PROPOSED COMERCIAL DEVELOPMENT ON LAND OFF ST AUSTELL BUSINESS PARK, ST AUSTELL, CORNWALL

FLOOD RISK ASSESSMENT & SURFACE WATER DRAINAGE STRATEGY

J-1980-Rev.01

Engineering & Development Solutions

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Report No.	Issue Detail	Originator	Date	Checked by	Date
J-1980	01	JM	09/09/2021	BD	09/09/2021

For: Mr. C. Nile
The Bakery
Morven Trading Estate
St Austell
PL25 4PP

Job No: J-1980
Date: September 2021
Edition: 01

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APPENDICES

1.0 INTRODUCTION

Mr. C. Nile is proposing to develop on land off St Austell Business Park, St Austell, PL25-3DQ in order to provide a new café & bakery and two commercial offices, associated access and parking. The site location and wider geographical area are shown in **Figures 1** and **2** below.

Figure 1 Geographical Area & Location

Figure 2 Geographical Area & Location (aerial photo view)

During the planning process, it has become apparent that the site lies within the St Austell Critical Drainage Area, as such the development will require a Flood Risk Assessment (FRA) in accordance with the National Planning Policy Framework (NPPF) on Planning and Flood Risk.

As the site is within Flood Zone 1 (Low Probability), the primary aim of the FRA will be to ensure that the development does not increase flood risk elsewhere. This can be achieved by providing a suitable sustainable drainage scheme (SuDS) that manages surface water runoff from the development.

To address this requirement, Engineering & Development Solutions (EDS) have been commissioned to prepare an FRA including a surface water drainage strategy for the proposed development, in accordance with the best practice principles of SuDS, the National Planning Policy Framework (NPPF), Drainage Guidance for Cornwall (DGfC) and Planning Practice Guidance (PPG). This report details the findings of the study.

2.0 SITE LOCATION & DESCRIPTION

Site Location

The proposed development site is located in Carclaze which is on the northern edge of the town St Austell. The site covers an area of around 0.35ha. The approximate Ordnance Survey Grid Reference for the site is SX 02200 54666.

The site is positioned on the eastern side of the A391, with commercial units to the north, east and south. A handful of residential properties are situated to the west of the A391.

In terms of existing site topography, the site falls primarily from north to south from a highpoint in the north-western boundary at an elevation of 203m AOD to a low point at a level of 196.89m AOD on the southern boundary. Existing site levels are shown on the Topographic Survey in **Appendix A**.

The land south of the site slopes gently down towards St Austell Bay, which is located approximately 4.1km south east.

Land immediately adjacent to the site western boundary falls rapidly down to (what is that a road / pavement

Existing Usage

The site currently comprises of a disused brownfield site located within the curtilage of St Austell Business Park located on the north eastern edge of St Austell.

Proposed Usage

The development proposal is for a new café / bakery, two commercial offices associated parking, access road and infrastructure. The proposed layout is shown in **Appendix A.**

3.0 ASSESSMENT OF FLOOD RISKS

Fluvial and Tidal Flooding

The site is located approximately 1.3km east of the St Austell River. The Environment Agency indicative flood map for planning (Figure 3, below) shows that the entire site is in Flood Zone 1 (less than 1 in 1,000 annual probability of river or sea flooding) and is therefore not at risk from either fluvial or tidal flooding.

