Kingscrown Land & Commercial Ltd

Bontnewydd

Bontnewydd Residential Development

Flood Consequence Assessment

ECL.9516.R05.001 Rev: -

March 2023

Prepared for

Kingscrown Land & Commercial Ltd

Prepared by

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Document Review

Rev	Date	Prepared By	Reviewed By	Approved By
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1.0 INTRODUCTION

1.0.1 Egniol Consulting Limited (Egniol) of Llys Onnen, Parc Menai, Bangor, Gwynedd have been appointed by Kingscrown Land & Commercial Ltd as Consultants to prepare a Flood Consequence Assessment Report (FCA) for the proposed new residential development at Lon Caeathro, Bontnewydd.

1.0.2 The proposed development includes 24 number residential properties and associated hard and soft landscaping. The total development area, including access road and landscaping measures circa 0.338 hectares. The development (Site) is currently greenfield with no utilities servicing the site. Highways access is currently gained via a small gate off of Lon Caeathro.

1.0.3 This FCA seeks to set out development principles and guidelines for the proposed residential development. Each residence has allocated parking and access as well as rear gardens. The master planning for the Site has been undertaken by Ainsley Gommon Architects (AGA).

1.0.4 The existing site is undeveloped, consisting of an agricultural field. A review of historical record maps show that the site has been undeveloped since at least 1870.

1.0.5 The site is located within the Gwynedd Council (GC) which is recognised as a unitary authority and therefore responsible for related Lead Local Flood Authority (LLFA) duties.

1.0.6 This assessment has been undertaken in accordance with the latest planning requirements including TAN 15, related policy, and associated guidance specific to GC.

2.0 SITE DETAILS

2.1 Site Location

2.1.1 The proposed development is located to the northeast of Bontnewydd. Access to the site is gained via Lon Caeathro. The site is approximately located to the below grid coordinates:

E: 248373.00m
N: 360169.00m

Figure 1: Site Location (Ordinance Survey Map Extract)

2.2 Site History

2.2.1 An engineering desk study has been carried out by Soil and Structures Ltd (October 2022). This FCA will make references to the findings within this desk study.

2.2.2 The site has been subject to one phase of use since the 1870s to the present day, where the Site has been used as a field.

2.3 Site Description

2.3.1 The site is rectangular in for, covers approximately 0.338ha, with levels falling from the south-east of the site (42.00m AOD) to the north-west of site (35.12m AOD).

2.3.2 The levels along the southern boundary run from 35.88m in the southwest corner to 42.00m in the southeast corner. The levels along the eastern boundary runs from 42.00m in the southeast corner to 37.91m at the north-eastern corner. The northern

boundary runs from 37.91m on the north-eastern corner to 35.37m on the north-western boundary. Refer to **Appendix 1** for site topographical survey for further details on existing levels.

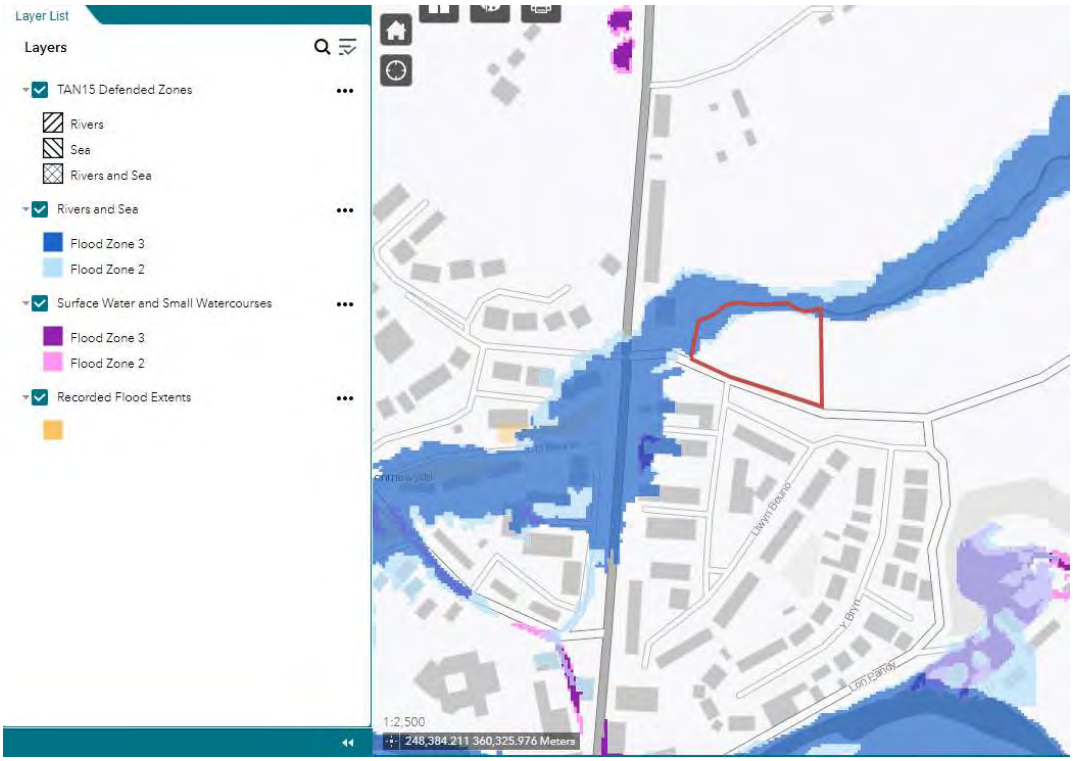
2.3.3 The southern boundary of site is abutted to the existing public highway (Lon Caeathro, maintained by Gwynedd Highways). The eastern boundary abuts an existing grassed field, with existing electricity pylons and associated cables crossing the site in a north easterly direction through the middle of the eastern boundary. The northern and western boundaries of site abut the Afon Bueno river, with existing trees and vegetation lining these boundaries.

2.4 Rivers and Waterways

2.4.1 The river Afon Bueno abuts the site's northern and western boundaries. Afon Beuno is an ordinary watercourse and tributary to the Afon Gwyrfai which is main river located about 450m to the west.

2.4.2 A review of the Natural Resources Wales Flood Map for Planning shows that the site predominately sits within Flood Zone 1, with Flood Zones 2 and 3 encroaching the sites lower levels along the northern and western boundaries with the Afon Bueno. Figure 2 shows an extract of the Natural Resources Wales Flood Map for Planning.

Figure 2: Natural Resources Wales Flood Map for Planning Extract



3.0 POLICY AND GUIDANCE

3.1 Policy

3.1.1 The relevant policy has been identified and set out in Table 1 below:

Table 1 – Policy

Policy/Regulations	Key Provisions
Planning Policy Wales (PPW) 10th Edition (December 2018)	PPW sets out the Welsh Government's plans to deliver the vision for Wales in accordance with the Well-being of Future Generations Act 2015. With respect to flooding it outlines the role of planning and the requirement to understand future flood risk.
Technical Advice Note 15: Development and Flood Risk (TAN15)	TAN 15 provides technical guidance which supplement the policy set out in PPW in relation to development and flooding. The aim of TAN 15 is to direct new development away from those areas which are identified as having a high risk of flooding.
Flood and Water Management Act 2010	The aim is to implement the findings of the 2007 Pitt Review and co-ordinate control of drainage and flood issues. Schedule 3 to the Flood and Water Management Act 2010 makes Sustainable Drainage Systems (SuDS) a mandatory requirement for all new developments in Wales. All new developments of more than one dwelling house or where the construction area is 100 m^2 or more requires, SuDS for surface water From January 2019, SuDS on new developments must be designed and built in accordance with the Statutory SuDS Standards published by the Welsh Ministers and SuDS Schemes must be approved by the local authority acting as SuDS Approval Body (SAB).
Water Framework Directive (2000)	The Water Framework Directive (WFD) came in to force in 2000 and requires all inland and coastal waters to reach 'good' chemical and biological status. The main impact of the WFD on flood risk management, both now and in the future, relates to the ecological quality of water bodies. Effects on chemical water quality resulting from Flood risk management, is most likely to occur as a result of sediment being disturbed or where pollutants are mobilised from contaminated land by flood waters.

3.2 Guidance

3.2.1 Key relevant guidance has been identified and set out in Table 2 below, a list of standards and best practice considered in preparing the FCA.

Table 2 – Guidance

Standards	Key Provisions
BS 8533: 2017 Assessing and managing flood risk in development – Code of Practice	This BS gives recommendations and guidance on the appropriate assessment and management of flood risk in developments. It is intended to provide practical assistance for understanding and dealing with the flood risk associated with a proposed development.
BS 8582: 2013 Code of Practice for surface water management for development sites	The focus of this BS is on the sustainable management of flood risks arising from surface water run-off on development sites, although criteria relating to the management of a wider suite of environmental risks is given. The benefits that can accrue from surface water drainage systems are highlighted and relevant references provided.
Ciria The SuDS Manual (Cira 753)	General guidance covering the planning, design, construction, and maintenance of SuDS aiding the effective implementation within both new and existing developments. The guidance provides a framework for designing SuDS; its contents is relevant for a wide array of professionals.

4.0 GEOLOGY AND HYDROLOGY

4.1 Geology

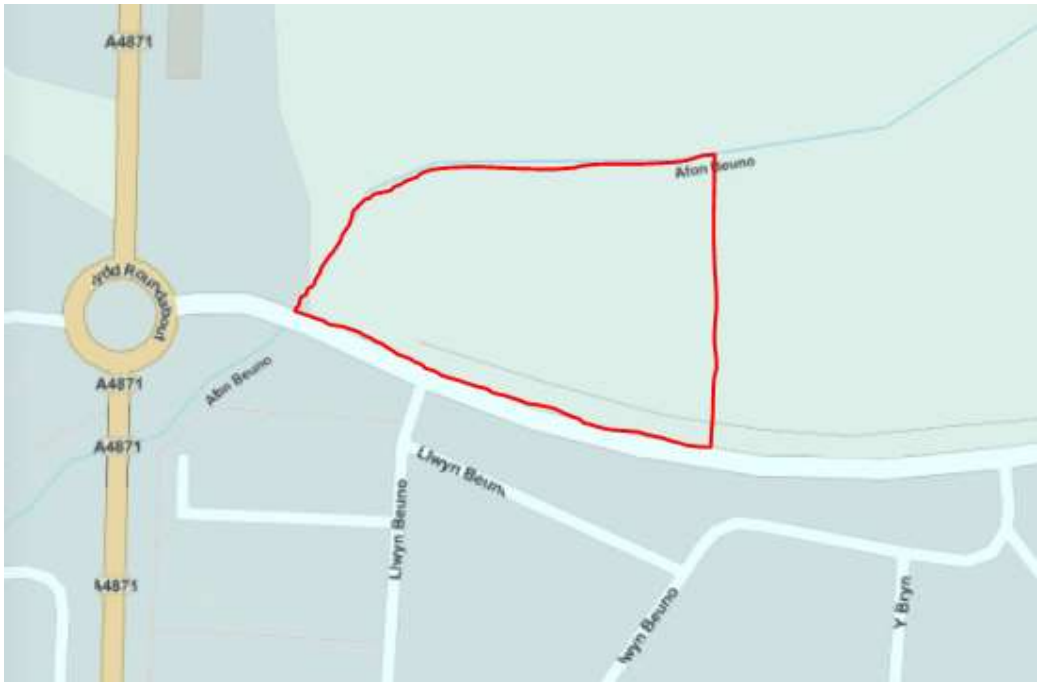
4.1.1 The following section covers the geology and hydrology of the site. The information given has been taken from the British Geological Survey (BGS) map viewers as well as the site Engineering Desk Study produced by Soil and Structures Ltd (report reference 20206-R-001-V01).

4.1.2 The majority of the site bedrock geology is described as Nant Ffancon Subgroup (consisting mainly of sedimentary Siltstone bedrock). The south-eastern section of site consists of the Fachwen Formation (consisting of sedimentary Sandstone and Siltstone bedrock). A fault runs through the site in a northeast to southwest direction. Details are shown below in Figure 3,obtained from the BGS.

Figure 3: Bedrock Geology (BGS Map Extract)

4.1.3 The BGS maps show that the site is underlain by superficial deposits of sedimentary Till. Details are shown below in Figure 4 (obtained from BGS).

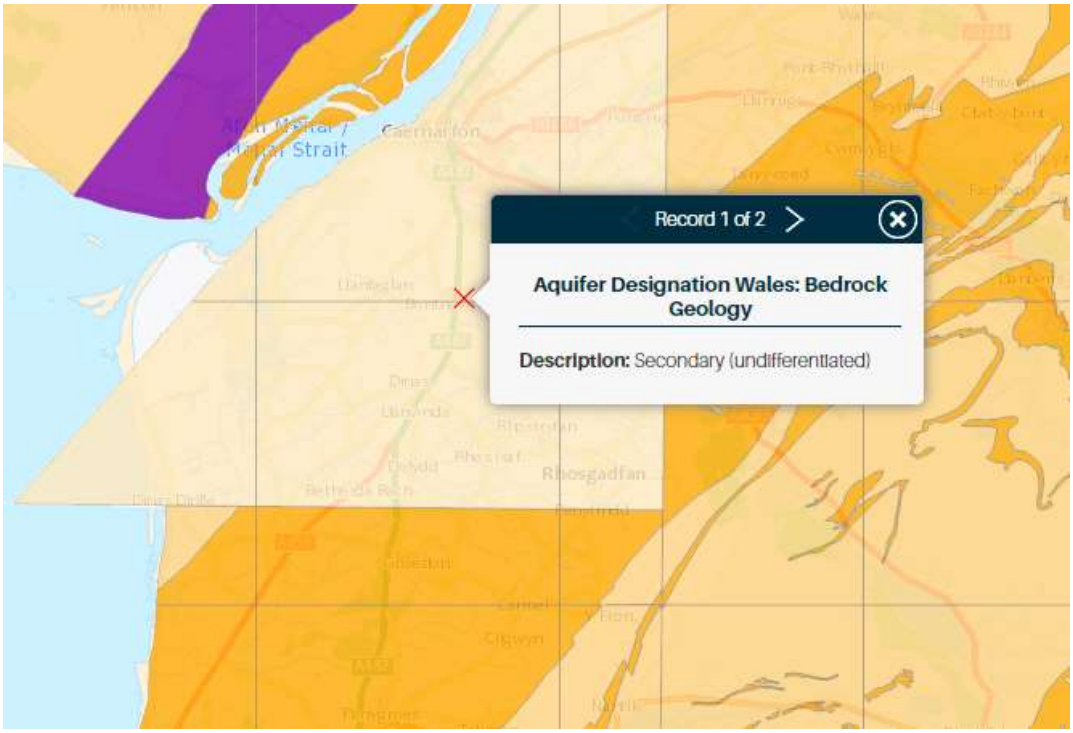
Figure 4: Superficial Geology (BGS Map Extract)



4.2 Hydrogeology

4.2.1 The aquifer designation for the bedrock geology is deemed to be a secondary (undifferentiated) aquifer, see details provided in Figure 5 (obtained from BGS).

