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CRANBROOK NEW TOWN EXPANSION, DEVON

Flood Risk Review and Surface Water Drainage Strategy

Submitted to:
East Devon District Council
The Knowle
Sidmouth
EX10 8HL

REPORT

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1.0 INTRODUCTION

1.1 Background

Golder Associates (UK) Limited (Golder) has been instructed by East Devon District Council (EDDC) to undertake a Flood Risk Review and prepare a Surface Water Drainage Strategy for the proposed expansion to the Cranbrook New Town, near Exeter, Devon.

All works have been undertaken in accordance with Golder's proposal P1779607/1/V.0 dated 28 April 2017.

1.2 Report Context

EDDC has instructed consultants to assist in preparing a masterplan for the proposed expansion of Cranbrook New Town. The masterplan will form a significant part of the evidence base for a Development Plan Document (DPD) and will need to be robust under scrutiny and challenge.

Integral to the masterplan will be the indicative Drainage Strategy, which will need to demonstrate that the proposed layout (and assumptions) will meet the current regulatory requirements and best practice for surface water drainage. Such guidance will include Devon County Council's Sustainable Drainage Systems: Guidance for Devon (version 1.6 dated January 2017).

This report is intended to meet this requirement and comprises the following elements:

- A review of existing legislation, policy and supporting documents in relation to surface water and drainage;
- A review of the elements that may cause or increase the risk of flooding to both the development and the local area including: fluvial, pluvial, groundwater, sewers and man-made infrastructure. The assessment also identifies and examines the residual flood risk to the proposed development and neighbouring areas from these sources;
- Demonstration through the use of Sustainable Drainage Systems (SuDS) that any potential flooding on this site can be safely mitigated;
- A Surface Water Drainage Strategy, illustrating that the site can be drained effectively and in accordance with Devon County Council (DCC), EDDC and Environment Agency (EA) requirements.

This report has been prepared in accordance with the requirements set out in the following documents:

- National Planning Policy Framework (NPPF) (Communities and Local Government, March 2012);
- Planning Practice Guidance (PPG) (Department for Communities and Local Government, updated April 2015);
- Devon County Council's Sustainable Drainage Systems: Guidance for Devon (version 1.6 dated January 2017)
- The SuDS Manual (CIRIA C753) and the Non-Statutory Technical Standards for Sustainable Drainage; and
- Relevant Environment Agency (EA) guidance.

2.0 DEVELOPMENT PROPOSALS

2.1 Development Proposals

The Expansion Areas, as shown in Appendix A. It is proposed that the development within the Expansion Areas will comprise residential dwellings, schools and local centres, including retail, employment, sports and recreational facilities.

3.0 BASELINE SITE CONDITIONS

3.1 Site Location

For the purposes of this assessment, the Cranbrook Expansion Areas are described by breaking it down into three development areas: The West Area, the South Area and the East Area. These are described below:

- The West Area is bounded by a railway line and a small number of residential properties to the north, Bluehayes Lane to the east, Shermoor Farm and Station Road to the west, and a small number of properties, fields and the B3174 London Road to the south;
- The South Area is bounded by the B3174 London Road to the north, agricultural fields to the east, and Treasbeare Farm to the south. Exeter Airport is located to the south and west of the site. Treasbeare Lane and Parsons Lane pass through the area from the B3174 London Road. The Masterplan outline is presented in Appendix A; and
- The East Area is bounded by a railway line and Southbrook Farm to the north, agricultural fields to the east and south, and the villages of Southbrook and Rockbeare to the west. The B3174 London Road traverses across the site.

3.2 Geology

British Geological Survey (BGS) data is presented in Appendix B. BGS mapping indicates that the bedrock geology of the West Area, and the western extents of the South Area, consist of Dawlish Sandstone Formation. The bedrock of the East Area and the remaining land within the South Area consists of Aylesbeare Mudstone Group.

The BGS mapping also shows the presence of superficial deposits across the site. River terrace deposits consisting of sand and gravel are recorded within the West Area and the East Area. Head deposits of sand, clay, silt and gravel are recorded within the South Area and East Area. Alluvial deposits are also recorded within the East Area.

3.3 Hydrology and Hydrogeology

Information acquired form the Environment Agency (EA) is presented in Appendix C.

According to the EA's mapping, the Cranny Brook and the Rockbeare Stream are Main Rivers which flow within the study area. The Cranny Brook runs from the north east to the west through the Expansion Areas. The river flows adjacent to the railway line and is culverted beneath it in several places before it discharges into the River Clyst, located to the west of the proposed development. The Rockbeare Stream runs from the south east of Rockbeare village and flows in a north western direction and makes confluence with the Cranny Brook within the existing Cranbrook development boundary.

There are a number of additional minor watercourses and ditches within the Expansion Areas which follow the existing hedge lines and field boundaries.

The BGS hydrogeological mapping (Appendix B) shows that the West Area and the western extents of the South Area are located within Permian Rocks, described as a moderately productive aquifer. The mapping also shows that the East Area and the remaining land within the South Area are located within Permian Rocks, described as rocks with essentially no groundwater.

EA groundwater mapping shows that the Expansion Areas are not located within a groundwater source protection zone, although the site is located across a number of groundwater vulnerability zones (Appendix C).

3.4 Topography

A study of the site's topography was undertaken using LiDAR (Light Detection and Ranging) data.

The topography in the West Area generally falls towards the north and west, towards the railway line or towards Station Road. Levels fall from a high point of approximately 28 m AOD on the southern boundary of the area, to a low point of approximately 16 m AOD.

In the South Area, the topography varies. The most western extents of the area fall towards the south west, and the central parcels fall in a southern direction. Towards the east, levels fall in a northern direction, towards the B3174 London Road. The most eastern extents of the area falling towards the Rockbeare Stream to the north east. The high point of the South Area is at approximately 40m AOD and the lowest point is at approximately 19 m AOD.

Levels in the East Area generally fall towards a central valley and the Cranny Brook and its tributaries. The high point of the development area is towards the south of the site, at approximately 52 m AOD, and the low point at the Cranny Brook is approximately 25 m AOD.

4.0 SUDS LEGISLATION AND POLICY REVIEW

4.1 Legislation

Flood and Water Management Act 2010

The Flood and Water Management Act 2010 (FWMA) received Royal Assent on 8 April 2010. The FWMA was introduced to enforce some of the key proposals set out within UK Government flood and water strategies along with the UK Government's response to Sir Michael Pitt's review of the summer 2007 floods.

Relevant to development sites, the FWMA is intended to encourage the uptake of SuDS by removing the automatic right to connect to sewers and the recommendation for unitary authorities and county councils to promote the use of SuDS for new developments.

National Policy

National Planning Policy Framework 2012

The NPPF replaced all planning policy documents (including Planning Policy Statement 25: Development and Flood Risk) upon publication in March 2012. The NPPF sets out the Government's planning policies for England and Wales, and how these policies should be applied.

As stated in Paragraph 103 of the NPPF (in part), when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider appropriate development in areas at risk of flooding where it can be demonstrated that the development gives priority to the use of SuDS.

Non-Statutory Technical Standards for Sustainable Drainage Systems 2015

The Standards were published by DEFRA in March 2015. The Standards are to be used in order to manage surface water runoff in accordance with Schedule 3 of the FWMA.

The Standards state that the destination of surface water runoff should be considered in the following order or preference:

- Discharge into the ground (infiltration);
- Discharge to a surface water body;
- Discharge to a surface water sewer; and
- Discharge to a combined sewer.

Local Policy

Devon County Council Sustainable Drainage Systems Guidance for Devon 2017

Section 5.1 of the guidance states that DCC's Flood and Coastal Risk Management (FCRM) Team requires all new surface water drainage management systems to provide a comprehensive SuDS management train.

It is stated in section 5.2 that sites must consider the use of a variety of above ground SuDS components, and these must be incorporated into surface water drainage management systems wherever possible.

Section 5.3 states that it is essential to consider SuDS as an integral part of the broad network of green infrastructure on developments, rather than standalone features.

As set out in section 6.2, when designing surface water drainage management systems, robust evidence must be submitted in order to demonstrate that flood risk will not be increased either upstream or downstream of the development site and, wherever practicable, betterment should be achieved.

East Devon Local Plan 2013 to 2031 – Adopted January 2016

Strategy 3 of the Local Plan focuses on sustainable development. Reducing the risk of flooding by incorporating measures such as SuDS is a measure included to address the issue of conserving and enhancing the environment.

Policy EN22 addresses surface runoff implications of new development, and it is stated that surface water in all major commercial developments or schemes for 10 homes or more (or any revised threshold set by Government) should be managed by SuDS, unless demonstrated to be inappropriate.

East Devon District Council Strategic Flood Risk Assessment 2008

It is stated in section 11 of the Strategic Flood Risk Assessment (SFRA) that SuDS should be implemented to ensure that runoff from the site (post-development) is reduced, with space set aside within the confines of the site to allow its implementation. The use of SuDS techniques and attenuation should take into account the local geological and groundwater conditions.

5.0 KEY SOURCES OF FLOOD RISK

5.1 Flooding from Rivers (Fluvial)

Fluvial flooding is caused by high flows in rivers or streams exceeding the capacity of the river channel and spilling into the floodplain, or in some cases non-designated floodplain, which can occur after a period of heavy rainfall.

According to EA mapping, the majority of the Expansion Area is shown to be located within Flood Zone 1: land having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%) in any given year. Some areas of the site are at risk of fluvial flooding within Flood Zones 2 and 3, associated with the rivers and some watercourses flowing across the site.

There are currently no detailed hydraulic models of the watercourses running through the site. This should be undertaken at the detailed FRA stage and it will include an analysis of all the recommended climate change allowances. The majority of the built development and all SuDS features are to be sited within Flood Zone 1. In areas where the proposed masterplan is shown to encroach into the floodplain such as the northern section of the West Area, flood compensation to be informed by detailed hydraulic modelling will be undertaken in order to ensure that flood risk is not exacerbated offsite. The EA flood maps are included within Appendix C and the fluvial floodplain has also been presented in Figures 1 and 2 in Appendix A.

Map 3E of the SFRA shows historical flooding incidents within Exeter and the surrounding areas to the east. The map shows property flooding to the north of the West Area, as recorded by the EA's Flood

Reconnaissance Information System. There is a cluster of flooding incidents within Rockbeare, however these are not located within the Expansion Areas. Map 3E of the SFRA is shown within Appendix D.

Figure 6-1 of DCC's Preliminary Flood Risk Assessment (PFRA) indicates that the site is not located in an area above flood risk thresholds. Figure 6-1 is included within Appendix E.

5.2 Flooding from Surface Water

Surface water flooding is caused by rainfall levels exceeding the natural infiltration properties of the surrounding soils. It occurs where there is a lack of a formalised drainage system, as a result of poorly designed or maintained sewer systems, due to no natural method of drainage such as watercourses and ditches, or where soil infiltration rates are low. It often results in ponding of water at low points or backing up behind obstructions.

The EA's updated Flood Map for Surface Water (uFMfSW), which is included within Appendix C, shows that the majority of the Expansion Area is located within an area at very low risk of surface water flooding. This is an area which has a less than 1 in 1,000 annual probability of surface water flooding (<0.1%) in any given year. However, there are some areas at high, medium and low risk of surface water flooding, predominantly associated with the existing watercourses, ditches and field boundaries across the site.

The development of the masterplan will ensure that green corridors are incorporated to allow for the conveyance of surface water runoff generated by catchments upstream and offsite without any impedance.

5.3 Groundwater Flooding

Groundwater flooding is caused by the emergence of water originating from sub-surface permeable strata. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Periods of prolonged rainfall may also be a cause of groundwater flooding with aquifers and soils becoming saturated.

As mentioned in Section 3.3, part of the site is underlain by rocks described as a moderately productive aquifer, and some areas are underlain by rocks with essentially no groundwater.

DCC's Surface Water Management Plan does not specifically list the site within the recorded incidents of groundwater flooding. Figure 5-2 of the PFRA (Appendix E) indicates that the site is between 25% and 50% susceptibility to groundwater flooding.

At the detailed FRA stage, the Finished Floor Levels should be set at least 150 mm above existing ground levels and ground levels altered to ensure that in the unlikely event of groundwater emerging, there is an allowance for safe conveyance of groundwater flood flows offsite.

6.0 SURFACE WATER DRAINAGE STRATEGY REQUIREMENTS

6.1 General Requirements

The NPPF requires that flood risk to land and property is not increased as a result of development. The associated Flood Risk and Coastal Change Planning Practice Guidance notes that flood risk should not be increased for events up to a 1 in 100 year return period with appropriate allowance for climate change.

Changes in the volume and rate of surface water runoff from the development as a result of increases in impermeable land uses could increase the risk of flooding downstream unless sufficient steps are taken within the proposed development to prevent this happening.

A fundamental principle of sustainable development in terms of flood defence is the reduction of surface water run-off from new developments. It is best practice that the surface water drainage arrangements for any development site should be such that the volumes and peak discharge rates of surface water leaving a development site are no greater than the rates prior to the proposed development, but where possible are

returned to those associated with the greenfield conditions of the site. Any increase in run-off above the pre-development (or greenfield) volumes must be attenuated on site.

The concept of sustainable drainage is that environmental and social factors such as the quantity and quality of runoff and amenity value of surface water in the urban or developed environment are considered when making decisions about drainage. SuDS can be used to compliment or replace conventional piped urban drainage to recreate the natural water cycle. This process can be used in certain locations to reduce or even eliminate the existing problems associated with such systems: risk of flooding, potential of pollution or poor water quality and damage to the natural environment.

A wide range of drainage systems and techniques can be categorised as Sustainable Drainage Systems. From site wide installations (wetlands, ponds) to domestic source control (green roofs), the scale of SuDS schemes and their benefits can vary widely. For a large development such as the Cranbrook Expansion, it is often necessary to incorporate a combination of site control and source control measures within the overall regional strategy.

6.2 Devon County Council – SuDS Guidance Requirements

DCC do not consider underground attenuation systems to be truly sustainable components within a SuDS system as they do not naturally fully provide water quality, visual amenity, and biodiversity benefits. Consideration should be given to above ground SuDS components unless robust evidence has been submitted which demonstrates that this is not viable.

It is also recommended that SuDS features be incorporated into the green infrastructure and contribute to creating and maintaining bio-diversity, in addition to providing public amenity, public health, education, and economic benefits.

The guidance establishes a hierarchy for surface water disposal, which is also in line with the Non-Statutory Technical Standards for Sustainable Drainage Systems (2015) and Part H of the Building Regulations: Drainage and Waste Disposal. This hierarchy stipulates that surface water runoff not collected for reuse must be discharged to one or more of the following in order of priority:

1) Discharge into ground (infiltration); or, where not reasonably practicable;

2) Discharge to a surface water body (with written permission from riparian owner); or, where not reasonably practicable;

3) Discharge to a surface water sewer, highway drain, or another drainage system (with written permission from South West Water Ltd, Devon County Council Highways, or the riparian owner respectively); or, where not reasonably practicable; and

4) Discharge to a combined sewer (with written permission from South West Water Ltd).

It is therefore recommended that discharge into ground must first be explored as the primary method of surface water disposal from all development sites in the first instance.

For developments on greenfield sites such as the Cranbrook expansion, the peak surface water runoff for the 1 in 1 year rainfall event, up to and including the 1 in 100 year rainfall event, must not exceed the peak greenfield runoff rate for the same event. Only areas draining to the proposed surface water management system should be represented in the greenfield runoff calculations. The 5 l/s minimum discharge rate recommendation is no longer acceptable because well-maintained modern flow control structures can now function at very low rates.

The volume of surface water runoff discharged off site in the 1 in 100 year, 6 hour rainfall event, must never exceed the greenfield runoff volume for the same event. It is also recommended that Long Term Storage be provided to store the additional volume of surface water runoff generated by the increase in impermeable area.

DCC's FCRM team recommend the use of the upper end climate change allowance of 40% when calculating the peak intensity for surface water drainage management systems on new developments.

Overland flow routes emanating from catchments off site must not be blocked so as to minimise risk to property and life. Surface water exceedance routes should be clearly marked and unless an area is designated to hold flood water, flooding should not occur;

- On any part of the development for a 1 in 30 year rainfall event; or
- In any part of a building or any utility plan susceptible to water for a 1 in 100 year rainfall event;

6.3 Easements and Other Constraints

The EA requires 8 m easements from the top of bank on both sides of all watercourses, including main rivers, to allow access for maintenance and to preserve riparian habitats.

There is likely to be a requirement for a 20 m easement associated with the existing railway embankment through the site.

It is proposed to locate all the SuDS features in Flood Zone 1 (low risk).

6.4 Opportunities

The proposals present an opportunity to enhance the aesthetic and ecological value of the area through habitat creation. In addition, the potential for large areas of public open space to be introduced as a result of the surface water attenuation requirements identified above offer an opportunity for maximising the amenity value offered by the development.

7.0 ALLOWABLE SURFACE WATER DISCHARGE CALCULATIONS

7.1 Existing Surface Water Drainage Regime

The Institute of Hydrology (IoH) Report 124 Flood Estimation for Small Catchments (1994) method has been used to estimate the greenfield site peak flow rate, which is an approved methodology specified within the Environment Agency's Rainfall Runoff Management for Developments Report[1], using the parameters detailed in Table **1** below. Table 1: ICP SuDS Parameters

Parameter	Value	Unit
Area	50	ha
SAAR	880	mm
Soil Class	0.45	-
Region	8	-
Urban	0.0	-

[1] R Kellagher (2013) *Rainfall Runoff Management for Development Report SC030219,* Environment Agency, Bristol

Table 2 summarises the estimated current greenfield discharge rates for the site.

Table 2: Existing Surface Water Discharge Rates

Return Period	Site Greenfield Discharge Rate – 50 ha (l/s)	Site Greenfield Discharge Rate (l/s/ha)
QBAR	287.1	5.74
Q1	223.9	4.48
Q30	547.3	10.95
Q100	694.8	13.90

The allowable discharge calculations for the proposals will be based on only the developable parcels draining to the swales and regional detention basins excluding large open green spaces such as designated floodplains and parks.

8.0 PRELIMINARY SURFACE WATER DRAINAGE STRATEGY

8.1 Development Lifespan

Based on the fact that a typical lifespan for a residential development is 100 years, the upper end climate change allowance of 40% when calculating the peak intensity has been adopted for the designs.

8.2 Hydrology and Rainfall Data

The rainfall files utilised in the design and sizing of the SuDS features are based on the latest Flood Estimation Handbook (FEH) Version 3 data and the constituent Depth Duration Frequency (DDF) parameters are detailed in Table 3.

Table 3: FEH DDF Parameters

Parameter	Value
C (1km)	-0.026
D1 (1km)	0.313
D2 (1km)	0.313
D3 (1km)	0.310
E (1km)	0.282
F (1km)	2.498

8.3 Surface Water Drainage Strategy

The EA flood mapping shows that the majority of the Expansion Area is shown to be located within Flood Zone 1, an area with a low probability of flooding. However, there are some areas located within Flood Zones 2 and 3. Where the development area encroaches on Flood Zones 2 and 3, appropriate land use should be considered. No built development or SuDS features will be located in the areas with a high fluvial flood risk.

The preliminary surface water management strategy described below is outlined on Drawings 1 and 2, which are presented in Appendix A.

It is anticipated that infiltration may not be suitable at the site. However this is to be confirmed following detailed intrusive ground investigation including soakage testing at detailed FRA stage. A conservative approach has been taken to assume zero infiltration in this assessment. Although following intrusive works at detailed FRA stage and an assessment of local groundwater levels in may be possible to include infiltration in the

calculations, especially for SuDS features at higher elevations, which would reduce the volumes for attenuation described herein.

The site control will involve the control of runoff close to where the rain falls on the ground or roof surfaces. The source control measures proposed will consist of a combination of interconnecting swales to transfer the remaining runoff to the regional control.

The regional control structures will be located at the lowest part of the development parcels in the form of detention basins and will be designed to attenuate flow prior to controlled discharge via hydraulic control structures.

Swales are linear, flat bottomed grassed or vegetated channels that convey water from one place to another. They can also store water and allow it to soak into the ground. Detention basins are vegetated depressions normally dry except during and immediately following storm events and they attenuate surface water runoff before controlled discharge to the watercourses. Drawings 1 and 2 in Appendix A present a network of swales and basins sufficient to manage the increase in surface water runoff due to the development during an extreme event.

It is proposed to split the proposed development into 12 discreet catchments with each served by an independent surface water drainage network. Each individual network would conform to the requirements of the surface water management system for the proposed development as a whole. This would enable individual development to be bought forward independently without necessitating the construction of drainage infrastructure that would support the development in its entirety.

The subdivision of the catchments has been undertaken with reference to the existing topography extracted from LiDAR data and proposed land use with a breakdown of the proposed development parcels and their constituent developable areas (Table 4).

The volume required in detention basins has been minimised wherever possible. Swales will provide attenuation, via check dams, as well as conveyance. Green corridors defined in the masterplan (Appendix A) have been favoured for locating swales. Table 4 presents the lengths of swales and volume of basins required to provide the correct conveyance and attenuation to manage surface water runoff during extreme events.

Table 4: Required Attenuation Storage Volumes

	Developable Area (ha)	Allowable Discharge (QBAR) at 5.74 l/s/ha (l/s)	Hardstanding Area (ha)	Volume of Storage Within Basins (m^3)	Length of Swales Required (m)
Catchment 1	23.09	132.54	15.02	11603	1893
Catchment 2	19.14	109.86	13.32	10452	1569
Catchment 3	6.89	39.55	4.13	2898	565
Catchment 4	2.13	12.23	1.28	873	175
Catchment 5	19.04	109.29	11.67	8536	1561
Catchment 6	12.57	72.15	7.96	5889	1030
Catchment 7	14.88	194.70	9.46	7441	1220
Catchment 8	3.26	18.71	1.96	1375	267
Catchment 9	3.29	18.88	1.97	1384	270
Catchment 10	1.61	9.24	0.97	671	132
Catchment 11	7.68	44.08	4.61	3352	630
Catchment 12	4.59	26.35	2.75	1987	376

The hard-standing areas (e.g. roofs, roads, car parks, footpaths) within the developable areas are based on the assumptions in Table 5. The calculations for areas proposed as mixed-use development are based on the assumptions for commercial land use.

Table 5: Estimates of Impermeable Areas

Land use	Percentage Impermeability
Residential	60%
Commercial	75%
Schools and Educational Facilities	70%

8.3.1 West Area Scheme

It is proposed that surface water runoff from the West Area will be conveyed via swales and pipes to a detention basin (Basin 1) located in the open space to the west of the development parcels. Surface water will then be discharged at a restricted rate to the ditch to the west of Station Road. The West Area scheme is presented in Drawing 1 (Appendix A).

8.3.2 South Area Scheme

Surface water runoff from the South Area will be conveyed via swales and pipes to five detention basins due to the topography of the site. Basins 2, 2a and 2b will discharge surface water to the ditch located to the west. At detailed FRA stage, underground storage, beneath a proposed car parking area, shall be considered in place of Basins 2a and 2b. It is recognised that DDC guidance (described in Section 6.2) does not give preference to underground storage solutions, but invert and discharge levels will be reviewed to ascertain the feasibility of an underground solution in this location and evidence will be compiled if viable.

The outfall from Basin 3 will be reliant on the capacity of the already consented Cranbrook scheme to the north, due to the topography and the low points within the catchment. At the detail FRA stage, liaison between our site and the already consented scheme is recommended to ensure that the outfall conveying flows from Basin 3 can run through any proposed roads and designated green corridors before eventually discharging into the watercourse. Alternatively, the outfall can connect to the network serving the consented site subject to a capacity check and possible upgrade of their systems. Basin 4 will discharge to the Rockbeare Stream. The South Area scheme is presented in Drawing 1 (Appendix A).

8.3.3 East Area Scheme

As the East Area is a particularly large development area intersected by a number of watercourses and ditches, the topography is variable. It is therefore proposed that surface water runoff within the East Area will drain to eight detention basins across the site. Runoff will be conveyed via a network of swales and surface water pipes to the individual basins, and then be discharged at restricted rates to the Cranny Brook or its tributaries. The East Area scheme is presented in Drawing 2 (Appendix A).

8.3.4 SuDS design

The swales and detention basins for all Expansion Areas have been designed in accordance with DCC design considerations listed within the SuDS guidance. Permanent pools of water can be incorporated into the detention basins at the later detail design stage if required for added ecological benefits. This can be undertaken at depths greater than the current designs so as not to compromise storage volumes specified. In the unlikely event that future groundwater monitoring shows an elevated water table, lining of the basins or design changes may be required.