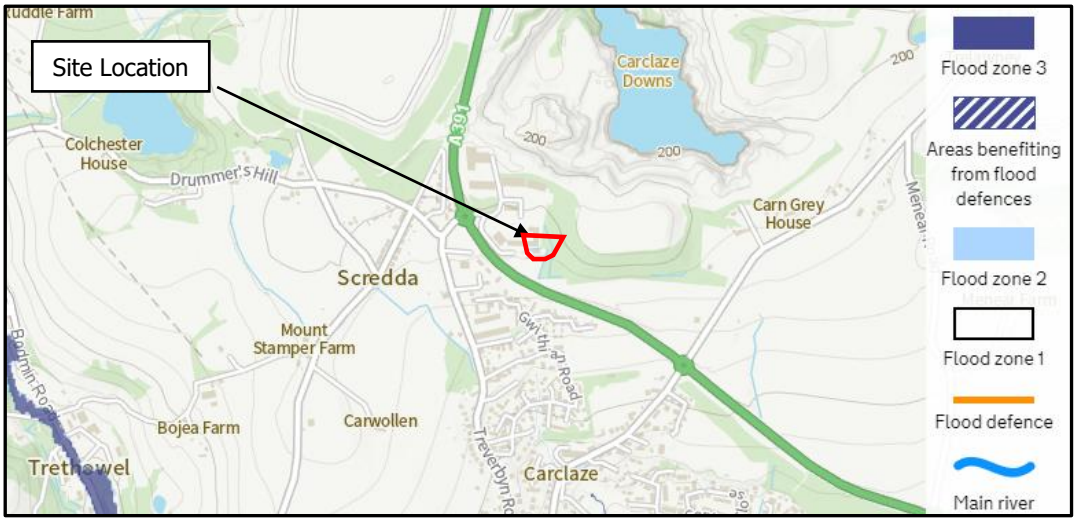


Figure 3 Environment Agency Flood Map for Planning (Rivers & Sea) Extract

Groundwater

Groundwater flooding is linked to the ability of the ground to hold water. The Cornwall Council Strategic Flood Risk Assessment (SFRA) highlights that the geology of Cornwall has only minor aquifers and generally does not experience much groundwater flooding.

In addition, trial pits opened on site for percolation testing to a maximum depth of 2.4m showed no evidence of any groundwater. As such, groundwater flooding is not considered any further in this report.

Overland Flow

The site is located towards the upper boundary of an urban catchment with commercial buildings located upslope with existing highway drainage in place. It is anticipated that rainfall generated upslope of the site during low to medium order rainfall events would be channelled around the north easter corner of the site.

The potential for flooding from overland sheet flow is therefore considered to be low.

The EA map extract, Figure 4 below, shows the risk of flooding from surface water for the site. It indicates that the site is at very low risk of flooding from surface water. During extreme rainfall events, the road network is likely act as a surface conveyance feature for overland flow and would act to carry flows past the site in a southernly direction. As such, it is considered that the site is not at significant risk of surface water flooding.

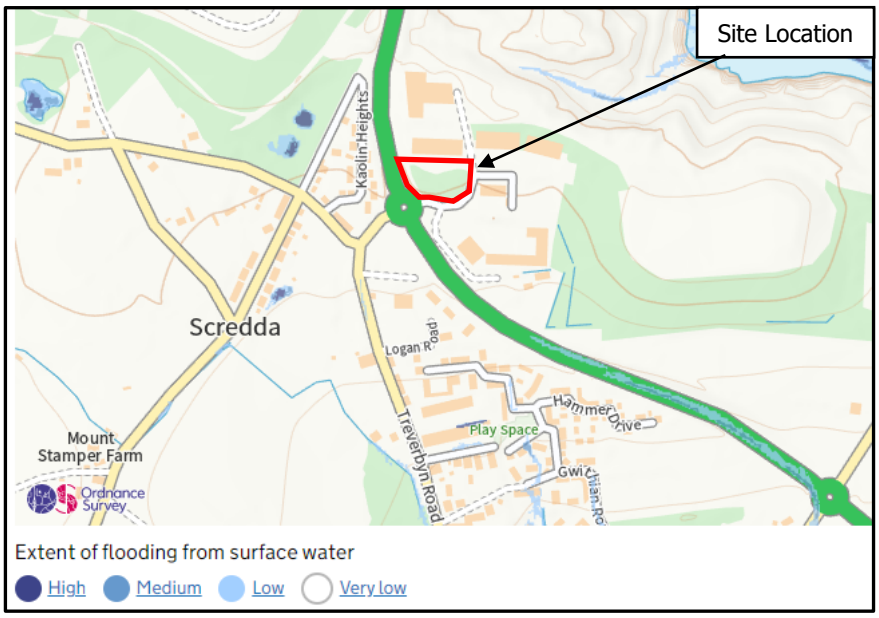


Figure 4 EA Flood Risk from Surface Water Map Extract

Flooding from Reservoirs, Canals and Other Artificial Sources

With reference to the EA map extent of flooding from reservoirs (Figure 5) there appears to be no risk from flooding from reservoirs, therefore flooding of the site from these sources can be discounted.