Figure 5: Bedrock Geology Aquifer (BGS Map Extract)



4.2 In-situ testing

On site infiltration tests have been carried out by Datrys (report reference 2007-E-01) which show that the site sub-strata is general impermeable, with the permeability test (TP3) to the west of the site showing infiltration potential.

5.0 EXISTING SEWERS

5.1 Surface Water Sewer

5.1.1 The existing site is greenfield and not currently served by any formal surface water drainage.

5.1.2 On site infiltration tests demonstrate that the site is suitable for infiltration systems It is proposed that the majority of the site's sustainable drainage will compromise of impermeable techniques, discharging to a SUDs basin which will utilise infiltration as well as a positive discharge to the Afon Bueno, this is covered further below.

5.1 Foul Water Sewer

5.2.1 The existing site is not served by any formal foul drainage. It is assumed that a public foul water sewer can be found in Lon Caeathro south of the site.

5.2.2 It is proposed that the foul flows from site be discharge via a new connection to the existing public foul water sewer. It is noted that Dwr Cymru Welsh Water (DCWW) is the sewerage undertaker owning and maintaining foul water sewers in this area.

6.0 FLOOD RISK

6.1 General

6.1.1 This section seeks to confirm which form of flooding the Site is most at risk from. The forms of flooding considered include the following as defined in BS 8533:

- Flooding from Rivers (fluvial flood risk)
- Flooding from the Sea (tidal flood risk)
- Flooding from the Land (pluvial flood risk)
- Flooding from Reservoirs, Canals, and other Artificial Structures

6.2 Flood Zone Delegation

6.2.1 The proposed site is north of Bontnewydd Town Centre. The Development Advice Maps provided by Natural Resources Wales (NRW) identifies the Site as being in Zone A. Zone A is considered 'to be at little or no risk of fluvial or coastal/tidal flooding'. Refer to Figure 6 for site Flood Risk as shown on NRWs development Advice Maps.

Figure 6: Site Flood Risk – Development Advice Maps (NRW)

6.3 Flood Risk

6.3.1 The different types of flood risk are considered in more detail in the following sections. Information regarding long term flood risk is provided within the Flood Map for Planning portal on the NRW website.

6.3.2 Flood Risk from Sea

The site sits within an area at no risk of flooding from the Sea.

6.3.3 Flood Risk from Surface Water (Pluvial)

There are no areas of the site affected by surface water flooding according to the NRW Flood Map for Planning portal. Refer to Figure 7 below.

Figure 7: Surface Water Flooding – Flood Map for Planning (NRW)

6.3.4 Flood Risk from Rivers (Fluvial)

As mentioned in section 2.4.1, the small area of site adjacent to the Afon Bueno sit within Flood Zones 2 and 3. The proposed residential development will be sited outside of the river flood zone with minimal works taking plan within the flood zone extent. Refer to Figure 8 for extent of Fluvial flooding as shown on the NRW Flood Map for Planning portal.

Figure 8: Flooding from Rivers (Fluvial) – Flood Map for Planning (NRW)

6.3.5 Flood Risk from Reservoirs.

The NRW FRAW maps show no flooding from reservoirs within the proximity of the site, therefore it is concluded that the site is not at risk of flooding due to reservoirs, canals and other artificial structures.

7.0 SURFACE WATER DRAINAGE STRATEGY

7.1 General

7.1.1 The development proposals include 24no. residential units with associated hard and soft landscaped areas. The surface water runoff from the hard surfaces will need to be managed. The hierarchy of disposal of surface water from new development are generally accepted as being the following:

- Discharge by infiltration to the ground
- Discharge to an open surface water body
- Discharge to a surface water sewer

7.1.2 The principles that set out the preferred method of disposal of surface water runoff generated by the new development are set out in the following sections. Essentially a set of principles are to be assigned to the development. Due to the variable permeability capabilities of the sites sub-strata, infiltration techniques will be used in conjunction with a positive discharge to the Afon Bueno to disperse the surface water run-off generated by the development.

7.1.3 The strategy for dealing with the surface water discharge and attenuation is illustrated within the Proposed Site Drainage Layout Plan in **Appendix 2**.

7.1.4 The application of sustainable urban drainage system (SuDS) is primarily driven by the nature of the residential development illustrated on the masterplan (**Appendix 3**). The development proposals include a mixture of hard and soft landscaping with numerous opportunities available utilise suds drainage techniques to dispose of surface water run-off. Taking into consideration the triarchy of suds design philosophy, quality, quantity and amenity, the following SuDS features that have been incorporated into the design include the following:

- Porous permeable paving
- Rainwater Harvesting
- Raingardens
- Attenuation/Infiltration Basin

7.1.5 Permeability testing has shown that only a western section of the site's sub-strata is permeable with an infiltration rate of $3.54x10^{-5}$ m/s. Due to the variedness of the sites permeability it is envisaged that the majority of the proposed SUDs devices will be designed without an allowance for infiltration whilst the main site attenuation basin will utilise infiltration as well as a positive outfall to the Afon Bueno. Refer to **Appendix 4** for site permeability testing report produced by Datrys.

7.1.6 The associated MicroDrainage source control calculations for the proposed development's surface water drainage system are attached within **Appendix 5.**

7.1.7 The surface water discharge from development is to be discharged at the existing greenfield run-off rate to the Afon Bueno, with infiltration techniques used where the site sub-strata allows.

7.1.8 The surface water run-off generated by roofs and private hardstanding areas (such as car parking bays and footpaths to the frontage of the buildings) are to discharge to attenuated permeable paving to the front of the proposed properties prior to discharging to the below ground surface water drainage network via orifice flow

control devices. Sedimentation control is to be provided through the use of upstream catchpits with the car parking sub-base providing pollution treatment within the granular material sub-matrix.

7.1.9 Surface water run-off from the new access road and public hardstanding areas are to discharge to the below ground drainage network prior to discharging to the site attenuation basin located to the west of the development. Additional storage is provided throughout development for low intensity storms using raingardens. Sedimentation control is provided using sumped gullies and catchpits, with further pollution control provided within the attenuation basin and raingarden storage matrix.

7.2 Flood Mitigation

7.2.1 Design Parameters

The design of the flood mitigation for the development is based on the following:

- Storm design: 1 in 100 year return period
- Climate change: 40%
- Rainfall: Flood Studies Report
- Restricted discharge: Runoff restricted to 5 l/s
- Infiltration: 3.54×10^{-5} m/s (west of site only)

7.2.2 Restricted Discharge Rate

Given the variable permeability of the site it is proposed that the site surface water run-off be attenuated within an attenuation basin to the west of the site prior to discharging to the Afon Bueno at a restricted greenfield discharge rate. Using the UKSUDs Greenfield Run-off calculation tool the Qbar discharge rate for the proposed site was calculated as 1.22 l/s. As per CIRIA guidance, due to the risk of blockage of a proposed flow control device at a discharge rate of 1.22l/s by vegetation and other material the proposed restricted discharge rate from development is to be set at 5.0 l/s. Refer to **Appendix 6** for UKSUDs greenfield run-off rate calculations, greenfield run-off rates are summarised below in Figure 9.

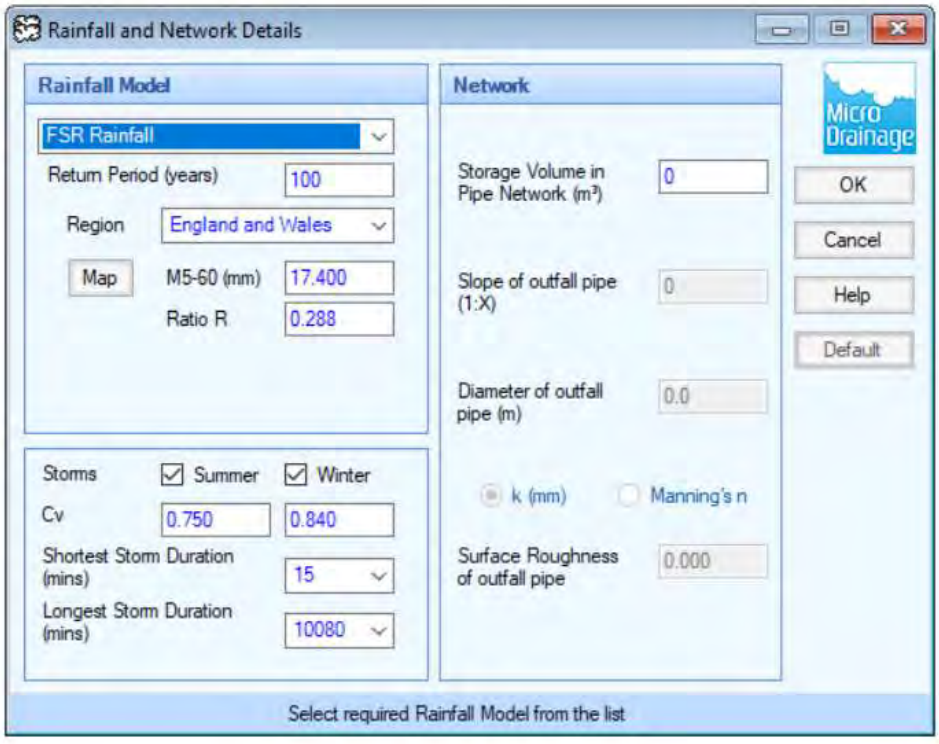
Figure 9: Greenfield Run-off Rates (UKSUDs Output)

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	1.22	1.22
1 in 1 year (l/s):	1.07	1.07
1 in 30 years (l/s):	2.17	2.17
1 in 100 year (l/s):	2.66	2.66
1 in 200 years (l/s):	3	3

7.2.3 Flood Mitigation

Preliminary flood mitigation volumes for site were calculated using MicroDrainage's Source Control module. The figure below shows the criteria used for the proposed design.

Figure 10: Simulation Criteria



7.2.3 Using the MicroDrainage Source Control module and cascade tool to model the proposed surface water storage requirements for the 1 in 100 year (plus 40% allowance for climate change) within the permeable car parks and attenuation

basin, the total amount of flood mitigation storage on site was calculated to be 84.5m^3.

7.2.4 Other SUDS Options

The options to introduce further SUDS features is reliant upon the respective unit developer's requirements considering the amount of roofs and hardstanding, the probable secondary options include the following:

- o Green roofs
- o Rainwater harvesting

7.2.5 Water Quality

The surface water runoff from each unit will require base level of treatment, this is expected to be provided by the provision of trapped gullies and catchpits; this will ensure detritus and hydrocarbons are intercepted. Sections 7.1.9 to 7.1.11 highlight the water quality control measures allowed for within the design.

7.2.6 Afon Bueno Flood Plain

As previously mentioned the proposed development's western and northern boundaries encroach the existing Afon Bueno flood plains (as shown on the NRW Flood Maps for Planning). To ensure that the built development footprint does not sit within this area and that the works are kept to a minimum within the flood plain an extract of the flood maps has been scaled and overlaid on to the proposed topographical survey and the proposed development orientated with this in mind (see Figure 11 below).

Figure 11: Site Plan Overlay with NRW Fluvial Flood Maps

7.2.7 The development has been designed such that the access road and residential development do not encroach the existing flood plain. Development levels will be set higher than the existing; and a retaining wall introduced between the higher

development area and the lower Afon Bueno flood plain to ensure that the flood risk is dealt with safely. (refer to Appendix 3, Architects illustrative masterplan). In terms of access and egress, vehicular access is gained directly off the existing highway, Lon Caeathro, which will sit lower than the proposed development levels.

7.2.8 The introduction of a retaining wall to the northern and western boundary seeks to address any residential flood risk relating from storm events in excess of the 1:100 year events (plus climate). The level of this wall is to be set according to…..

8.0 SURFACE WATER MANAGEMENT

8.0.1 The management of the surface water system is to be carried out in line with the generic surface water management plan provided in **Appendix 7**.

8.0.2 The above surface water management plan may be supplemented during the development construction phase with further measures. Further measures to be considered by the contractor as part of the ongoing risk assessments and method statements pertinent to the works.

9.0 CONCLUSION

9.0.1 The proposed development consists of twenty four dwellings contained within an existing greenfield site to the north of Bontnewydd. The 0.338hectare development will be constructed in in a single phase; construction access will be gained via a new bellmouth with Lon Caeathro.

9.0.2 Due to the variable permeability of the existing site sub-strata, soakaway devices are considered suitable for the west of the site only and are deemed inappropriate means of disposing surface water run-off from the entirety of the development. Therefore, attenuated permeable car parking and raingardens will be utilised to the east and centre of the site, with an unlined attenuation basin to the west of the site which will utilise a positive restricted connection to the Afon Bueno as well infiltration.

9.0.3 The proposed surface water drainage solution for the development utilises attenuated (or lined) permeable block paved car parks, raingardens and an attenuation basin to discharge the surface water run-off primarily to the local watercourse with some infiltration to ground. Flood mitigation is to be designed for the 1 in 100-year storm event plus 40% allowance for climate change.

9.0.4 Water quality within the development is to be managed by implementing appropriate surface water system; this will comprise of trapped gullies and catchpits as appropriate and in line with Building Regulations. Further interception of hydrocarbons is expected to occur via the permeable paved car parking. The proposed suds devices will also provide a betterment in water quality being dispersed from the proposed development.

9.0.5 The overland flows are expected to follow the general topography of the site which falls from the southeast of the site to the northwest. It is anticipated that the site levels will be designed such as to allow any overland flooding events to be retained within the site boundary.

9.0.6 The management of surface water systems is anticipated to be carried out by the residents and developers; this should be carried out in accordance with a recommended surface water management plan.