Table 6: Selected Design Criteria for Detention Basins

Parameter	Value
Maximum side slopes	1 in 3
Length width ratio	3:1 – 5:1
Minimum depth for water open areas	1.2m

Basin outfalls have been designed by assessing the topography of the site and the nature of the watercourses and ditches. There are some ditches which cannot be used to receive the surface water runoff, as they are low points with no specific direction of flow. No runoff will be allowed to discharge to the river without attenuation. Even though the topography shows some natural slopes falling away from the main basins, these will be captured and redirected to the regional basins.

Swales have been incorporated across the site where practicable, however swales cannot be used everywhere throughout the site to capture runoff due to various constraints. For example, some flow routes are susceptible to medium and high risk surface water flooding, and so a swale in these locations would not be appropriate. In addition, there are depth constraints in some areas, as the Sustainable Drainage Systems: Guidance for Devon states that normal maximum swale depth is 400-600mm. The guidance also states that longitudinal slopes of swales should be between 0.5% and 6%, with check dams being incorporated on slopes greater than 3%. Some of the links from the swales to the basins will be via culverts, e.g. at road crossings.

The SuDS features shown on the proposed drainage strategy have been sized to attenuate flows for all rainfall events up to the 1 in 100 year event plus climate change (+40%) whilst restricting discharge rates from the detention basins to Q_{BAR}. This therefore negated the requirement to provide Long Term Storage for the site. The Micro Drainage Calculations are presented in Appendix F.

Hydraulic modelling of the watercourses will be required at detailed FRA stage to ensure the invert levels of the outfalls will ensure no surcharging occurs.

8.3.5 Permitting and Consents

The Rockbeare Stream and Cranny Brook are both designated as Main Rivers, Environmental Permits for water discharge will be required for all outfalls by the EA. Ordinary Water Discharge Consents from East Devon District Council will also be required for outfalls to any interconnecting smaller ditches ending up in the Main Rivers.

9.0 MAINTENANCE OF SUDS FEATURES

The SuDS features proposed at the site are visible to the surface and will form part of the overall site landscape and include a range of habitats. The SuDS maintenance scheme will therefore take account of the wider landscape context of amenity and biodiversity, as well as drainage requirements.

All maintenance will take the protection of habitats and associated ecology into account. The maintenance regime will be regularly assessed to make sure that the approach is still meeting the drainage, landscape, and any other objectives.

The SuDS design process considered the ease of maintenance and access ensuring appropriate and permanent access to points in the systems where future maintenance is required.

The ownership details for the proposed SuDS features are shown in the Table 7.

Table 7: Ownership of SuDS Features

Proposed Feature	Ownership
Onsite Sewer Network	South West Water
Permeable Paving, Swales, flow control devices, Downstream Defender (or similar), Infiltrating Basin	Private Management Company
SuDS features incorporated as part of the adopted highways	Devon County Council

Requests for inspection reports of the system and a review of the maintenance arrangements at longer term intervals should be sent to the relevant company, as the drainage features will not all be adopted and maintained by the same organization.

The designs of the SuDS will ensure ease of routine maintenance and that all SuDS features remain operational over their design life.

9.1 Swales

Table 8 presents maintenance requirements for swales throughout the life of the development.

Table 8: Swales Maintenance Activities & Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Debris and litter removal.	n/a	Monthly, or as required.
	Grass cutting and vegetation management.	Retain grass height to an ideal height of 100mm and remove nuisance plants.	Monthly during growing season, or as required.
	Manage other vegetation and remove nuisance plants.	n/a	Monthly at the start, then as required.
	Inspection for blockages.	Inspect inlets, outlets, and overflows for blockages, and clear if required.	Monthly, or following extreme events
	Inspection for infiltration, if identified during detailed FRA.	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for more than 48 hours.	Monthly or when required.
	Inspection for silt build-up.	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies.	Half yearly, or following extreme events.
Infrequent maintenance.	Check for poor vegetation growth.	Cut back adjacent vegetation where possible.	Annually.
	Reseed.	Reseed areas of poor vegetation growth.	As required, or when bare soil is exposed over

Maintenance Category	Maintenance Activity	Comments	Frequency
			10% or more of the treatment area.
Corrective maintenance.	Repair erosion.	Repair erosion by returfing or reseeding.	As required.
	Re-level swale surface.	Remove uneven surfaces or reinstate to design levels.	As required.
	Scarify.	Scarify top layer to improve infiltration performance.	As required.
	Sediment removal.	Remove build-up of sediment on upstream gravel trench or at top of filter strip.	As required.
	Oil removal.	Remove oils or petrol residues using safe work practices.	As required.

9.2 Detention Basins

Table 9 presents maintenance requirements for basins throughout the life of the development

Table 9: Basin Maintenance Activities & Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Debris and litter removal.	n/a	Monthly, or as required
	Grass cutting – for spillways and access routes.	Retain grass height to an ideal height of 100mm and remove nuisance plants.	Monthly (during growing season), or as required.
	Grass cutting – meadow grass in and around basin.	Retain grass height within specified design range and remove nuisance plants.	Six-monthly (spring – before nesting season and autumn).
	Manage other vegetation and remove nuisance plants.	Check for poor vegetation growth.	Monthly at start, then as required.
	Plant debris removal.	Tidy all dead growth before start of growing season.	Annually, or following extreme events.
	Sediment removal.	Remove sediment from inlets and outlet.	Annually, or as required.
Infrequent maintenance.	Reseed areas of poor vegetation.	n/a	Annually, or as required.
	Prune and trim trees and remove cuttings.	n/a	Every 2 years, or as required.
Corrective maintenance.	Repair erosion.	Repair of erosion or other damage by reseeding or re-turfing.	As required.

Maintenance Category	Maintenance Activity	Comments	Frequency
	Realignment of rip-rap, if included in detailed design.	n/a	As required.
	Repair / rehabilitation of inlets, outlets and overflows.	n/a	As required.
	Re-level uneven surfaces and reinstate design levels.	n/a	As required.

Table 10: Infiltration Basin Inspection & Frequency

Inspection Activity	Frequency
Inspect inlets, outlets, and overflows for blockages, and clear if required.	Monthly, or after extreme events.
Inspect banksides, structures, pipework etc. for evidence of physical damage.	Monthly, or after extreme events.
Inspect inlets and facility surface silt accumulation. Establish appropriate silt removal frequencies.	Six-monthly.

9.3 Flow Control Devices

SuDS flow control structures are vortex control features such as Hydrobrakes® and small orifices in control chambers. Control structures limit the flow through the outlet and this causes water to back up in the SuDS component, allowing the attenuation storage volume to be utilised. The flow control devices have been designed to be nearer the surface meaning they are accessible and easy to maintain.

Table 11: Flow Control Devices Maintenance Activities & Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Inspect and identify any areas that are not operating correctly.	n/a	Monthly (for the first three months), then six-monthly.
	Hose down unit / chamber.	n/a	Six-monthly, or as required.
Infrequent maintenance.	Clear blockages.	Pivoting bypass door to ensure manhole can be drained in the event of a blockage.	As required, or following extreme events.

Table 12: Flow Control Devices Inspection & Frequency

Inspection Activity	Frequency
Inspect all inlets / outlets to check they are in good condition and operating as designed.	Annually.
Check mechanical devices within associated chambers.	Six-monthly.

9.4 Pipes Systems, Gullies, and Channel Drainage

The maintenance of the pipe systems, gullies and channel drainage are set out in Tables 13 and 14 below.

Table 13: Pipe Systems, Gullies, Channel Drainage, and Manholes Maintenance - Activities & Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Inspect and identify any areas that are not operating correctly.	Gullies and manholes.	Monthly (for the first three months, then annually.
	Remove debris from gratings, sumps / silt traps.	n/a	Annually, or following extreme events.
Infrequent maintenance.	Clear blockages.	Piped system.	As required, or following extreme events.

Table 14: Pipe Systems, Gullies, Channel Drainage, and Manholes - Inspection & Frequency

Inspection Activity	Comments	Frequency
Clearing of gullies / sumps.	Gullies found to be non-functioning / blocked on annual inspection will be noted and cleared at three-monthly intervals. Recurring blockages should be investigated further.	Six-monthly (or three-monthly if blocked annually).
Cleaning / jetting.	Pipes and manholes.	When required.

10.0 SUDS COSTING

10.1 Costing

The indicative costing for the proposed SuDS features within the surface water drainage strategy at the site is set out below. The information used has been taken from EA Report SC080039/R9 'Cost Estimation for SuDS – Summary of Evidence' (2015). The following capital cost estimates are based on actual costs from a number of projects within the UK and from a wider literature review. The EA state that if used for cost estimating purposes, the values below should be increased to allow for inflation to present day values.

Table 15 shows the indicative costs for the detention basins. It should be noted that the values are based upon the worst-case scenario of total excavation instead of storage volume, as this takes into account the earthworks required. The lower cost is based on £15.00 per m^3 excavation volume and the upper cost is £20.00 per m^3 excavation volume.

Table 15: Indicative capital costs for detention basins

	Area (m^2)	Extraction Volume (m^3)	Lower Cost	Upper Cost
Basin 1	11,084	13,480	£202,200.00	£269,600.00
Basin 2	6,330	12,076	£181,140.00	£241,520.00
Basin 2a	4,270	6,943	£104,145.00	£138,860.00
Basin 2b	3,735	4,853	£72,795.00	£97,060.00
Basin 3	4,728	7,029	£105,435.00	£140,580.00
Basin 4	3,047	7,144	£107,160.00	£142,880.00
Basin 5	7,703	14,798	£221,970.00	£295,960.00
Basin 6	6,900	12,163	£182,445.00	£243,260.00
Basin 7	12,198	25,340	£380,100.00	£506,800.00
Basin 8	3,981	6,061	£90,915.00	£121,220.00
Basin 9	1,769	2,620	£39,300.00	£52,400.00
Basin 10	4,921	11,262	£168,930.00	£225,240.00
Basin 11	8,322	17,458	£261,870.00	£349,160.00

	Area (m^2)	Extraction Volume (m^3)	Lower Cost	Upper Cost
Basin 12	9,103	23,524	£352,860.00	£470,480.00
Total	**88,091**	**164,751**	**£2,471,265.00**	**£3,295,020.00**

Table 16 shows the indicative costs for the swales. The estimates are based upon swales with 1m base and 0.6m deep with 1:3 side slopes (total 7m wide). The lower cost is based on £10.00 per m^2 swale area and the upper cost is £15.00 per m^2 swale area. It should be noted that the West Area and South Area are listed as 'West Site'.

Table 16: Indicative capital costs for swales

	Length of Swale (m)	Area of Swale (m^2)	Lower Cost	Upper Cost
West Site	4,202	17,648.4	£176,484.00	£264,726.00
East Site	5,486	23,041.2	£230,412.00	£345,618.00
Total	**9,688**	**40,689.6**	**£406,896.00**	**£610,344.00**

The construction of SuDS is highly variable and depends on the proposed design and construction methods implemented. The costs associated with any specific site will depend on a number of factors, including scale and size of development, hydraulic design criteria, water quality design criteria, soil types, proximity to receiving watercourses, and amenity / public education / safety requirements.

11.0 SUMMARY & CONCLUSIONS

Where the development area encroaches on Flood Zones 2 and 3, appropriate land use should be considered. No built development or SuDS features will be located in the areas with a high fluvial flood risk.

The majority of the site is located within an area at very low risk of surface water flooding, although there are some areas at high, medium and low risk of pluvial flooding. These areas are mainly associated with the existing watercourses, ditches and field boundaries across the site, and are largely located within the fluvial floodplain extents.

The underlying geological conditions indicate that infiltrating SuDS features may not be suitable for the site. It is proposed that surface water will be attenuated in swales and detention basins across the site, prior to restricted discharge into proximate watercourses and ditches. However if infiltration testing and consideration of groundwater levels lead to infiltration being feasible in SuDS design at detailed FRA stage, this could lead to a reduction in attenuation volumes described herein.

The SuDS features shown on the proposed drainage strategy have been sized to attenuate flows for all rainfall events up to the 1 in 100 year event plus climate change (40%).

This report describes a network of swales and basins sufficient to manage the increase in surface water runoff due to the development, during an extreme event, and demonstrates that the surface water drainage proposals within the Expansion Areas are fully compliant with the requirements of the NPPF.

Report Signature Page

GOLDER ASSOCIATES (UK) LTD





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Project Manager

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Senior Hydrologist, Associate

DH/AM/es

07 September 2017

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APPENDIX A

Drawings

N

BASIN 1
TOTAL DEV AREA: 23.09ha
IMP AREA: 15.02ha
ALLOW. DISCHARGE: 132.54l/
1.2m DEEP

BASIN 3
TOTAL DEV AREA: 6.89ha
IMP AREA: 4.13ha
ALLOW. DISCHARGE: 39.55l/
1.2M DEEP

SUBJECT TO CAPACITY OF EXISTING DEVELOPMENT DRAINAGE SYSTEM

BASIN 4
TOTAL DEV AREA: 2.13ha
IMP AREA: 1.28ha
ALLOW. DISCHARGE: 12.23l/
1.2m DEEP

BASIN 2
BASIN 2a
BASIN 2b

BASIN 2, BASIN 2a, BASIN 2b
TOTAL DEV AREA: 19.14ha
IMP AREA: 13.32ha
ALLOW. DISCHARGE: 109.86l/
1.6m DEEP - BASIN 2
1.2m DEEP - BASIN 2a, BASIN 2b

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NOTES

1. DO NOT SCALE FROM THIS DRAWING.

2. ALL DIMENSIONS SHOWN IN METRES UNLESS NOTED OTHERWISE.

KEY

- DEVELOPMENT AREA
- FLUVIAL FLOOD ZONE
- INDICATIVE LOCATION OF DETENTION BASINS
- DIRECTION OF EXISTING GREENFIELD RUNOFF VIA SHEET FLOW
- EXISTING DITCH AND DIRECTION OF FLOW
- INDICATIVE BASIN OUTFALL ROUTE
- INDICATIVE PROPOSED SWALE IN GREEN CORRIDOR
- CULVERTED SECTION OF SWALE
- DTM 250mm CONTOURS

CLIENT
SAVILLS URBAN DESIGN STUDIO

PROJECT
FLOOD RISK REVIEW AND SURFACE WATER DRAINAGE STRATEGY FOR CRANBROOK EXPANSION AREAS

SHEET TITLE
DRAINAGE STRATEGY SHEET 1 OF 2

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-09-06
PREPARED	ECS
DESIGN	AM
REVIEW	AM
APPROVED	DH

PROJECT NO	CONTROL	REV	DRAWING
1779607	1001-XX-0001	A	1

N

BASIN 11
TOTAL DEV AREA: 7.68ha
IMP AREA: 4.61ha
ALLOW. DISCHARGE: 44.08l/
1.2m DEEP

BASIN 12
TOTAL DEV AREA: 4.59ha
IMP AREA: 2.75ha
ALLOW. DISCHARGE: 26.35l/
1.2m DEEP

BASIN 10
TOTAL DEV AREA: 1.61ha
IMP AREA: 0.97ha
ALLOW. DISCHARGE: 9.24l/
1.2m DEEP

BASIN 9
TOTAL DEV AREA: 3.29ha
IMP AREA: 1.97ha
ALLOW. DISCHARGE: 18.88l/
2.0m DEEP

SUBJECT TO THIRD PARTY LAND ACCESS AND CAPACITY OF EXISTING DRAINAGE SYSTEM

BASIN 8
TOTAL DEV AREA: 3.26ha
IMP AREA: 1.96ha
ALLOW. DISCHARGE: 18.71l/
1.2m DEEP

BASIN 7
TOTAL DEV AREA: 14.88ha
IMP AREA: 9.46ha
ALLOW. DISCHARGE: 194.70l/
1.2m DEEP

BASIN 6
TOTAL DEV AREA: 12.57ha
IMP AREA: 7.96ha
ALLOW. DISCHARGE: 72.15l/
1.3m DEEP

BASIN 5
TOTAL DEV AREA: 19.04ha
IMP AREA: 11.67ha
ALLOW. DISCHARGE: 109.29l/
1.9m DEEP

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- CULVERTED SECTION OF SWALE
- DTM 250mm CONTOURS

CLIENT
SAVILLS URBAN DESIGN STUDIO

PROJECT
FLOOD RISK REVIEW AND SURFACE WATER DRAINAGE STRATEGY FOR CRANBROOK EXPANSION AREAS

SHEET TITLE
DRAINAGE STRATEGY SHEET 2 OF 2

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-09-06
PREPARED	ECS
DESIGN	AM
REVIEW	AM
APPROVED	DH

PROJECT NO	CONTROL	REV	DRAWING
1779607	1001-XX-0001	A	2

Existing settlement

Emerging/ consented

- Town Centre and Local Centre
- Secondary, Special Needs and Primary Education
- Employment
- Country Park
- Sports hub
- General open space

Expansion areas

- Residential
- Mixed-use residential and employment
- Local Centre mixed-use and retail frontage
- Employment
- Traveller site
- Allotment site
- Country Park and SANG mitigation
- Park
- Sports hub
- General open space
- Play area
- Existing vegetation within public realm
- Structural planting
- Stream
- SuDS attenuation features
- Retained pylons and power lines

Movement/ access

- Existing railway station
- Proposed railway station
- Primary movement routes
- Secondary movement routes
- Green lanes/ cycle paths
- Potential vehicle access
- Potential pedestrian links

DRAFT

Cranbrook

on behalf of East Devon District Council

drawing no.	SK204	drawing	OVERALL MASTERPLAN		
revision	-	drawn by	NT	job no.	OXUD 346475
scale at A3	1:12,500	checked by	-	date	August 2017

N

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CRANBROOK MASTERPLAN LAND BUDGET

Reference drawing SK204

Description	Area (ha)
residential	78.52
mixed use residential including XXha. of B class employment and XXha. of unprescribed uses incorporating all community uses to be provided as serviced land.	15.53
mixed use neighbourhood centre (residential/ B class employment/ retail)	2.86
traveller site	2.1
B class employment	4.68
education	5.5
sports hub including landscaping and structural planting	13.2
allotments	4
general open space and green infrastructure including parks, green corridors, play areas and SuDS attenuation features	59.09
countrypark to provide SANG mitigation	67.32
additional land available for SANG mitigation	9.3
sui generis	1.9
Total site area	**1.43**

DRAFT

Density

higher density

medium density

lower density

Area	Average density (net)	Dwellings
34.21	45 dwellings per hectare	1555
54.7	40 dwellings per hectare	2200
8.16	30 dwellings per hectare	245
Total dwellings		**4000**

DRAFT

Cranbrook

on behalf of East Devon District Council

drawing no.	SK204	drawing	OVERALL MASTERPLAN		
revision	-	drawn by	NT	job no.	OXUD 346475
scale at A3	1:12,500	checked by	-	date	August 2017

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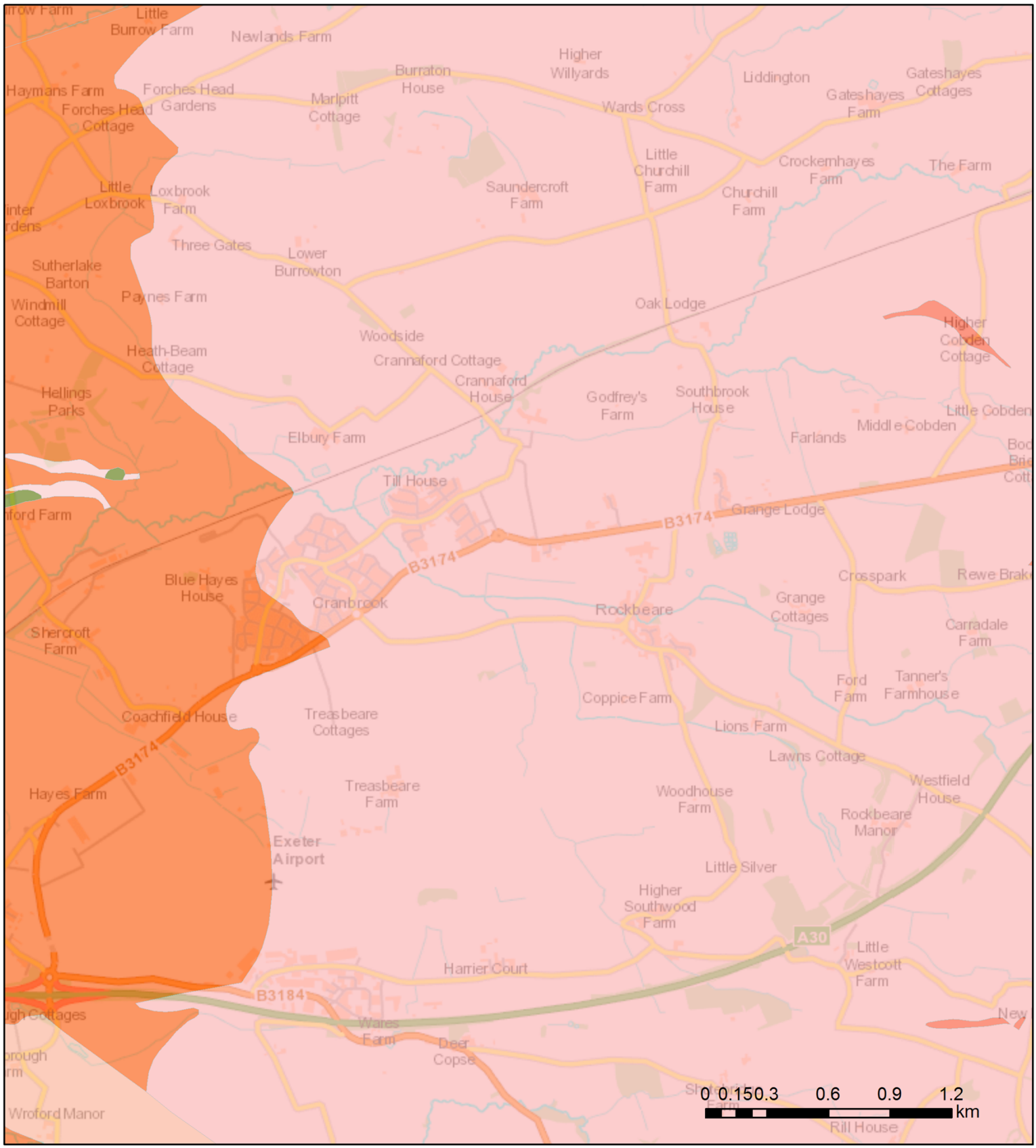
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APPENDIX B

British Geological Survey Data

Bedrock Geology

GEOINDEX ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Bedrock geology 1:50,000 scale

- THORVERTON SANDSTONE FORMATION - BASALT
- CRACKINGTON FORMATION - MUDSTONE AND SANDSTONE, INTERBEDDED
- DAWLISH SANDSTONE FORMATION - MUDSTONE
- MONKERTON FORMATION - SANDSTONE
- AYLESBEARE MUDSTONE GROUP - MUDSTONE
- EXMOUTH MUDSTONE AND SANDSTONE FORMATION - MUDSTONE
- BUDLEIGH SALTERTON PEBBLE BEDS FORMATION - CONGLOMERATE
- AYLESBEARE MUDSTONE GROUP - SANDSTONE
- WHIPTON FORMATION - SANDSTONE
- OTTER SANDSTONE FORMATION - SANDSTONE
- BUDLEIGH SALTERTON PEBBLE BEDS FORMATION - SANDSTONE
- SHUTE SANDSTONE FORMATION - BRECCIA
- SOUTHWEST ENGLAND MINOR INTRUSIVE SUITE - LAMPROPHYRES

Superficial Deposits

GEOINDEX ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Superficial deposits 1:50,000 scale

- ALLUVIUM - CLAY, SILT, SAND AND GRAVEL
- HEAD - SAND WITH CLAY AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME - EXTENDED]
- RIVER TERRACE DEPOSITS, 1 - SAND AND GRAVEL
- PEAT - PEAT
- HEAD, 1 - CLAY, SILT, SAND AND GRAVEL

Hydrogeology



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Hydrogeology 1:625,000 scale

Aquifers with significant intergranular flow

Highly productive aquifer

Moderately productive aquifer

Low productivity aquifer

Aquifers in which flow is virtually all through fractures and other discontinuities

Highly productive aquifer

Moderately productive aquifer

Low productivity aquifer

Rocks with essentially no groundwater

APPENDIX C

Environment Agency Data

This service will be closing on July 27, 2017
For more information and where the data can now be found please see the information pages.