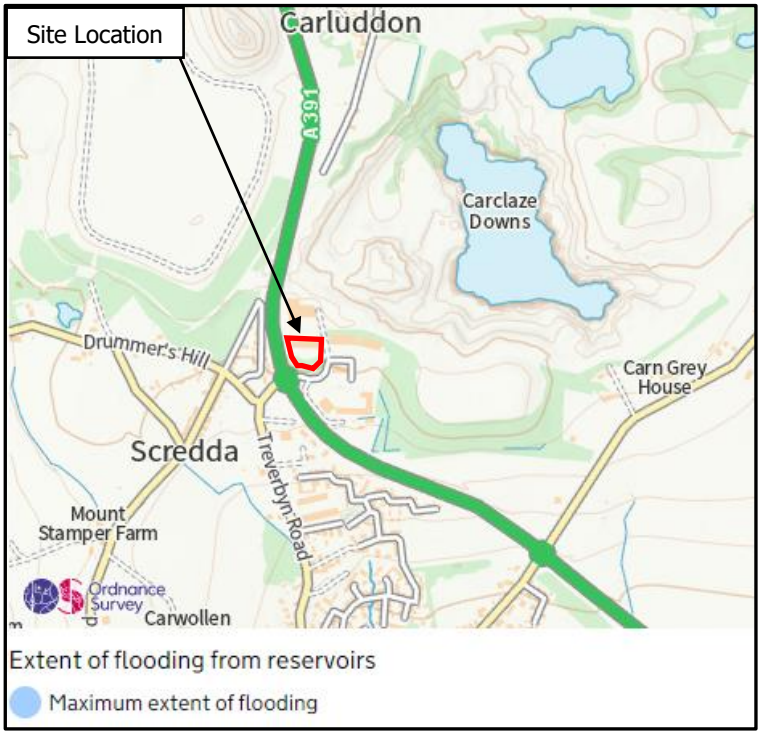


Figure 5 EA Flood Risk from Reservoir Flooding Map Extract

Flooding as a Result of Development

The development of the site will alter the nature of the surface permeability throughout the site. The development will create impermeable areas through the implementation of commercial units and paved areas where there are currently greenfield permeable areas. Thus, the rate at which water runs off these areas could increase. Consequently, it is important that surface water runoff from the development is understood and managed by means of a sustainable surface water drainage system, to prevent an increase in the risk of flooding to areas downstream of the site.

By designing the site's surface water drainage infrastructure in accordance with the advice reproduced in **Section 4**, the proposed development will not increase flood risk to third parties downslope. In consideration of the above, the proposed sustainable drainage system to be installed within the development is described in more detail in **Section 5** of this report.

4.0 DESIGN STANDARDS

Design of the site drainage infrastructure and Sustainable Drainage System (SuDs) is to be carried out in line with best practice, and to industry standard design procedures. Several publications, including design guidance and best practice guidance will be applied to different components of the final SuDs infrastructure. The sections below provide an overview of the design standards to be used on this project for various aspects of the SuDs infrastructure design.

The CIRIA SuDS Manual (C753)

This document is a comprehensive publication covering design, construction, operation and maintenance of SuDs. The advice and best practice outlined in this document has been utilised in the design of the site SuDs features which have been detailed in this report.

Building Regulations Part H

Building Regulations Part H 'Drainage and Waste Disposal' covers the design and installation of surface water and foul water systems. All private drainage including pipes, manholes, down pipes, and other drainage infrastructure on the site should be designed and installed in accordance with this document.

The Wallingford Procedure

Developed by HR Wallingford, this publication covers the design of urban drainage systems. In addition, the document includes regional rainfall data for use in design for varying return period events. Basic sizing calculations for the proposed SuDS system and the estimation of the runoff volumes have been made using this method.

National Planning Policy Framework

The National Planning Policy Framework (NPPF) contains the policy relating to the appropriate assessment of flood risk within the UK. The associated technical guidance provides further details on the definitions, classifications and constraints used to apply national policy to new developments.

It contains details on flood zone definition, site specific FRA's, vulnerability classifications, appropriate development, climate change allowances, residual risk management, flood resilience, the sequential test and the exception test.

Minimum Drainage Standards Required

All new developments will have to play their part in reducing current rainfall runoff rates. This requirement also applies to brownfield sites that will have to match the same standards. The surface water drainage hierarchy should be followed by using infiltration as far as is practicable. Further guidance on such systems can be found in the CIRIA SuDS Manual and in Lead Local Flood Authority guidance.

All off-site surface water discharges from developments should mimic greenfield performance up to a maximum 1 in 10-year discharge rate. On site all surface water should be safely managed up to the 1 in 100 plus climate change conditions. This will require additional water storage areas to be created thereby contributing to a reduction in flooding downstream.

With regards to the guidance above, a drainage design has been proposed below.

5.0 PROPOSED SUSTAINABLE DRAINAGE SYSTEM (SUDS)

The preferable drainage solution for the site would be to drain all surface water runoff from the development using infiltration, in line with best practice guidance to deal with runoff as close to source as possible.

Site investigation work was undertaken in line with BRE 365/CIRIA 156 on 14/07/2021. Percolation tests were carried out in three trial pits across the site; the results are summarised below and included in **Appendix B**. The pits all failed with no measurable change in water level noted over a four-hour period, due to the presence of thick clay.

Trial Pit	Infiltration Rate (m/s)	Infiltration Rate (m/hr)
TP1	Fail	Fail
TP2	Fail	Fail
TP3	Fail	Fail

Given the results described above, infiltration is ruled out as a means of surface water disposal and an alternative system, based on attenuation and controlled rate discharge is proposed.