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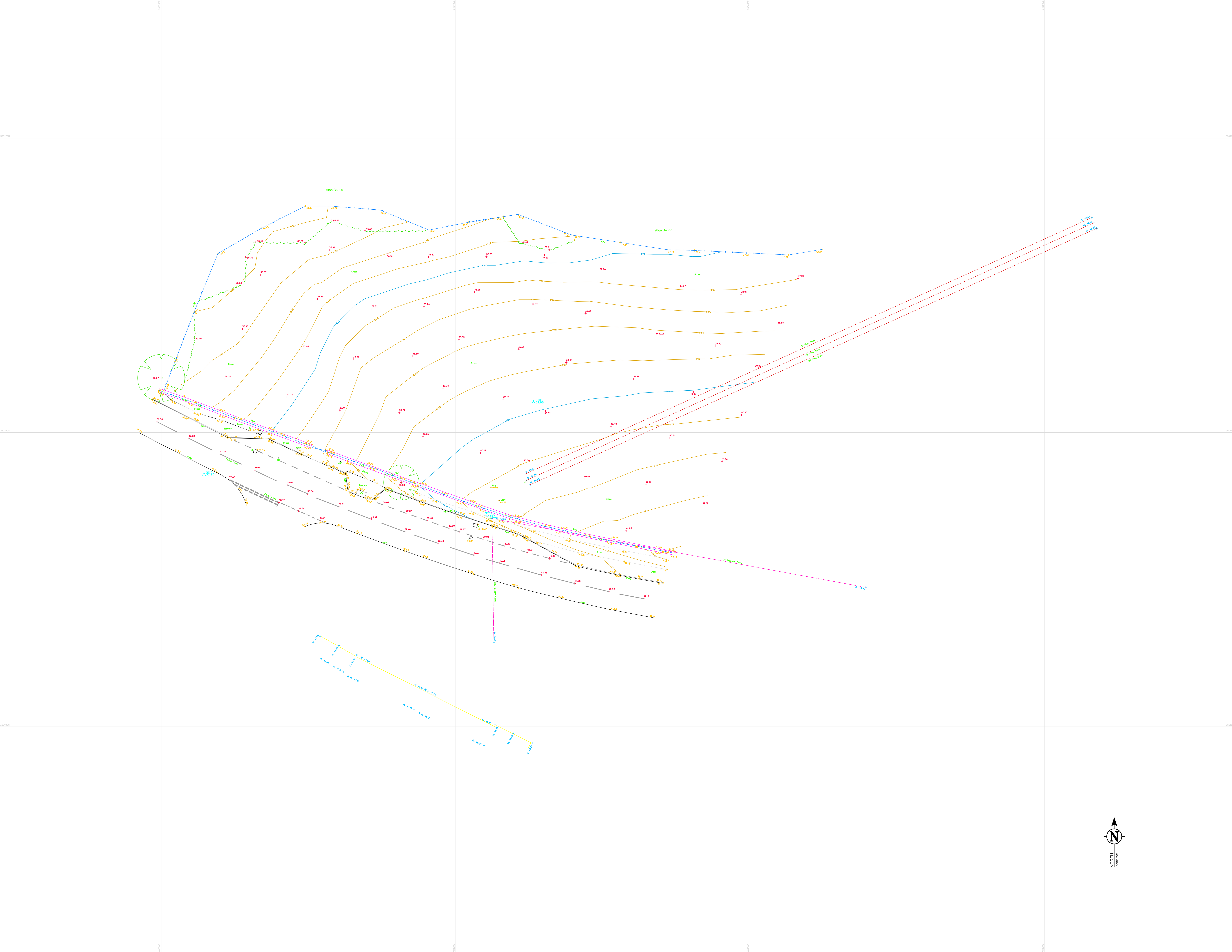
Appendix 1

Site Topographical Survey



Topographical Survey Legend

B	Bollard	h	Height	RWP	Rain Water Pipe
BS	Bus Stop	Hyd	Hydrant	SP	Soil Pipe
BT	Telecommunications IC	IC	Inspection Cover	SPS	Stone Paving Slabs
CPS	Concrete Paving Slabs	JB	Junction Box	ST	Stop Tap
CTV	Cable Television Cover	KO	Kerb Outlet	Stay	Cable Stay
DP	Downpipe	LB	Letter Box	SV	Stop Valve
DR	Drain	LP	Lamp Post	TCB	Telephone Call Box
Elec	Electrical IC	Mkr	Utility Marker	TL	Traffic Light
EP	Elec. Pole	MP	Mile Post	TP	Telegraph Pole
ER	Earth Rod	NP	Name Plate	TPS	Tactile Paving Slabs
FP	Flagpole	P	Post	VP	Vent Pipe
FT	Floodlight	PM	Parking Meter	WM	Water Meter
G	Gully	RE	Rodding Eye	WO	Water Outlet
GP	Gate Post	RS	Road Sign	UTL	Unable To Lift
GV	Gas Valve	RTW	Retaining Wall		

Fence Annotation

B/W	Barbed Wire
C/B	Closed Boarded
C/I	Corrugated Iron
C/L	Chain Link
C/P	Concrete Panel
H/R	Hand Rail
I/R	Iron Railings
O/B	Open Boarded
P/C	Post & Chain
P/R	Post & Rail
P/W	Post & Wire
W/M	Wire Mesh

Level Prefix Descriptions

AL	Arch Level	RL	Roof/ridge Level
BL	Bed Level	SL	Soffit Level
CL	Cover Level	Spr	Arch Springing Level
EL	Eaves Level	TF	Top Of Fence Level
FL	Floor Level	TW	Top Of Wall Level
IL	Invert Level	Thr	Threshold Level
OL	Overhead Cable Level	WL	Water Level
PL	Parapet Level		

50.00 Spot Level

SSL1 50.00 Survey Control Station (coordinated point)

C/L Fence

Safety Barrier

Gate

Stile

MT Tree Multi Trunk

Hedge

Limit of Foliage & Tree Canopy

Levels defining edge of carriageway are observed at channel (bottom of kerb). Unless otherwise stated.

DRAWING NOTES

Topographical Surveys

Trees are drawn to scale showing the average canopy spread. Descriptions and heights should be used as a guide only.

All building names, descriptions, number of storeys, construction type including roof line details are indicative only and taken externally from ground level.

All below ground details including drainage, voids and services have been identified from above ground and therefore all details relating to these features including; sizes, depth, description etc will be approximate only. All critical dimensions and connections should be checked and verified prior to starting work.

Detail, services and features may not have been surveyed if obstructed or not reasonably visible at the time of the survey.

Surveyed physical features may not necessarily represent the legal boundary line.

Measured Building Surveys

Measurements to internal walls are taken to the wall finishes at approx 1m above the floor level and the wall assumed to be vertical.

General

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work. Any errors or discrepancies must be notified to Survey Solutions immediately.

The accuracy of the digital data is the same as the plotting scale implies. All dimensions are in metres unless otherwise stated.

The survey control listed is only to be used for topographical surveys at the stated scale. All control must be checked and verified prior to use.

Do not scale from this drawing.

Drainage/Services Legend

Foul		CATV	CCTV		
Surface		E	Electric		
Combined		SL	Street lighting		
Drainage (unspecified)		TM	Traffic management		
BT	British telecom	GAS	Gas		
T	Telecom	W	Water	d	Service depth (m)
FO	Fibre optics	F	Fuel	ø	Pipe diameter (mm)
CATV	CATV	UK	Unknown / misc	EOT	End of trace
Utility Survey Boundary		Ducting		UTT	Unable to trace

Drainage pipe size data has been determined from the surface, in order to comply with confined spaces health and safetylegislation. Please regard this data as approximate.

PAS128 Quality Levels

Please refer to PAS128:2014 Table 1 - "Quality level of survey outputs (normative)" for in anticipated accuracy of quality levels.

All utilities are located to PAS128 QL-B2 unless otherwise stated.

The following table identifies the PAS128 quality level based on the text notes shown on the drawing:

Annotation found on drawing	PAS128 Quality Level
Added from records	PAS128 QL-D
Trench scar, street furniture, visual note/reference to utility	PAS128 QL-C
Assumed route	PAS128 QL-B4
Unable to obtain depth	PAS128 QL-B3
QL-B1	PAS128 QL-B1
QL-B3P	PAS128 QL-B3P
QL-B2P	PAS128 QL-B2P
QL-B1P	PAS128 QL-B1P

Quality levels ending with a "P" refer to a utility that has been located with post processed Ground Penetrating Radar (GPR).

Drawing caveats, please note:

LSS carry out surveys in accordance with site procedures using approved detectors.

Depth data is limited by the accuracy of the detection equipment. Average accuracy is +/- 10% of depth with GPR and +/- 5% of the depth with electromagnetic technologies.

It is LSS procedure to use statutory undertakers plans prior to and during the survey as a guide for the survey team.

In accordance with British Telecom's national policy survey companies are not permitted to raise BT inspection chamber covers.

Drainage routes between manholes, if not able to be traced by LSS survey methodologies, are assumed to be direct lines between manholes.

LSS advise that excavations in the vicinity of services are carried out with due diligence, please refer to HSG47.

SURVEY CONTROL CO-ORDINATES

STATIONS	EASTINGS	NORTHINGS	LEVEL	DESCRIPTION
ST02	248406.483	360135.821	40.852	
ST01	248357.252	360142.921	37.230	
ST03	248413.209	360155.149	39.975	

Levels are related to **OSGB15**
Value **N/A**

Coordinates are related to **National Grid** (GPS)

Please note:

Any discrepancy found between an Ordnance Survey benchmark and an OSGB15 computed orthometric height is likely to be due to bench mark subsidence or uplift and, assuming precise GPS survey has been carefully carried out, the orthometric height given by OSGB15 should be considered correct in preference to archive benchmark heights. OSGB15 converts GPS ellipsoid heights to orthometric heights above mean sea level.

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS

LAND SURVEYING
BUILDING SURVEYING
UNDERGROUND SURVEYING
SITE ENGINEERING
MONITORING

0845 040 5969
survey-solutions.co.uk

IPSWICH BEDFORD COVENTRY GLASGOW LONDON MANCHESTER NORWICH NOTTINGHAM YEOVIL

PROJECT TITLE
Site Near to Cae Stanley, Bontnewydd

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 1 of 1

CLIENT				SCALE
Kingscrown				1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
SO	17/10/22	AG	AG	FINAL
DRAWING NUMBER			REVISION	ISSUE DATE
44388MCLS-01				24/10/22

Original Sheet Size A0H

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Appendix 2

Proposed Surface Water Drainage Layout Plan

KEY:

- Proposed Surface Water Sewer
- Proposed Permeable Block Paving
- Proposed Raingarden
- Proposed Attenuation Basin

NOTES:

1. Surface water storage to be provided throughout the site as follows:
   Permeable paving throughout site: 44.7 cu.m
   Surface water attenuation basin: 40 cu.m
2. The Permeable Paving is to have a 600mm deep storage layer with the outfall flows restricted via orifice plate flow control devices.
3. The proposed Suds basin has been designed for the 1 in 100yr storm event (+40% allowance for climate change). The storage volume required for the design storm is 40m³. The dimensions of the attenuation basin shown is as follows: 114sqm x 1.1m depth, 1 in 3 grading to base.
4. Surface water discharge from site to Afon Bueno to be restricted to 5 l/s via a vortex flow controller chamber.
5. Raingardens throughout site are to provide additional storage, as well as enhancing site biodiversity, providing an amenity to the residents and providing additional pollution control.

Notes

Rev	Modification	By	Chk	App	Date

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KINGSCROWN LAND & COMMERCIAL LTD

BONTNEWYDD RESIDENTIAL DEVELOPMENT

PROPOSED SURFACE WATER DRAINAGE LAYOUT PLAN

Drawn by	Checked by	Approved by
PNN	DH	DH
Date	Date	Date
15/03/2023	15.03.23	15.03.23
Status		Scale @ A1
PRELIMINARY		1:200
Drawing Number		Revision
ECL.9516.D.05.003		

CAD File Ref:P:\9516 Bontnewydd, Caernarfon FRA & SAB\CAD & BIM\Drawings\Current Working Drawings\ECL.9516.D.05.003_Proposed Surface Water Drainage Layout Plan.dwg

Kingscrown Land & Commercial Ltd

Bontnewydd
Bontnewydd Residential Development

Flood Consequence Assessment
ECL.9516.R05.001 Rev -

March 2023

Appendix 3

Illustrative Site Masterplan

NORTH
Indicative

AFON BEUNO

Approx position of Afon Beuno (not surveyed)

RETAINING WALL

Afon Beuno

Flood Basin

STOCK PROOF FENCE

N 360,175.000 m
E 248,350.000 m

1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
21-22
23-24

37925
38225
38600
39130
37706
38350
38800
39000
37500
39650
39600
39735
39791
40520
39850
41195
40339
37000
37250
37440
40140

Planted Edge
Planted Strip
Hedge

OVERHEAD POWERLINE TAKEN UNDERGROUND

NEW FOOTPATH

3 PARKING BAYS

NEW SITE ENTRANCE

LÔN CAEATHRO

LLWYN BEUNO

Llwyn Beuno

46
50
51

1 | SITE - GROUND FLOOR - LEVELS
SCALE: 1 : 200

0m 4m 8m 12m 16m 20m
VISUAL SCALE 1:200 @ A1

REV	DESCRIPTION	DATE	BY
A	RETAINING WALL ADDED, PLOT 7-16 RAISED, BIN STORE ALTERED, SHEET CHANGED TO A1, FRONT FOOTPATH ALTERED, ROAD NAME ADDED, CANOPY TRELLIS ADDED AND FLOOD BASIN UPDATED	16/01/23	IO

PROJECT
SITE AT BONTNEWYDD for KINGSCROWN PROPERTIES

DRAWING TITLE
SITE PLAN - LEVELS

SCALE	DATE	DRAWN	CHECKED
1 : 200 @A1	06/01/23	IO	SV

DRAWING STATUS: PRELIMINARY

JOB No	DRAWING No	REVISION
C1104	007	A

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A1

Kingscrown Land & Commercial Ltd

Bontnewydd
Bontnewydd Residential Development

Flood Consequence Assessment
ECL.9516.R05.001 Rev -

March 2023

Appendix 4

Site Permeability Test Report

DATRYS

Site at Bontnewydd for Kingscrown Land and Commercial

Porosity Report

February 2023

Site at Bontnewydd for Kingscrown Land and Commercial

Porosity Report

Client:	Kingscrown Group
Report Status:	**Final**
Written By:	Adam Caldwell
Date:	February 2023

Contents Page

1. INTRODUCTION

In accordance with your instructions, Datrys undertook porosity tests at the site of a proposed new housing development on the 1st & 2nd February 2023.