Enter a postcode or place name:

Go

Other topics for this area...

Flood Warning Areas

Main Rivers Map

Map legend

Official Main River Line

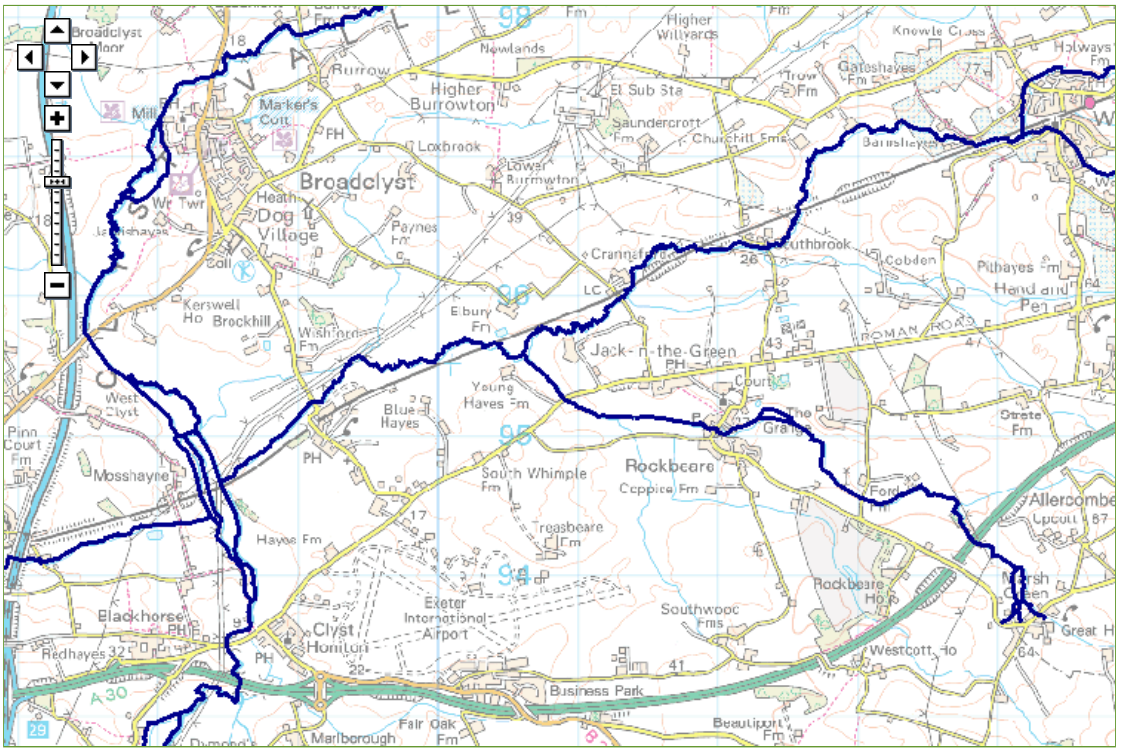
Main River

Main River

Other national environmental organisations

X: 300,876;Y: 95,424 at scale 1:40,000

Other maps | Data search | Text only version



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Main Rivers:

Understanding the Main Rivers map

The main rivers map shows which rivers in England are designated as Main Rivers.

The Environment Agency decides which watercourses are main rivers. We consult with other risk management authorities and the public before making these decision.

The Environment Agency is responsible for carrying out maintenance, improvement or construction work on main rivers to manage flood risk.

More information on Main Rivers

If you want to carry out building or construction work near a main river you may need a Flood Risk Activities permit.

Find out if you need a permit

creating a better place

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Author: Environment Agency | wiybysupport@environment-agency.gov.uk
Last updated: 22 June 2017

GOV.UK

Long term flood risk information

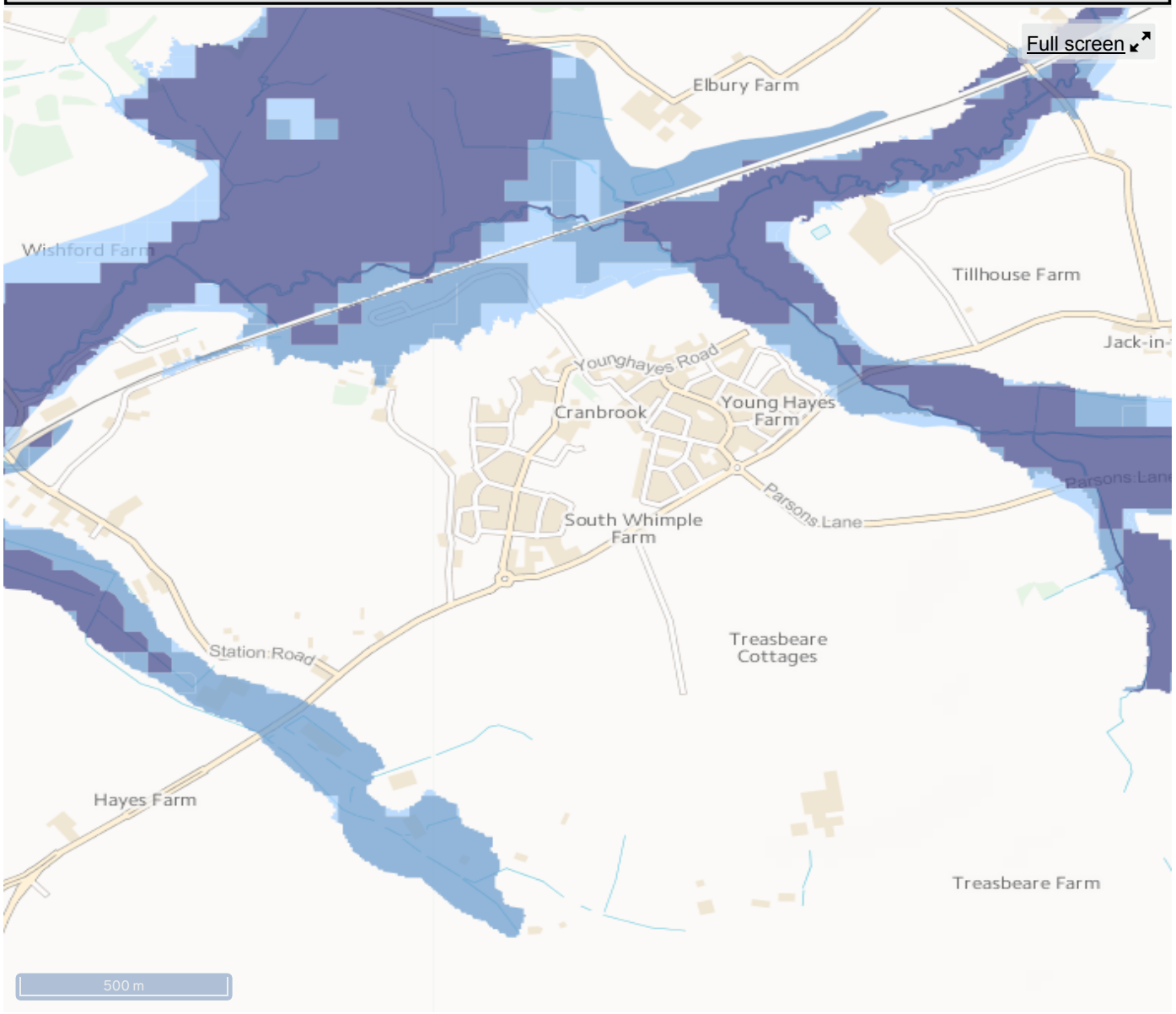
Learn more about this area's flood risk

'Detailed view' shows more options.

From the list below, select the information you're interested in. The map view will then update.

Enter a place or postcode in England

Extent of flooding



Fluvial Flood Risk
Data obtained 19th July 2017

High Medium Low Very low Location you selected

View the flood risk information for the location you originally searched for

View the flood risk information for another location

GOV.UK

Long term flood risk information

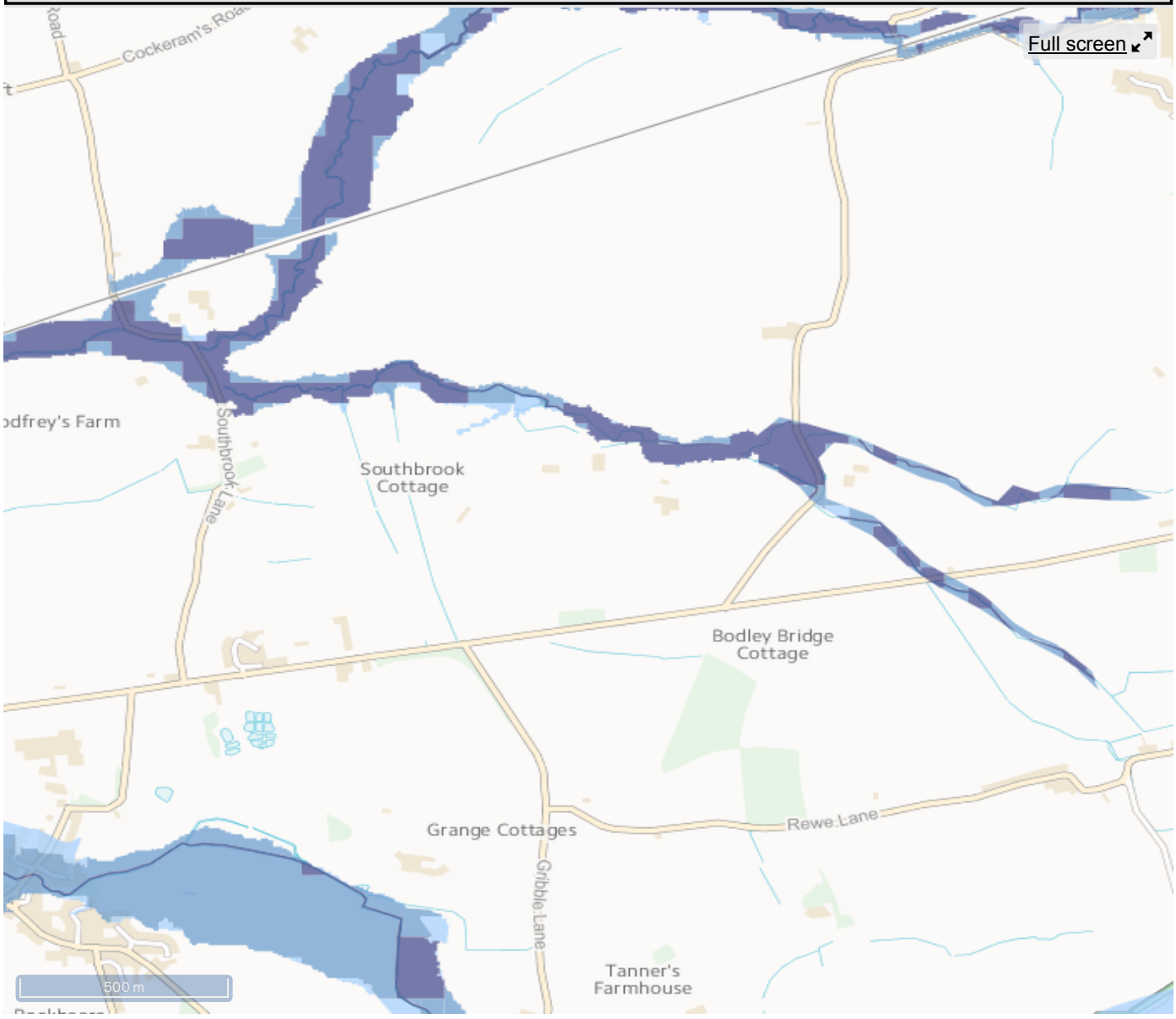
Learn more about this area's flood risk

'Detailed view' shows more options.

From the list below, select the information you're interested in. The map view will then update.

Enter a place or postcode in England

Extent of flooding



Fluvial Flood Risk
Data obtained 19th July 2017

High Medium Low Very low Location you selected

View the flood risk information for the location you originally searched for

View the flood risk information for another location

GOV.UK

Long term flood risk information

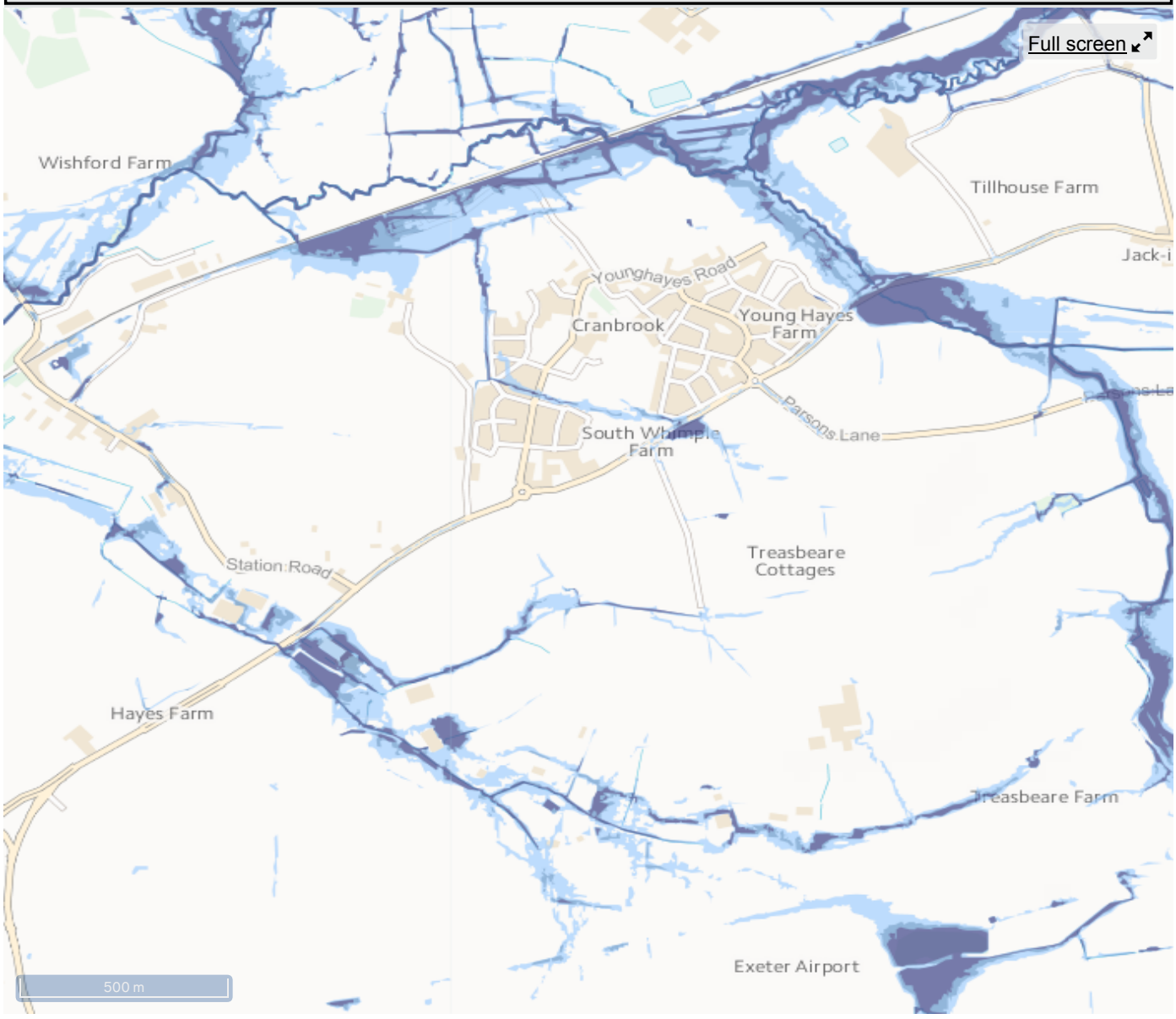
Learn more about this area's flood risk

'Detailed view' shows more options.

From the list below, select the information you're interested in. The map view will then update.

Enter a place or postcode in England

Extent of flooding



Flood Risk from Surface Water
Data obtained 19th July 2017

High Medium Low Very low Location you selected

View the flood risk information for the location you originally searched for

View the flood risk information for another location

GOV.UK

Long term flood risk information

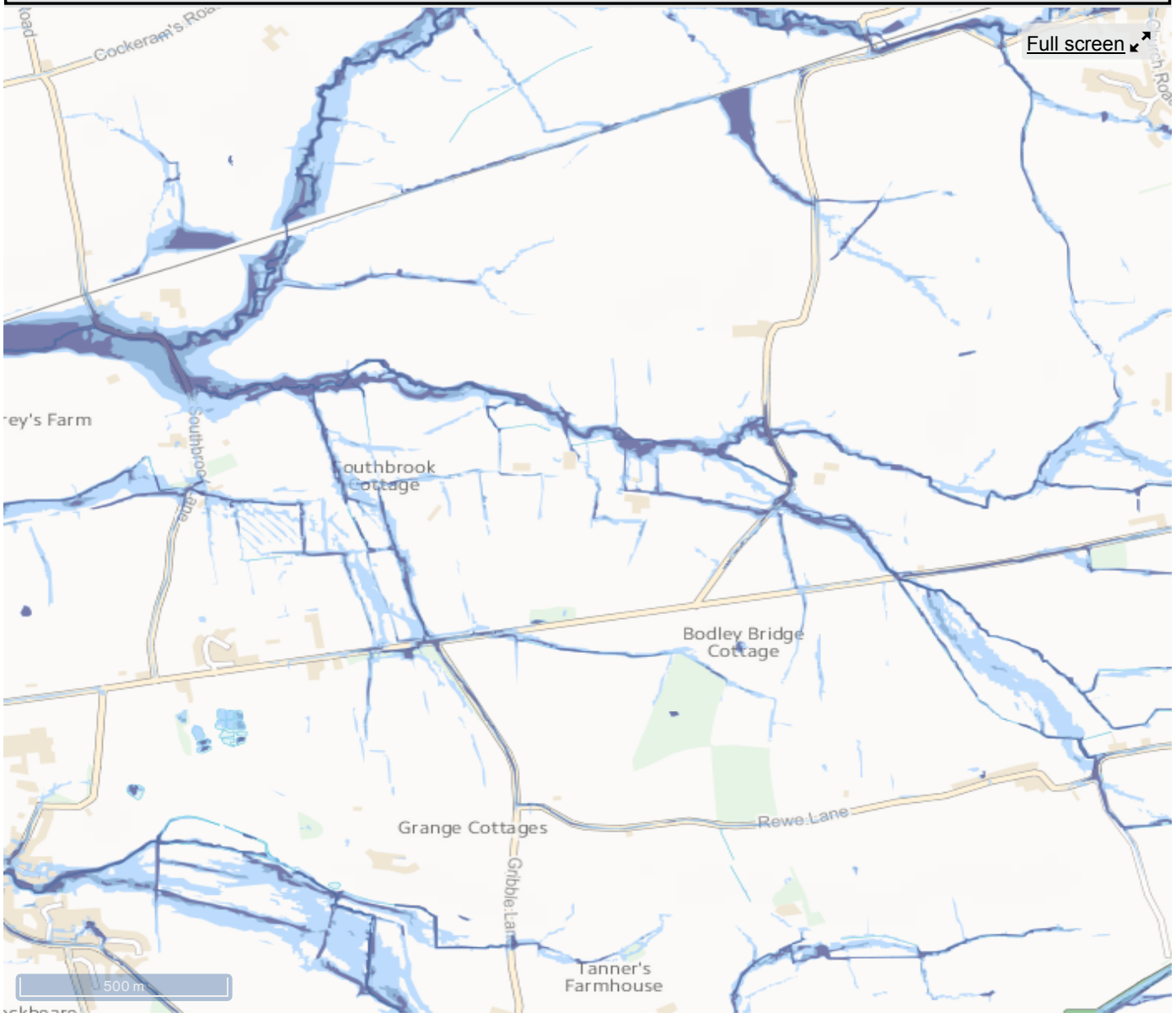
Learn more about this area's flood risk

'Detailed view' shows more options.

From the list below, select the information you're interested in. The map view will then update.

Enter a place or postcode in England

Extent of flooding



Flood Risk from Surface Water
Data obtained 19th July 2017

High Medium Low Very low Location you selected

View the flood risk information for the location you originally searched for

View the flood risk information for another location

This service will be closing on July 27, 2017
For more information and where the data can now be found please see the information pages.

Enter a postcode or place name:

Go

Other topics for this area...

Groundwater

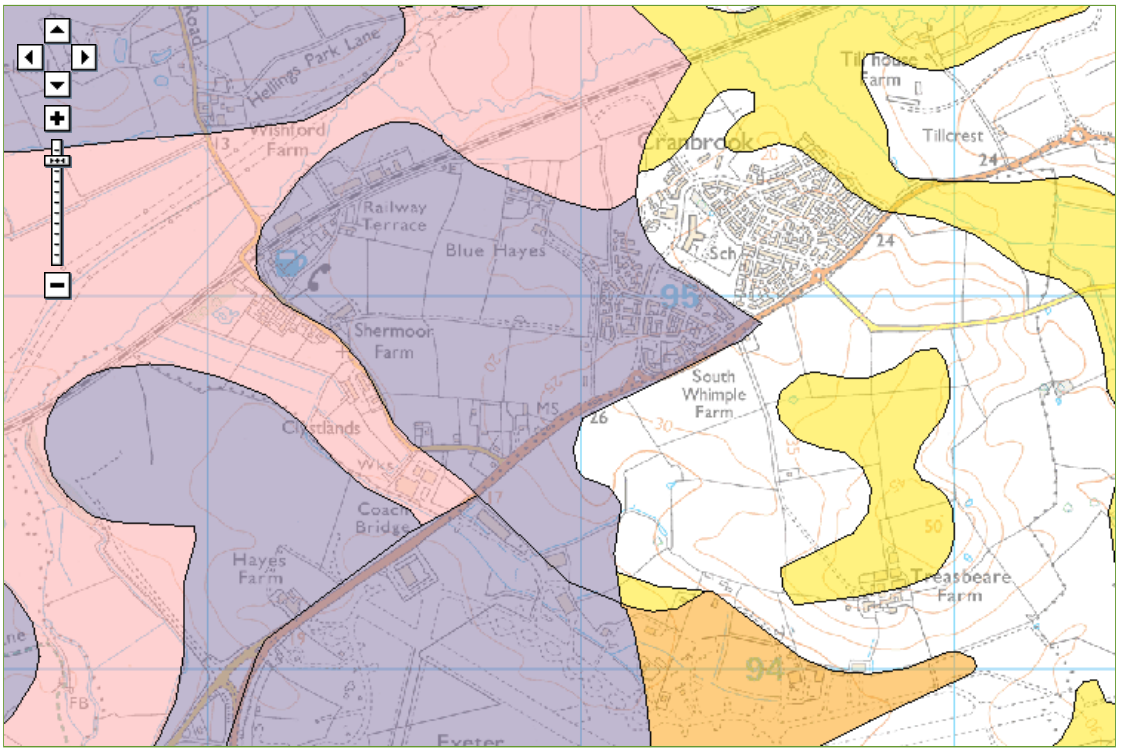
Groundwater

Map legend

- Groundwater source protection zones
- BGS Aquifer Maps - Superficial Deposits Designation
- BGS Aquifer Maps - Bedrock Designation
- Groundwater Vulnerability Zones
- Other national environmental organisations

X: 299,947;Y: 94,783 at scale 1:15,000

Other maps | Data search | Text only version



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More about Groundwater

Groundwater Source Protection Zones:

Groundwater provides a third of our drinking water. We ensure that your water is safe to drink defining Source Protection Zones. These zones help to monitor the risk of contamination from any activities that might cause pollution in the area.

The Source Protection Zones are not displayed at scales greater than 1:20,000 (Ordnance Survey 1:50,000 scale) as the data was only modelled to this level and is not accurate pass this. They should not be compared against field boundaries.

Understanding Groundwater Source Protection Zones maps

British Geological Survey's Aquifer Maps:

From 1st April 2010 new aquifer designations replace the old system of classifying aquifers as Major, Minor and Non-Aquifer. This new system is in line with our Groundwater Protection Policy (GP3) and the Water Framework Directive (WFD) and is based on British Geological Survey mapping.

The Aquifer Extents are not displayed at scales greater than 1:75,000 (Ordnance Survey 1:250,000 scale) as the data was only modelled to this level and is not accurate pass this.