Drainage Design – Attenuation System

The surface water run-off from the site will need to be attenuated on site and discharged to a suitable receptor at an appropriate rate in line with the requirements of the CDA standing advice.

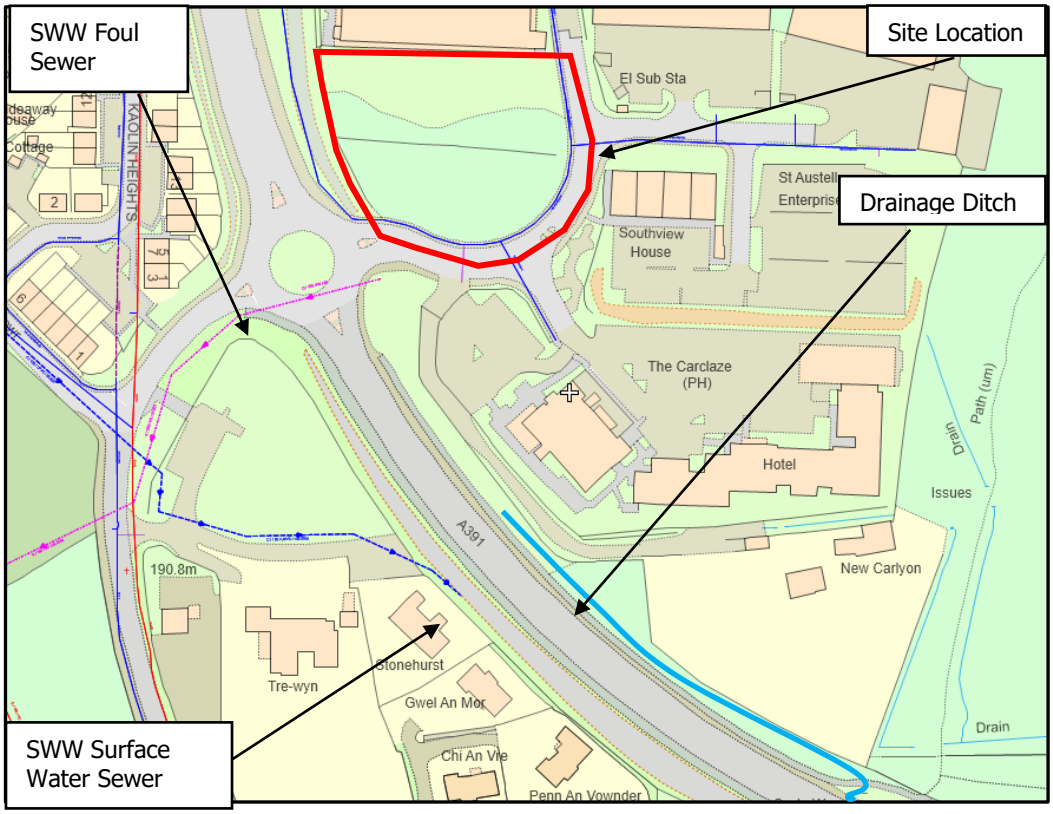


Figure 5 SWWIM Extract

A review of The South West Water Interactive Mapping system (SWWIM) (**Figure 5**) shows the nearest SWW surface water sewer runs across the A391. However, digging up the road wouldn't be cost effective and would require a section 50.

It is possible that because the area around the site is developed that an existing system to dispose of surface water may be in place, however this would be needed to be inspected further by the contractor.

A site visit showed that there was a ditch that ran parallel to the A391 in a south easterly direction (**Figure 5**) which flowed into a tributary that's gets culverted underneath the A391 and joins the Crinnis River. This would be the most suitable receptor to discharge the surface water to.

The greenfield runoff rate for the remining development has been calculated, using the ICP SUDS method, to be about 6.2 l/s based on a return period of 100 years. As such this flow rate has been used to size a storage device.

Surface water originating from the impermeable areas of the development (roofs) and parking area would drain via a positively piped drainage system towards a flow control device. MicroDrainage software has been used to size the storage required to facilitate a discharge limited to 6.2 l/s for an impermeable area of 3,530m^2.

These Calculations indicate a minimum tank size of 190m^3, to accommodate the worst-case design storm (100-year) with rainfall intensities increased by 40% to allow for the effects of climate change as required by the standing advice. The minimum tank size could be achieved by using a tank with the dimensions of 5m (w) x 25m (l) x 1.6m (d). Outflow from the tank would be controlled by means of a flow control device within a manhole. If the upstream flow rate exceeds 6.2 l/s, flows will back up into the proposed attenuation tank.