In carrying out these tests Datrys did not encounter any services & utilities or below ground structures.

A pre-soak exercise was undertaken on the 1st February with testing commencing the subsequent day with tests in all intended positions undertaken as desired.

The results of the tests were recorded for evaluation and future design purposes.

The intention of the testing was to identify ground permeability for potential use of soakaways for surface water design.

2. GENERAL OVERVIEW

The site is agricultural land located immediately east of Bontnewydd Roundabout at National Grid Reference SH 48415 60163.

The purpose of the investigation was to undertake Soil Infiltration tests in accordance with BRE Digest 365 and Building Regulations Part H.

The porosity pits were undertaken within the site boundary and located in grassed areas as indicated within the attached plan (**Appendix A**). Three Trial Pits were first undertaken to understand the make-up of the ground strata, to ascertain if will encounter groundwater and to identify an appropriate depth for testing.

Each pit consisted of an organic topsoil layer underlain by a well graded gravelly sand atop a medium dense clay strata, the boundary of the lower differing strata ranging from 1m – 1.9m depth across the pits.

Porosity pits were then dug to a pre-determined depth based on the trial pit findings within the well graded gravelly sand layer. A pre-soak was then undertaken in each and the pits made secure and left overnight.

The purpose of this report is to ascertain the infiltration values of the underlying strata for the design of surface water soakaways.

3. SITE CONDITIONS

The weather at the time of the investigation was dry and was preceded by a relatively dry period. No rain fell overnight with it remaining dry for the duration of the testing.

The site topography consists of a gradual fall from east to west with a steepening incline down toward the adjacent watercourse. The site topography appears consistent with the surrounding land which indicates that the site has remained at its natural level.

The nearest watercourse (Afon Beuno) runs along the north and western boundary of the site. The flood mapping for the area suggests this watercourse is at high risk of flooding but appears to be mostly on the opposite side, outside the site extent.

The trial pits indicated that the site comprises of an approximately 300mm organic topsoil underlain by a well graded gravelly sand of varying thickness ranging from 0.7-1.6m. A medium dense clay strata containing gravels and cobbles made up the remainder of the test pit depths down to the maximum reach of the excavator, approximately 2.5m. Its possible that some fill has been deposited in the centre of the site around the area of P2.

Groundwater was not encountered within any of the pits.

4. SOIL INFILTRATION RESULTS

Despite the pre-soak being undertaken in the well graded gravelly sand, P1 and P2 failed to have that pre-soak drain away by the next day and the water remained in the pits throughout the 2nd day.

P3 was dry on return to site on day 2, thus only this pit was subjected to porosity testing. Three tests were undertaken in P3 with the results given below. The results indicated a trend of the rate slowing from test to test so a 4th test was undertaken to determine if the trend continued. The reduction in the 2-4th test was relatively minimal.

Results:

P1	Depth (m)	Ground Water Depth	Soil Infiltration Rate (m/s)	Comments
Pre-soak	1.50	N/A	N/A	Pre-soak did not drain 100mm remained in pit from day 1

P2	Depth (m)	Ground Water Depth	Soil Infiltration Rate (m/s)	Comments
Pre-soak	1.00	N/A	N/A	Pre-soak did not drain 220mm remained in pit from day 1

P3	Depth (m)	Ground Water Depth	Soil Infiltration Rate (m/s)	Comments
Pre-soak	1.00	N/A	N/A	Fully drained
Test 1	1.00	N/A	5.35×10^{-5}	
Test 2	1.00	N/A	3.71×10^{-5}	
Test 3	1.00	N/A	3.54×10^{-5}	
Test 4	1.00	N/A	3.49×10^{-5}	Undertaken to see if continued to slow

5. CONCLUSIONS

Our findings indicate that the site ground conditions vary across the site with areas of the site offering no capacity for infiltration whilst the western side of the site suggests a good capacity for infiltration. However, the depth of suitable ground is limited to approximately 1.4m with the underlying strata consisting of a predominately clay soil.

Some further trial pits were then undertaken to attempt to ascertain if the ground conditions remained the same local to TP3 and P3. TP4, 5 and 6 where undertaken with TP6 being between TP3 and P2 to ascertain if there was any noticeable difference in material encountered. It had been noted that P2 appeared to suggest the upper 1.0m could be fill with some shale fragments and larger granular material. TP5 appeared to give the same strata log as TP3 whilst TP4 suggested the layer suitable for infiltration is limited to 1.2m depth. TP6 sides were not stable and the material was noted to be closer in similarity to that encountered in P2.

In conclusion, there appears to be a suitable albeit relatively shallow area of material that could afford an opportunity for infiltration in the western side of the site with a rate of 3.54×10^{-5} to be applied in any design calculations.

Given the free draining material is somewhat limited in depth, infiltration may not be achievable for the whole site. It is possible that any design could use a soakaway or an infiltration basin with high level overflow to the watercourse to address more significant design events.

If the development does not afford adequate space to accommodate soakaways, then an alternative means of discharge should be investigated following the hierarchy set out by SUDS and the Building Regulations.

APPENDIX

APPENDIX A – POROSITY PIT LOCATION PLAN

TRIAL PIT PLAN
1 & 2 FEB 2023

AFON BEUNO

Afon Beuno

Flood Basin

Flood Basin

TP4

TP5

TP3

TP6

TP2

TP1

P1

P2

P3

N 360,175.000 m
E 248,350.000 m

15 m

24 m

22 m

23 m

21 m

31 m

9 m

4 m

5 m

20 m

1-2

3-4

5-6

7-8

9-10

11-12

13-14

15-16

17-18

19-20

21-22

23-24

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

V

GATE

UP

EP

Planted Edge

Planted Strip

Hedge

No Access / Overgrown

Grass

FUTURE SITE ACCESS

OVERHEAD POWERLINE TAKEN UNDERGROUND

3 PARKING BAYS

Pond

an-Beuno

1 | SITE
SCALE: 1 : 200

UNIT KEY

HOUSE TYPE	DESCRIPTION	PLOT No.	SIZE m²	AMOUNT
2P1B	WALK UP FLATS	5-6, 9-10, 11-14, 17-20	53	12
2P1B	WALK UP FLATS - WIDE	3-4, 21-22	53	4
3P2B	WALK UP FLATS	1-2, 7-9, 15-16, 23-24	65	8
TOTAL UNITS:				24

0m 4m 8m 12m 16m 20m

VISUAL SCALE 1:200 @ A2

N

REV	DESCRIPTION	DATE	BY
B	CHANGES TO BIN STORES AND SITE BOUNDARY	06/01/23	IO
A	CHANGES TO HOUSE LAYOUT. TOPO UPDATED	21/12/22	IO

PROJECT
SITE AT BONTNEWYDD
for KINGSCROWN PROPERTIES

DRAWING TITLE
INDICATIVE MASTERPLAN

SCALE	DATE	DRAWN	CHECKED
As indicated@A2	01/12/22	IO	SV

DRAWING STATUS: PRELIMINARY

JOB No	DRAWING No	REVISION
C1104	004	B

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A2

APPENDIX B – POROSITY CALCULATIONS

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Gwynedd
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Tel 01286 671027

Project:	23007
Title:	Bontnewydd
Ref:	Porosity Pit 3, Test 1
Test Date:	02.02.23

Trial Pit Dimensions: Length (m) 0.3 Width (m) 0.3 Depth (m) 1

Time (mins)	Depth to water (m)	Rate of change (m/min)	Actual Water Depth (m)
0	0.700		0.300
10	0.800	0.01000	0.200
20	0.910	0.01100	0.090
27	0.950	0.00571	0.050

Max effective storage depth	0.30	m
Volume Outflow, Vp75-25	0.01	m3
Surface Area, ap50	0.27	m2
Time Taken, tp75-25	16	min
Soil Infiltration Rate, f	**5.35E-05**	**m/s**

75% depth (m)	0.23	Calc 75% time (min)	7
25% depth (m)	0.08	Calc 25% time (min)	23

Vp	**6.24**	**s/mm**

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Project:	23007
Title:	Bontnewydd
Ref:	Porosity Pit 3, Test 2
Test Date:	02.02.23

Trial Pit Dimensions: Length (m) 0.3 Width (m) 0.3 Depth (m) 1

Time (mins)	Depth to water (m)	Rate of change (m/min)	Actual Water Depth (m)
0	0.700		0.300
10	0.790	0.00900	0.210
20	0.830	0.00400	0.170
30	0.910	0.00800	0.090
37	0.950	0.00571	0.050

Max effective storage depth	0.30	m
Volume Outflow, Vp75-25	0.01	m3
Surface Area, ap50	0.27	m2
Time Taken, tp75-25	22	min
Soil Infiltration Rate, f	**3.71E-05**	**m/s**

75% depth (m)	0.23	Calc 75% time (min)	10
25% depth (m)	0.08	Calc 25% time (min)	33

Vp	**8.98**	**s/mm**

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Project:	23007
Title:	Bontnewydd
Ref:	Porosity Pit 3, Test 3
Test Date:	02.02.23

Trial Pit Dimensions: Length (m) 0.3 Width (m) 0.3 Depth (m) 1

Time (mins)	Depth to water (m)	Rate of change (m/min)	Actual Water Depth (m)
0	0.700		0.300
10	0.790	0.00900	0.210
20	0.830	0.00400	0.170
30	0.875	0.00450	0.125
37	0.950	0.01071	0.050

Max effective storage depth	0.30	m
Volume Outflow, Vp75-25	0.01	m3
Surface Area, ap50	0.27	m2
Time Taken, tp75-25	24	min
Soil Infiltration Rate, f	**3.54E-05**	**m/s**

75% depth (m)	0.23	Calc 75% time (min)	11
25% depth (m)	0.08	Calc 25% time (min)	34

Vp	**9.43**	**s/mm**

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Project:	23007
Title:	Bontnewydd
Ref:	Porosity Pit 3, Test 4
Test Date:	02.02.23

Trial Pit Dimensions: Length (m) 0.3 Width (m) 0.3 Depth (m) 1

Time (mins)	Depth to water (m)	Rate of change (m/min)	Actual Water Depth (m)
0	0.700		0.300
10	0.780	0.00800	0.220
25	0.865	0.00567	0.135
30	0.885	0.00400	0.115
35	0.930	0.00900	0.070
39	0.950	0.00500	0.050

Max effective storage depth	0.30	m
Volume Outflow, Vp75-25	0.01	m3
Surface Area, ap50	0.27	m2
Time Taken, tp75-25	24	min
Soil Infiltration Rate, f	**3.49E-05**	**m/s**

75% depth (m)	0.23	Calc 75% time (min)	11
25% depth (m)	0.08	Calc 25% time (min)	35

Vp	**9.54**	**s/mm**

DATRYS

Kingscrown Land & Commercial Ltd

Bontnewydd
Bontnewydd Residential Development

Flood Consequence Assessment
ECL.9516.R05.001 Rev -

March 2023

Appendix 5

MicroDrainage Surface Water Calculations

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 1-2.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 91 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.558	0.268	0.0	0.3	0.3	2.0	O K
30 min Summer	99.649	0.359	0.0	0.4	0.4	2.7	O K
60 min Summer	99.727	0.437	0.0	0.4	0.4	3.3	Flood Risk
120 min Summer	99.776	0.486	0.0	0.4	0.4	3.7	Flood Risk
180 min Summer	99.788	0.498	0.0	0.4	0.4	3.8	Flood Risk
240 min Summer	99.783	0.493	0.0	0.4	0.4	3.7	Flood Risk
360 min Summer	99.759	0.469	0.0	0.4	0.4	3.5	Flood Risk
480 min Summer	99.731	0.441	0.0	0.4	0.4	3.3	Flood Risk
600 min Summer	99.705	0.415	0.0	0.4	0.4	3.1	Flood Risk
720 min Summer	99.679	0.389	0.0	0.4	0.4	2.9	O K
960 min Summer	99.633	0.343	0.0	0.4	0.4	2.6	O K
1440 min Summer	99.560	0.270	0.0	0.3	0.3	2.0	O K
2160 min Summer	99.485	0.195	0.0	0.3	0.3	1.5	O K
2880 min Summer	99.435	0.145	0.0	0.3	0.3	1.1	O K
4320 min Summer	99.374	0.084	0.0	0.2	0.2	0.6	O K
5760 min Summer	99.341	0.051	0.0	0.2	0.2	0.4	O K
7200 min Summer	99.321	0.031	0.0	0.2	0.2	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	2.2	18
30 min Summer	73.497	0.0	3.2	32
60 min Summer	49.020	0.0	4.3	60
120 min Summer	31.620	0.0	5.5	90
180 min Summer	24.081	0.0	6.4	126
240 min Summer	19.682	0.0	6.9	160
360 min Summer	14.719	0.0	7.8	228
480 min Summer	11.975	0.0	8.5	296
600 min Summer	10.193	0.0	9.0	362
720 min Summer	8.930	0.0	9.5	428
960 min Summer	7.238	0.0	10.2	558
1440 min Summer	5.370	0.0	11.4	806
2160 min Summer	3.972	0.0	12.6	1168
2880 min Summer	3.201	0.0	13.5	1528
4320 min Summer	2.356	0.0	14.9	2248
5760 min Summer	1.897	0.0	16.0	2944
7200 min Summer	1.604	0.0	16.8	3672