Understanding the British Geological Survey's Aquifer maps

Groundwater Vulnerability Maps:

Ww are currently updating our groundwater vulnerability maps to reflect improvements in data mapping and understanding of the factors affecting vulnerability. The new maps will be released later in 2017.

The 'New groundwater vulnerability mapping methodology' report provides technical information about how the new maps have been created.

This service will be closing on July 27, 2017
For more information and where the data can now be found please see the information pages.

Enter a postcode or place name: Go

Other topics for this area... Groundwater

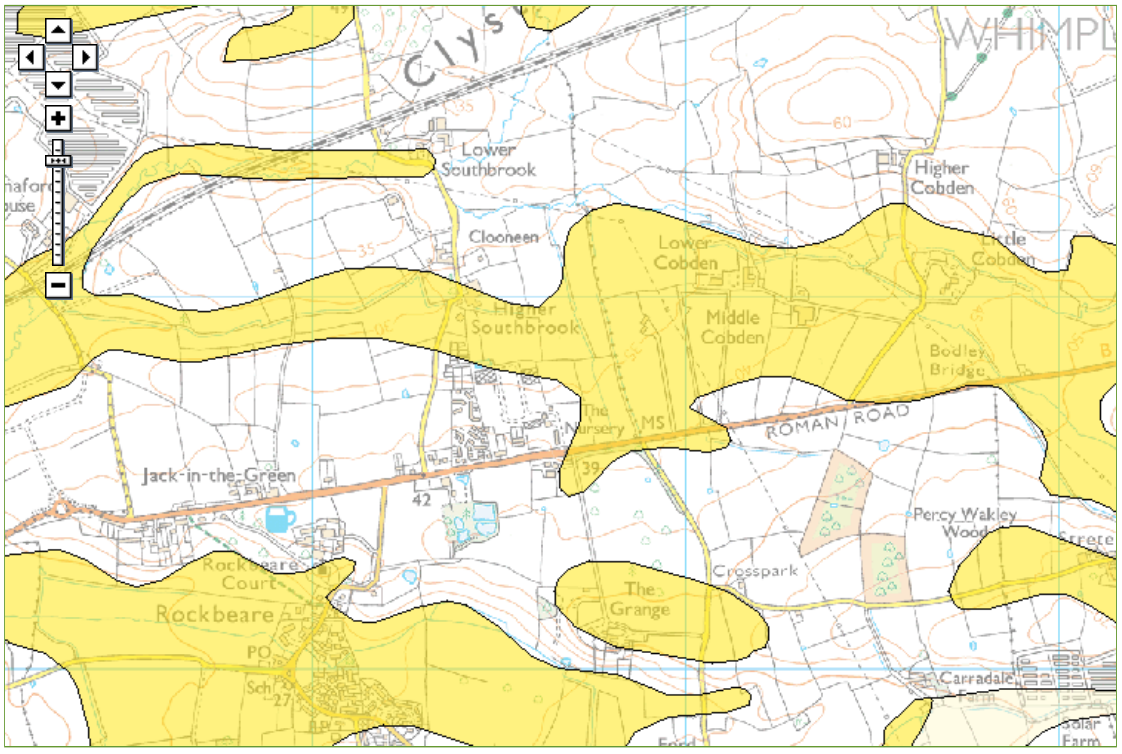
Groundwater

Map legend

- Groundwater source protection zones
- BGS Aquifer Maps - Superficial Deposits Designation
- BGS Aquifer Maps - Bedrock Designation
- Groundwater Vulnerability Zones
  - Major Aquifer High
  - Major Aquifer Intermediate
  - Major Aquifer Low
  - Minor Aquifer High
  - Minor Aquifer Intermediate
  - Minor Aquifer Low
- Other national environmental organisations

X: 302,670;Y: 95,785 at scale 1:15,000

Other maps | Data search | Text only version



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More about Groundwater

Groundwater Source Protection Zones:

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Understanding Groundwater Source Protection Zones maps

British Geological Survey's Aquifer Maps:

From 1st April 2010 new aquifer designations replace the old system of classifying aquifers as Major, Minor and Non-Aquifer. This new system is in line with our Groundwater Protection Policy (GP3) and the Water Framework Directive (WFD) and is based on British Geological Survey mapping.

The Aquifer Extents are not displayed at scales greater than 1:75,000 (Ordnance Survey 1:250,000 scale) as the data was only modelled to this level and is not accurate pass this.

Understanding the British Geological Survey's Aquifer maps

Groundwater Vulnerability Maps:

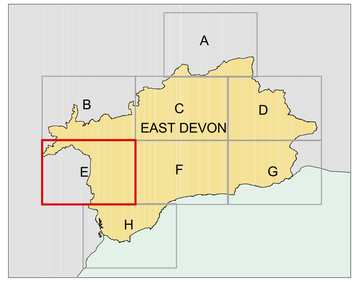
Ww are currently updating our groundwater vulnerability maps to reflect improvements in data mapping and understanding of the factors affecting vulnerability. The new maps will be released later in 2017.

The 'New groundwater vulnerability mapping methodology' report provides technical information about how the new maps have been created.

APPENDIX D

East Devon District Council Strategic Flood Risk Assessment Extract

Location Plan:



Legend:

- East Devon District Council Boundary
- Main River
- Ordinary Watercourses

Fire and Rescue Incidents
Data Source: Devon and Somerset Fire and Rescue Service

- Flood Incidents

Incidents of highway flooding
Data Source: Devon County Council

- Flood Incidents

Flooding on the M5
Data Source: Highways Agency

- Flood Incidents

Location of foul sewerage flooding (DG5 Register)
Data Source: South West Water

- DG5

Flood Reconnaissance Information System: Flood Incidents
Data Source: Environment Agency

- Property
- Incidents

Note: the Environment Agency holds information on flooding further to that contained in the FRIS database which it has not been possible to include here.

0.5 0 0.5 1 1.5 2 Kilometres

Project: **EAST DEVON STRATEGIC FLOOD RISK ASSESSMENT**

Title: **3E - HISTORICAL FLOODING**

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Drawn By	: Karen Ulloa	Revision	Drawing Scale	: 1:25,000	Drawing No.	: WB/EDSF/3E
Checked By	: Sofia Pasman	1	Sheet Ref.	: E	Date	: September 2008
Approved By	: Andy Barnes	Status	Plot Scale	: 1:1 @ A1	Issuing Office	: Exeter
		Final				

Halcrow
www.halcrow.com
Ash House
Falcon Road
Sowton
Exeter
EX2 7LB

East Devon District Council
Council Offices
Knowle
Sidmouth
Devon
EX10 8HL

APPENDIX E

Devon County Council Preliminary Flood Risk Assessment Extracts

N
W E
S

Devon County Council
Preliminary Flood Risk Assessment

Areas Susceptible to Groundwater Flooding

Devon Boundary

District Council Boundaries

Areas Susceptible to Groundwater Flooding

RISK

>= 75%

>= 50% <75%

>= 25% <50%

< 25%

0 5 10 km

Date: 16/03/2011	*Author:* Flood Risk Management (RR)
Scale: 1:450,000 @ A3	*File:* ....\GIS\PFRA Maps\ AStGWF DCC 2.mxd

Devon County Council

Highway Management
Devon County Council
Environment, Economy & Culture
Lucombe House, County Hall
Exeter, EX2 4QW
Tel: 01392 382104, Fax: 01392 381459

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Figure 5-2 AStGWF map showing 1km grid squares of susceptibility to groundwater flooding

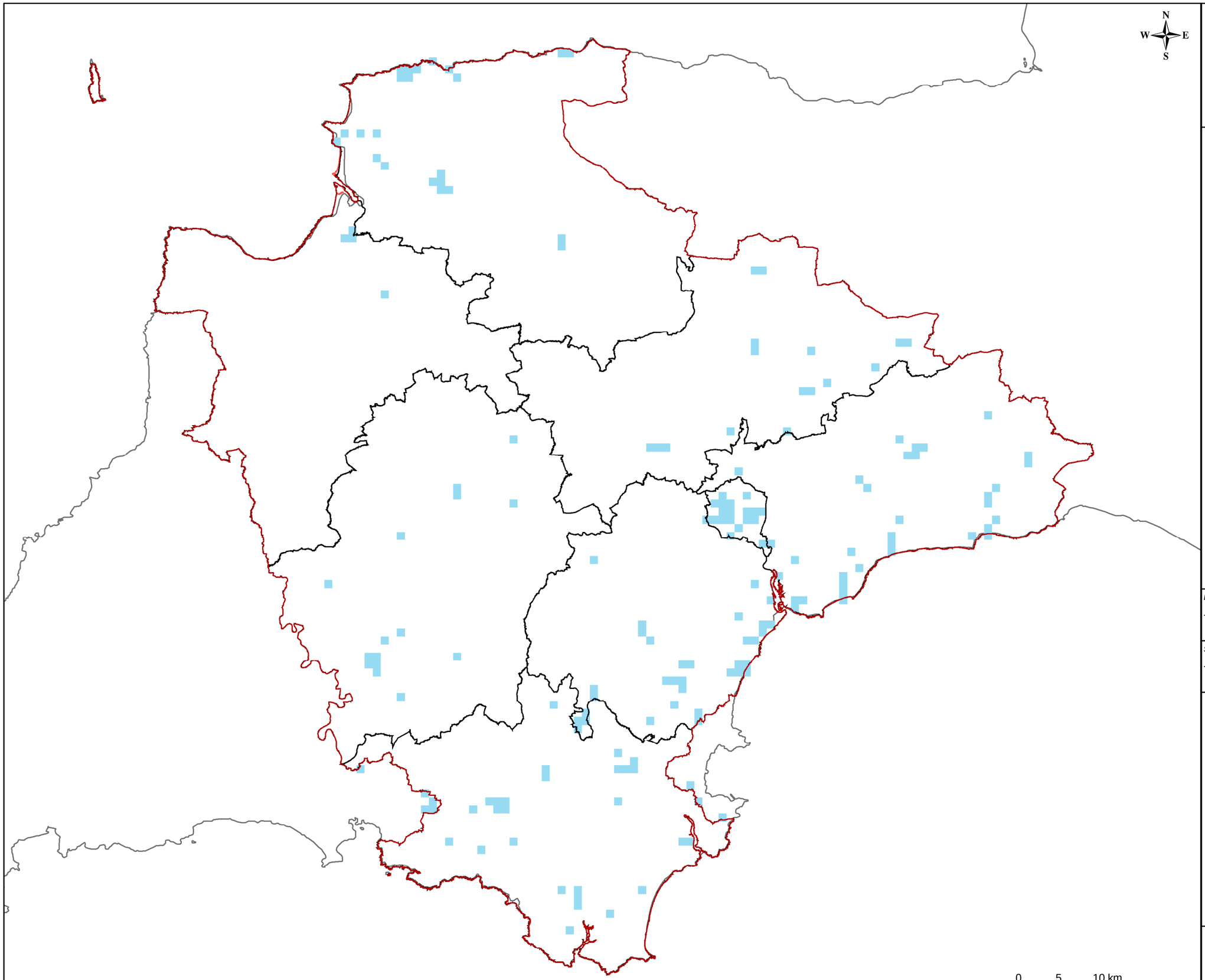


Figure 6-1 'Blue squares' showing areas above the nationally set flood risk threshold levels.

Devon County Council
Preliminary Flood Risk Assessment

1km Areas Above Nationally Set Flood Risk Thresholds

Devon Boundary

District Council Boundaries

Places Above Flood Risk Thresholds

Places above the Flood Risk Thresholds are 1km grid squares where at least one of the following flood risk indicators is above the threshold given below:

1. Number of People > 200
2. Critical Services > 1
3. Number of Non-Residential Properties > 20

Indicators calculated using the Environment Agency's detailed method of counting (based on property outlines) for the new Flood Map for Surface Water (deep – for 1 in 200 annual probability rainfall).

Date:	*Author:*
16/03/2011	*Flood Risk Management (RR)*
Scale:	*File:\GIS\PFRA Maps\Blue Squares\Blue Squares Selection.mxd*
1:450,000 @ A3	

Highway Management
Devon County Council
Environment, Economy & Culture
Lucombe House, County Hall
Exeter, EX2 4QW
Tel: 01392 382104, Fax: 01392 381459

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APPENDIX F

Micro Drainage Calculations

Cascade Summary of Results for 2017-08-30 Swale 1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 1.srcx	(None)

Half Drain Time : 7 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	14.871	0.471	0.0	29.5	29.5	15.5	Flood Risk
30 min Summer	14.848	0.448	0.0	28.7	28.7	13.6	Flood Risk
60 min Summer	14.797	0.397	0.0	26.6	26.6	9.8	Flood Risk
120 min Summer	14.714	0.314	0.0	22.9	22.9	5.3	Flood Risk
180 min Summer	14.654	0.254	0.0	19.9	19.9	3.0	O K
240 min Summer	14.615	0.215	0.0	17.6	17.6	2.0	O K
360 min Summer	14.579	0.179	0.0	13.5	13.5	1.2	O K
480 min Summer	14.557	0.157	0.0	11.1	11.1	0.9	O K
600 min Summer	14.542	0.142	0.0	9.5	9.5	0.7	O K
720 min Summer	14.531	0.131	0.0	8.3	8.3	0.6	O K
960 min Summer	14.514	0.114	0.0	6.6	6.6	0.4	O K
1440 min Summer	14.490	0.090	0.0	4.7	4.7	0.2	O K
2160 min Summer	14.477	0.077	0.0	3.4	3.4	0.2	O K
2880 min Summer	14.471	0.071	0.0	2.8	2.8	0.1	O K
4320 min Summer	14.458	0.058	0.0	1.9	1.9	0.1	O K
5760 min Summer	14.452	0.052	0.0	1.6	1.6	0.1	O K
7200 min Summer	14.448	0.048	0.0	1.3	1.3	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	32.2	13
30 min Summer	103.351	0.0	38.8	21
60 min Summer	62.285	0.0	46.7	36
120 min Summer	37.536	0.0	56.3	66
180 min Summer	27.912	0.0	62.8	96
240 min Summer	22.621	0.0	67.9	124
360 min Summer	16.821	0.0	75.7	184
480 min Summer	13.633	0.0	81.8	244
600 min Summer	11.582	0.0	86.9	306
720 min Summer	10.137	0.0	91.2	366
960 min Summer	8.038	0.0	96.5	488
1440 min Summer	5.796	0.0	104.3	718
2160 min Summer	4.179	0.0	112.8	1096
2880 min Summer	3.314	0.0	119.3	1444
4320 min Summer	2.386	0.0	128.9	2124
5760 min Summer	1.891	0.0	136.1	2904
7200 min Summer	1.578	0.0	142.0	3568

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Cascade Summary of Results for 2017-08-30 Swale 1.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	14.445	0.045	0.0	1.1	1.1	0.0	O K
10080 min Summer	14.442	0.042	0.0	1.0	1.0	0.0	O K
15 min Winter	14.894	0.494	0.0	30.4	30.4	17.8	Flood Risk
30 min Winter	14.860	0.460	0.0	29.1	29.1	14.6	Flood Risk
60 min Winter	14.783	0.383	0.0	26.1	26.1	8.9	Flood Risk
120 min Winter	14.663	0.263	0.0	20.4	20.4	3.3	O K
180 min Winter	14.603	0.203	0.0	16.2	16.2	1.7	O K
240 min Winter	14.577	0.177	0.0	13.3	13.3	1.2	O K
360 min Winter	14.546	0.146	0.0	9.9	9.9	0.8	O K
480 min Winter	14.529	0.129	0.0	8.0	8.0	0.6	O K
600 min Winter	14.517	0.117	0.0	6.9	6.9	0.4	O K
720 min Winter	14.506	0.106	0.0	6.0	6.0	0.4	O K
960 min Winter	14.490	0.090	0.0	4.7	4.7	0.2	O K
1440 min Winter	14.477	0.077	0.0	3.4	3.4	0.2	O K
2160 min Winter	14.467	0.067	0.0	2.5	2.5	0.1	O K
2880 min Winter	14.459	0.059	0.0	2.0	2.0	0.1	O K
4320 min Winter	14.450	0.050	0.0	1.4	1.4	0.1	O K
5760 min Winter	14.444	0.044	0.0	1.1	1.1	0.1	O K
7200 min Winter	14.440	0.040	0.0	1.0	1.0	0.0	O K
8640 min Winter	14.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Winter	14.435	0.035	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	147.0	4280
10080 min Summer	1.202	0.0	151.4	5096
15 min Winter	171.494	0.0	36.0	13
30 min Winter	103.351	0.0	43.4	22
60 min Winter	62.285	0.0	52.3	38
120 min Winter	37.536	0.0	63.1	68
180 min Winter	27.912	0.0	70.3	94
240 min Winter	22.621	0.0	76.0	124
360 min Winter	16.821	0.0	84.8	186
480 min Winter	13.633	0.0	91.6	244
600 min Winter	11.582	0.0	97.3	306
720 min Winter	10.137	0.0	102.2	360
960 min Winter	8.038	0.0	108.0	490
1440 min Winter	5.796	0.0	116.8	720
2160 min Winter	4.179	0.0	126.4	1076
2880 min Winter	3.314	0.0	133.6	1456
4320 min Winter	2.386	0.0	144.3	2204
5760 min Winter	1.891	0.0	152.5	2784
7200 min Winter	1.578	0.0	159.1	3528
8640 min Winter	1.362	0.0	164.7	4384
10080 min Winter	1.202	0.0	169.6	4936

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Cascade Rainfall Details for 2017-08-30 Swale 1.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299400 94600 SX 99400 94600
C (1km)	-0.026
D1 (1km)	0.389
D2 (1km)	0.313
D3 (1km)	0.310
E (1km)	0.282
F (1km)	2.498
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.100

Time (mins) From:	To:	Area (ha)
0	4	0.100

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Cascade Model Details for 2017-08-30 Swale 1.srcx

Storage is Online Cover Level (m) 15.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1893.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	80.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	14.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 14.400

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Cascade Summary of Results for 2017-08-30 Basin 1.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 1.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	14.308	0.508	130.9	4744.5	O K
30 min Summer	14.403	0.603	132.3	5673.7	O K
60 min Summer	14.509	0.709	132.3	6727.9	O K
120 min Summer	14.624	0.824	132.3	7881.5	O K
180 min Summer	14.691	0.891	132.3	8566.9	O K
240 min Summer	14.737	0.937	132.3	9034.9	Flood Risk
360 min Summer	14.794	0.994	132.3	9627.9	Flood Risk
480 min Summer	14.825	1.025	132.3	9946.5	Flood Risk
600 min Summer	14.839	1.039	132.3	10096.2	Flood Risk
720 min Summer	14.848	1.048	132.3	10190.7	Flood Risk
960 min Summer	14.833	1.033	132.3	10035.2	Flood Risk
1440 min Summer	14.795	0.995	132.3	9636.8	Flood Risk
2160 min Summer	14.722	0.922	132.3	8878.3	Flood Risk
2880 min Summer	14.645	0.845	132.3	8096.8	O K
4320 min Summer	14.503	0.703	132.3	6667.9	O K
5760 min Summer	14.388	0.588	132.2	5531.8	O K
7200 min Summer	14.302	0.502	130.8	4690.7	O K
8640 min Summer	14.239	0.439	128.5	4083.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	4042.9	19
30 min Summer	103.351	0.0	4957.5	34
60 min Summer	62.285	0.0	6578.2	64
120 min Summer	37.536	0.0	7980.1	122
180 min Summer	27.912	0.0	8924.0	182
240 min Summer	22.621	0.0	9654.5	242
360 min Summer	16.821	0.0	10774.2	362
480 min Summer	13.633	0.0	11634.9	480
600 min Summer	11.582	0.0	12340.1	574
720 min Summer	10.137	0.0	12938.5	624
960 min Summer	8.038	0.0	13617.3	748
1440 min Summer	5.796	0.0	14539.9	1010
2160 min Summer	4.179	0.0	16623.6	1404
2880 min Summer	3.314	0.0	17553.3	1792
4320 min Summer	2.386	0.0	18812.9	2552
5760 min Summer	1.891	0.0	20276.7	3280
7200 min Summer	1.578	0.0	21121.2	3960
8640 min Summer	1.362	0.0	21801.2	4592

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Cascade Summary of Results for 2017-08-30 Basin 1.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	14.200	0.400	124.1	3705.8	O K
15 min Winter	14.367	0.567	132.0	5317.4	O K
30 min Winter	14.473	0.673	132.3	6366.7	O K
60 min Winter	14.592	0.792	132.3	7563.1	O K
120 min Winter	14.722	0.922	132.3	8881.7	Flood Risk
180 min Winter	14.799	0.999	132.3	9682.0	Flood Risk
240 min Winter	14.852	1.052	132.3	10229.8	Flood Risk
360 min Winter	14.917	1.117	132.3	10914.6	Flood Risk
480 min Winter	14.953	1.153	132.3	11296.9	Flood Risk
600 min Winter	14.973	1.173	132.3	11505.4	Flood Risk
720 min Winter	14.982	1.182	132.3	11602.2	Flood Risk
960 min Winter	14.955	1.155	132.3	11320.2	Flood Risk
1440 min Winter	14.903	1.103	132.3	10771.2	Flood Risk
2160 min Winter	14.802	1.002	132.3	9705.4	Flood Risk
2880 min Winter	14.681	0.881	132.3	8467.4	O K
4320 min Winter	14.466	0.666	132.3	6297.8	O K
5760 min Winter	14.308	0.508	130.9	4750.7	O K
7200 min Winter	14.212	0.412	127.1	3822.6	O K
8640 min Winter	14.171	0.371	113.5	3429.3	O K
10080 min Winter	14.142	0.342	101.9	3153.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	22307.1	5256
15 min Winter	171.494	0.0	4581.5	19
30 min Winter	103.351	0.0	5596.8	33
60 min Winter	62.285	0.0	7401.3	62
120 min Winter	37.536	0.0	8967.1	120
180 min Winter	27.912	0.0	10019.5	180
240 min Winter	22.621	0.0	10833.4	238
360 min Winter	16.821	0.0	12081.6	352
480 min Winter	13.633	0.0	13039.6	466
600 min Winter	11.582	0.0	13821.8	574
720 min Winter	10.137	0.0	14482.7	680
960 min Winter	8.038	0.0	15224.2	782
1440 min Winter	5.796	0.0	16182.4	1082
2160 min Winter	4.179	0.0	18636.4	1536
2880 min Winter	3.314	0.0	19682.2	1960
4320 min Winter	2.386	0.0	21128.4	2720
5760 min Winter	1.891	0.0	22730.3	3352
7200 min Winter	1.578	0.0	23682.2	3960
8640 min Winter	1.362	0.0	24455.0	4664
10080 min Winter	1.202	0.0	25048.1	5344

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Cascade Rainfall Details for 2017-08-30 Basin 1.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299400 94600 SX 99400 94600
C (1km)	-0.026
D1 (1km)	0.389
D2 (1km)	0.313
D3 (1km)	0.310
E (1km)	0.282
F (1km)	2.498
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 14.920

Time (mins) From:	To:	Area (ha)
0	4	14.920

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Cascade Model Details for 2017-08-30 Basin 1.srcx

Storage is Online Cover Level (m) 15.000

Tank or Pond Structure

Invert Level (m) 13.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	9000.0	1.200	10686.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0441-1325-1200-1325
Design Head (m)	1.200
Design Flow (l/s)	132.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	441
Invert Level (m)	13.800
Minimum Outlet Pipe Diameter (mm)	500
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	132.5
Flush-Flo™	0.624	132.3
Kick-Flo®	0.993	120.8
Mean Flow over Head Range	-	102.3

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	11.7	1.200	132.5	3.000	207.2	7.000	314.0
0.200	42.4	1.400	142.8	3.500	223.4	7.500	324.8
0.300	83.8	1.600	152.4	4.000	238.5	8.000	335.3
0.400	124.2	1.800	161.4	4.500	252.7	8.500	345.4
0.500	130.7	2.000	169.9	5.000	266.1	9.000	355.3
0.600	132.3	2.200	178.0	5.500	278.9	9.500	364.9
0.800	129.8	2.400	185.8	6.000	291.1		
1.000	121.2	2.600	193.2	6.500	302.7		

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Cascade Summary of Results for 2017-08-30 Swale 2.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 2.srcx	(None)

