systems for source control. Permavoid is suitable for use in a range of applications including residential, industrial estates, car parks, sports pitches, roofs, basements, pedestrian areas and rainwater harvesting.

Key Benefits

- High strength, high capacity, shallow, sub-base replacement system
- Stormwater attenuation and/or infiltration system
- Used as part of a sustainable drainage system (SuDS) scheme to offer stormwater storage at shallow construction depth
- 100% recyclable
- Units are manufactured from 90% recycled polypropylene (PP)

Performance

The structural load bearing capacity of the Permavoid units have been tested in accordance with the following European Standard: BS 7533-13:2009. The system's structural design life expectancy, based upon creep test data (tested in accordance with CIRIA guidelines) is as follows; for lightly loaded areas such as car parks a design life of 50 years is achievable. For areas with prolonged HGV loading a typical design life may only be 25 years, depending on the design of the pavement surfacing and structural layers over the tank.

Installation

All calculations for Permavoid units are based upon site-specific load cases, pavement construction types and thicknesses, soil cover and ground conditions and the suitability must therefore be approved for each project.

Technical Support

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ELEMENT	VALUE
PHYSICAL PROPERTIES	
Weight per unit	2.25kg
Weight per square metre	9kg
Length	708mm
Width	354mm
Depth	85mm
SHORT TERM COMPRESSIVE STRENGTH	
Vertical	715kN/m²
Lateral	156kN/m²
SHORT TERM DEFLECTION	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
TENSILE STRENGTH	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
OTHER PROPERTIES	
Volumetric void ratio	92%
Average effective perforated surface area	52%
Intrinsic permeability (k)	Minimum 1.0 x 10^{-5}
Ancillary	Permavoid Permatie Permavoid Shear Connector
Material	Polypropylene (PP)

HYDRAULIC PERFORMANCE			
3 units wide, 1 unit deep (1.06m x 0.15m)			
FREE DISCHARGE			
Gradient (%)	0	1	2
Flow Rate (l/m/s)	4	6	7

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Permavoid Modular Cell 85

Data Sheet

Permavoid Modular Cell 85 can be utilised in these SuDS techniques

TECHNIQUES													
Blue-Green roofs	Podium Decks	Trees	Sports Pitches	Cycle Paths	Permeable Paving (sub base & podium)	Bioretention & Rain Gardens	Attenuation Storage Tanks	Infiltration	Swales	Filter Drains	Detention Basins	Ponds & Wetlands	Filter Strips
✓	✓	✓	✓		✓	✓	✓	✓	✓				

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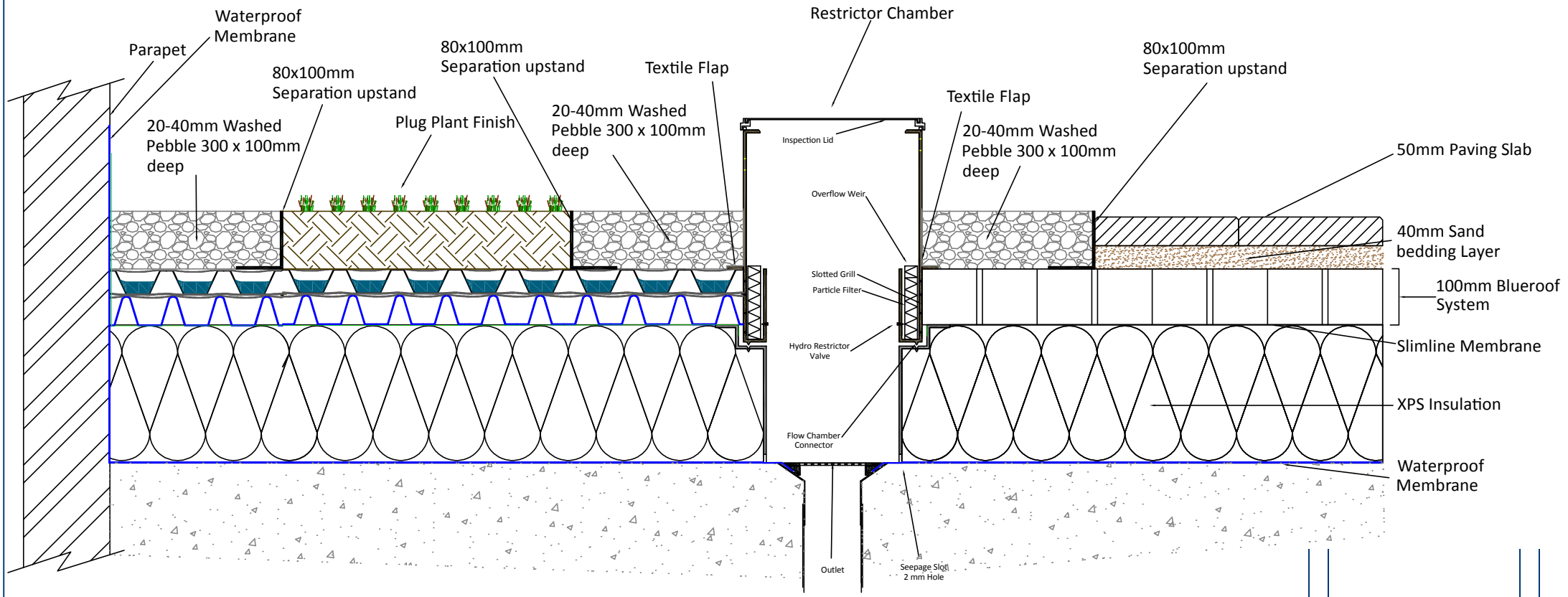