The proposed drainage layout (Drawing 3001A) included in **Annex A** shows the proposed layout of the surface water attenuation system at the site. Calculations for the conceptual surface water drainage option are presented in **Annex B**.

Exceedance Events

In the unlikely event of a storm in excess of the 1 in 100 year return period rainfall event (including climate change allowance) or if the proposed drainage system were to become blocked, water may surcharge from the system. In this case it is considered that the overflowing water would run over ground towards the south of the site, as per the pre-developed scenario.

Due to the storage provided in the proposed infiltration/Attenuation systems, and design standards used (1 in 100-year storm with an additional 40% allowance for the effects of climate change), any exceedance flows would be lower than would flow off the site in the pre-development scenario for a similar storm event.

Maintenance

Maintenance of the attenuation tank will be undertaken by a management company set up for the site. Maintenance activities will broadly comprise regular maintenance, occasional tasks and remedial work where necessary, as per the guidance in the CIRIA SuDS Manual (C753) 2015

ATTENUATION TANK	Required Action	Typical Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris form the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank form above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Residual Risks After Development

Rainfall over and above the design event could cause the sustainable drainage system to surcharge, however, any exceedance flows would be dealt with as outlined above.

The sustainable surface water drainage system proposed in this report has been designed for the volume of surface runoff resulting from the proposed development, thus any unauthorised future connections into the soakaway network could potentially overload the system. Any future development on the site, beyond the current proposal, should be suitably planned and considered.

6.0 SUMMARY AND CONCLUSIONS

This study has investigated mechanisms of flooding and the potential for Sustainable Drainage (SuDS) to be installed as part of the development on land off St Austell Business Park, St Austell.

Environment Agency (EA) indicative flood mapping shows that the development site is located entirely within Flood Zone 1; at little or no risk from tidal or fluvial flooding and is therefore suitable for all types of development. The development proposal is for over ten residential units, within a critical drainage area and therefore further consideration of surface water drainage has been undertaken.

The study has investigated alternative mechanisms for flooding at the site and has concluded that the site is not at risk of flooding and will not cause any increase in flood risk elsewhere once the proposed sustainable drainage system is operational. Indeed the use of infiltration drainage will reduce the level of runoff from the site when compared to the pre-development scenario.

Infiltration testing has been undertaken on the site and showed that infiltration was not feasible. As such an attenuation-based drainage system for the site, this has been designed to the 100-year standard with a 40% allowance for climate change. Surface water will be discharged to the drainage ditch to the south of the site at the 10yr greenfield run off flow rate of 6.2l/s.

Provided the recommendations outlined in this report are adopted in the development proposal then there is the capacity to manage the surface water runoff from the development onsite. Regarding the criteria outlined in the NPPF, PPG and the CDA, the development is appropriate on this site from a flood risk perspective.