Half Drain Time : 6 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	18.862	0.462	0.0	29.2	29.2	18.5	Flood Risk
30 min Summer	18.843	0.443	0.0	28.5	28.5	16.5	Flood Risk
60 min Summer	18.800	0.400	0.0	26.8	26.8	12.5	Flood Risk
120 min Summer	18.727	0.327	0.0	23.6	23.6	7.3	Flood Risk
180 min Summer	18.670	0.270	0.0	20.8	20.8	4.5	O K
240 min Summer	18.630	0.230	0.0	18.5	18.5	3.0	O K
360 min Summer	18.589	0.189	0.0	14.7	14.7	1.8	O K
480 min Summer	18.566	0.166	0.0	12.1	12.1	1.3	O K
600 min Summer	18.551	0.151	0.0	10.4	10.4	1.0	O K
720 min Summer	18.539	0.139	0.0	9.1	9.1	0.8	O K
960 min Summer	18.521	0.121	0.0	7.2	7.2	0.6	O K
1440 min Summer	18.496	0.096	0.0	5.2	5.2	0.3	O K
2160 min Summer	18.480	0.080	0.0	3.8	3.8	0.2	O K
2880 min Summer	18.473	0.073	0.0	3.0	3.0	0.2	O K
4320 min Summer	18.462	0.062	0.0	2.2	2.2	0.1	O K
5760 min Summer	18.455	0.055	0.0	1.7	1.7	0.1	O K
7200 min Summer	18.450	0.050	0.0	1.4	1.4	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	35.4	13
30 min Summer	103.351	0.0	42.6	21
60 min Summer	62.285	0.0	51.4	38
120 min Summer	37.536	0.0	61.9	68
180 min Summer	27.912	0.0	69.1	96
240 min Summer	22.621	0.0	74.7	126
360 min Summer	16.821	0.0	83.3	184
480 min Summer	13.633	0.0	90.0	244
600 min Summer	11.582	0.0	95.6	304
720 min Summer	10.137	0.0	100.4	366
960 min Summer	8.038	0.0	106.1	480
1440 min Summer	5.796	0.0	114.8	714
2160 min Summer	4.179	0.0	124.1	1068
2880 min Summer	3.314	0.0	131.2	1420
4320 min Summer	2.386	0.0	141.8	2200
5760 min Summer	1.891	0.0	149.7	2896
7200 min Summer	1.578	0.0	156.2	3544

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Cascade Summary of Results for 2017-08-30 Swale 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	18.447	0.047	0.0	1.3	1.3	0.1	O K
10080 min Summer	18.444	0.044	0.0	1.1	1.1	0.1	O K
15 min Winter	18.886	0.486	0.0	30.1	30.1	21.2	Flood Risk
30 min Winter	18.858	0.458	0.0	29.1	29.1	18.0	Flood Risk
60 min Winter	18.792	0.392	0.0	26.5	26.5	11.9	Flood Risk
120 min Winter	18.684	0.284	0.0	21.5	21.5	5.1	O K
180 min Winter	18.616	0.216	0.0	17.7	17.7	2.5	O K
240 min Winter	18.588	0.188	0.0	14.5	14.5	1.8	O K
360 min Winter	18.555	0.155	0.0	10.9	10.9	1.1	O K
480 min Winter	18.536	0.136	0.0	8.8	8.8	0.8	O K
600 min Winter	18.524	0.124	0.0	7.5	7.5	0.6	O K
720 min Winter	18.514	0.114	0.0	6.6	6.6	0.5	O K
960 min Winter	18.497	0.097	0.0	5.2	5.2	0.4	O K
1440 min Winter	18.481	0.081	0.0	3.8	3.8	0.2	O K
2160 min Winter	18.471	0.071	0.0	2.8	2.8	0.2	O K
2880 min Winter	18.462	0.062	0.0	2.2	2.2	0.1	O K
4320 min Winter	18.452	0.052	0.0	1.6	1.6	0.1	O K
5760 min Winter	18.447	0.047	0.0	1.3	1.3	0.1	O K
7200 min Winter	18.442	0.042	0.0	1.0	1.0	0.1	O K
8640 min Winter	18.439	0.039	0.0	0.9	0.9	0.0	O K
10080 min Winter	18.437	0.037	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	161.8	4368
10080 min Summer	1.202	0.0	166.6	4968
15 min Winter	171.494	0.0	39.6	14
30 min Winter	103.351	0.0	47.7	22
60 min Winter	62.285	0.0	57.6	40
120 min Winter	37.536	0.0	69.4	68
180 min Winter	27.912	0.0	77.4	96
240 min Winter	22.621	0.0	83.6	124
360 min Winter	16.821	0.0	93.3	184
480 min Winter	13.633	0.0	100.8	244
600 min Winter	11.582	0.0	107.0	302
720 min Winter	10.137	0.0	112.4	366
960 min Winter	8.038	0.0	118.8	482
1440 min Winter	5.796	0.0	128.5	714
2160 min Winter	4.179	0.0	139.0	1096
2880 min Winter	3.314	0.0	147.0	1472
4320 min Winter	2.386	0.0	158.8	2164
5760 min Winter	1.891	0.0	167.7	2936
7200 min Winter	1.578	0.0	175.0	3640
8640 min Winter	1.362	0.0	181.2	4296
10080 min Winter	1.202	0.0	186.6	4944

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Cascade Rainfall Details for 2017-08-30 Swale 2.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299400 94600 SX 99400 94600
C (1km)	-0.026
D1 (1km)	0.389
D2 (1km)	0.313
D3 (1km)	0.310
E (1km)	0.282
F (1km)	2.498
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.110

Time (mins) From:	To:	Area (ha)
0	4	0.110

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Cascade Model Details for 2017-08-30 Swale 2.srcx

Storage is Online Cover Level (m) 19.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1569.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	18.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 18.400

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Cascade Summary of Results for 2017-08-30 Basin 2.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 2.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.305	0.505	109.1	4205.7	O K
30 min Summer	18.400	0.600	109.8	5034.4	O K
60 min Summer	18.507	0.707	109.8	5979.1	O K
120 min Summer	18.622	0.822	109.8	7015.7	O K
180 min Summer	18.690	0.890	109.8	7638.4	O K
240 min Summer	18.737	0.937	109.8	8069.2	Flood Risk
360 min Summer	18.797	0.997	109.8	8624.8	Flood Risk
480 min Summer	18.830	1.030	109.8	8928.3	Flood Risk
600 min Summer	18.846	1.046	109.8	9081.9	Flood Risk
720 min Summer	18.855	1.055	109.8	9162.3	Flood Risk
960 min Summer	18.840	1.040	109.8	9027.5	Flood Risk
1440 min Summer	18.805	1.005	109.8	8693.3	Flood Risk
2160 min Summer	18.736	0.936	109.8	8055.2	Flood Risk
2880 min Summer	18.662	0.862	109.8	7379.0	O K
4320 min Summer	18.522	0.722	109.8	6116.5	O K
5760 min Summer	18.406	0.606	109.8	5080.7	O K
7200 min Summer	18.314	0.514	109.3	4286.0	O K
8640 min Summer	18.247	0.447	107.8	3701.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	3614.8	19
30 min Summer	103.351	0.0	4422.0	34
60 min Summer	62.285	0.0	5852.3	64
120 min Summer	37.536	0.0	7094.0	122
180 min Summer	27.912	0.0	7929.4	182
240 min Summer	22.621	0.0	8575.2	242
360 min Summer	16.821	0.0	9563.8	362
480 min Summer	13.633	0.0	10322.8	480
600 min Summer	11.582	0.0	10942.9	600
720 min Summer	10.137	0.0	11467.3	656
960 min Summer	8.038	0.0	12056.8	768
1440 min Summer	5.796	0.0	12827.0	1024
2160 min Summer	4.179	0.0	14750.9	1428
2880 min Summer	3.314	0.0	15575.8	1816
4320 min Summer	2.386	0.0	16705.7	2592
5760 min Summer	1.891	0.0	17991.7	3296
7200 min Summer	1.578	0.0	18742.8	4032
8640 min Summer	1.362	0.0	19349.3	4672

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Cascade Summary of Results for 2017-08-30 Basin 2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	18.198	0.398	106.0	3281.9	O K
15 min Winter	18.364	0.564	109.7	4713.5	O K
30 min Winter	18.470	0.670	109.8	5647.7	O K
60 min Winter	18.590	0.790	109.8	6719.8	O K
120 min Winter	18.719	0.919	109.8	7903.5	Flood Risk
180 min Winter	18.798	0.998	109.8	8628.9	Flood Risk
240 min Winter	18.851	1.051	109.8	9127.0	Flood Risk
360 min Winter	18.918	1.118	109.8	9761.5	Flood Risk
480 min Winter	18.957	1.157	109.8	10128.5	Flood Risk
600 min Winter	18.979	1.179	109.8	10340.1	Flood Risk
720 min Winter	18.990	1.190	109.8	10450.8	Flood Risk
960 min Winter	18.966	1.166	109.8	10216.1	Flood Risk
1440 min Winter	18.917	1.117	109.8	9752.1	Flood Risk
2160 min Winter	18.825	1.025	109.8	8881.2	Flood Risk
2880 min Winter	18.713	0.913	109.8	7843.1	Flood Risk
4320 min Winter	18.498	0.698	109.8	5900.0	O K
5760 min Winter	18.332	0.532	109.5	4441.2	O K
7200 min Winter	18.220	0.420	106.9	3474.4	O K
8640 min Winter	18.164	0.364	100.2	3000.4	O K
10080 min Winter	18.134	0.334	90.1	2742.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	19804.0	5344
15 min Winter	171.494	0.0	4090.4	19
30 min Winter	103.351	0.0	4984.6	33
60 min Winter	62.285	0.0	6581.4	62
120 min Winter	37.536	0.0	7967.4	120
180 min Winter	27.912	0.0	8897.6	180
240 min Winter	22.621	0.0	9616.5	238
360 min Winter	16.821	0.0	10717.0	354
480 min Winter	13.633	0.0	11558.9	466
600 min Winter	11.582	0.0	12243.5	578
720 min Winter	10.137	0.0	12818.4	686
960 min Winter	8.038	0.0	13452.8	876
1440 min Winter	5.796	0.0	14219.7	1096
2160 min Winter	4.179	0.0	16533.7	1556
2880 min Winter	3.314	0.0	17459.5	1988
4320 min Winter	2.386	0.0	18755.4	2764
5760 min Winter	1.891	0.0	20167.6	3456
7200 min Winter	1.578	0.0	21014.1	4040
8640 min Winter	1.362	0.0	21702.9	4664
10080 min Winter	1.202	0.0	22234.9	5352

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Cascade Rainfall Details for 2017-08-30 Basin 2.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299400 94600 SX 99400 94600
C (1km)	-0.026
D1 (1km)	0.389
D2 (1km)	0.313
D3 (1km)	0.310
E (1km)	0.282
F (1km)	2.498
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 13.210

Time (mins) From:	To:	Area (ha)
0	4	13.210

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Cascade Model Details for 2017-08-30 Basin 2.srcx

Storage is Online Cover Level (m) 19.000

Tank or Pond Structure

Invert Level (m) 17.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	8000.0	1.200	9594.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0408-1098-1200-1098
Design Head (m)	1.200
Design Flow (l/s)	109.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	408
Invert Level (m)	17.800
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	109.7
Flush-Flo™	0.592	109.8
Kick-Flo®	0.976	99.3
Mean Flow over Head Range	-	86.2

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	11.1	1.200	109.7	3.000	171.5	7.000	259.8
0.200	39.9	1.400	118.3	3.500	184.9	7.500	268.7
0.300	77.5	1.600	126.2	4.000	197.4	8.000	277.4
0.400	106.1	1.800	133.7	4.500	209.2	8.500	285.8
0.500	109.0	2.000	140.7	5.000	220.2	9.000	293.9
0.600	109.8	2.200	147.4	5.500	230.8	9.500	301.8
0.800	106.9	2.400	153.8	6.000	240.8		
1.000	100.5	2.600	159.9	6.500	250.5		

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Cascade Summary of Results for 2017-08-30 Swale 3.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 3.srcx	(None)

Half Drain Time : 6 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	27.862	0.462	0.0	29.2	29.2	18.4	Flood Risk
30 min Summer	27.842	0.442	0.0	28.4	28.4	16.4	Flood Risk
60 min Summer	27.797	0.397	0.0	26.7	26.7	12.3	Flood Risk
120 min Summer	27.723	0.323	0.0	23.4	23.4	7.1	Flood Risk
180 min Summer	27.666	0.266	0.0	20.5	20.5	4.3	O K
240 min Summer	27.626	0.226	0.0	18.3	18.3	2.8	O K
360 min Summer	27.587	0.187	0.0	14.4	14.4	1.7	O K
480 min Summer	27.564	0.164	0.0	11.9	11.9	1.3	O K
600 min Summer	27.549	0.149	0.0	10.2	10.2	1.0	O K
720 min Summer	27.537	0.137	0.0	8.9	8.9	0.8	O K
960 min Summer	27.520	0.120	0.0	7.1	7.1	0.6	O K
1440 min Summer	27.496	0.096	0.0	5.2	5.2	0.3	O K
2160 min Summer	27.480	0.080	0.0	3.8	3.8	0.2	O K
2880 min Summer	27.473	0.073	0.0	3.0	3.0	0.2	O K
4320 min Summer	27.462	0.062	0.0	2.2	2.2	0.1	O K
5760 min Summer	27.455	0.055	0.0	1.7	1.7	0.1	O K
7200 min Summer	27.450	0.050	0.0	1.4	1.4	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	35.3	13
30 min Summer	102.749	0.0	42.4	21
60 min Summer	61.665	0.0	50.9	38
120 min Summer	37.008	0.0	61.1	68
180 min Summer	27.453	0.0	68.0	96
240 min Summer	22.210	0.0	73.3	126
360 min Summer	16.476	0.0	81.6	184
480 min Summer	13.330	0.0	88.0	244
600 min Summer	11.309	0.0	93.3	306
720 min Summer	9.888	0.0	97.9	364
960 min Summer	7.881	0.0	104.0	484
1440 min Summer	5.724	0.0	113.3	732
2160 min Summer	4.158	0.0	123.5	1068
2880 min Summer	3.314	0.0	131.2	1468
4320 min Summer	2.388	0.0	141.9	2124
5760 min Summer	1.893	0.0	150.0	2888
7200 min Summer	1.581	0.0	156.5	3648

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Cascade Summary of Results for 2017-08-30 Swale 3.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	27.447	0.047	0.0	1.3	1.3	0.1	O K
10080 min Summer	27.444	0.044	0.0	1.1	1.1	0.1	O K
15 min Winter	27.885	0.485	0.0	30.1	30.1	21.1	Flood Risk
30 min Winter	27.856	0.456	0.0	29.0	29.0	17.8	Flood Risk
60 min Winter	27.789	0.389	0.0	26.3	26.3	11.6	Flood Risk
120 min Winter	27.680	0.280	0.0	21.3	21.3	4.9	O K
180 min Winter	27.613	0.213	0.0	17.4	17.4	2.4	O K
240 min Winter	27.585	0.185	0.0	14.3	14.3	1.7	O K
360 min Winter	27.553	0.153	0.0	10.7	10.7	1.1	O K
480 min Winter	27.535	0.135	0.0	8.7	8.7	0.8	O K
600 min Winter	27.522	0.122	0.0	7.3	7.3	0.6	O K
720 min Winter	27.512	0.112	0.0	6.4	6.4	0.5	O K
960 min Winter	27.495	0.095	0.0	5.1	5.1	0.3	O K
1440 min Winter	27.480	0.080	0.0	3.8	3.8	0.2	O K
2160 min Winter	27.470	0.070	0.0	2.7	2.7	0.2	O K
2880 min Winter	27.462	0.062	0.0	2.2	2.2	0.1	O K
4320 min Winter	27.452	0.052	0.0	1.6	1.6	0.1	O K
5760 min Winter	27.447	0.047	0.0	1.3	1.3	0.1	O K
7200 min Winter	27.442	0.042	0.0	1.0	1.0	0.1	O K
8640 min Winter	27.439	0.039	0.0	0.9	0.9	0.0	O K
10080 min Winter	27.437	0.037	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.365	0.0	162.1	4368
10080 min Summer	1.205	0.0	167.0	4968
15 min Winter	171.205	0.0	39.5	14
30 min Winter	102.749	0.0	47.5	22
60 min Winter	61.665	0.0	57.0	40
120 min Winter	37.008	0.0	68.4	68
180 min Winter	27.453	0.0	76.1	96
240 min Winter	22.210	0.0	82.1	124
360 min Winter	16.476	0.0	91.3	184
480 min Winter	13.330	0.0	98.5	244
600 min Winter	11.309	0.0	104.5	306
720 min Winter	9.888	0.0	109.6	360
960 min Winter	7.881	0.0	116.5	490
1440 min Winter	5.724	0.0	126.9	728
2160 min Winter	4.158	0.0	138.3	1076
2880 min Winter	3.314	0.0	147.0	1468
4320 min Winter	2.388	0.0	158.9	2136
5760 min Winter	1.893	0.0	167.9	2832
7200 min Winter	1.581	0.0	175.3	3624
8640 min Winter	1.365	0.0	181.6	4256
10080 min Winter	1.205	0.0	187.0	5072

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Cascade Rainfall Details for 2017-08-30 Swale 3.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 300950 95250 SY 00950 95250
C (1km)	-0.026
D1 (1km)	0.383
D2 (1km)	0.331
D3 (1km)	0.312
E (1km)	0.282
F (1km)	2.488
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.110

Time (mins) From:	To:	Area (ha)
0	4	0.110

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Cascade Model Details for 2017-08-30 Swale 3.srcx

Storage is Online Cover Level (m) 28.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	565.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	27.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 27.400

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Cascade Summary of Results for 2017-08-30 Basin 3.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 3.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	27.374	0.574	39.5	1286.3	O K
30 min Summer	27.476	0.676	39.5	1537.2	O K
60 min Summer	27.585	0.785	39.5	1814.0	O K
120 min Summer	27.696	0.896	39.5	2105.9	O K
180 min Summer	27.757	0.957	39.5	2269.5	Flood Risk
240 min Summer	27.794	0.994	39.5	2371.0	Flood Risk
360 min Summer	27.833	1.033	39.5	2477.9	Flood Risk
480 min Summer	27.846	1.046	39.5	2514.4	Flood Risk
600 min Summer	27.849	1.049	39.5	2522.3	Flood Risk
720 min Summer	27.849	1.049	39.5	2522.7	Flood Risk
960 min Summer	27.826	1.026	39.5	2458.5	Flood Risk
1440 min Summer	27.773	0.973	39.5	2313.3	Flood Risk
2160 min Summer	27.683	0.883	39.5	2071.6	O K
2880 min Summer	27.584	0.784	39.5	1813.4	O K
4320 min Summer	27.404	0.604	39.5	1359.9	O K
5760 min Summer	27.264	0.464	39.5	1023.0	O K
7200 min Summer	27.165	0.365	39.3	790.9	O K
8640 min Summer	27.097	0.297	38.5	638.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	1259.3	19
30 min Summer	102.749	0.0	1517.1	34
60 min Summer	61.665	0.0	1877.5	64
120 min Summer	37.008	0.0	2257.0	122
180 min Summer	27.453	0.0	2512.8	182
240 min Summer	22.210	0.0	2711.4	242
360 min Summer	16.476	0.0	3017.5	360
480 min Summer	13.330	0.0	3254.7	478
600 min Summer	11.309	0.0	3450.6	526
720 min Summer	9.888	0.0	3618.8	592
960 min Summer	7.881	0.0	3841.0	720
1440 min Summer	5.724	0.0	4168.3	984
2160 min Summer	4.158	0.0	4614.0	1404
2880 min Summer	3.314	0.0	4902.1	1788
4320 min Summer	2.388	0.0	5284.8	2512
5760 min Summer	1.893	0.0	5617.8	3224
7200 min Summer	1.581	0.0	5861.3	3888
8640 min Summer	1.365	0.0	6064.6	4576

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Cascade Summary of Results for 2017-08-30 Basin 3.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	27.060	0.260	37.3	554.2	O K
15 min Winter	27.437	0.637	39.5	1441.5	O K
30 min Winter	27.550	0.750	39.5	1723.9	O K
60 min Winter	27.672	0.872	39.5	2042.4	O K
120 min Winter	27.795	0.995	39.5	2375.0	Flood Risk
180 min Winter	27.863	1.063	39.5	2562.6	Flood Risk
240 min Winter	27.906	1.106	39.5	2683.4	Flood Risk
360 min Winter	27.954	1.154	39.5	2820.3	Flood Risk
480 min Winter	27.975	1.175	39.5	2880.3	Flood Risk
600 min Winter	27.981	1.181	39.5	2897.0	Flood Risk
720 min Winter	27.978	1.178	39.5	2887.5	Flood Risk
960 min Winter	27.947	1.147	39.5	2798.1	Flood Risk
1440 min Winter	27.876	1.076	39.5	2599.5	Flood Risk
2160 min Winter	27.752	0.952	39.5	2256.0	Flood Risk
2880 min Winter	27.603	0.803	39.5	1860.8	O K
4320 min Winter	27.330	0.530	39.5	1178.2	O K
5760 min Winter	27.146	0.346	39.1	748.4	O K
7200 min Winter	27.059	0.259	37.2	551.9	O K
8640 min Winter	27.029	0.229	32.5	486.9	O K
10080 min Winter	27.009	0.209	29.0	442.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.205	0.0	6232.3	5152
15 min Winter	171.205	0.0	1414.2	19
30 min Winter	102.749	0.0	1701.5	34
60 min Winter	61.665	0.0	2105.1	62
120 min Winter	37.008	0.0	2529.8	120
180 min Winter	27.453	0.0	2816.2	178
240 min Winter	22.210	0.0	3038.4	236
360 min Winter	16.476	0.0	3380.8	350
480 min Winter	13.330	0.0	3645.8	462
600 min Winter	11.309	0.0	3864.6	570
720 min Winter	9.888	0.0	4052.2	670
960 min Winter	7.881	0.0	4299.4	758
1440 min Winter	5.724	0.0	4659.7	1068
2160 min Winter	4.158	0.0	5169.1	1520
2880 min Winter	3.314	0.0	5492.1	1932
4320 min Winter	2.388	0.0	5924.8	2640
5760 min Winter	1.893	0.0	6293.5	3280
7200 min Winter	1.581	0.0	6566.7	3816
8640 min Winter	1.365	0.0	6795.7	4496
10080 min Winter	1.205	0.0	6987.0	5240

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Cascade Rainfall Details for 2017-08-30 Basin 3.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 300950 95250 SY 00950 95250
C (1km)	-0.026
D1 (1km)	0.383
D2 (1km)	0.331
D3 (1km)	0.312
E (1km)	0.282
F (1km)	2.488
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 4.020

Time (mins) From:	To:	Area (ha)
0	4	4.020

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Cascade Model Details for 2017-08-30 Basin 3.srcx

Storage is Online Cover Level (m) 28.000

Tank or Pond Structure

Invert Level (m) 26.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2050.0	1.200	2892.8

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0264-3950-1200-3950
Design Head (m)	1.200
Design Flow (l/s)	39.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	264
Invert Level (m)	26.800
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	39.5
Flush-Flo™	0.435	39.5
Kick-Flo®	0.881	34.0
Mean Flow over Head Range	-	32.9

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	8.4	1.200	39.5	3.000	61.4	7.000	92.7
0.200	27.2	1.400	42.5	3.500	66.2	7.500	95.9
0.300	38.5	1.600	45.3	4.000	70.6	8.000	99.0
0.400	39.4	1.800	48.0	4.500	74.8	8.500	101.9
0.500	39.4	2.000	50.5	5.000	78.7	9.000	104.8
0.600	38.8	2.200	52.9	5.500	82.4	9.500	107.6
0.800	36.4	2.400	55.1	6.000	86.0		
1.000	36.2	2.600	57.3	6.500	89.4		

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Cascade Summary of Results for 2017-08-30 Swale 4.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 4.srcx	(None)