Rev:	Comments:	By:	Date:

Project: BLUE ROOF

Title: INVERTED

Drawn by:	Date:	
GJB	29/10/15	
Scale: NTS	Drawing Ref: BR02	Rev: XX

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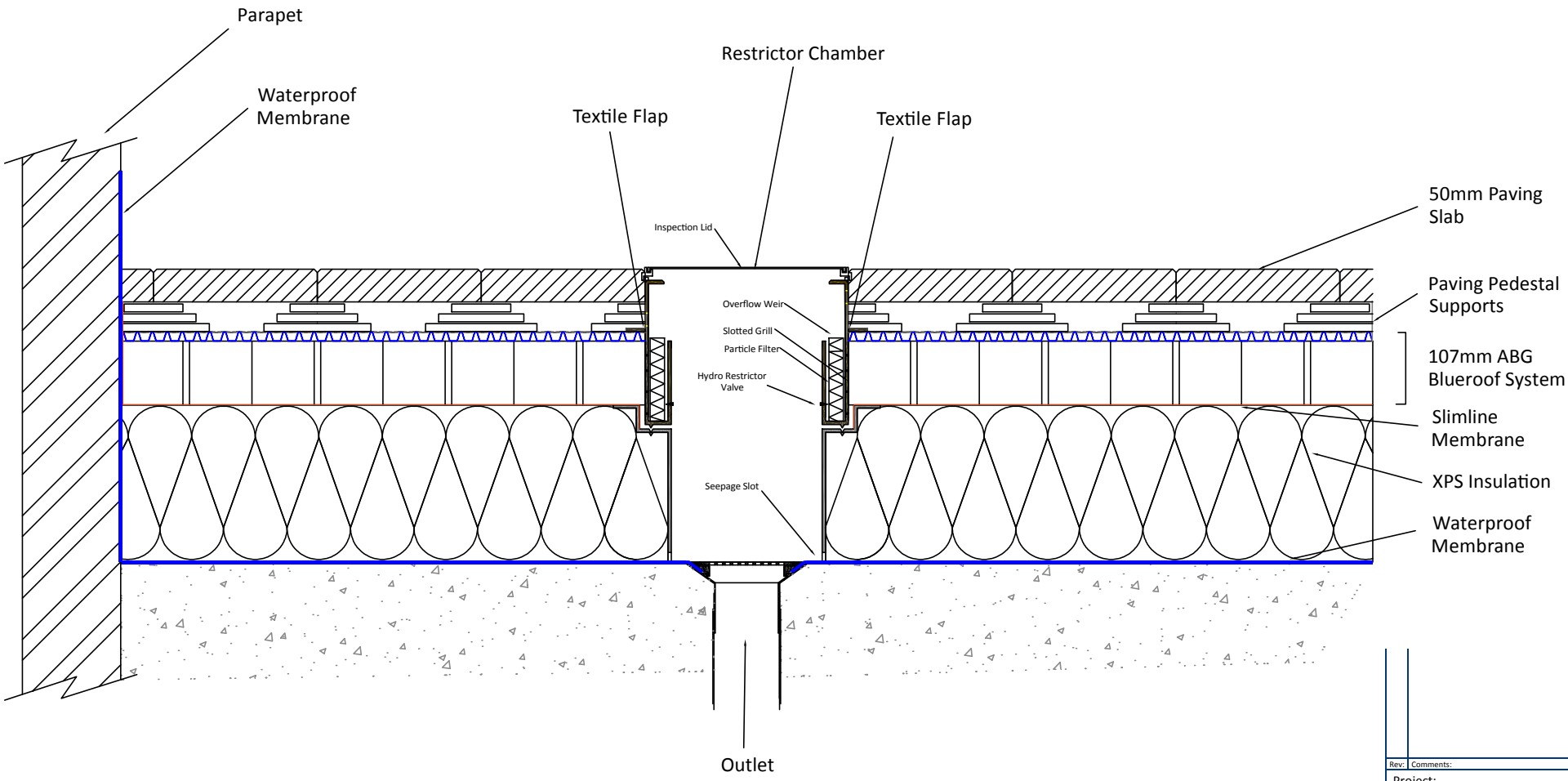
Tunnels | Green Roofs | Landscaping | Highways