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 1-2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.308	0.018	0.0	0.1	0.1	0.1	O K
10080 min Summer	99.298	0.008	0.0	0.1	0.1	0.1	O K
15 min Winter	99.595	0.305	0.0	0.3	0.3	2.3	O K
30 min Winter	99.699	0.409	0.0	0.4	0.4	3.1	O K
60 min Winter	99.791	0.501	0.0	0.4	0.4	3.8	Flood Risk
120 min Winter	99.846	0.556	0.0	0.5	0.5	4.2	Flood Risk
180 min Winter	99.855	0.565	0.0	0.5	0.5	4.3	Flood Risk
240 min Winter	99.843	0.553	0.0	0.5	0.5	4.2	Flood Risk
360 min Winter	99.802	0.512	0.0	0.4	0.4	3.9	Flood Risk
480 min Winter	99.759	0.469	0.0	0.4	0.4	3.5	Flood Risk
600 min Winter	99.717	0.427	0.0	0.4	0.4	3.2	Flood Risk
720 min Winter	99.679	0.389	0.0	0.4	0.4	2.9	O K
960 min Winter	99.614	0.324	0.0	0.4	0.4	2.4	O K
1440 min Winter	99.519	0.229	0.0	0.3	0.3	1.7	O K
2160 min Winter	99.433	0.143	0.0	0.3	0.3	1.1	O K
2880 min Winter	99.382	0.092	0.0	0.2	0.2	0.7	O K
4320 min Winter	99.331	0.041	0.0	0.2	0.2	0.3	O K
5760 min Winter	99.306	0.016	0.0	0.1	0.1	0.1	O K
7200 min Winter	99.293	0.003	0.0	0.1	0.1	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	17.6	4408
10080 min Summer	1.247	0.0	18.2	5136
15 min Winter	105.613	0.0	2.5	17
30 min Winter	73.497	0.0	3.6	31
60 min Winter	49.020	0.0	4.8	58
120 min Winter	31.620	0.0	6.2	96
180 min Winter	24.081	0.0	7.1	134
240 min Winter	19.682	0.0	7.8	172
360 min Winter	14.719	0.0	8.8	246
480 min Winter	11.975	0.0	9.5	318
600 min Winter	10.193	0.0	10.1	386
720 min Winter	8.930	0.0	10.6	454
960 min Winter	7.238	0.0	11.5	584
1440 min Winter	5.370	0.0	12.8	836
2160 min Winter	3.972	0.0	14.2	1192
2880 min Winter	3.201	0.0	15.2	1556
4320 min Winter	2.356	0.0	16.7	2248
5760 min Winter	1.897	0.0	17.9	2944
7200 min Winter	1.604	0.0	18.9	3672
8640 min Winter	1.399	0.0	19.7	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 1-2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	20.5	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 1-2.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.012

Time (mins) From:	To:	Area (ha)
0	4	0.012

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 1-2.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.4
Membrane Percolation (mm/hr)	1000	Length (m)	10.5
Max Percolation (l/s)	7.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.017 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 3-4.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 76 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.529	0.239	0.0	0.3	0.3	1.7	O K
30 min Summer	99.609	0.319	0.0	0.4	0.4	2.2	O K
60 min Summer	99.672	0.382	0.0	0.4	0.4	2.6	O K
120 min Summer	99.713	0.423	0.0	0.4	0.4	2.9	Flood Risk
180 min Summer	99.718	0.428	0.0	0.4	0.4	3.0	Flood Risk
240 min Summer	99.710	0.420	0.0	0.4	0.4	2.9	Flood Risk
360 min Summer	99.683	0.393	0.0	0.4	0.4	2.7	O K
480 min Summer	99.655	0.365	0.0	0.4	0.4	2.5	O K
600 min Summer	99.629	0.339	0.0	0.4	0.4	2.3	O K
720 min Summer	99.605	0.315	0.0	0.4	0.4	2.2	O K
960 min Summer	99.563	0.273	0.0	0.3	0.3	1.9	O K
1440 min Summer	99.497	0.207	0.0	0.3	0.3	1.4	O K
2160 min Summer	99.433	0.143	0.0	0.3	0.3	1.0	O K
2880 min Summer	99.391	0.101	0.0	0.2	0.2	0.7	O K
4320 min Summer	99.343	0.053	0.0	0.2	0.2	0.4	O K
5760 min Summer	99.318	0.028	0.0	0.1	0.1	0.2	O K
7200 min Summer	99.303	0.013	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	1.9	17
30 min Summer	73.497	0.0	2.6	31
60 min Summer	49.020	0.0	3.6	56
120 min Summer	31.620	0.0	4.6	88
180 min Summer	24.081	0.0	5.3	122
240 min Summer	19.682	0.0	5.8	158
360 min Summer	14.719	0.0	6.5	226
480 min Summer	11.975	0.0	7.0	292
600 min Summer	10.193	0.0	7.5	358
720 min Summer	8.930	0.0	7.9	422
960 min Summer	7.238	0.0	8.5	548
1440 min Summer	5.370	0.0	9.5	794
2160 min Summer	3.972	0.0	10.5	1148
2880 min Summer	3.201	0.0	11.3	1504
4320 min Summer	2.356	0.0	12.4	2208
5760 min Summer	1.897	0.0	13.3	2944
7200 min Summer	1.604	0.0	14.0	3672

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 3-4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.294	0.004	0.0	0.1	0.1	0.0	O K
10080 min Summer	99.290	0.000	0.0	0.1	0.1	0.0	O K
15 min Winter	99.563	0.273	0.0	0.3	0.3	1.9	O K
30 min Winter	99.655	0.365	0.0	0.4	0.4	2.5	O K
60 min Winter	99.730	0.440	0.0	0.4	0.4	3.0	Flood Risk
120 min Winter	99.772	0.482	0.0	0.4	0.4	3.3	Flood Risk
180 min Winter	99.773	0.483	0.0	0.4	0.4	3.3	Flood Risk
240 min Winter	99.758	0.468	0.0	0.4	0.4	3.2	Flood Risk
360 min Winter	99.713	0.423	0.0	0.4	0.4	2.9	Flood Risk
480 min Winter	99.670	0.380	0.0	0.4	0.4	2.6	O K
600 min Winter	99.630	0.340	0.0	0.4	0.4	2.4	O K
720 min Winter	99.595	0.305	0.0	0.4	0.4	2.1	O K
960 min Winter	99.537	0.247	0.0	0.3	0.3	1.7	O K
1440 min Winter	99.456	0.166	0.0	0.3	0.3	1.1	O K
2160 min Winter	99.386	0.096	0.0	0.2	0.2	0.7	O K
2880 min Winter	99.348	0.058	0.0	0.2	0.2	0.4	O K
4320 min Winter	99.309	0.019	0.0	0.1	0.1	0.1	O K
5760 min Winter	99.292	0.002	0.0	0.1	0.1	0.0	O K
7200 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	14.6	4400
10080 min Summer	1.247	0.0	15.1	0
15 min Winter	105.613	0.0	2.1	17
30 min Winter	73.497	0.0	3.0	31
60 min Winter	49.020	0.0	4.0	58
120 min Winter	31.620	0.0	5.2	94
180 min Winter	24.081	0.0	5.9	132
240 min Winter	19.682	0.0	6.5	170
360 min Winter	14.719	0.0	7.3	242
480 min Winter	11.975	0.0	7.9	312
600 min Winter	10.193	0.0	8.4	380
720 min Winter	8.930	0.0	8.9	444
960 min Winter	7.238	0.0	9.6	570
1440 min Winter	5.370	0.0	10.6	820
2160 min Winter	3.972	0.0	11.8	1172
2880 min Winter	3.201	0.0	12.7	1528
4320 min Winter	2.356	0.0	13.9	2244
5760 min Winter	1.897	0.0	14.9	2936
7200 min Winter	1.604	0.0	15.7	0
8640 min Winter	1.399	0.0	16.4	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 3-4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	17.0	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 3-4.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.010

Time (mins) From:	To:	Area (ha)
0	4	0.010

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 3-4.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	4.8
Max Percolation (l/s)	6.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.017 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 5-6.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 81 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.557	0.267	0.0	0.3	0.3	1.8	O K
30 min Summer	99.645	0.355	0.0	0.4	0.4	2.5	O K
60 min Summer	99.718	0.428	0.0	0.4	0.4	3.0	Flood Risk
120 min Summer	99.764	0.474	0.0	0.4	0.4	3.3	Flood Risk
180 min Summer	99.773	0.483	0.0	0.4	0.4	3.3	Flood Risk
240 min Summer	99.765	0.475	0.0	0.4	0.4	3.3	Flood Risk
360 min Summer	99.737	0.447	0.0	0.4	0.4	3.1	Flood Risk
480 min Summer	99.708	0.418	0.0	0.4	0.4	2.9	Flood Risk
600 min Summer	99.680	0.390	0.0	0.4	0.4	2.7	O K
720 min Summer	99.653	0.363	0.0	0.4	0.4	2.5	O K
960 min Summer	99.607	0.317	0.0	0.4	0.4	2.2	O K
1440 min Summer	99.535	0.245	0.0	0.3	0.3	1.7	O K
2160 min Summer	99.462	0.172	0.0	0.3	0.3	1.2	O K
2880 min Summer	99.414	0.124	0.0	0.2	0.2	0.9	O K
4320 min Summer	99.359	0.069	0.0	0.2	0.2	0.5	O K
5760 min Summer	99.330	0.040	0.0	0.2	0.2	0.3	O K
7200 min Summer	99.312	0.022	0.0	0.1	0.1	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	2.1	17
30 min Summer	73.497	0.0	2.9	31
60 min Summer	49.020	0.0	3.9	56
120 min Summer	31.620	0.0	5.1	88
180 min Summer	24.081	0.0	5.8	124
240 min Summer	19.682	0.0	6.4	158
360 min Summer	14.719	0.0	7.1	226
480 min Summer	11.975	0.0	7.8	294
600 min Summer	10.193	0.0	8.3	360
720 min Summer	8.930	0.0	8.7	424
960 min Summer	7.238	0.0	9.4	550
1440 min Summer	5.370	0.0	10.4	794
2160 min Summer	3.972	0.0	11.6	1164
2880 min Summer	3.201	0.0	12.4	1524
4320 min Summer	2.356	0.0	13.7	2244
5760 min Summer	1.897	0.0	14.6	2944
7200 min Summer	1.604	0.0	15.4	3672

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 5-6.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.300	0.010	0.0	0.1	0.1	0.1	O K
10080 min Summer	99.292	0.002	0.0	0.1	0.1	0.0	O K
15 min Winter	99.593	0.303	0.0	0.3	0.3	2.1	O K
30 min Winter	99.695	0.405	0.0	0.4	0.4	2.8	O K
60 min Winter	99.782	0.492	0.0	0.4	0.4	3.4	Flood Risk
120 min Winter	99.831	0.541	0.0	0.5	0.5	3.7	Flood Risk
180 min Winter	99.836	0.546	0.0	0.5	0.5	3.8	Flood Risk
240 min Winter	99.820	0.530	0.0	0.5	0.5	3.7	Flood Risk
360 min Winter	99.774	0.484	0.0	0.4	0.4	3.3	Flood Risk
480 min Winter	99.728	0.438	0.0	0.4	0.4	3.0	Flood Risk
600 min Winter	99.685	0.395	0.0	0.4	0.4	2.7	O K
720 min Winter	99.647	0.357	0.0	0.4	0.4	2.5	O K
960 min Winter	99.582	0.292	0.0	0.3	0.3	2.0	O K
1440 min Winter	99.491	0.201	0.0	0.3	0.3	1.4	O K
2160 min Winter	99.410	0.120	0.0	0.2	0.2	0.8	O K
2880 min Winter	99.365	0.075	0.0	0.2	0.2	0.5	O K
4320 min Winter	99.320	0.030	0.0	0.1	0.1	0.2	O K
5760 min Winter	99.299	0.009	0.0	0.1	0.1	0.1	O K
7200 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	16.1	4408
10080 min Summer	1.247	0.0	16.7	5136
15 min Winter	105.613	0.0	2.3	17
30 min Winter	73.497	0.0	3.3	31
60 min Winter	49.020	0.0	4.4	58
120 min Winter	31.620	0.0	5.7	94
180 min Winter	24.081	0.0	6.5	132
240 min Winter	19.682	0.0	7.1	170
360 min Winter	14.719	0.0	8.0	244
480 min Winter	11.975	0.0	8.7	314
600 min Winter	10.193	0.0	9.3	380
720 min Winter	8.930	0.0	9.8	448
960 min Winter	7.238	0.0	10.5	578
1440 min Winter	5.370	0.0	11.7	822
2160 min Winter	3.972	0.0	13.0	1188
2880 min Winter	3.201	0.0	13.9	1528
4320 min Winter	2.356	0.0	15.3	2248
5760 min Winter	1.897	0.0	16.4	2936
7200 min Winter	1.604	0.0	17.3	0
8640 min Winter	1.399	0.0	18.1	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 5-6.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	18.8	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 5-6.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.011

Time (mins) From:	To:	Area (ha)
0	4	0.011

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 5-6.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	4.8
Max Percolation (l/s)	6.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.017 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 7-8.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 84 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.584	0.294	0.0	0.3	0.3	2.0	O K
30 min Summer	99.682	0.392	0.0	0.4	0.4	2.7	O K
60 min Summer	99.763	0.473	0.0	0.4	0.4	3.3	Flood Risk
120 min Summer	99.816	0.526	0.0	0.5	0.5	3.6	Flood Risk
180 min Summer	99.827	0.537	0.0	0.5	0.5	3.7	Flood Risk
240 min Summer	99.821	0.531	0.0	0.5	0.5	3.7	Flood Risk
360 min Summer	99.793	0.503	0.0	0.4	0.4	3.5	Flood Risk
480 min Summer	99.762	0.472	0.0	0.4	0.4	3.3	Flood Risk
600 min Summer	99.732	0.442	0.0	0.4	0.4	3.1	Flood Risk
720 min Summer	99.703	0.413	0.0	0.4	0.4	2.9	Flood Risk
960 min Summer	99.653	0.363	0.0	0.4	0.4	2.5	O K
1440 min Summer	99.574	0.284	0.0	0.3	0.3	2.0	O K
2160 min Summer	99.493	0.203	0.0	0.3	0.3	1.4	O K
2880 min Summer	99.440	0.150	0.0	0.3	0.3	1.0	O K
4320 min Summer	99.376	0.086	0.0	0.2	0.2	0.6	O K
5760 min Summer	99.342	0.052	0.0	0.2	0.2	0.4	O K
7200 min Summer	99.322	0.032	0.0	0.2	0.2	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	2.3	17
30 min Summer	73.497	0.0	3.2	31
60 min Summer	49.020	0.0	4.3	58
120 min Summer	31.620	0.0	5.6	90
180 min Summer	24.081	0.0	6.4	124
240 min Summer	19.682	0.0	7.0	158
360 min Summer	14.719	0.0	7.8	228
480 min Summer	11.975	0.0	8.5	294
600 min Summer	10.193	0.0	9.0	362
720 min Summer	8.930	0.0	9.5	426
960 min Summer	7.238	0.0	10.3	552
1440 min Summer	5.370	0.0	11.4	796
2160 min Summer	3.972	0.0	12.6	1164
2880 min Summer	3.201	0.0	13.6	1528
4320 min Summer	2.356	0.0	14.9	2244
5760 min Summer	1.897	0.0	16.0	2944
7200 min Summer	1.604	0.0	16.9	3672