Half Drain Time : 2 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	23.876	0.476	0.0	29.7	29.7	4.0	Flood Risk
30 min Summer	23.816	0.416	0.0	27.4	27.4	2.8	Flood Risk
60 min Summer	23.702	0.302	0.0	22.4	22.4	1.2	Flood Risk
120 min Summer	23.598	0.198	0.0	15.7	15.7	0.4	O K
180 min Summer	23.566	0.166	0.0	12.1	12.1	0.3	O K
240 min Summer	23.547	0.147	0.0	10.0	10.0	0.2	O K
360 min Summer	23.523	0.123	0.0	7.4	7.4	0.1	O K
480 min Summer	23.506	0.106	0.0	6.0	6.0	0.1	O K
600 min Summer	23.495	0.095	0.0	5.1	5.1	0.1	O K
720 min Summer	23.487	0.087	0.0	4.5	4.5	0.1	O K
960 min Summer	23.479	0.079	0.0	3.6	3.6	0.0	O K
1440 min Summer	23.469	0.069	0.0	2.6	2.6	0.0	O K
2160 min Summer	23.458	0.058	0.0	1.9	1.9	0.0	O K
2880 min Summer	23.451	0.051	0.0	1.5	1.5	0.0	O K
4320 min Summer	23.444	0.044	0.0	1.1	1.1	0.0	O K
5760 min Summer	23.439	0.039	0.0	0.9	0.9	0.0	O K
7200 min Summer	23.437	0.037	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	17.7	12
30 min Summer	102.749	0.0	21.2	19
60 min Summer	61.665	0.0	25.4	34
120 min Summer	37.008	0.0	30.5	62
180 min Summer	27.453	0.0	34.0	92
240 min Summer	22.210	0.0	36.6	122
360 min Summer	16.476	0.0	40.8	184
480 min Summer	13.330	0.0	44.0	242
600 min Summer	11.309	0.0	46.7	302
720 min Summer	9.888	0.0	48.9	362
960 min Summer	7.881	0.0	52.0	486
1440 min Summer	5.724	0.0	56.7	724
2160 min Summer	4.158	0.0	61.7	1068
2880 min Summer	3.314	0.0	65.6	1460
4320 min Summer	2.388	0.0	70.9	2160
5760 min Summer	1.893	0.0	74.9	2912
7200 min Summer	1.581	0.0	78.2	3672

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Cascade Summary of Results for 2017-08-30 Swale 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	23.434	0.034	0.0	0.7	0.7	0.0	O K
10080 min Summer	23.431	0.031	0.0	0.6	0.6	0.0	O K
15 min Winter	23.895	0.495	0.0	30.4	30.4	4.5	Flood Risk
30 min Winter	23.790	0.390	0.0	26.3	26.3	2.3	Flood Risk
60 min Winter	23.640	0.240	0.0	19.1	19.1	0.7	O K
120 min Winter	23.564	0.164	0.0	11.9	11.9	0.3	O K
180 min Winter	23.537	0.137	0.0	8.9	8.9	0.2	O K
240 min Winter	23.521	0.121	0.0	7.2	7.2	0.1	O K
360 min Winter	23.499	0.099	0.0	5.4	5.4	0.1	O K
480 min Winter	23.486	0.086	0.0	4.4	4.4	0.1	O K
600 min Winter	23.480	0.080	0.0	3.7	3.7	0.0	O K
720 min Winter	23.475	0.075	0.0	3.2	3.2	0.0	O K
960 min Winter	23.469	0.069	0.0	2.6	2.6	0.0	O K
1440 min Winter	23.457	0.057	0.0	1.9	1.9	0.0	O K
2160 min Winter	23.449	0.049	0.0	1.4	1.4	0.0	O K
2880 min Winter	23.444	0.044	0.0	1.1	1.1	0.0	O K
4320 min Winter	23.437	0.037	0.0	0.8	0.8	0.0	O K
5760 min Winter	23.434	0.034	0.0	0.7	0.7	0.0	O K
7200 min Winter	23.431	0.031	0.0	0.6	0.6	0.0	O K
8640 min Winter	23.429	0.029	0.0	0.5	0.5	0.0	O K
10080 min Winter	23.427	0.027	0.0	0.4	0.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.365	0.0	80.9	4312
10080 min Summer	1.205	0.0	83.4	5136
15 min Winter	171.205	0.0	19.8	12
30 min Winter	102.749	0.0	23.7	19
60 min Winter	61.665	0.0	28.5	34
120 min Winter	37.008	0.0	34.2	64
180 min Winter	27.453	0.0	38.0	94
240 min Winter	22.210	0.0	41.0	124
360 min Winter	16.476	0.0	45.7	180
480 min Winter	13.330	0.0	49.3	248
600 min Winter	11.309	0.0	52.2	298
720 min Winter	9.888	0.0	54.8	356
960 min Winter	7.881	0.0	58.3	476
1440 min Winter	5.724	0.0	63.5	748
2160 min Winter	4.158	0.0	69.2	1092
2880 min Winter	3.314	0.0	73.5	1456
4320 min Winter	2.388	0.0	79.4	2140
5760 min Winter	1.893	0.0	84.0	2840
7200 min Winter	1.581	0.0	87.6	3800
8640 min Winter	1.365	0.0	90.6	4392
10080 min Winter	1.205	0.0	93.5	5064

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Cascade Rainfall Details for 2017-08-30 Swale 4.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 300950 95250 SY 00950 95250
C (1km)	-0.026
D1 (1km)	0.383
D2 (1km)	0.331
D3 (1km)	0.312
E (1km)	0.282
F (1km)	2.488
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.055

Time (mins) From:	To:	Area (ha)
0	4	0.055

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Cascade Model Details for 2017-08-30 Swale 4.srcx

Storage is Online Cover Level (m) 24.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	175.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	20.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	23.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 23.400

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Cascade Summary of Results for 2017-08-30 Basin 4.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 4.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	23.438	0.638	12.2	401.7	O K
30 min Summer	23.535	0.735	12.2	476.5	O K
60 min Summer	23.639	0.839	12.2	560.2	O K
120 min Summer	23.741	0.941	12.2	646.2	Flood Risk
180 min Summer	23.793	0.993	12.2	692.4	Flood Risk
240 min Summer	23.824	1.024	12.2	720.2	Flood Risk
360 min Summer	23.854	1.054	12.2	747.1	Flood Risk
480 min Summer	23.860	1.060	12.2	753.0	Flood Risk
600 min Summer	23.858	1.058	12.2	750.9	Flood Risk
720 min Summer	23.854	1.054	12.2	747.1	Flood Risk
960 min Summer	23.825	1.025	12.2	721.2	Flood Risk
1440 min Summer	23.769	0.969	12.2	670.8	Flood Risk
2160 min Summer	23.684	0.884	12.2	597.5	O K
2880 min Summer	23.592	0.792	12.2	522.0	O K
4320 min Summer	23.392	0.592	12.2	367.9	O K
5760 min Summer	23.235	0.435	12.2	258.2	O K
7200 min Summer	23.120	0.320	12.1	183.6	O K
8640 min Summer	23.043	0.243	11.8	136.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	404.5	19
30 min Summer	102.749	0.0	485.8	34
60 min Summer	61.665	0.0	589.0	64
120 min Summer	37.008	0.0	707.3	122
180 min Summer	27.453	0.0	787.2	182
240 min Summer	22.210	0.0	849.2	242
360 min Summer	16.476	0.0	944.9	360
480 min Summer	13.330	0.0	1019.3	478
600 min Summer	11.309	0.0	1080.9	526
720 min Summer	9.888	0.0	1133.9	592
960 min Summer	7.881	0.0	1204.5	720
1440 min Summer	5.724	0.0	1310.4	984
2160 min Summer	4.158	0.0	1435.0	1408
2880 min Summer	3.314	0.0	1524.8	1816
4320 min Summer	2.388	0.0	1647.0	2548
5760 min Summer	1.893	0.0	1743.8	3232
7200 min Summer	1.581	0.0	1820.0	3888
8640 min Summer	1.365	0.0	1884.3	4576

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Cascade Summary of Results for 2017-08-30 Basin 4.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	22.994	0.194	11.4	107.1	O K
15 min Winter	23.502	0.702	12.2	450.9	O K
30 min Winter	23.610	0.810	12.2	535.9	O K
60 min Winter	23.723	0.923	12.2	630.6	Flood Risk
120 min Winter	23.835	1.035	12.2	729.7	Flood Risk
180 min Winter	23.894	1.094	12.2	784.8	Flood Risk
240 min Winter	23.931	1.131	12.2	819.4	Flood Risk
360 min Winter	23.970	1.170	12.2	856.7	Flood Risk
480 min Winter	23.985	1.185	12.2	870.8	Flood Risk
600 min Winter	23.986	1.186	12.2	872.0	Flood Risk
720 min Winter	23.979	1.179	12.2	865.5	Flood Risk
960 min Winter	23.944	1.144	12.2	831.5	Flood Risk
1440 min Winter	23.871	1.071	12.2	763.0	Flood Risk
2160 min Winter	23.751	0.951	12.2	654.9	Flood Risk
2880 min Winter	23.618	0.818	12.2	542.6	O K
4320 min Winter	23.308	0.508	12.2	308.3	O K
5760 min Winter	23.099	0.299	12.1	170.3	O K
7200 min Winter	22.990	0.190	11.4	104.7	O K
8640 min Winter	22.956	0.156	10.2	85.4	O K
10080 min Winter	22.940	0.140	9.1	76.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.205	0.0	1939.4	5240
15 min Winter	171.205	0.0	453.3	19
30 min Winter	102.749	0.0	544.1	33
60 min Winter	61.665	0.0	659.9	62
120 min Winter	37.008	0.0	792.4	120
180 min Winter	27.453	0.0	881.8	178
240 min Winter	22.210	0.0	951.2	236
360 min Winter	16.476	0.0	1058.4	350
480 min Winter	13.330	0.0	1141.6	462
600 min Winter	11.309	0.0	1210.5	570
720 min Winter	9.888	0.0	1269.7	670
960 min Winter	7.881	0.0	1348.6	758
1440 min Winter	5.724	0.0	1466.4	1068
2160 min Winter	4.158	0.0	1607.3	1532
2880 min Winter	3.314	0.0	1707.9	1984
4320 min Winter	2.388	0.0	1845.2	2676
5760 min Winter	1.893	0.0	1953.2	3280
7200 min Winter	1.581	0.0	2038.5	3824
8640 min Winter	1.365	0.0	2110.7	4416
10080 min Winter	1.205	0.0	2173.0	5144

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Cascade Rainfall Details for 2017-08-30 Basin 4.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 300950 95250 SY 00950 95250
C (1km)	-0.026
D1 (1km)	0.383
D2 (1km)	0.331
D3 (1km)	0.312
E (1km)	0.282
F (1km)	2.488
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.225

Time (mins) From:	To:	Area (ha)
0	4	1.225

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Cascade Model Details for 2017-08-30 Basin 4.srcx

Storage is Online Cover Level (m) 24.000

Tank or Pond Structure

Invert Level (m) 22.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	520.0	1.200	980.4

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0156-1220-1200-1220
Design Head (m)	1.200
Design Flow (l/s)	12.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	156
Invert Level (m)	22.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	12.2
Flush-Flo™	0.364	12.2
Kick-Flo®	0.795	10.0
Mean Flow over Head Range	-	10.5

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	5.6	1.200	12.2	3.000	18.8	7.000	28.2
0.200	11.5	1.400	13.1	3.500	20.2	7.500	29.2
0.300	12.1	1.600	13.9	4.000	21.6	8.000	30.1
0.400	12.2	1.800	14.7	4.500	22.8	8.500	31.0
0.500	12.0	2.000	15.5	5.000	24.0	9.000	31.9
0.600	11.7	2.200	16.2	5.500	25.1	9.500	32.7
0.800	10.1	2.400	16.9	6.000	26.2		
1.000	11.2	2.600	17.6	6.500	27.3		

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Cascade Summary of Results for 2017-08-30 Swale 5.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 5.srcx	(None)

Half Drain Time : 3 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	39.863	0.463	0.0	29.2	29.2	7.4	Flood Risk
30 min Summer	39.818	0.418	0.0	27.5	27.5	5.7	Flood Risk
60 min Summer	39.732	0.332	0.0	23.8	23.8	3.1	Flood Risk
120 min Summer	39.629	0.229	0.0	18.4	18.4	1.2	O K
180 min Summer	39.587	0.187	0.0	14.5	14.5	0.7	O K
240 min Summer	39.564	0.164	0.0	11.9	11.9	0.5	O K
360 min Summer	39.537	0.137	0.0	8.9	8.9	0.3	O K
480 min Summer	39.521	0.121	0.0	7.2	7.2	0.2	O K
600 min Summer	39.508	0.108	0.0	6.1	6.1	0.2	O K
720 min Summer	39.498	0.098	0.0	5.3	5.3	0.1	O K
960 min Summer	39.485	0.085	0.0	4.3	4.3	0.1	O K
1440 min Summer	39.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Summer	39.464	0.064	0.0	2.3	2.3	0.1	O K
2880 min Summer	39.456	0.056	0.0	1.8	1.8	0.0	O K
4320 min Summer	39.448	0.048	0.0	1.3	1.3	0.0	O K
5760 min Summer	39.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Summer	39.439	0.039	0.0	0.9	0.9	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	179.718	0.0	21.9	12
30 min Summer	107.217	0.0	26.1	20
60 min Summer	63.964	0.0	31.2	34
120 min Summer	38.160	0.0	37.2	64
180 min Summer	28.209	0.0	41.3	94
240 min Summer	22.765	0.0	44.4	124
360 min Summer	16.829	0.0	49.2	184
480 min Summer	13.581	0.0	53.0	242
600 min Summer	11.501	0.0	56.1	306
720 min Summer	10.040	0.0	58.7	366
960 min Summer	8.014	0.0	62.5	488
1440 min Summer	5.834	0.0	68.3	722
2160 min Summer	4.247	0.0	74.5	1076
2880 min Summer	3.390	0.0	79.3	1448
4320 min Summer	2.460	0.0	86.3	2140
5760 min Summer	1.959	0.0	91.7	2832
7200 min Summer	1.642	0.0	96.1	3544

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Cascade Summary of Results for 2017-08-30 Swale 5.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	39.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Summer	39.435	0.035	0.0	0.7	0.7	0.0	O K
15 min Winter	39.881	0.481	0.0	29.9	29.9	8.3	Flood Risk
30 min Winter	39.812	0.412	0.0	27.3	27.3	5.4	Flood Risk
60 min Winter	39.690	0.290	0.0	21.8	21.8	2.1	O K
120 min Winter	39.587	0.187	0.0	14.4	14.4	0.7	O K
180 min Winter	39.554	0.154	0.0	10.8	10.8	0.4	O K
240 min Winter	39.535	0.135	0.0	8.7	8.7	0.3	O K
360 min Winter	39.512	0.112	0.0	6.5	6.5	0.2	O K
480 min Winter	39.496	0.096	0.0	5.2	5.2	0.1	O K
600 min Winter	39.487	0.087	0.0	4.4	4.4	0.1	O K
720 min Winter	39.481	0.081	0.0	3.9	3.9	0.1	O K
960 min Winter	39.474	0.074	0.0	3.1	3.1	0.1	O K
1440 min Winter	39.463	0.063	0.0	2.3	2.3	0.1	O K
2160 min Winter	39.453	0.053	0.0	1.6	1.6	0.0	O K
2880 min Winter	39.448	0.048	0.0	1.3	1.3	0.0	O K
4320 min Winter	39.440	0.040	0.0	1.0	1.0	0.0	O K
5760 min Winter	39.436	0.036	0.0	0.8	0.8	0.0	O K
7200 min Winter	39.433	0.033	0.0	0.7	0.7	0.0	O K
8640 min Winter	39.431	0.031	0.0	0.6	0.6	0.0	O K
10080 min Winter	39.429	0.029	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.421	0.0	99.8	4272
10080 min Summer	1.258	0.0	103.1	5192
15 min Winter	179.718	0.0	24.6	12
30 min Winter	107.217	0.0	29.3	20
60 min Winter	63.964	0.0	34.9	36
120 min Winter	38.160	0.0	41.7	64
180 min Winter	28.209	0.0	46.2	92
240 min Winter	22.765	0.0	49.7	124
360 min Winter	16.829	0.0	55.1	182
480 min Winter	13.581	0.0	59.3	244
600 min Winter	11.501	0.0	62.8	304
720 min Winter	10.040	0.0	65.8	368
960 min Winter	8.014	0.0	70.0	492
1440 min Winter	5.834	0.0	76.4	710
2160 min Winter	4.247	0.0	83.5	1064
2880 min Winter	3.390	0.0	88.8	1460
4320 min Winter	2.460	0.0	96.7	2172
5760 min Winter	1.959	0.0	102.7	2840
7200 min Winter	1.642	0.0	107.6	3504
8640 min Winter	1.421	0.0	111.7	4080
10080 min Winter	1.258	0.0	115.4	5200

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Cascade Rainfall Details for 2017-08-30 Swale 5.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302650 95050 SY 02650 95050
C (1km)	-0.027
D1 (1km)	0.379
D2 (1km)	0.341
D3 (1km)	0.333
E (1km)	0.288
F (1km)	2.497
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.065

Time (mins) From:	To:	Area (ha)
0	4	0.065

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Cascade Model Details for 2017-08-30 Swale 5.srcx

Storage is Online Cover Level (m) 40.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1561.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	40.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	39.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 39.400

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Cascade Summary of Results for 2017-08-30 Basin 5.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 5.srcx	2017-08-30 Basin 7.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	39.219	0.719	108.8	3860.0	O K
30 min Summer	39.339	0.839	108.8	4559.9	O K
60 min Summer	39.471	0.971	108.8	5342.3	O K
120 min Summer	39.608	1.108	108.8	6178.3	O K
180 min Summer	39.685	1.185	108.8	6659.5	O K
240 min Summer	39.734	1.234	108.8	6964.1	Flood Risk
360 min Summer	39.786	1.286	108.8	7295.3	Flood Risk
480 min Summer	39.806	1.306	108.8	7424.5	Flood Risk
600 min Summer	39.811	1.311	108.8	7456.1	Flood Risk
720 min Summer	39.813	1.313	108.8	7466.8	Flood Risk
960 min Summer	39.792	1.292	108.8	7336.1	Flood Risk
1440 min Summer	39.740	1.240	108.8	7000.1	Flood Risk
2160 min Summer	39.642	1.142	108.8	6386.3	O K
2880 min Summer	39.531	1.031	108.8	5708.0	O K
4320 min Summer	39.329	0.829	108.8	4498.7	O K
5760 min Summer	39.165	0.665	108.8	3550.9	O K
7200 min Summer	39.042	0.542	108.4	2862.0	O K
8640 min Summer	38.955	0.455	106.7	2381.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	179.718	0.0	3628.2	19
30 min Summer	107.217	0.0	4353.5	34
60 min Summer	63.964	0.0	5444.8	64
120 min Summer	38.160	0.0	6512.0	122
180 min Summer	28.209	0.0	7227.0	182
240 min Summer	22.765	0.0	7779.7	242
360 min Summer	16.829	0.0	8627.7	360
480 min Summer	13.581	0.0	9281.2	480
600 min Summer	11.501	0.0	9818.6	548
720 min Summer	10.040	0.0	10277.4	604
960 min Summer	8.014	0.0	10915.8	724
1440 min Summer	5.834	0.0	11838.4	996
2160 min Summer	4.247	0.0	13273.1	1408
2880 min Summer	3.390	0.0	14121.3	1792
4320 min Summer	2.460	0.0	15307.8	2552
5760 min Summer	1.959	0.0	16402.9	3240
7200 min Summer	1.642	0.0	17172.0	3960
8640 min Summer	1.421	0.0	17812.4	4584

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Cascade Summary of Results for 2017-08-30 Basin 5.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	38.897	0.397	104.6	2064.1	O K
15 min Winter	39.300	0.800	108.8	4328.2	O K
30 min Winter	39.434	0.934	108.8	5121.0	O K
60 min Winter	39.581	1.081	108.8	6010.1	O K
120 min Winter	39.735	1.235	108.8	6968.3	Flood Risk
180 min Winter	39.820	1.320	108.8	7513.6	Flood Risk
240 min Winter	39.875	1.375	108.8	7867.7	Flood Risk
360 min Winter	39.938	1.438	108.8	8278.1	Flood Risk
480 min Winter	39.967	1.467	108.8	8468.2	Flood Risk
600 min Winter	39.977	1.477	108.8	8534.7	Flood Risk
720 min Winter	39.976	1.476	108.8	8524.0	Flood Risk
960 min Winter	39.944	1.444	108.8	8316.3	Flood Risk
1440 min Winter	39.872	1.372	108.8	7848.5	Flood Risk
2160 min Winter	39.735	1.235	108.8	6973.7	Flood Risk
2880 min Winter	39.570	1.070	108.8	5947.3	O K
4320 min Winter	39.258	0.758	108.8	4085.1	O K
5760 min Winter	39.033	0.533	108.3	2810.7	O K
7200 min Winter	38.900	0.400	104.8	2081.3	O K
8640 min Winter	38.852	0.352	94.7	1820.2	O K
10080 min Winter	38.822	0.322	84.6	1662.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.258	0.0	18332.3	5248
15 min Winter	179.718	0.0	4080.8	19
30 min Winter	107.217	0.0	4887.1	33
60 min Winter	63.964	0.0	6109.1	62
120 min Winter	38.160	0.0	7302.3	120
180 min Winter	28.209	0.0	8102.3	180
240 min Winter	22.765	0.0	8720.3	238
360 min Winter	16.829	0.0	9668.0	352
480 min Winter	13.581	0.0	10397.4	464
600 min Winter	11.501	0.0	10996.3	572
720 min Winter	10.040	0.0	11506.5	674
960 min Winter	8.014	0.0	12213.3	762
1440 min Winter	5.834	0.0	13215.2	1068
2160 min Winter	4.247	0.0	14872.2	1536
2880 min Winter	3.390	0.0	15823.3	1960
4320 min Winter	2.460	0.0	17169.4	2680
5760 min Winter	1.959	0.0	18378.5	3344
7200 min Winter	1.642	0.0	19242.4	3896
8640 min Winter	1.421	0.0	19964.7	4576
10080 min Winter	1.258	0.0	20560.9	5248

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Cascade Rainfall Details for 2017-08-30 Basin 5.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302650 95050 SY 02650 95050
C (1km)	-0.027
D1 (1km)	0.379
D2 (1km)	0.341
D3 (1km)	0.333
E (1km)	0.288
F (1km)	2.497
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 11.605

Time (mins) From:	To:	Area (ha)
0	4	11.605

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Cascade Model Details for 2017-08-30 Basin 5.srcx

Storage is Online Cover Level (m) 40.000

Tank or Pond Structure

Invert Level (m) 38.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5000.0	1.500	6617.1

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0403-1093-1500-1093
Design Head (m)	1.500
Design Flow (l/s)	109.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	403
Invert Level (m)	38.500
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	109.2
Flush-Flo™	0.625	108.8
Kick-Flo®	1.143	95.7
Mean Flow over Head Range	-	88.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	11.1	1.200	98.0	3.000	153.1	7.000	231.8
0.200	39.6	1.400	105.6	3.500	165.1	7.500	239.7
0.300	76.5	1.600	112.7	4.000	176.2	8.000	247.5
0.400	104.8	1.800	119.4	4.500	186.7	8.500	254.9
0.500	107.7	2.000	125.6	5.000	196.5	9.000	262.2
0.600	108.8	2.200	131.6	5.500	205.9	9.500	269.3
0.800	107.4	2.400	137.3	6.000	214.9		
1.000	102.9	2.600	142.8	6.500	223.5		

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Cascade Summary of Results for 2017-08-30 Swale 6.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 6.srcx	(None)

Half Drain Time : 7 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	37.873	0.473	0.0	29.6	29.6	13.8	Flood Risk
30 min Summer	37.844	0.444	0.0	28.5	28.5	11.6	Flood Risk
60 min Summer	37.786	0.386	0.0	26.2	26.2	8.0	Flood Risk
120 min Summer	37.695	0.295	0.0	22.0	22.0	3.9	O K
180 min Summer	37.633	0.233	0.0	18.7	18.7	2.1	O K
240 min Summer	37.601	0.201	0.0	16.1	16.1	1.5	O K
360 min Summer	37.567	0.167	0.0	12.2	12.2	0.9	O K
480 min Summer	37.546	0.146	0.0	9.9	9.9	0.7	O K
600 min Summer	37.533	0.133	0.0	8.5	8.5	0.5	O K
720 min Summer	37.523	0.123	0.0	7.4	7.4	0.4	O K
960 min Summer	37.505	0.105	0.0	5.9	5.9	0.3	O K
1440 min Summer	37.485	0.085	0.0	4.3	4.3	0.2	O K
2160 min Summer	37.474	0.074	0.0	3.1	3.1	0.1	O K
2880 min Summer	37.467	0.067	0.0	2.5	2.5	0.1	O K
4320 min Summer	37.456	0.056	0.0	1.8	1.8	0.1	O K
5760 min Summer	37.450	0.050	0.0	1.4	1.4	0.1	O K
7200 min Summer	37.446	0.046	0.0	1.2	1.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	30.1	13
30 min Summer	106.565	0.0	36.0	21
60 min Summer	63.619	0.0	43.0	36
120 min Summer	37.980	0.0	51.3	66
180 min Summer	28.087	0.0	56.9	94
240 min Summer	22.674	0.0	61.2	124
360 min Summer	16.768	0.0	67.9	184
480 min Summer	13.536	0.0	73.1	244
600 min Summer	11.465	0.0	77.4	304
720 min Summer	10.011	0.0	81.1	362
960 min Summer	7.973	0.0	86.1	484
1440 min Summer	5.785	0.0	93.7	712
2160 min Summer	4.197	0.0	102.0	1080
2880 min Summer	3.343	0.0	108.3	1428
4320 min Summer	2.411	0.0	117.2	2124
5760 min Summer	1.912	0.0	123.9	2872
7200 min Summer	1.597	0.0	129.4	3592