Rev:	Comments:	By:	Date:

Project:
BLUE ROOF

Title:
Restrictor Chamber and Paving Detail

Drawn by:	Date:	
GJB	30/03/16	
Scale: NTS	Drawing Ref: XXXXXXXXX	Rev: XX

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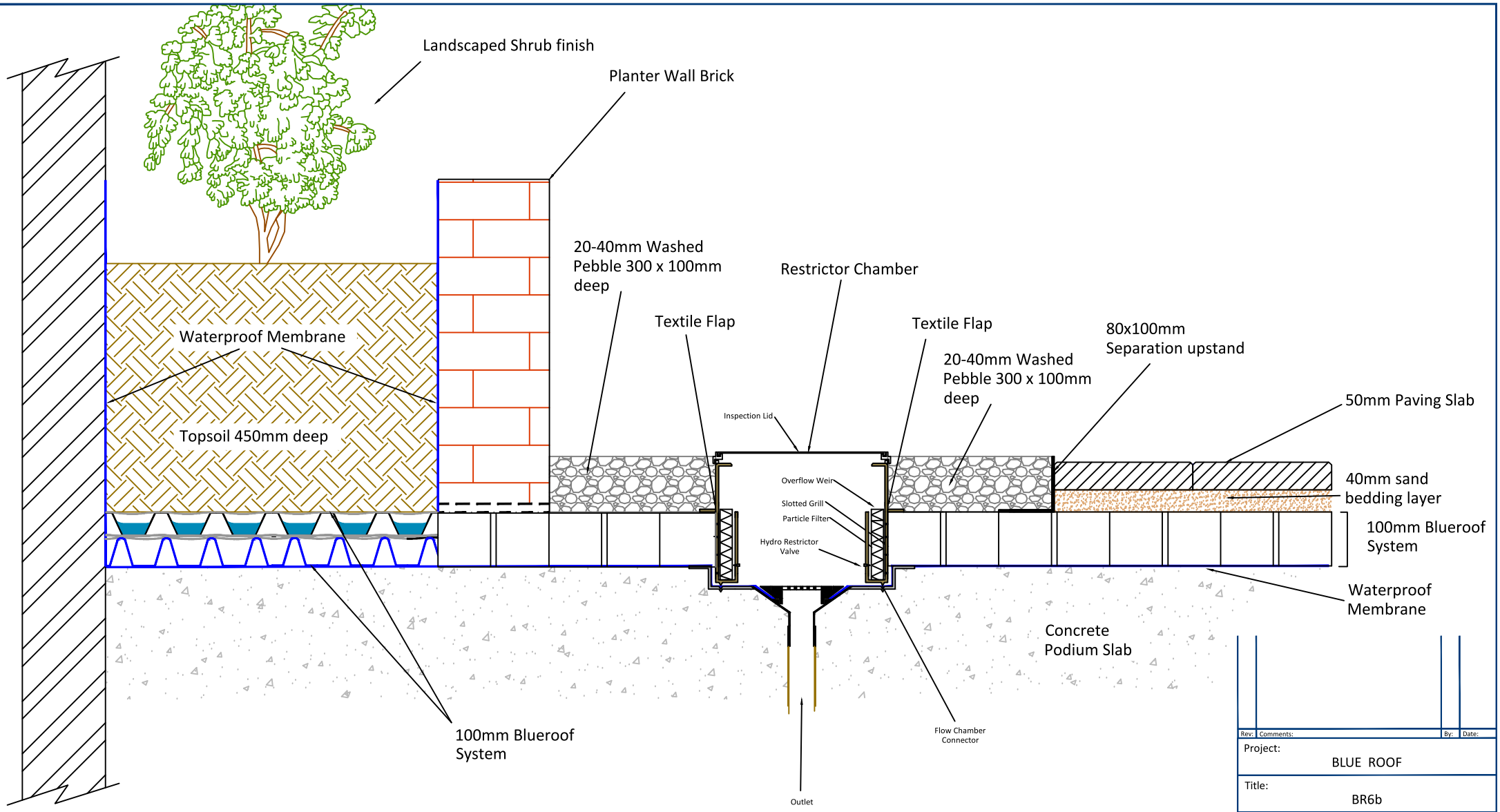

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Project: BLUE ROOF		
Title: BR6b		
Drawn by: GJB	Date: 08/10/15	
Scale: NTS	Drawing Ref: XXXXXXXXX	Rev: XX

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