APPENDIX A TOPOGRAPHIC SURVEY AND PROPOSED SITE DRAINAGE PLAN

KEY

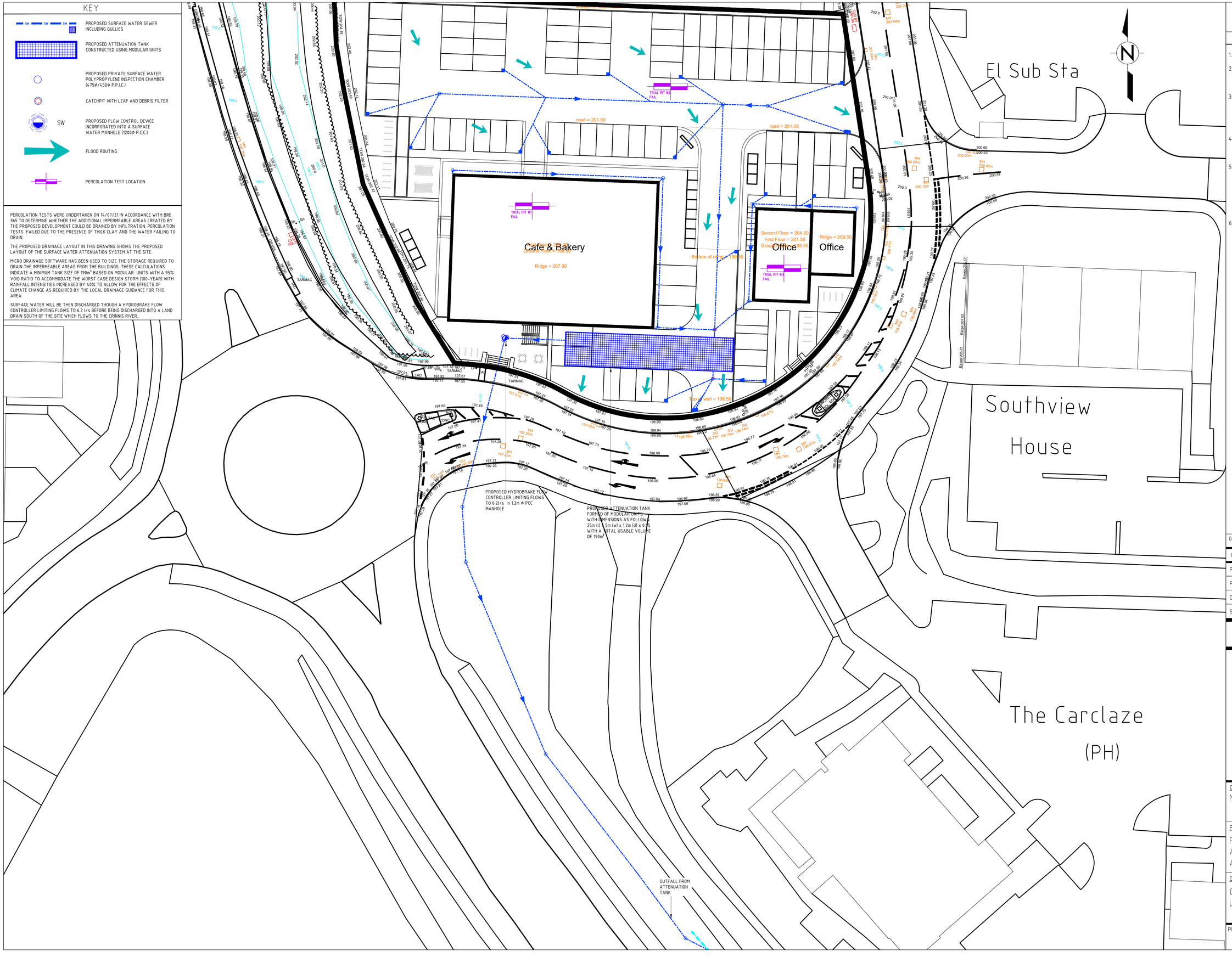
- PROPOSED SURFACE WATER SEWER INCLUDING GULLIES
- PROPOSED ATTENUATION TANK CONSTRUCTED USING MODULAR UNITS
- PROPOSED PRIVATE SURFACE WATER POLYPROPYLENE INSPECTION CHAMBER (475ø/450ø P.P.I.C.)
- CATCHPIT WITH LEAF AND DEBRIS FILTER
- SW — PROPOSED FLOW CONTROL DEVICE INCORPORATED INTO A SURFACE WATER MANHOLE (1200ø P.C.C.)
- FLOOD ROUTING
- PERCOLATION TEST LOCATION

PERCOLATION TESTS WERE UNDERTAKEN ON 14/07/21 IN ACCORDANCE WITH BRE 365 TO DETERMINE WHETHER THE ADDITIONAL IMPERMEABLE AREAS CREATED BY THE PROPOSED DEVELOPMENT COULD BE DRAINED BY INFILTRATION. PERCOLATION TESTS FAILED DUE TO THE PRESENCE OF THICK CLAY AND THE WATER FAILING TO DRAIN.

THE PROPOSED DRAINAGE LAYOUT IN THIS DRAWING SHOWS THE PROPOSED LAYOUT OF THE SURFACE WATER ATTENUATION SYSTEM AT THE SITE.

MICRO DRAINAGE SOFTWARE HAS BEEN USED TO SIZE THE STORAGE REQUIRED TO DRAIN THE IMPERMEABLE AREAS FROM THE BUILDINGS. THESE CALCULATIONS INDICATE A MINIMUM TANK SIZE OF 190m³ BASED ON MODULAR UNITS WITH A 95% VOID RATIO TO ACCOMMODATE THE WORST CASE DESIGN STORM (100-YEAR) WITH RAINFALL INTENSITIES INCREASED BY 40% TO ALLOW FOR THE EFFECTS OF CLIMATE CHANGE AS REQUIRED BY THE LOCAL DRAINAGE GUIDANCE FOR THIS AREA.

SURFACE WATER WILL BE THEN DISCHARGED THOUGH A HYDROBRAKE FLOW CONTROLLER LIMITING FLOWS TO 6.2 l/s BEFORE BEING DISCHARGED INTO A LAND DRAIN SOUTH OF THE SITE WHICH FLOWS TO THE CRINNIS RIVER.