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 7-8.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.308	0.018	0.0	0.1	0.1	0.1	O K
10080 min Summer	99.298	0.008	0.0	0.1	0.1	0.1	O K
15 min Winter	99.624	0.334	0.0	0.4	0.4	2.3	O K
30 min Winter	99.737	0.447	0.0	0.4	0.4	3.1	Flood Risk
60 min Winter	99.835	0.545	0.0	0.5	0.5	3.8	Flood Risk
120 min Winter	99.895	0.605	0.0	0.5	0.5	4.2	Flood Risk
180 min Winter	99.941	0.651	0.0	0.5	0.5	4.2	Flood Risk
240 min Winter	99.884	0.594	0.0	0.5	0.5	4.1	Flood Risk
360 min Winter	99.837	0.547	0.0	0.5	0.5	3.8	Flood Risk
480 min Winter	99.788	0.498	0.0	0.4	0.4	3.4	Flood Risk
600 min Winter	99.741	0.451	0.0	0.4	0.4	3.1	Flood Risk
720 min Winter	99.700	0.410	0.0	0.4	0.4	2.8	O K
960 min Winter	99.629	0.339	0.0	0.4	0.4	2.3	O K
1440 min Winter	99.527	0.237	0.0	0.3	0.3	1.6	O K
2160 min Winter	99.436	0.146	0.0	0.3	0.3	1.0	O K
2880 min Winter	99.384	0.094	0.0	0.2	0.2	0.7	O K
4320 min Winter	99.331	0.041	0.0	0.2	0.2	0.3	O K
5760 min Winter	99.307	0.017	0.0	0.1	0.1	0.1	O K
7200 min Winter	99.293	0.003	0.0	0.1	0.1	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	17.6	4408
10080 min Summer	1.247	0.0	18.2	5136
15 min Winter	105.613	0.0	2.5	17
30 min Winter	73.497	0.0	3.6	31
60 min Winter	49.020	0.0	4.8	58
120 min Winter	31.620	0.0	6.2	94
180 min Winter	24.081	0.0	7.1	132
240 min Winter	19.682	0.0	7.8	172
360 min Winter	14.719	0.0	8.8	244
480 min Winter	11.975	0.0	9.5	316
600 min Winter	10.193	0.0	10.1	384
720 min Winter	8.930	0.0	10.7	450
960 min Winter	7.238	0.0	11.5	578
1440 min Winter	5.370	0.0	12.8	824
2160 min Winter	3.972	0.0	14.2	1188
2880 min Winter	3.201	0.0	15.2	1532
4320 min Winter	2.356	0.0	16.8	2248
5760 min Winter	1.897	0.0	18.0	2944
7200 min Winter	1.604	0.0	18.9	3672
8640 min Winter	1.399	0.0	19.8	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 7-8.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	20.5	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 7-8.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.012

Time (mins) From:	To:	Area (ha)
0	4	0.012

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 7-8.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	4.8
Max Percolation (l/s)	6.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.017 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 9-10.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 48 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.635	0.345	0.0	0.7	0.7	2.4	O K
30 min Summer	99.730	0.440	0.0	0.8	0.8	3.0	Flood Risk
60 min Summer	99.797	0.507	0.0	0.9	0.9	3.5	Flood Risk
120 min Summer	99.827	0.537	0.0	0.9	0.9	3.7	Flood Risk
180 min Summer	99.812	0.522	0.0	0.9	0.9	3.6	Flood Risk
240 min Summer	99.784	0.494	0.0	0.9	0.9	3.4	Flood Risk
360 min Summer	99.727	0.437	0.0	0.8	0.8	3.0	Flood Risk
480 min Summer	99.677	0.387	0.0	0.8	0.8	2.7	O K
600 min Summer	99.634	0.344	0.0	0.7	0.7	2.4	O K
720 min Summer	99.597	0.307	0.0	0.7	0.7	2.1	O K
960 min Summer	99.539	0.249	0.0	0.6	0.6	1.7	O K
1440 min Summer	99.459	0.169	0.0	0.5	0.5	1.2	O K
2160 min Summer	99.393	0.103	0.0	0.4	0.4	0.7	O K
2880 min Summer	99.355	0.065	0.0	0.4	0.4	0.5	O K
4320 min Summer	99.317	0.027	0.0	0.3	0.3	0.2	O K
5760 min Summer	99.299	0.009	0.0	0.2	0.2	0.1	O K
7200 min Summer	99.290	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	2.9	17
30 min Summer	73.497	0.0	4.0	30
60 min Summer	49.020	0.0	5.4	46
120 min Summer	31.620	0.0	7.0	80
180 min Summer	24.081	0.0	8.0	116
240 min Summer	19.682	0.0	8.7	148
360 min Summer	14.719	0.0	9.8	214
480 min Summer	11.975	0.0	10.6	278
600 min Summer	10.193	0.0	11.3	340
720 min Summer	8.930	0.0	11.9	402
960 min Summer	7.238	0.0	12.9	522
1440 min Summer	5.370	0.0	14.3	764
2160 min Summer	3.972	0.0	15.9	1124
2880 min Summer	3.201	0.0	17.0	1472
4320 min Summer	2.356	0.0	18.8	2204
5760 min Summer	1.897	0.0	20.1	2936
7200 min Summer	1.604	0.0	21.2	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 9-10.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.290	0.000	0.0	0.2	0.2	0.0	O K
10080 min Summer	99.290	0.000	0.0	0.2	0.2	0.0	O K
15 min Winter	99.683	0.393	0.0	0.8	0.8	2.7	O K
30 min Winter	99.795	0.505	0.0	0.9	0.9	3.5	Flood Risk
60 min Winter	99.869	0.579	0.0	0.9	0.9	4.0	Flood Risk
120 min Winter	99.890	0.600	0.0	1.0	1.0	4.1	Flood Risk
180 min Winter	99.858	0.568	0.0	0.9	0.9	3.9	Flood Risk
240 min Winter	99.812	0.522	0.0	0.9	0.9	3.6	Flood Risk
360 min Winter	99.725	0.435	0.0	0.8	0.8	3.0	Flood Risk
480 min Winter	99.654	0.364	0.0	0.8	0.8	2.5	O K
600 min Winter	99.597	0.307	0.0	0.7	0.7	2.1	O K
720 min Winter	99.550	0.260	0.0	0.6	0.6	1.8	O K
960 min Winter	99.481	0.191	0.0	0.6	0.6	1.3	O K
1440 min Winter	99.400	0.110	0.0	0.4	0.4	0.8	O K
2160 min Winter	99.343	0.053	0.0	0.3	0.3	0.4	O K
2880 min Winter	99.316	0.026	0.0	0.3	0.3	0.2	O K
4320 min Winter	99.292	0.002	0.0	0.2	0.2	0.0	O K
5760 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K
7200 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	22.1	0
10080 min Summer	1.247	0.0	23.0	0
15 min Winter	105.613	0.0	3.2	17
30 min Winter	73.497	0.0	4.5	30
60 min Winter	49.020	0.0	6.1	48
120 min Winter	31.620	0.0	7.8	88
180 min Winter	24.081	0.0	9.0	124
240 min Winter	19.682	0.0	9.8	160
360 min Winter	14.719	0.0	11.0	226
480 min Winter	11.975	0.0	11.9	292
600 min Winter	10.193	0.0	12.7	354
720 min Winter	8.930	0.0	13.4	416
960 min Winter	7.238	0.0	14.4	538
1440 min Winter	5.370	0.0	16.1	778
2160 min Winter	3.972	0.0	17.8	1124
2880 min Winter	3.201	0.0	19.1	1472
4320 min Winter	2.356	0.0	21.1	2204
5760 min Winter	1.897	0.0	22.6	0
7200 min Winter	1.604	0.0	23.8	0
8640 min Winter	1.399	0.0	24.9	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 9-10.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	25.8	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 9-10.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.015

Time (mins) From:	To:	Area (ha)
0	4	0.015

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 9-10.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	4.8
Max Percolation (l/s)	6.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.024 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 11-16.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 87 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.532	0.242	0.0	0.8	0.8	5.0	O K
30 min Summer	99.615	0.325	0.0	1.0	1.0	6.7	O K
60 min Summer	99.684	0.394	0.0	1.1	1.1	8.2	O K
120 min Summer	99.729	0.439	0.0	1.1	1.1	9.1	Flood Risk
180 min Summer	99.739	0.449	0.0	1.1	1.1	9.3	Flood Risk
240 min Summer	99.734	0.444	0.0	1.1	1.1	9.2	Flood Risk
360 min Summer	99.711	0.421	0.0	1.1	1.1	8.7	Flood Risk
480 min Summer	99.686	0.396	0.0	1.1	1.1	8.2	O K
600 min Summer	99.661	0.371	0.0	1.0	1.0	7.7	O K
720 min Summer	99.637	0.347	0.0	1.0	1.0	7.2	O K
960 min Summer	99.595	0.305	0.0	0.9	0.9	6.3	O K
1440 min Summer	99.529	0.239	0.0	0.8	0.8	5.0	O K
2160 min Summer	99.461	0.171	0.0	0.7	0.7	3.6	O K
2880 min Summer	99.417	0.127	0.0	0.6	0.6	2.6	O K
4320 min Summer	99.364	0.074	0.0	0.5	0.5	1.5	O K
5760 min Summer	99.335	0.045	0.0	0.4	0.4	0.9	O K
7200 min Summer	99.318	0.028	0.0	0.4	0.4	0.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	5.6	18
30 min Summer	73.497	0.0	7.9	32
60 min Summer	49.020	0.0	10.7	58
120 min Summer	31.620	0.0	13.9	90
180 min Summer	24.081	0.0	15.8	124
240 min Summer	19.682	0.0	17.3	160
360 min Summer	14.719	0.0	19.5	228
480 min Summer	11.975	0.0	21.1	296
600 min Summer	10.193	0.0	22.5	362
720 min Summer	8.930	0.0	23.7	426
960 min Summer	7.238	0.0	25.6	552
1440 min Summer	5.370	0.0	28.4	796
2160 min Summer	3.972	0.0	31.5	1168
2880 min Summer	3.201	0.0	33.8	1528
4320 min Summer	2.356	0.0	37.2	2244
5760 min Summer	1.897	0.0	39.8	2944
7200 min Summer	1.604	0.0	41.9	3672

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 11-16.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.306	0.016	0.0	0.3	0.3	0.3	O K
10080 min Summer	99.298	0.008	0.0	0.3	0.3	0.2	O K
15 min Winter	99.566	0.276	0.0	0.9	0.9	5.7	O K
30 min Winter	99.661	0.371	0.0	1.0	1.0	7.7	O K
60 min Winter	99.743	0.453	0.0	1.1	1.1	9.4	Flood Risk
120 min Winter	99.791	0.501	0.0	1.2	1.2	10.4	Flood Risk
180 min Winter	99.798	0.508	0.0	1.2	1.2	10.5	Flood Risk
240 min Winter	99.787	0.497	0.0	1.2	1.2	10.3	Flood Risk
360 min Winter	99.748	0.458	0.0	1.1	1.1	9.5	Flood Risk
480 min Winter	99.708	0.418	0.0	1.1	1.1	8.7	Flood Risk
600 min Winter	99.669	0.379	0.0	1.0	1.0	7.9	O K
720 min Winter	99.635	0.345	0.0	1.0	1.0	7.1	O K
960 min Winter	99.576	0.286	0.0	0.9	0.9	5.9	O K
1440 min Winter	99.491	0.201	0.0	0.8	0.8	4.2	O K
2160 min Winter	99.414	0.124	0.0	0.6	0.6	2.6	O K
2880 min Winter	99.370	0.080	0.0	0.5	0.5	1.7	O K
4320 min Winter	99.326	0.036	0.0	0.4	0.4	0.7	O K
5760 min Winter	99.305	0.015	0.0	0.3	0.3	0.3	O K
7200 min Winter	99.293	0.003	0.0	0.3	0.3	0.1	O K
8640 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	43.7	4408
10080 min Summer	1.247	0.0	45.3	5136
15 min Winter	105.613	0.0	6.3	17
30 min Winter	73.497	0.0	8.9	31
60 min Winter	49.020	0.0	12.0	58
120 min Winter	31.620	0.0	15.6	96
180 min Winter	24.081	0.0	17.8	134
240 min Winter	19.682	0.0	19.5	172
360 min Winter	14.719	0.0	21.8	246
480 min Winter	11.975	0.0	23.7	316
600 min Winter	10.193	0.0	25.2	384
720 min Winter	8.930	0.0	26.5	450
960 min Winter	7.238	0.0	28.7	578
1440 min Winter	5.370	0.0	31.9	824
2160 min Winter	3.972	0.0	35.4	1188
2880 min Winter	3.201	0.0	38.0	1532
4320 min Winter	2.356	0.0	41.8	2248
5760 min Winter	1.897	0.0	44.7	2944
7200 min Winter	1.604	0.0	47.1	3672
8640 min Winter	1.399	0.0	49.2	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 11-16.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	51.0	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 11-16.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.030