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Cascade Summary of Results for 2017-08-30 Swale 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	37.442	0.042	0.0	1.0	1.0	0.0	O K
10080 min Summer	37.440	0.040	0.0	0.9	0.9	0.0	O K
15 min Winter	37.897	0.497	0.0	30.5	30.5	15.8	Flood Risk
30 min Winter	37.854	0.454	0.0	28.9	28.9	12.3	Flood Risk
60 min Winter	37.766	0.366	0.0	25.3	25.3	6.9	Flood Risk
120 min Winter	37.640	0.240	0.0	19.1	19.1	2.3	O K
180 min Winter	37.590	0.190	0.0	14.8	14.8	1.3	O K
240 min Winter	37.565	0.165	0.0	12.0	12.0	0.9	O K
360 min Winter	37.537	0.137	0.0	8.9	8.9	0.6	O K
480 min Winter	37.521	0.121	0.0	7.2	7.2	0.4	O K
600 min Winter	37.508	0.108	0.0	6.1	6.1	0.3	O K
720 min Winter	37.498	0.098	0.0	5.3	5.3	0.3	O K
960 min Winter	37.485	0.085	0.0	4.3	4.3	0.2	O K
1440 min Winter	37.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Winter	37.463	0.063	0.0	2.3	2.3	0.1	O K
2880 min Winter	37.456	0.056	0.0	1.8	1.8	0.1	O K
4320 min Winter	37.448	0.048	0.0	1.3	1.3	0.1	O K
5760 min Winter	37.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Winter	37.438	0.038	0.0	0.9	0.9	0.0	O K
8640 min Winter	37.436	0.036	0.0	0.8	0.8	0.0	O K
10080 min Winter	37.434	0.034	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	134.0	4400
10080 min Summer	1.218	0.0	138.1	4976
15 min Winter	178.502	0.0	33.7	13
30 min Winter	106.565	0.0	40.3	22
60 min Winter	63.619	0.0	48.1	38
120 min Winter	37.980	0.0	57.4	66
180 min Winter	28.087	0.0	63.7	94
240 min Winter	22.674	0.0	68.6	124
360 min Winter	16.768	0.0	76.1	184
480 min Winter	13.536	0.0	81.9	246
600 min Winter	11.465	0.0	86.7	306
720 min Winter	10.011	0.0	90.8	366
960 min Winter	7.973	0.0	96.4	478
1440 min Winter	5.785	0.0	105.0	730
2160 min Winter	4.197	0.0	114.2	1076
2880 min Winter	3.343	0.0	121.3	1452
4320 min Winter	2.411	0.0	131.2	2144
5760 min Winter	1.912	0.0	138.7	2912
7200 min Winter	1.597	0.0	144.9	3544
8640 min Winter	1.379	0.0	150.1	4160
10080 min Winter	1.218	0.0	154.6	4952

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Cascade Rainfall Details for 2017-08-30 Swale 6.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302350 96250 SY 02350 96250
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.090

Time (mins) From:	To:	Area (ha)
0	4	0.090

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Cascade Model Details for 2017-08-30 Swale 6.srcx

Storage is Online Cover Level (m) 38.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1030.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	70.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	37.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 37.400

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Cascade Summary of Results for 2017-08-30 Basin 6.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 6.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	37.359	0.559	72.0	2610.4	O K
30 min Summer	37.456	0.656	72.0	3094.4	O K
60 min Summer	37.562	0.762	72.0	3630.9	O K
120 min Summer	37.672	0.872	72.0	4206.1	O K
180 min Summer	37.735	0.935	72.0	4541.3	Flood Risk
240 min Summer	37.776	0.976	72.0	4760.4	Flood Risk
360 min Summer	37.822	1.022	72.0	5006.1	Flood Risk
480 min Summer	37.842	1.042	72.0	5112.1	Flood Risk
600 min Summer	37.848	1.048	72.0	5144.5	Flood Risk
720 min Summer	37.850	1.050	72.0	5159.7	Flood Risk
960 min Summer	37.834	1.034	72.0	5069.9	Flood Risk
1440 min Summer	37.792	0.992	72.0	4843.3	Flood Risk
2160 min Summer	37.713	0.913	72.0	4421.3	Flood Risk
2880 min Summer	37.627	0.827	72.0	3971.4	O K
4320 min Summer	37.466	0.666	72.0	3146.2	O K
5760 min Summer	37.337	0.537	72.0	2503.4	O K
7200 min Summer	37.242	0.442	71.6	2038.1	O K
8640 min Summer	37.174	0.374	70.5	1713.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	2415.3	19
30 min Summer	106.565	0.0	2904.5	34
60 min Summer	63.619	0.0	3670.0	64
120 min Summer	37.980	0.0	4394.9	122
180 min Summer	28.087	0.0	4880.4	182
240 min Summer	22.674	0.0	5255.4	242
360 min Summer	16.768	0.0	5830.5	362
480 min Summer	13.536	0.0	6273.1	480
600 min Summer	11.465	0.0	6636.5	560
720 min Summer	10.011	0.0	6946.2	614
960 min Summer	7.973	0.0	7356.2	740
1440 min Summer	5.785	0.0	7938.7	998
2160 min Summer	4.197	0.0	8929.9	1408
2880 min Summer	3.343	0.0	9477.4	1812
4320 min Summer	2.411	0.0	10203.6	2552
5760 min Summer	1.912	0.0	10908.9	3280
7200 min Summer	1.597	0.0	11380.1	3960
8640 min Summer	1.379	0.0	11768.4	4584

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Cascade Summary of Results for 2017-08-30 Basin 6.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	37.130	0.330	69.2	1503.4	O K
15 min Winter	37.423	0.623	72.0	2926.1	O K
30 min Winter	37.531	0.731	72.0	3472.7	O K
60 min Winter	37.649	0.849	72.0	4083.4	O K
120 min Winter	37.773	0.973	72.0	4744.5	Flood Risk
180 min Winter	37.844	1.044	72.0	5126.3	Flood Risk
240 min Winter	37.890	1.090	72.0	5376.9	Flood Risk
360 min Winter	37.944	1.144	72.0	5674.2	Flood Risk
480 min Winter	37.970	1.170	72.0	5820.5	Flood Risk
600 min Winter	37.981	1.181	72.0	5881.3	Flood Risk
720 min Winter	37.982	1.182	72.0	5888.1	Flood Risk
960 min Winter	37.956	1.156	72.0	5740.3	Flood Risk
1440 min Winter	37.899	1.099	72.0	5428.3	Flood Risk
2160 min Winter	37.792	0.992	72.0	4841.5	Flood Risk
2880 min Winter	37.662	0.862	72.0	4150.8	O K
4320 min Winter	37.416	0.616	72.0	2891.6	O K
5760 min Winter	37.240	0.440	71.6	2027.5	O K
7200 min Winter	37.136	0.336	69.4	1531.4	O K
8640 min Winter	37.097	0.297	62.2	1349.8	O K
10080 min Winter	37.072	0.272	55.6	1231.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	12075.9	5248
15 min Winter	178.502	0.0	2719.5	19
30 min Winter	106.565	0.0	3262.7	33
60 min Winter	63.619	0.0	4119.5	62
120 min Winter	37.980	0.0	4929.6	120
180 min Winter	28.087	0.0	5472.4	180
240 min Winter	22.674	0.0	5891.6	238
360 min Winter	16.768	0.0	6533.8	352
480 min Winter	13.536	0.0	7027.4	464
600 min Winter	11.465	0.0	7431.7	572
720 min Winter	10.011	0.0	7775.3	678
960 min Winter	7.973	0.0	8227.5	770
1440 min Winter	5.785	0.0	8852.7	1080
2160 min Winter	4.197	0.0	10006.5	1536
2880 min Winter	3.343	0.0	10620.8	1960
4320 min Winter	2.411	0.0	11447.5	2684
5760 min Winter	1.912	0.0	12224.0	3344
7200 min Winter	1.597	0.0	12753.7	3896
8640 min Winter	1.379	0.0	13192.5	4576
10080 min Winter	1.218	0.0	13547.4	5248

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Cascade Rainfall Details for 2017-08-30 Basin 6.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302350 96250 SY 02350 96250
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.870

Time (mins) From:	To:	Area (ha)
0	4	7.870

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Cascade Model Details for 2017-08-30 Basin 6.srcx

Storage is Online Cover Level (m) 38.000

Tank or Pond Structure

Invert Level (m) 36.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	4400.0	1.200	5601.1

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0341-7220-1200-7220
Design Head (m)	1.200
Design Flow (l/s)	72.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	341
Invert Level (m)	36.800
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	72.1
Flush-Flo™	0.522	72.0
Kick-Flo®	0.932	63.8
Mean Flow over Head Range	-	58.2

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	10.0	1.200	72.1	3.000	112.5	7.000	170.2
0.200	34.6	1.400	77.7	3.500	121.3	7.500	176.0
0.300	62.9	1.600	82.9	4.000	129.4	8.000	181.7
0.400	71.0	1.800	87.8	4.500	137.1	8.500	187.2
0.500	72.0	2.000	92.4	5.000	144.4	9.000	192.5
0.600	71.7	2.200	96.7	5.500	151.2	9.500	197.7
0.800	68.7	2.400	100.9	6.000	157.8		
1.000	66.0	2.600	104.9	6.500	164.1		

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Cascade Summary of Results for 2017-08-30 Swale 7.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 7.srcx	(None)

Half Drain Time : 5 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	29.865	0.465	0.0	29.3	29.3	11.3	Flood Risk
30 min Summer	29.833	0.433	0.0	28.1	28.1	9.3	Flood Risk
60 min Summer	29.767	0.367	0.0	25.4	25.4	6.0	Flood Risk
120 min Summer	29.670	0.270	0.0	20.7	20.7	2.7	O K
180 min Summer	29.614	0.214	0.0	17.5	17.5	1.5	O K
240 min Summer	29.587	0.187	0.0	14.5	14.5	1.1	O K
360 min Summer	29.555	0.155	0.0	10.9	10.9	0.7	O K
480 min Summer	29.537	0.137	0.0	8.9	8.9	0.5	O K
600 min Summer	29.524	0.124	0.0	7.5	7.5	0.4	O K
720 min Summer	29.514	0.114	0.0	6.6	6.6	0.3	O K
960 min Summer	29.497	0.097	0.0	5.2	5.2	0.2	O K
1440 min Summer	29.481	0.081	0.0	3.9	3.9	0.1	O K
2160 min Summer	29.471	0.071	0.0	2.8	2.8	0.1	O K
2880 min Summer	29.463	0.063	0.0	2.3	2.3	0.1	O K
4320 min Summer	29.453	0.053	0.0	1.6	1.6	0.1	O K
5760 min Summer	29.448	0.048	0.0	1.3	1.3	0.0	O K
7200 min Summer	29.443	0.043	0.0	1.1	1.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	179.718	0.0	27.0	12
30 min Summer	107.217	0.0	32.2	20
60 min Summer	63.964	0.0	38.4	36
120 min Summer	38.160	0.0	45.8	66
180 min Summer	28.209	0.0	50.8	94
240 min Summer	22.765	0.0	54.6	124
360 min Summer	16.829	0.0	60.6	184
480 min Summer	13.581	0.0	65.2	244
600 min Summer	11.501	0.0	69.0	306
720 min Summer	10.040	0.0	72.3	362
960 min Summer	8.014	0.0	76.9	482
1440 min Summer	5.834	0.0	84.0	718
2160 min Summer	4.247	0.0	91.7	1084
2880 min Summer	3.390	0.0	97.6	1432
4320 min Summer	2.460	0.0	106.3	2180
5760 min Summer	1.959	0.0	112.8	2872
7200 min Summer	1.642	0.0	118.2	3576

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Cascade Summary of Results for 2017-08-30 Swale 7.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	29.440	0.040	0.0	1.0	1.0	0.0	O K
10080 min Summer	29.438	0.038	0.0	0.8	0.8	0.0	O K
15 min Winter	29.888	0.488	0.0	30.2	30.2	12.9	Flood Risk
30 min Winter	29.838	0.438	0.0	28.3	28.3	9.6	Flood Risk
60 min Winter	29.739	0.339	0.0	24.1	24.1	4.8	Flood Risk
120 min Winter	29.615	0.215	0.0	17.6	17.6	1.5	O K
180 min Winter	29.576	0.176	0.0	13.2	13.2	0.9	O K
240 min Winter	29.554	0.154	0.0	10.7	10.7	0.6	O K
360 min Winter	29.528	0.128	0.0	8.0	8.0	0.4	O K
480 min Winter	29.512	0.112	0.0	6.4	6.4	0.3	O K
600 min Winter	29.499	0.099	0.0	5.4	5.4	0.2	O K
720 min Winter	29.491	0.091	0.0	4.8	4.8	0.2	O K
960 min Winter	29.481	0.081	0.0	3.8	3.8	0.1	O K
1440 min Winter	29.471	0.071	0.0	2.8	2.8	0.1	O K
2160 min Winter	29.460	0.060	0.0	2.0	2.0	0.1	O K
2880 min Winter	29.453	0.053	0.0	1.6	1.6	0.1	O K
4320 min Winter	29.445	0.045	0.0	1.2	1.2	0.0	O K
5760 min Winter	29.440	0.040	0.0	0.9	0.9	0.0	O K
7200 min Winter	29.437	0.037	0.0	0.8	0.8	0.0	O K
8640 min Winter	29.434	0.034	0.0	0.7	0.7	0.0	O K
10080 min Winter	29.432	0.032	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.421	0.0	122.8	4280
10080 min Summer	1.258	0.0	126.8	5080
15 min Winter	179.718	0.0	30.2	13
30 min Winter	107.217	0.0	36.0	21
60 min Winter	63.964	0.0	43.0	36
120 min Winter	38.160	0.0	51.3	64
180 min Winter	28.209	0.0	56.9	94
240 min Winter	22.765	0.0	61.2	124
360 min Winter	16.829	0.0	67.9	182
480 min Winter	13.581	0.0	73.0	244
600 min Winter	11.501	0.0	77.3	306
720 min Winter	10.040	0.0	81.0	362
960 min Winter	8.014	0.0	86.2	484
1440 min Winter	5.834	0.0	94.1	722
2160 min Winter	4.247	0.0	102.7	1120
2880 min Winter	3.390	0.0	109.3	1480
4320 min Winter	2.460	0.0	119.0	2196
5760 min Winter	1.959	0.0	126.4	2816
7200 min Winter	1.642	0.0	132.4	3664
8640 min Winter	1.421	0.0	137.5	4504
10080 min Winter	1.258	0.0	142.0	5120

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Cascade Rainfall Details for 2017-08-30 Swale 7.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302650 95050 SY 02650 95050
C (1km)	-0.027
D1 (1km)	0.379
D2 (1km)	0.341
D3 (1km)	0.333
E (1km)	0.288
F (1km)	2.497
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.080

Time (mins) From:	To:	Area (ha)
0	4	0.080

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Cascade Model Details for 2017-08-30 Swale 7.srcx

Storage is Online Cover Level (m) 30.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1220.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	60.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	29.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 29.400

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Cascade Summary of Results for 2017-08-30 Basin 7.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 7.srcx 2017-08-30 Basin 5.srcx 2017-08-30 Swale 5.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	29.326	0.526	190.0	3149.2	O K
30 min Summer	29.418	0.618	193.5	3729.7	O K
60 min Summer	29.519	0.719	194.6	4382.6	O K
120 min Summer	29.627	0.827	194.6	5089.1	O K
180 min Summer	29.688	0.888	194.6	5498.0	O K
240 min Summer	29.730	0.930	194.6	5780.5	Flood Risk
360 min Summer	29.784	0.984	194.6	6145.3	Flood Risk
480 min Summer	29.815	1.015	194.6	6353.1	Flood Risk
600 min Summer	29.832	1.032	194.6	6470.1	Flood Risk
720 min Summer	29.844	1.044	194.6	6551.4	Flood Risk
960 min Summer	29.841	1.041	194.6	6533.3	Flood Risk
1440 min Summer	29.815	1.015	194.6	6357.2	Flood Risk
2160 min Summer	29.755	0.955	194.6	5947.2	Flood Risk
2880 min Summer	29.693	0.893	194.6	5529.0	O K
4320 min Summer	29.568	0.768	194.6	4702.1	O K
5760 min Summer	29.463	0.663	194.3	4020.8	O K
7200 min Summer	29.380	0.580	192.4	3488.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	179.718	0.0	6271.5	19
30 min Summer	107.217	0.0	7552.1	34
60 min Summer	63.964	0.0	9707.3	64
120 min Summer	38.160	0.0	11625.6	122
180 min Summer	28.209	0.0	12908.3	182
240 min Summer	22.765	0.0	13898.6	242
360 min Summer	16.829	0.0	15415.0	360
480 min Summer	13.581	0.0	16579.8	480
600 min Summer	11.501	0.0	17534.1	560
720 min Summer	10.040	0.0	18345.1	616
960 min Summer	8.014	0.0	19461.8	738
1440 min Summer	5.834	0.0	21031.0	982
2160 min Summer	4.247	0.0	23927.0	1380
2880 min Summer	3.390	0.0	25449.9	1784
4320 min Summer	2.460	0.0	27530.1	2552
5760 min Summer	1.959	0.0	29644.5	3288
7200 min Summer	1.642	0.0	31021.5	3968

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Cascade Summary of Results for 2017-08-30 Basin 7.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Summer	29.315	0.515	189.4	3080.9	O K
10080 min Summer	29.271	0.471	186.5	2804.3	O K
15 min Winter	29.386	0.586	192.6	3526.0	O K
30 min Winter	29.488	0.688	194.5	4183.5	O K
60 min Winter	29.602	0.802	194.6	4922.0	O K
120 min Winter	29.723	0.923	194.6	5727.3	Flood Risk
180 min Winter	29.796	0.996	194.6	6221.7	Flood Risk
240 min Winter	29.847	1.047	194.6	6573.9	Flood Risk
360 min Winter	29.911	1.111	194.6	7018.7	Flood Risk
480 min Winter	29.946	1.146	194.6	7260.2	Flood Risk
600 min Winter	29.964	1.164	194.6	7387.1	Flood Risk
720 min Winter	29.972	1.172	194.6	7440.0	Flood Risk
960 min Winter	29.959	1.159	194.6	7348.0	Flood Risk
1440 min Winter	29.922	1.122	194.6	7090.8	Flood Risk
2160 min Winter	29.827	1.027	194.6	6435.6	Flood Risk
2880 min Winter	29.724	0.924	194.6	5740.2	Flood Risk
4320 min Winter	29.536	0.736	194.6	4491.8	O K
5760 min Winter	29.385	0.585	192.6	3521.2	O K
7200 min Winter	29.282	0.482	187.3	2873.3	O K
8640 min Winter	29.233	0.433	169.4	2572.9	O K
10080 min Winter	29.200	0.400	152.1	2365.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.421	0.0	32153.6	4664
10080 min Summer	1.258	0.0	33035.1	5256
15 min Winter	179.718	0.0	7072.5	19
30 min Winter	107.217	0.0	8491.2	33
60 min Winter	63.964	0.0	10902.6	62
120 min Winter	38.160	0.0	13045.6	120
180 min Winter	28.209	0.0	14479.7	180
240 min Winter	22.765	0.0	15586.2	238
360 min Winter	16.829	0.0	17278.5	352
480 min Winter	13.581	0.0	18576.0	464
600 min Winter	11.501	0.0	19636.7	574
720 min Winter	10.040	0.0	20535.2	678
960 min Winter	8.014	0.0	21763.5	772
1440 min Winter	5.834	0.0	23436.9	1070
2160 min Winter	4.247	0.0	26815.9	1516
2880 min Winter	3.390	0.0	28524.6	1928
4320 min Winter	2.460	0.0	30901.0	2684
5760 min Winter	1.959	0.0	33221.9	3400
7200 min Winter	1.642	0.0	34771.0	3968
8640 min Winter	1.421	0.0	36052.7	4600
10080 min Winter	1.258	0.0	37076.8	5344

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Cascade Rainfall Details for 2017-08-30 Basin 7.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302650 95050 SY 02650 95050
C (1km)	-0.027
D1 (1km)	0.379
D2 (1km)	0.341
D3 (1km)	0.333
E (1km)	0.288
F (1km)	2.497
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 9.380

Time (mins) From:	To:	Area (ha)
0	4	9.380

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Cascade Model Details for 2017-08-30 Basin 7.srcx

Storage is Online Cover Level (m) 30.000

Tank or Pond Structure

Invert Level (m) 28.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	5700.0	1.200	7057.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0519-1947-1200-1947
Design Head (m)	1.200
Design Flow (l/s)	194.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	519
Invert Level (m)	28.800
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	194.6
Flush-Flo™	0.708	194.6
Kick-Flo®	1.045	181.8
Mean Flow over Head Range	-	145.0

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	12.9	1.200	194.6	3.000	304.7	7.000	462.1
0.200	47.5	1.400	209.8	3.500	328.6	7.500	478.1
0.300	97.0	1.600	223.9	4.000	350.9	8.000	493.6
0.400	152.2	1.800	237.2	4.500	371.8	8.500	508.5
0.500	188.5	2.000	249.8	5.000	391.6	9.000	523.1
0.600	193.1	2.200	261.7	5.500	410.4	9.500	537.2
0.800	193.6	2.400	273.1	6.000	428.4		
1.000	185.1	2.600	284.0	6.500	445.6		

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Cascade Summary of Results for 2017-08-30 Swale 9.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 9.srcx	(None)

Half Drain Time : 5 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	27.864	0.464	0.0	29.3	29.3	11.2	Flood Risk
30 min Summer	27.831	0.431	0.0	28.0	28.0	9.2	Flood Risk
60 min Summer	27.766	0.366	0.0	25.3	25.3	5.9	Flood Risk
120 min Summer	27.668	0.268	0.0	20.6	20.6	2.6	O K
180 min Summer	27.613	0.213	0.0	17.4	17.4	1.5	O K
240 min Summer	27.587	0.187	0.0	14.4	14.4	1.0	O K
360 min Summer	27.555	0.155	0.0	10.9	10.9	0.7	O K
480 min Summer	27.536	0.136	0.0	8.8	8.8	0.5	O K
600 min Summer	27.524	0.124	0.0	7.5	7.5	0.4	O K
720 min Summer	27.513	0.113	0.0	6.5	6.5	0.3	O K
960 min Summer	27.496	0.096	0.0	5.2	5.2	0.2	O K
1440 min Summer	27.481	0.081	0.0	3.8	3.8	0.1	O K
2160 min Summer	27.471	0.071	0.0	2.8	2.8	0.1	O K
2880 min Summer	27.463	0.063	0.0	2.2	2.2	0.1	O K
4320 min Summer	27.452	0.052	0.0	1.6	1.6	0.1	O K
5760 min Summer	27.447	0.047	0.0	1.3	1.3	0.0	O K
7200 min Summer	27.443	0.043	0.0	1.1	1.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	26.8	12
30 min Summer	106.565	0.0	32.0	20
60 min Summer	63.619	0.0	38.2	36
120 min Summer	37.980	0.0	45.6	66
180 min Summer	28.087	0.0	50.6	94
240 min Summer	22.674	0.0	54.4	124
360 min Summer	16.768	0.0	60.4	184
480 min Summer	13.536	0.0	65.0	244
600 min Summer	11.465	0.0	68.8	300
720 min Summer	10.011	0.0	72.1	366
960 min Summer	7.973	0.0	76.5	488
1440 min Summer	5.785	0.0	83.3	712
2160 min Summer	4.197	0.0	90.7	1100
2880 min Summer	3.343	0.0	96.3	1456
4320 min Summer	2.411	0.0	104.1	2124
5760 min Summer	1.912	0.0	110.1	2936
7200 min Summer	1.597	0.0	115.0	3616