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NOTES

1. This drawing is copyright. Refer to details above.
2. This drawing is only to be used for the purposes described in the status box below.
   Work to figured dimensions only, do not scale.
3. This drawing is to be read in conjunction with all other drawings, details and specifications pertaining to the work described. It should only be used for the purpose marked in the status box below, and shall not be used for construction unless clearly marked CONSTRUCTION.
4. Materials and workmanship shall comply to the appropriate British Standards and Codes of Practice unless otherwise stated.
5. The activities required to construct the work, shown on drawings clearly marked CONSTRUCTION, may be subject to the provisions of the Construction (Design & Management) Regulations 2015. The Contractor and Client must ensure that they are adequately conversant with these regulations and that the appropriate procedures required under the regulations are observed at all times.
6. Design Risk Assessment

   A risk assessment relating to potential hazards associated with the works described within this drawing, in so far as they have been designed by EDS Ltd, has been undertaken. Risks identified have been eliminated by design wherever practicable. The status with regard to residual risks is as follows:

   The work is at an early planning stage and is not sufficiently advanced to allow a meaningful assessment of risks to be undertaken at this time.

Designer - EDS Drawing revision - A
Date - 06:09:21

DATE.	DRWN.	CHKD.	REV.	NOTES.
06:09:21	JM	BD	A	PRELIMINARY ISSUE

PROJECT MANAGER:-	JAN CLARK
PROJECT ENGINEER:-	JOSHUA MUNYARD
DRAWN DATE:-	SEP 2021
SCALE & SHEET SIZE:-	1:250 @ A1

PRELIMINARY

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CLIENT
MR. C. NILE.

PROJECT
PROPOSED COMERICAL DEVELOPMENT AT ST AUSTELL BUSINESS PARK, ST AUSTELL

DRAWING TITLE
CONCEPTUAL SURFACE WATER DRAINAGE LAYOUT

PROJECT No.	DRAWING No.	REV.
J-1980	3001	A

APPENDIX B CALCULATIONS

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

Half Drain Time : 264 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	98.044	0.544	0.0	6.2	0.0	6.2	64.6	O K
30 min Summer	98.262	0.762	0.0	6.2	0.0	6.2	90.5	O K
60 min Summer	98.507	1.007	0.0	6.2	0.0	6.2	119.6	O K
120 min Summer	98.728	1.228	0.0	6.2	0.0	6.2	145.8	O K
180 min Summer	98.809	1.309	0.0	6.2	0.0	6.2	155.4	O K
240 min Summer	98.832	1.332	0.0	6.2	0.0	6.2	158.1	O K
360 min Summer	98.848	1.348	0.0	6.2	0.0	6.2	160.1	O K
480 min Summer	98.841	1.341	0.0	6.2	0.0	6.2	159.3	O K
600 min Summer	98.824	1.324	0.0	6.2	0.0	6.2	157.2	O K
720 min Summer	98.801	1.301	0.0	6.2	0.0	6.2	154.5	O K
960 min Summer	98.744	1.244	0.0	6.2	0.0	6.2	147.7	O K
1440 min Summer	98.609	1.109	0.0	6.2	0.0	6.2	131.7	O K
2160 min Summer	98.343	0.843	0.0	6.2	0.0	6.2	100.2	O K
2880 min Summer	98.123	0.623	0.0	6.2	0.0	6.2	74.0	O K
4320 min Summer	97.859	0.359	0.0	6.1	0.0	6.1	42.6	O K
5760 min Summer	97.731	0.231	0.0	5.7	0.0	5.7	27.4	O K
7200 min Summer	97.665	0.165	0.0	5.2	0.0	5.2	19.6	O K
8640 min Summer	97.630	0.130	0.0	4.8	0.0	4.8	15.5	O K
10080 min Summer	97.617	0.117	0.0	4.3	0.0	4.3	13.8	O K
15 min Winter	98.114	0.614	0.0	6.2	0.0	6.2	72.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	105.591	0.0	69.6	0.0	21
30 min Summer	75.240	0.0	99.3	0.0	36
60 min Summer	51.407	0.0	136.0	0.0	64
120 min Summer	33.834	0.0	179.0	0.0	122
180 min Summer	25.951	0.0	206.0	0.0	180
240 min Summer	21.313	0.0	225.5	0.0	224
360 min Summer	16.157	0.0	256.5	0.0	286
480 min Summer	13.243	0.0	280.3	0.0	352
600 min Summer	11.335	0.0	299.9	0.0	420
720 min Summer	9.973	0.0	316.6	0.0	492
960 min Summer	8.137	0.0	344.5	0.0	630
1440 min Summer	6.089	0.0	386.6	0.0	912
2160 min Summer	4.539	0.0	432.5	0.0	1296
2880 min Summer	3.681	0.0	467.6	0.0	1644
4320 min Summer	2.746	0.0	523.2	0.0	2300
5760 min Summer	2.233	0.0	567.4	0.0	3000
7200 min Summer	1.903	0.0	604.7	0.0	3680
8640 min Summer	1.673	0.0	637.7	0.0	4400
10080 min Summer	1.501	0.0	667.6	0.0	5136
15 min Winter	105.591	0.0	78.0	0.0	21