Time (mins) From:	To:	Area (ha)
0	4	0.030

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 11-16.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	14.4
Max Percolation (l/s)	19.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.028 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 17-18.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 40 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.652	0.362	0.0	0.9	0.9	2.5	O K
30 min Summer	99.745	0.455	0.0	1.0	1.0	3.1	Flood Risk
60 min Summer	99.811	0.521	0.0	1.0	1.0	3.6	Flood Risk
120 min Summer	99.832	0.542	0.0	1.1	1.1	3.7	Flood Risk
180 min Summer	99.810	0.520	0.0	1.0	1.0	3.6	Flood Risk
240 min Summer	99.777	0.487	0.0	1.0	1.0	3.4	Flood Risk
360 min Summer	99.713	0.423	0.0	0.9	0.9	2.9	Flood Risk
480 min Summer	99.659	0.369	0.0	0.9	0.9	2.5	O K
600 min Summer	99.614	0.324	0.0	0.8	0.8	2.2	O K
720 min Summer	99.576	0.286	0.0	0.8	0.8	2.0	O K
960 min Summer	99.516	0.226	0.0	0.7	0.7	1.6	O K
1440 min Summer	99.439	0.149	0.0	0.6	0.6	1.0	O K
2160 min Summer	99.376	0.086	0.0	0.5	0.5	0.6	O K
2880 min Summer	99.343	0.053	0.0	0.4	0.4	0.4	O K
4320 min Summer	99.309	0.019	0.0	0.3	0.3	0.1	O K
5760 min Summer	99.294	0.004	0.0	0.2	0.2	0.0	O K
7200 min Summer	99.290	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	3.1	16
30 min Summer	73.497	0.0	4.3	28
60 min Summer	49.020	0.0	5.8	44
120 min Summer	31.620	0.0	7.5	80
180 min Summer	24.081	0.0	8.5	114
240 min Summer	19.682	0.0	9.3	146
360 min Summer	14.719	0.0	10.5	212
480 min Summer	11.975	0.0	11.4	274
600 min Summer	10.193	0.0	12.1	336
720 min Summer	8.930	0.0	12.7	398
960 min Summer	7.238	0.0	13.7	520
1440 min Summer	5.370	0.0	15.3	754
2160 min Summer	3.972	0.0	16.9	1108
2880 min Summer	3.201	0.0	18.2	1472
4320 min Summer	2.356	0.0	20.0	2204
5760 min Summer	1.897	0.0	21.5	2912
7200 min Summer	1.604	0.0	22.6	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 17-18.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.290	0.000	0.0	0.2	0.2	0.0	O K
10080 min Summer	99.290	0.000	0.0	0.2	0.2	0.0	O K
15 min Winter	99.702	0.412	0.0	0.9	0.9	2.8	Flood Risk
30 min Winter	99.813	0.523	0.0	1.0	1.0	3.6	Flood Risk
60 min Winter	99.883	0.593	0.0	1.1	1.1	4.1	Flood Risk
120 min Winter	99.894	0.604	0.0	1.1	1.1	4.2	Flood Risk
180 min Winter	99.848	0.558	0.0	1.1	1.1	3.9	Flood Risk
240 min Winter	99.795	0.505	0.0	1.0	1.0	3.5	Flood Risk
360 min Winter	99.699	0.409	0.0	0.9	0.9	2.8	O K
480 min Winter	99.625	0.335	0.0	0.8	0.8	2.3	O K
600 min Winter	99.567	0.277	0.0	0.8	0.8	1.9	O K
720 min Winter	99.521	0.231	0.0	0.7	0.7	1.6	O K
960 min Winter	99.455	0.165	0.0	0.6	0.6	1.1	O K
1440 min Winter	99.381	0.091	0.0	0.5	0.5	0.6	O K
2160 min Winter	99.331	0.041	0.0	0.4	0.4	0.3	O K
2880 min Winter	99.308	0.018	0.0	0.3	0.3	0.1	O K
4320 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K
5760 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K
7200 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	23.6	0
10080 min Summer	1.247	0.0	24.5	0
15 min Winter	105.613	0.0	3.4	16
30 min Winter	73.497	0.0	4.8	29
60 min Winter	49.020	0.0	6.5	48
120 min Winter	31.620	0.0	8.4	86
180 min Winter	24.081	0.0	9.6	122
240 min Winter	19.682	0.0	10.5	156
360 min Winter	14.719	0.0	11.7	222
480 min Winter	11.975	0.0	12.7	286
600 min Winter	10.193	0.0	13.6	348
720 min Winter	8.930	0.0	14.2	410
960 min Winter	7.238	0.0	15.4	530
1440 min Winter	5.370	0.0	17.1	764
2160 min Winter	3.972	0.0	19.0	1120
2880 min Winter	3.201	0.0	20.4	1468
4320 min Winter	2.356	0.0	22.5	0
5760 min Winter	1.897	0.0	24.1	0
7200 min Winter	1.604	0.0	25.4	0
8640 min Winter	1.399	0.0	26.5	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 17-18.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	27.5	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 17-18.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.016

Time (mins) From:	To:	Area (ha)
0	4	0.016

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 17-18.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	4.8
Max Percolation (l/s)	6.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 19-22.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 92 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.559	0.269	0.0	0.6	0.6	3.7	O K
30 min Summer	99.650	0.360	0.0	0.7	0.7	5.0	O K
60 min Summer	99.729	0.439	0.0	0.8	0.8	6.1	Flood Risk
120 min Summer	99.778	0.488	0.0	0.8	0.8	6.8	Flood Risk
180 min Summer	99.791	0.501	0.0	0.8	0.8	6.9	Flood Risk
240 min Summer	99.787	0.497	0.0	0.8	0.8	6.9	Flood Risk
360 min Summer	99.763	0.473	0.0	0.8	0.8	6.5	Flood Risk
480 min Summer	99.735	0.445	0.0	0.8	0.8	6.2	Flood Risk
600 min Summer	99.708	0.418	0.0	0.7	0.7	5.8	Flood Risk
720 min Summer	99.683	0.393	0.0	0.7	0.7	5.4	O K
960 min Summer	99.637	0.347	0.0	0.7	0.7	4.8	O K
1440 min Summer	99.564	0.274	0.0	0.6	0.6	3.8	O K
2160 min Summer	99.488	0.198	0.0	0.5	0.5	2.7	O K
2880 min Summer	99.438	0.148	0.0	0.5	0.5	2.0	O K
4320 min Summer	99.377	0.087	0.0	0.4	0.4	1.2	O K
5760 min Summer	99.344	0.054	0.0	0.3	0.3	0.8	O K
7200 min Summer	99.324	0.034	0.0	0.3	0.3	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	4.1	18
30 min Summer	73.497	0.0	5.8	32
60 min Summer	49.020	0.0	7.9	60
120 min Summer	31.620	0.0	10.2	90
180 min Summer	24.081	0.0	11.7	126
240 min Summer	19.682	0.0	12.7	160
360 min Summer	14.719	0.0	14.3	228
480 min Summer	11.975	0.0	15.5	296
600 min Summer	10.193	0.0	16.5	362
720 min Summer	8.930	0.0	17.4	428
960 min Summer	7.238	0.0	18.8	558
1440 min Summer	5.370	0.0	20.9	806
2160 min Summer	3.972	0.0	23.2	1168
2880 min Summer	3.201	0.0	24.8	1528
4320 min Summer	2.356	0.0	27.3	2248
5760 min Summer	1.897	0.0	29.3	2944
7200 min Summer	1.604	0.0	30.8	3672

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 19-22.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.311	0.021	0.0	0.2	0.2	0.3	O K
10080 min Summer	99.301	0.011	0.0	0.2	0.2	0.2	O K
15 min Winter	99.596	0.306	0.0	0.6	0.6	4.2	O K
30 min Winter	99.701	0.411	0.0	0.7	0.7	5.7	Flood Risk
60 min Winter	99.794	0.504	0.0	0.8	0.8	7.0	Flood Risk
120 min Winter	99.849	0.559	0.0	0.8	0.8	7.7	Flood Risk
180 min Winter	99.858	0.568	0.0	0.9	0.9	7.9	Flood Risk
240 min Winter	99.847	0.557	0.0	0.8	0.8	7.7	Flood Risk
360 min Winter	99.806	0.516	0.0	0.8	0.8	7.1	Flood Risk
480 min Winter	99.763	0.473	0.0	0.8	0.8	6.5	Flood Risk
600 min Winter	99.721	0.431	0.0	0.7	0.7	6.0	Flood Risk
720 min Winter	99.683	0.393	0.0	0.7	0.7	5.4	O K
960 min Winter	99.618	0.328	0.0	0.7	0.7	4.5	O K
1440 min Winter	99.523	0.233	0.0	0.6	0.6	3.2	O K
2160 min Winter	99.436	0.146	0.0	0.5	0.5	2.0	O K
2880 min Winter	99.386	0.096	0.0	0.4	0.4	1.3	O K
4320 min Winter	99.334	0.044	0.0	0.3	0.3	0.6	O K
5760 min Winter	99.310	0.020	0.0	0.2	0.2	0.3	O K
7200 min Winter	99.296	0.006	0.0	0.2	0.2	0.1	O K
8640 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	32.2	4408
10080 min Summer	1.247	0.0	33.3	5136
15 min Winter	105.613	0.0	4.6	17
30 min Winter	73.497	0.0	6.5	31
60 min Winter	49.020	0.0	8.8	58
120 min Winter	31.620	0.0	11.4	96
180 min Winter	24.081	0.0	13.1	134
240 min Winter	19.682	0.0	14.3	172
360 min Winter	14.719	0.0	16.1	246
480 min Winter	11.975	0.0	17.4	318
600 min Winter	10.193	0.0	18.5	386
720 min Winter	8.930	0.0	19.5	454
960 min Winter	7.238	0.0	21.1	584
1440 min Winter	5.370	0.0	23.4	836
2160 min Winter	3.972	0.0	26.0	1192
2880 min Winter	3.201	0.0	27.9	1556
4320 min Winter	2.356	0.0	30.7	2248
5760 min Winter	1.897	0.0	32.9	2944
7200 min Winter	1.604	0.0	34.6	3672
8640 min Winter	1.399	0.0	36.2	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 19-22.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.2	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	37.5	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 19-22.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.022

Time (mins) From:	To:	Area (ha)
0	4	0.022

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 19-22.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	9.6
Max Percolation (l/s)	12.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.023 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 23-V2.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 121 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.340	0.050	0.0	0.1	0.1	0.7	O K
30 min Summer	99.363	0.073	0.0	0.1	0.1	1.0	O K
60 min Summer	99.385	0.095	0.0	0.1	0.1	1.3	O K
120 min Summer	99.401	0.111	0.0	0.1	0.1	1.5	O K
180 min Summer	99.406	0.116	0.0	0.1	0.1	1.6	O K
240 min Summer	99.407	0.117	0.0	0.1	0.1	1.6	O K
360 min Summer	99.404	0.114	0.0	0.1	0.1	1.6	O K
480 min Summer	99.399	0.109	0.0	0.1	0.1	1.5	O K
600 min Summer	99.394	0.104	0.0	0.1	0.1	1.4	O K
720 min Summer	99.389	0.099	0.0	0.1	0.1	1.4	O K
960 min Summer	99.379	0.089	0.0	0.1	0.1	1.2	O K
1440 min Summer	99.361	0.071	0.0	0.1	0.1	1.0	O K
2160 min Summer	99.341	0.051	0.0	0.1	0.1	0.7	O K
2880 min Summer	99.326	0.036	0.0	0.1	0.1	0.5	O K
4320 min Summer	99.306	0.016	0.0	0.1	0.1	0.2	O K
5760 min Summer	99.295	0.005	0.0	0.1	0.1	0.1	O K
7200 min Summer	99.290	0.000	0.0	0.1	0.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	0.8	18
30 min Summer	73.497	0.0	1.1	32
60 min Summer	49.020	0.0	1.6	60
120 min Summer	31.620	0.0	2.1	104
180 min Summer	24.081	0.0	2.5	136
240 min Summer	19.682	0.0	2.7	170
360 min Summer	14.719	0.0	3.0	238
480 min Summer	11.975	0.0	3.3	308
600 min Summer	10.193	0.0	3.5	376
720 min Summer	8.930	0.0	3.7	442
960 min Summer	7.238	0.0	4.0	576
1440 min Summer	5.370	0.0	4.5	834
2160 min Summer	3.972	0.0	4.9	1192
2880 min Summer	3.201	0.0	5.2	1560
4320 min Summer	2.356	0.0	5.7	2288
5760 min Summer	1.897	0.0	6.0	2952
7200 min Summer	1.604	0.0	6.3	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 23-V2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.290	0.000	0.0	0.1	0.1	0.0	O K
10080 min Summer	99.290	0.000	0.0	0.0	0.0	0.0	O K
15 min Winter	99.349	0.059	0.0	0.1	0.1	0.8	O K
30 min Winter	99.375	0.085	0.0	0.1	0.1	1.2	O K
60 min Winter	99.400	0.110	0.0	0.1	0.1	1.5	O K
120 min Winter	99.419	0.129	0.0	0.1	0.1	1.8	O K
180 min Winter	99.424	0.134	0.0	0.1	0.1	1.9	O K
240 min Winter	99.424	0.134	0.0	0.1	0.1	1.9	O K
360 min Winter	99.419	0.129	0.0	0.1	0.1	1.8	O K
480 min Winter	99.411	0.121	0.0	0.1	0.1	1.7	O K
600 min Winter	99.403	0.113	0.0	0.1	0.1	1.6	O K
720 min Winter	99.395	0.105	0.0	0.1	0.1	1.5	O K
960 min Winter	99.380	0.090	0.0	0.1	0.1	1.2	O K
1440 min Winter	99.355	0.065	0.0	0.1	0.1	0.9	O K
2160 min Winter	99.328	0.038	0.0	0.1	0.1	0.5	O K
2880 min Winter	99.311	0.021	0.0	0.1	0.1	0.3	O K
4320 min Winter	99.292	0.002	0.0	0.1	0.1	0.0	O K
5760 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K
7200 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	6.5	0
10080 min Summer	1.247	0.0	6.7	0
15 min Winter	105.613	0.0	0.9	18
30 min Winter	73.497	0.0	1.3	32
60 min Winter	49.020	0.0	1.8	60
120 min Winter	31.620	0.0	2.4	114
180 min Winter	24.081	0.0	2.8	142
240 min Winter	19.682	0.0	3.0	182
360 min Winter	14.719	0.0	3.4	258
480 min Winter	11.975	0.0	3.7	332
600 min Winter	10.193	0.0	4.0	404
720 min Winter	8.930	0.0	4.2	476
960 min Winter	7.238	0.0	4.5	610
1440 min Winter	5.370	0.0	5.0	868
2160 min Winter	3.972	0.0	5.6	1236
2880 min Winter	3.201	0.0	5.9	1588
4320 min Winter	2.356	0.0	6.5	2248
5760 min Winter	1.897	0.0	6.9	0
7200 min Winter	1.604	0.0	7.2	0
8640 min Winter	1.399	0.0	7.4	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing 23-V2.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	7.6	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing 23-V2.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.005

Time (mins) From:	To:	Area (ha)
0	4	0.005

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing 23-V2.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	9.6
Max Percolation (l/s)	12.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.013 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing V3-V4.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	9516 - Preliminary Pond Sizing.SRCX	(None)

Half Drain Time : 52 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	99.299	0.009	0.0	0.1	0.1	0.1	O K
30 min Summer	99.307	0.017	0.0	0.1	0.1	0.2	O K
60 min Summer	99.314	0.024	0.0	0.1	0.1	0.3	O K
120 min Summer	99.320	0.030	0.0	0.1	0.1	0.4	O K
180 min Summer	99.322	0.032	0.0	0.1	0.1	0.4	O K
240 min Summer	99.321	0.031	0.0	0.1	0.1	0.4	O K
360 min Summer	99.318	0.028	0.0	0.1	0.1	0.4	O K
480 min Summer	99.314	0.024	0.0	0.1	0.1	0.3	O K
600 min Summer	99.311	0.021	0.0	0.1	0.1	0.3	O K
720 min Summer	99.307	0.017	0.0	0.1	0.1	0.2	O K
960 min Summer	99.302	0.012	0.0	0.1	0.1	0.2	O K
1440 min Summer	99.295	0.005	0.0	0.1	0.1	0.1	O K
2160 min Summer	99.290	0.000	0.0	0.1	0.1	0.0	O K
2880 min Summer	99.290	0.000	0.0	0.1	0.1	0.0	O K
4320 min Summer	99.290	0.000	0.0	0.0	0.0	0.0	O K
5760 min Summer	99.290	0.000	0.0	0.0	0.0	0.0	O K
7200 min Summer	99.290	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	0.2	17
30 min Summer	73.497	0.0	0.3	31
60 min Summer	49.020	0.0	0.5	52
120 min Summer	31.620	0.0	0.7	86
180 min Summer	24.081	0.0	0.8	120
240 min Summer	19.682	0.0	0.9	154
360 min Summer	14.719	0.0	1.1	222
480 min Summer	11.975	0.0	1.2	286
600 min Summer	10.193	0.0	1.2	350
720 min Summer	8.930	0.0	1.3	412
960 min Summer	7.238	0.0	1.4	532
1440 min Summer	5.370	0.0	1.6	766
2160 min Summer	3.972	0.0	1.7	0
2880 min Summer	3.201	0.0	1.8	0
4320 min Summer	2.356	0.0	1.9	0
5760 min Summer	1.897	0.0	1.9	0
7200 min Summer	1.604	0.0	2.0	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing V3-V4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	99.290	0.000	0.0	0.0	0.0	0.0	O K
10080 min Summer	99.290	0.000	0.0	0.0	0.0	0.0	O K
15 min Winter	99.303	0.013	0.0	0.1	0.1	0.2	O K
30 min Winter	99.312	0.022	0.0	0.1	0.1	0.3	O K
60 min Winter	99.320	0.030	0.0	0.1	0.1	0.4	O K
120 min Winter	99.325	0.035	0.0	0.1	0.1	0.5	O K
180 min Winter	99.326	0.036	0.0	0.1	0.1	0.5	O K
240 min Winter	99.324	0.034	0.0	0.1	0.1	0.5	O K
360 min Winter	99.319	0.029	0.0	0.1	0.1	0.4	O K
480 min Winter	99.313	0.023	0.0	0.1	0.1	0.3	O K
600 min Winter	99.308	0.018	0.0	0.1	0.1	0.2	O K
720 min Winter	99.303	0.013	0.0	0.1	0.1	0.2	O K
960 min Winter	99.296	0.006	0.0	0.1	0.1	0.1	O K
1440 min Winter	99.290	0.000	0.0	0.1	0.1	0.0	O K
2160 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K
2880 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K
4320 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K
5760 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K
7200 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K
8640 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.399	0.0	2.0	0
10080 min Summer	1.247	0.0	1.9	0
15 min Winter	105.613	0.0	0.2	17
30 min Winter	73.497	0.0	0.4	31
60 min Winter	49.020	0.0	0.6	58
120 min Winter	31.620	0.0	0.8	92
180 min Winter	24.081	0.0	1.0	130
240 min Winter	19.682	0.0	1.1	168
360 min Winter	14.719	0.0	1.2	238
480 min Winter	11.975	0.0	1.3	304
600 min Winter	10.193	0.0	1.4	368
720 min Winter	8.930	0.0	1.5	432
960 min Winter	7.238	0.0	1.6	548
1440 min Winter	5.370	0.0	1.8	0
2160 min Winter	3.972	0.0	2.0	0
2880 min Winter	3.201	0.0	2.1	0
4320 min Winter	2.356	0.0	2.2	0
5760 min Winter	1.897	0.0	2.3	0
7200 min Winter	1.604	0.0	2.3	0
8640 min Winter	1.399	0.0	2.4	0

Cascade Summary of Results for 9516 - Preliminary Permeable Paving Sizing V3-V4.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	99.290	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.247	0.0	2.4	0

Cascade Rainfall Details for 9516 - Preliminary Permeable Paving Sizing V3-V4.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.002

Time (mins) From:	To:	Area (ha)
0	4	0.002

Cascade Model Details for 9516 - Preliminary Permeable Paving Sizing V3-V4.SRCX

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	9.6
Max Percolation (l/s)	12.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.290	Cap Volume Depth (m)	0.600

Orifice Outflow Control

Diameter (m) 0.013 Discharge Coefficient 0.600 Invert Level (m) 99.250

Cascade Summary of Results for 9516 - Preliminary Pond Sizing.SRCX

Upstream Structures	Outflow To	Overflow To
9516 - Preliminary Permeable Paving Sizing 1-2.SRCX	(None)	(None)
9516 - Preliminary Permeable Paving Sizing 3-4.SRCX		
9516 - Preliminary Permeable Paving Sizing 5-6.SRCX		
9516 - Preliminary Permeable Paving Sizing 7-8.SRCX		
9516 - Preliminary Permeable Paving Sizing 9-10.SRCX		
9516 - Preliminary Permeable Paving Sizing 11-16.SRCX		
9516 - Preliminary Permeable Paving Sizing 17-18.SRCX		
9516 - Preliminary Permeable Paving Sizing 19-22.SRCX		
9516 - Preliminary Permeable Paving Sizing 23-V2.SRCX		
9516 - Preliminary Permeable Paving Sizing V3-V4.SRCX		

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.496	0.596	5.0	11.5	O K
30 min Summer	99.597	0.697	5.0	16.8	O K
60 min Summer	99.690	0.790	5.0	22.8	O K
120 min Summer	99.773	0.873	5.0	29.0	Flood Risk
180 min Summer	99.810	0.910	5.0	32.1	Flood Risk
240 min Summer	99.825	0.925	5.0	33.5	Flood Risk
360 min Summer	99.815	0.915	5.0	32.6	Flood Risk
480 min Summer	99.797	0.897	5.0	31.0	Flood Risk
600 min Summer	99.776	0.876	5.0	29.3	Flood Risk
720 min Summer	99.754	0.854	5.0	27.5	Flood Risk
960 min Summer	99.703	0.803	5.0	23.7	Flood Risk
1440 min Summer	99.567	0.667	5.0	15.1	O K
2160 min Summer	99.134	0.234	5.0	1.3	O K
2880 min Summer	98.900	0.000	4.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	105.613	0.0	37.7	37
30 min Summer	73.497	0.0	53.1	66
60 min Summer	49.020	0.0	71.3	102
120 min Summer	31.620	0.0	92.4	152
180 min Summer	24.081	0.0	105.9	194
240 min Summer	19.682	0.0	115.3	242
360 min Summer	14.719	0.0	129.7	330
480 min Summer	11.975	0.0	140.8	390
600 min Summer	10.193	0.0	149.7	452
720 min Summer	8.930	0.0	157.7	514
960 min Summer	7.238	0.0	170.4	638
1440 min Summer	5.370	0.0	189.5	896
2160 min Summer	3.972	0.0	210.1	1152
2880 min Summer	3.201	0.0	225.5	0

Cascade Summary of Results for 9516 - Preliminary Pond Sizing.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
4320 min Summer	98.900	0.000	3.6	0.0	O K
5760 min Summer	98.900	0.000	3.0	0.0	O K
7200 min Summer	98.900	0.000	2.6	0.0	O K
8640 min Summer	98.900	0.000	2.2	0.0	O K
10080 min Summer	98.900	0.000	2.0	0.0	O K
15 min Winter	99.538	0.638	5.0	13.5	O K
30 min Winter	99.646	0.746	5.0	19.8	O K
60 min Winter	99.747	0.847	5.0	26.9	Flood Risk
120 min Winter	99.837	0.937	5.0	34.5	Flood Risk
180 min Winter	99.877	0.977	5.0	38.3	Flood Risk
240 min Winter	99.895	0.995	5.0	40.0	Flood Risk
360 min Winter	99.893	0.993	5.0	39.8	Flood Risk
480 min Winter	99.865	0.965	5.0	37.1	Flood Risk
600 min Winter	99.834	0.934	5.0	34.2	Flood Risk
720 min Winter	99.798	0.898	5.0	31.1	Flood Risk
960 min Winter	99.712	0.812	5.0	24.3	Flood Risk
1440 min Winter	99.302	0.402	5.0	4.7	O K
2160 min Winter	98.900	0.000	4.3	0.0	O K
2880 min Winter	98.900	0.000	3.6	0.0	O K
4320 min Winter	98.900	0.000	2.7	0.0	O K
5760 min Winter	98.900	0.000	2.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
4320 min Summer	2.356	0.0	248.3	0
5760 min Summer	1.897	0.0	265.8	0
7200 min Summer	1.604	0.0	280.3	0
8640 min Summer	1.399	0.0	292.7	0
10080 min Summer	1.247	0.0	303.5	0
15 min Winter	105.613	0.0	42.3	45
30 min Winter	73.497	0.0	59.7	74
60 min Winter	49.020	0.0	80.2	110
120 min Winter	31.620	0.0	103.9	162
180 min Winter	24.081	0.0	118.9	206
240 min Winter	19.682	0.0	129.7	246
360 min Winter	14.719	0.0	145.6	348
480 min Winter	11.975	0.0	157.7	416
600 min Winter	10.193	0.0	168.0	476
720 min Winter	8.930	0.0	176.7	544
960 min Winter	7.238	0.0	191.1	680
1440 min Winter	5.370	0.0	212.6	882
2160 min Winter	3.972	0.0	235.7	0
2880 min Winter	3.201	0.0	253.0	0
4320 min Winter	2.356	0.0	278.7	0
5760 min Winter	1.897	0.0	298.5	0

Cascade Summary of Results for 9516 - Preliminary Pond Sizing.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
7200 min Winter	98.900	0.000	1.9	0.0	O K
8640 min Winter	98.900	0.000	1.6	0.0	O K
10080 min Winter	98.900	0.000	1.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
7200 min Winter	1.604	0.0	314.8	0
8640 min Winter	1.399	0.0	328.8	0
10080 min Winter	1.247	0.0	341.1	0

Cascade Rainfall Details for 9516 - Preliminary Pond Sizing.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Shortest Storm (mins)	15
Ratio R	0.288	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.064

Time (mins) From:	To:	Area (ha)
0	4	0.064

Cascade Model Details for 9516 - Preliminary Pond Sizing.SRCX

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 98.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2.0	0.700	58.8	1.400	0.0	2.100	0.0
0.100	4.7	0.800	71.7	1.500	0.0	2.200	0.0
0.200	8.2	0.900	85.2	1.600	0.0	2.300	0.0
0.300	21.7	1.000	99.3	1.700	0.0	2.400	0.0
0.400	24.1	1.100	113.9	1.800	0.0	2.500	0.0
0.500	34.9	1.200	150.0	1.900	0.0		
0.600	46.6	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0101-5000-1300-5000
Design Head (m)	1.300
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	98.700
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.300	5.0
Flush-Flo™	0.384	5.0
Kick-Flo®	0.798	4.0
Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.4	1.200	4.8	3.000	7.4	7.000	11.0
0.200	4.7	1.400	5.2	3.500	7.9	7.500	11.4
0.300	4.9	1.600	5.5	4.000	8.5	8.000	11.8
0.400	5.0	1.800	5.8	4.500	9.0	8.500	12.1
0.500	4.9	2.000	6.1	5.000	9.4	9.000	12.5
0.600	4.8	2.200	6.4	5.500	9.8	9.500	12.8
0.800	4.0	2.400	6.7	6.000	10.3		
1.000	4.4	2.600	6.9	6.500	10.7		

Kingscrown Land & Commercial Ltd

Bontnewydd
Bontnewydd Residential Development

Flood Consequence Assessment
ECL.9516.R05.001 Rev -

March 2023

Appendix 6

UKSUDs Greenfield Run-off Calculations

Print | Close Report

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Paul Nye
Site name:	9516 - Bontnewydd
Site location:	Residential Bontnewydd

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.11700° N
Longitude:	4.26665° W
Reference:	3245964668
Date:	Mar 14 2023 10:10

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.338

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics	Default	Edited
SAAR (mm):	1255	1255
Hydrological region:	9	9
Growth curve factor 1 year:	0.88	0.88
Growth curve factor 30 years:	1.78	1.78
Growth curve factor 100 years:	2.18	2.18
Growth curve factor 200 years:	2.46	2.46

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	1.22	1.22
1 in 1 year (l/s):	1.07	1.07
1 in 30 years (l/s):	2.17	2.17
1 in 100 year (l/s):	2.66	2.66
1 in 200 years (l/s):	3	3

Kingscrown Land & Commercial Ltd

Bontnewydd
Bontnewydd Residential Development

Flood Consequence Assessment
ECL.9516.R05.001 Rev -

March 2023

Appendix 7

Surface Water Management Plan

Appendix 7 – Generic Surface Management Plan

Apparatus	Monitoring/ Maintenance	*Required Action*	*Frequency of inspection/action*
Road gullies & catchpits	Monitoring Maintenance	Inspect gullies and catchpits remove silt when sump is full	Six monthly, changing to yearly after 18-month period
Surface water drainage pipes	Monitoring Maintenance	Inspect surface water drains via manholes or catchpits to ascertain rate of siltation or other related matters remove debris and silt when fouled	Six monthly, changing to yearly after 18-month period
Grilles and non-return valve	Monitoring Maintenance	Inspect grilles and non-return valves within the eastern ditchcourse to ensure no fouling / blockages remove debris and silt when fouled	Every 14 days or after a significant rainfall event
Site wide	Monitoring Monitoring	Inspect silt accumulation rates and establish appropriate removal Frequencies Inspection of sediment for possible hazardous materials	Six Monthly Six Monthly
French drains and infiltration	Monitoring Maintenance	Inspect drainage system and any outfall locations Remove debris and silt when fouled and possible sources of contaminants	Inspect six monthly or after significant rainfall event