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	98.363	0.863	0.0	6.2	0.0	6.2	102.5	O K
60 min Winter	98.643	1.143	0.0	6.2	0.0	6.2	135.7	O K
120 min Winter	98.902	1.402	0.0	6.2	0.0	6.2	166.5	O K
180 min Winter	99.006	1.506	0.0	6.2	0.0	6.2	178.9	O K
240 min Winter	99.043	1.543	0.0	6.2	0.0	6.2	183.3	O K
360 min Winter	99.055	1.555	0.0	6.2	0.0	6.2	184.6	O K
480 min Winter	99.044	1.544	0.0	6.2	0.0	6.2	183.3	O K
600 min Winter	99.014	1.514	0.0	6.2	0.0	6.2	179.8	O K
720 min Winter	98.974	1.474	0.0	6.2	0.0	6.2	175.0	O K
960 min Winter	98.877	1.377	0.0	6.2	0.0	6.2	163.6	O K
1440 min Winter	98.656	1.156	0.0	6.2	0.0	6.2	137.3	O K
2160 min Winter	98.223	0.723	0.0	6.2	0.0	6.2	85.9	O K
2880 min Winter	97.938	0.438	0.0	6.1	0.0	6.1	52.0	O K
4320 min Winter	97.696	0.196	0.0	5.4	0.0	5.4	23.3	O K
5760 min Winter	97.626	0.126	0.0	4.6	0.0	4.6	14.9	O K
7200 min Winter	97.607	0.107	0.0	4.0	0.0	4.0	12.7	O K
8640 min Winter	97.595	0.095	0.0	3.5	0.0	3.5	11.3	O K
10080 min Winter	97.587	0.087	0.0	3.1	0.0	3.1	10.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	75.240	0.0	111.2	0.0	35
60 min Winter	51.407	0.0	152.3	0.0	64
120 min Winter	33.834	0.0	200.5	0.0	120
180 min Winter	25.951	0.0	230.7	0.0	176
240 min Winter	21.313	0.0	252.6	0.0	232
360 min Winter	16.157	0.0	287.3	0.0	298
480 min Winter	13.243	0.0	314.0	0.0	372
600 min Winter	11.335	0.0	335.9	0.0	452
720 min Winter	9.973	0.0	354.7	0.0	530
960 min Winter	8.137	0.0	385.8	0.0	684
1440 min Winter	6.089	0.0	433.0	0.0	984
2160 min Winter	4.539	0.0	484.5	0.0	1348
2880 min Winter	3.681	0.0	523.8	0.0	1672
4320 min Winter	2.746	0.0	586.0	0.0	2296
5760 min Winter	2.233	0.0	635.5	0.0	2936
7200 min Winter	1.903	0.0	677.2	0.0	3672
8640 min Winter	1.673	0.0	714.2	0.0	4408
10080 min Winter	1.501	0.0	747.7	0.0	5056

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.200	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.353

Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)
0	4	0.177	4	8	0.176

Model Details

Storage is Online Cover Level (m) 100.000

Cellular Storage Structure

Invert Level (m) 97.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	125.0	125.0	1.601	0.0	221.0
1.600	125.0	221.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-6200-1600-6200
Design Head (m)	1.600
Design Flow (l/s)	6.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	97.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	6.2
Flush-Flo™	0.472	6.2
Kick-Flo®	0.964	4.9
Mean Flow over Head Range	-	5.4

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	3.7	1.200	5.4	3.000	8.3	7.000	12.4
0.200	5.5	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.9	1.600	6.2	4.000	9.5	8.000	13.3
0.400	6.1	1.800	6.6	4.500	10.1	8.500	13.7
0.500	6.1	2.000	6.9	5.000	10.6	9.000	14.0
0.600	6.1	2.200	7.2	5.500	11.1	9.500	14.4
0.800	5.7	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.0		

Pipe Overflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	10.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	99.100
Roughness k (mm)	0.600		

ICP SUDS Mean Annual Flood

Input

Return Period (years)	10	Soil	0.500
Area (ha)	0.353	Urban	0.000
SAAR (mm)	1341	Region Number	Region 8

Results l/s

QBAR Rural	4.2
QBAR Urban	4.2
Q10 years	6.2
Q1 year	3.3
Q30 years	7.9
Q100 years	10.1

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