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Cascade Summary of Results for 2017-08-30 Swale 9.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	27.440	0.040	0.0	0.9	0.9	0.0	O K
10080 min Summer	27.437	0.037	0.0	0.8	0.8	0.0	O K
15 min Winter	27.886	0.486	0.0	30.1	30.1	12.8	Flood Risk
30 min Winter	27.836	0.436	0.0	28.2	28.2	9.5	Flood Risk
60 min Winter	27.737	0.337	0.0	24.1	24.1	4.8	Flood Risk
120 min Winter	27.614	0.214	0.0	17.5	17.5	1.5	O K
180 min Winter	27.575	0.175	0.0	13.1	13.1	0.9	O K
240 min Winter	27.553	0.153	0.0	10.7	10.7	0.6	O K
360 min Winter	27.528	0.128	0.0	7.9	7.9	0.4	O K
480 min Winter	27.512	0.112	0.0	6.4	6.4	0.3	O K
600 min Winter	27.499	0.099	0.0	5.4	5.4	0.2	O K
720 min Winter	27.490	0.090	0.0	4.7	4.7	0.2	O K
960 min Winter	27.481	0.081	0.0	3.8	3.8	0.1	O K
1440 min Winter	27.471	0.071	0.0	2.8	2.8	0.1	O K
2160 min Winter	27.459	0.059	0.0	2.0	2.0	0.1	O K
2880 min Winter	27.453	0.053	0.0	1.6	1.6	0.1	O K
4320 min Winter	27.445	0.045	0.0	1.1	1.1	0.0	O K
5760 min Winter	27.440	0.040	0.0	0.9	0.9	0.0	O K
7200 min Winter	27.437	0.037	0.0	0.8	0.8	0.0	O K
8640 min Winter	27.434	0.034	0.0	0.7	0.7	0.0	O K
10080 min Winter	27.432	0.032	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	119.1	4328
10080 min Summer	1.218	0.0	122.7	5016
15 min Winter	178.502	0.0	30.0	13
30 min Winter	106.565	0.0	35.8	21
60 min Winter	63.619	0.0	42.8	36
120 min Winter	37.980	0.0	51.0	64
180 min Winter	28.087	0.0	56.6	94
240 min Winter	22.674	0.0	60.9	124
360 min Winter	16.768	0.0	67.6	184
480 min Winter	13.536	0.0	72.8	242
600 min Winter	11.465	0.0	77.0	304
720 min Winter	10.011	0.0	80.7	360
960 min Winter	7.973	0.0	85.7	488
1440 min Winter	5.785	0.0	93.3	722
2160 min Winter	4.197	0.0	101.5	1068
2880 min Winter	3.343	0.0	107.8	1420
4320 min Winter	2.411	0.0	116.6	2172
5760 min Winter	1.912	0.0	123.3	2840
7200 min Winter	1.597	0.0	128.8	3600
8640 min Winter	1.379	0.0	133.4	4488
10080 min Winter	1.218	0.0	137.5	5088

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Cascade Rainfall Details for 2017-08-30 Swale 9.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302350 96250 SY 02350 96250
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.080

Time (mins) From:	To:	Area (ha)
0	4	0.080

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Cascade Model Details for 2017-08-30 Swale 9.srcx

Storage is Online Cover Level (m) 28.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	267.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	60.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	27.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 27.400

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Cascade Summary of Results for 2017-08-30 Basin 9.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 9.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	27.433	0.633	18.6	638.3	O K
30 min Summer	27.534	0.734	18.6	758.3	O K
60 min Summer	27.640	0.840	18.6	887.8	O K
120 min Summer	27.744	0.944	18.6	1021.5	Flood Risk
180 min Summer	27.798	0.998	18.6	1093.4	Flood Risk
240 min Summer	27.830	1.030	18.6	1136.7	Flood Risk
360 min Summer	27.861	1.061	18.6	1179.0	Flood Risk
480 min Summer	27.869	1.069	18.6	1189.0	Flood Risk
600 min Summer	27.866	1.066	18.6	1185.9	Flood Risk
720 min Summer	27.862	1.062	18.6	1180.2	Flood Risk
960 min Summer	27.835	1.035	18.6	1142.4	Flood Risk
1440 min Summer	27.777	0.977	18.6	1065.7	Flood Risk
2160 min Summer	27.690	0.890	18.6	951.1	O K
2880 min Summer	27.592	0.792	18.6	828.9	O K
4320 min Summer	27.401	0.601	18.6	601.6	O K
5760 min Summer	27.248	0.448	18.6	433.7	O K
7200 min Summer	27.137	0.337	18.6	317.5	O K
8640 min Summer	27.062	0.262	18.2	242.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	640.1	21
30 min Summer	106.565	0.0	765.1	34
60 min Summer	63.619	0.0	927.8	64
120 min Summer	37.980	0.0	1108.5	122
180 min Summer	28.087	0.0	1229.9	182
240 min Summer	22.674	0.0	1324.0	242
360 min Summer	16.768	0.0	1468.8	360
480 min Summer	13.536	0.0	1580.8	480
600 min Summer	11.465	0.0	1673.3	534
720 min Summer	10.011	0.0	1752.8	594
960 min Summer	7.973	0.0	1860.1	720
1440 min Summer	5.785	0.0	2020.0	994
2160 min Summer	4.197	0.0	2216.3	1408
2880 min Summer	3.343	0.0	2353.2	1816
4320 min Summer	2.411	0.0	2541.9	2548
5760 min Summer	1.912	0.0	2695.2	3232
7200 min Summer	1.597	0.0	2813.6	3896
8640 min Summer	1.379	0.0	2913.4	4576

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Cascade Summary of Results for 2017-08-30 Basin 9.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	27.014	0.214	17.7	196.3	O K
15 min Winter	27.498	0.698	18.6	715.4	O K
30 min Winter	27.611	0.811	18.6	851.9	O K
60 min Winter	27.727	0.927	18.6	999.1	Flood Risk
120 min Winter	27.842	1.042	18.6	1152.2	Flood Risk
180 min Winter	27.903	1.103	18.6	1237.1	Flood Risk
240 min Winter	27.941	1.141	18.6	1290.5	Flood Risk
360 min Winter	27.982	1.182	18.6	1348.1	Flood Risk
480 min Winter	27.997	1.197	18.7	1369.9	Flood Risk
600 min Winter	27.998	1.198	18.7	1371.9	Flood Risk
720 min Winter	27.992	1.192	18.6	1361.9	Flood Risk
960 min Winter	27.956	1.156	18.6	1311.5	Flood Risk
1440 min Winter	27.883	1.083	18.6	1208.1	Flood Risk
2160 min Winter	27.759	0.959	18.6	1041.2	Flood Risk
2880 min Winter	27.620	0.820	18.6	862.7	O K
4320 min Winter	27.322	0.522	18.6	513.4	O K
5760 min Winter	27.117	0.317	18.5	297.7	O K
7200 min Winter	27.011	0.211	17.6	192.7	O K
8640 min Winter	26.980	0.180	15.7	163.5	O K
10080 min Winter	26.962	0.162	14.0	146.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	2998.0	5240
15 min Winter	178.502	0.0	717.5	23
30 min Winter	106.565	0.0	856.9	33
60 min Winter	63.619	0.0	1039.6	62
120 min Winter	37.980	0.0	1241.9	120
180 min Winter	28.087	0.0	1377.9	180
240 min Winter	22.674	0.0	1483.2	236
360 min Winter	16.768	0.0	1645.1	352
480 min Winter	13.536	0.0	1770.4	462
600 min Winter	11.465	0.0	1873.9	570
720 min Winter	10.011	0.0	1962.7	670
960 min Winter	7.973	0.0	2082.3	760
1440 min Winter	5.785	0.0	2259.3	1068
2160 min Winter	4.197	0.0	2482.5	1532
2880 min Winter	3.343	0.0	2635.9	1984
4320 min Winter	2.411	0.0	2848.4	2676
5760 min Winter	1.912	0.0	3018.9	3288
7200 min Winter	1.597	0.0	3151.7	3824
8640 min Winter	1.379	0.0	3263.7	4480
10080 min Winter	1.218	0.0	3359.4	5144

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Cascade Rainfall Details for 2017-08-30 Basin 9.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302350 96250 SY 02350 96250
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.880

Time (mins) From:	To:	Area (ha)
0	4	1.880

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Cascade Model Details for 2017-08-30 Basin 9.srcx

Storage is Online Cover Level (m) 28.000

Tank or Pond Structure

Invert Level (m) 26.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	870.0	1.200	1444.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0190-1870-1200-1870
Design Head (m)	1.200
Design Flow (l/s)	18.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	190
Invert Level (m)	26.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	18.7
Flush-Flo™	0.376	18.6
Kick-Flo®	0.823	15.6
Mean Flow over Head Range	-	16.0

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	6.6	1.200	18.7	3.000	29.0	7.000	43.6
0.200	17.5	1.400	20.1	3.500	31.2	7.500	45.1
0.300	18.5	1.600	21.4	4.000	33.3	8.000	46.5
0.400	18.6	1.800	22.7	4.500	35.2	8.500	47.9
0.500	18.4	2.000	23.8	5.000	37.0	9.000	49.2
0.600	18.0	2.200	25.0	5.500	38.8	9.500	50.6
0.800	16.1	2.400	26.0	6.000	40.5		
1.000	17.1	2.600	27.0	6.500	42.1		

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Cascade Summary of Results for 2017-08-30 Swale 10.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 10.srcx	(None)

Half Drain Time : 5 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	29.872	0.472	0.0	29.6	29.6	9.8	Flood Risk
30 min Summer	29.835	0.435	0.0	28.2	28.2	7.8	Flood Risk
60 min Summer	29.760	0.360	0.0	25.1	25.1	4.7	Flood Risk
120 min Summer	29.657	0.257	0.0	20.0	20.0	2.0	O K
180 min Summer	29.605	0.205	0.0	16.5	16.5	1.1	O K
240 min Summer	29.579	0.179	0.0	13.6	13.6	0.8	O K
360 min Summer	29.549	0.149	0.0	10.2	10.2	0.5	O K
480 min Summer	29.531	0.131	0.0	8.3	8.3	0.4	O K
600 min Summer	29.520	0.120	0.0	7.1	7.1	0.3	O K
720 min Summer	29.508	0.108	0.0	6.1	6.1	0.2	O K
960 min Summer	29.492	0.092	0.0	4.9	4.9	0.2	O K
1440 min Summer	29.479	0.079	0.0	3.6	3.6	0.1	O K
2160 min Summer	29.469	0.069	0.0	2.6	2.6	0.1	O K
2880 min Summer	29.460	0.060	0.0	2.1	2.1	0.1	O K
4320 min Summer	29.451	0.051	0.0	1.5	1.5	0.0	O K
5760 min Summer	29.446	0.046	0.0	1.2	1.2	0.0	O K
7200 min Summer	29.441	0.041	0.0	1.0	1.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	25.1	12
30 min Summer	106.565	0.0	30.0	20
60 min Summer	63.619	0.0	35.8	36
120 min Summer	37.980	0.0	42.7	64
180 min Summer	28.087	0.0	47.4	94
240 min Summer	22.674	0.0	51.0	124
360 min Summer	16.768	0.0	56.6	184
480 min Summer	13.536	0.0	60.9	244
600 min Summer	11.465	0.0	64.5	302
720 min Summer	10.011	0.0	67.6	360
960 min Summer	7.973	0.0	71.8	484
1440 min Summer	5.785	0.0	78.1	712
2160 min Summer	4.197	0.0	85.0	1096
2880 min Summer	3.343	0.0	90.3	1420
4320 min Summer	2.411	0.0	97.6	2164
5760 min Summer	1.912	0.0	103.2	2888
7200 min Summer	1.597	0.0	107.8	3632

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Cascade Summary of Results for 2017-08-30 Swale 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	29.438	0.038	0.0	0.9	0.9	0.0	O K
10080 min Summer	29.436	0.036	0.0	0.8	0.8	0.0	O K
15 min Winter	29.893	0.493	0.0	30.4	30.4	11.0	Flood Risk
30 min Winter	29.836	0.436	0.0	28.2	28.2	7.9	Flood Risk
60 min Winter	29.727	0.327	0.0	23.6	23.6	3.7	Flood Risk
120 min Winter	29.605	0.205	0.0	16.5	16.5	1.1	O K
180 min Winter	29.568	0.168	0.0	12.4	12.4	0.7	O K
240 min Winter	29.547	0.147	0.0	10.0	10.0	0.5	O K
360 min Winter	29.523	0.123	0.0	7.4	7.4	0.3	O K
480 min Winter	29.506	0.106	0.0	6.0	6.0	0.2	O K
600 min Winter	29.495	0.095	0.0	5.1	5.1	0.2	O K
720 min Winter	29.487	0.087	0.0	4.4	4.4	0.1	O K
960 min Winter	29.478	0.078	0.0	3.5	3.5	0.1	O K
1440 min Winter	29.469	0.069	0.0	2.6	2.6	0.1	O K
2160 min Winter	29.457	0.057	0.0	1.9	1.9	0.1	O K
2880 min Winter	29.451	0.051	0.0	1.5	1.5	0.0	O K
4320 min Winter	29.443	0.043	0.0	1.1	1.1	0.0	O K
5760 min Winter	29.438	0.038	0.0	0.9	0.9	0.0	O K
7200 min Winter	29.435	0.035	0.0	0.7	0.7	0.0	O K
8640 min Winter	29.433	0.033	0.0	0.6	0.6	0.0	O K
10080 min Winter	29.431	0.031	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	111.7	4400
10080 min Summer	1.218	0.0	115.1	4952
15 min Winter	178.502	0.0	28.1	13
30 min Winter	106.565	0.0	33.6	21
60 min Winter	63.619	0.0	40.1	36
120 min Winter	37.980	0.0	47.9	64
180 min Winter	28.087	0.0	53.1	94
240 min Winter	22.674	0.0	57.1	124
360 min Winter	16.768	0.0	63.4	186
480 min Winter	13.536	0.0	68.2	240
600 min Winter	11.465	0.0	72.2	306
720 min Winter	10.011	0.0	75.7	366
960 min Winter	7.973	0.0	80.4	484
1440 min Winter	5.785	0.0	87.5	732
2160 min Winter	4.197	0.0	95.2	1096
2880 min Winter	3.343	0.0	101.1	1492
4320 min Winter	2.411	0.0	109.3	2120
5760 min Winter	1.912	0.0	115.6	2856
7200 min Winter	1.597	0.0	120.7	3392
8640 min Winter	1.379	0.0	125.1	4304
10080 min Winter	1.218	0.0	128.9	5088

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Cascade Rainfall Details for 2017-08-30 Swale 10.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 301950 96300 SY 01950 96300
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.075

Time (mins) From:	To:	Area (ha)
0	4	0.075

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Cascade Model Details for 2017-08-30 Swale 10.srcx

Storage is Online Cover Level (m) 30.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	270.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	50.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	29.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 29.400

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Cascade Summary of Results for 2017-08-30 Basin 10.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 10.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	29.419	0.619	18.8	642.9	O K
30 min Summer	29.518	0.718	18.8	762.2	O K
60 min Summer	29.622	0.822	18.8	892.2	O K
120 min Summer	29.725	0.925	18.8	1027.4	Flood Risk
180 min Summer	29.779	0.979	18.8	1100.2	Flood Risk
240 min Summer	29.811	1.011	18.8	1144.3	Flood Risk
360 min Summer	29.842	1.042	18.8	1187.6	Flood Risk
480 min Summer	29.850	1.050	18.8	1198.5	Flood Risk
600 min Summer	29.848	1.048	18.8	1195.6	Flood Risk
720 min Summer	29.844	1.044	18.8	1190.0	Flood Risk
960 min Summer	29.817	1.017	18.8	1152.3	Flood Risk
1440 min Summer	29.760	0.960	18.8	1075.1	Flood Risk
2160 min Summer	29.673	0.873	18.8	958.7	O K
2880 min Summer	29.574	0.774	18.8	832.3	O K
4320 min Summer	29.388	0.588	18.8	606.2	O K
5760 min Summer	29.240	0.440	18.8	438.2	O K
7200 min Summer	29.131	0.331	18.7	322.2	O K
8640 min Summer	29.058	0.258	18.4	246.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	642.4	20
30 min Summer	106.565	0.0	768.0	34
60 min Summer	63.619	0.0	932.1	64
120 min Summer	37.980	0.0	1113.7	122
180 min Summer	28.087	0.0	1235.7	182
240 min Summer	22.674	0.0	1330.2	242
360 min Summer	16.768	0.0	1475.6	360
480 min Summer	13.536	0.0	1588.2	480
600 min Summer	11.465	0.0	1681.1	536
720 min Summer	10.011	0.0	1761.0	598
960 min Summer	7.973	0.0	1868.7	722
1440 min Summer	5.785	0.0	2029.1	994
2160 min Summer	4.197	0.0	2227.3	1408
2880 min Summer	3.343	0.0	2364.9	1812
4320 min Summer	2.411	0.0	2554.3	2548
5760 min Summer	1.912	0.0	2708.8	3232
7200 min Summer	1.597	0.0	2827.7	3896
8640 min Summer	1.379	0.0	2927.9	4576

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Cascade Summary of Results for 2017-08-30 Basin 10.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	29.013	0.213	17.8	201.4	O K
15 min Winter	29.484	0.684	18.8	720.5	O K
30 min Winter	29.594	0.794	18.8	856.6	O K
60 min Winter	29.707	0.907	18.8	1004.4	Flood Risk
120 min Winter	29.821	1.021	18.8	1158.8	Flood Risk
180 min Winter	29.882	1.082	18.8	1244.6	Flood Risk
240 min Winter	29.920	1.120	18.8	1298.6	Flood Risk
360 min Winter	29.961	1.161	18.8	1357.3	Flood Risk
480 min Winter	29.976	1.176	18.8	1379.9	Flood Risk
600 min Winter	29.978	1.178	18.8	1382.5	Flood Risk
720 min Winter	29.971	1.171	18.8	1373.0	Flood Risk
960 min Winter	29.936	1.136	18.8	1322.1	Flood Risk
1440 min Winter	29.864	1.064	18.8	1218.4	Flood Risk
2160 min Winter	29.741	0.941	18.8	1049.7	Flood Risk
2880 min Winter	29.599	0.799	18.8	863.3	O K
4320 min Winter	29.310	0.510	18.8	517.0	O K
5760 min Winter	29.112	0.312	18.7	301.8	O K
7200 min Winter	29.009	0.209	17.8	197.8	O K
8640 min Winter	28.980	0.180	15.8	169.1	O K
10080 min Winter	28.962	0.162	14.0	151.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	3012.8	5240
15 min Winter	178.502	0.0	720.2	21
30 min Winter	106.565	0.0	860.2	33
60 min Winter	63.619	0.0	1044.5	62
120 min Winter	37.980	0.0	1247.7	120
180 min Winter	28.087	0.0	1384.3	180
240 min Winter	22.674	0.0	1490.1	236
360 min Winter	16.768	0.0	1652.9	352
480 min Winter	13.536	0.0	1778.7	462
600 min Winter	11.465	0.0	1882.6	570
720 min Winter	10.011	0.0	1971.8	672
960 min Winter	7.973	0.0	2091.9	760
1440 min Winter	5.785	0.0	2269.3	1068
2160 min Winter	4.197	0.0	2494.9	1532
2880 min Winter	3.343	0.0	2649.1	1960
4320 min Winter	2.411	0.0	2862.4	2676
5760 min Winter	1.912	0.0	3034.2	3288
7200 min Winter	1.597	0.0	3167.6	3816
8640 min Winter	1.379	0.0	3280.1	4488
10080 min Winter	1.218	0.0	3376.1	5152

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Cascade Rainfall Details for 2017-08-30 Basin 10.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 301950 96300 SY 01950 96300
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.895

Time (mins) From:	To:	Area (ha)
0	4	1.895

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Cascade Model Details for 2017-08-30 Basin 10.srcx

Storage is Online Cover Level (m) 30.000

Tank or Pond Structure

Invert Level (m) 28.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	900.0	1.200	1482.8

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0191-1880-1200-1880
Design Head (m)	1.200
Design Flow (l/s)	18.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	191
Invert Level (m)	28.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	18.8
Flush-Flo™	0.373	18.8
Kick-Flo®	0.823	15.7
Mean Flow over Head Range	-	16.1

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	6.6	1.200	18.8	3.000	29.1	7.000	43.8
0.200	17.6	1.400	20.2	3.500	31.4	7.500	45.3
0.300	18.6	1.600	21.6	4.000	33.4	8.000	46.8
0.400	18.8	1.800	22.8	4.500	35.4	8.500	48.2
0.500	18.6	2.000	24.0	5.000	37.2	9.000	49.5
0.600	18.2	2.200	25.1	5.500	39.0	9.500	50.8
0.800	16.2	2.400	26.2	6.000	40.7		
1.000	17.2	2.600	27.2	6.500	42.3		

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Cascade Summary of Results for 2017-08-30 Swale 11.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 11.srcx	(None)

Half Drain Time : 3 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	29.861	0.461	0.0	29.2	29.2	7.3	Flood Risk
30 min Summer	29.816	0.416	0.0	27.4	27.4	5.6	Flood Risk
60 min Summer	29.731	0.331	0.0	23.8	23.8	3.0	Flood Risk
120 min Summer	29.628	0.228	0.0	18.4	18.4	1.1	O K
180 min Summer	29.587	0.187	0.0	14.4	14.4	0.7	O K
240 min Summer	29.564	0.164	0.0	11.9	11.9	0.5	O K
360 min Summer	29.537	0.137	0.0	8.9	8.9	0.3	O K
480 min Summer	29.521	0.121	0.0	7.2	7.2	0.2	O K
600 min Summer	29.508	0.108	0.0	6.1	6.1	0.2	O K
720 min Summer	29.498	0.098	0.0	5.3	5.3	0.1	O K
960 min Summer	29.485	0.085	0.0	4.3	4.3	0.1	O K
1440 min Summer	29.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Summer	29.463	0.063	0.0	2.3	2.3	0.1	O K
2880 min Summer	29.456	0.056	0.0	1.8	1.8	0.0	O K
4320 min Summer	29.448	0.048	0.0	1.3	1.3	0.0	O K
5760 min Summer	29.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Summer	29.438	0.038	0.0	0.9	0.9	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	21.8	12
30 min Summer	106.565	0.0	26.0	20
60 min Summer	63.619	0.0	31.0	34
120 min Summer	37.980	0.0	37.0	64
180 min Summer	28.087	0.0	41.1	94
240 min Summer	22.674	0.0	44.2	124
360 min Summer	16.768	0.0	49.0	184
480 min Summer	13.536	0.0	52.8	242
600 min Summer	11.465	0.0	55.9	304
720 min Summer	10.011	0.0	58.6	366
960 min Summer	7.973	0.0	62.2	484
1440 min Summer	5.785	0.0	67.7	730
2160 min Summer	4.197	0.0	73.7	1092
2880 min Summer	3.343	0.0	78.2	1432
4320 min Summer	2.411	0.0	84.6	2200
5760 min Summer	1.912	0.0	89.5	2848
7200 min Summer	1.597	0.0	93.4	3656

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Cascade Summary of Results for 2017-08-30 Swale 11.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	29.436	0.036	0.0	0.8	0.8	0.0	O K
10080 min Summer	29.434	0.034	0.0	0.7	0.7	0.0	O K
15 min Winter	29.879	0.479	0.0	29.9	29.9	8.2	Flood Risk
30 min Winter	29.810	0.410	0.0	27.2	27.2	5.3	Flood Risk
60 min Winter	29.688	0.288	0.0	21.7	21.7	2.1	O K
120 min Winter	29.586	0.186	0.0	14.4	14.4	0.7	O K
180 min Winter	29.554	0.154	0.0	10.7	10.7	0.4	O K
240 min Winter	29.535	0.135	0.0	8.7	8.7	0.3	O K
360 min Winter	29.512	0.112	0.0	6.4	6.4	0.2	O K
480 min Winter	29.496	0.096	0.0	5.2	5.2	0.1	O K
600 min Winter	29.487	0.087	0.0	4.4	4.4	0.1	O K
720 min Winter	29.481	0.081	0.0	3.9	3.9	0.1	O K
960 min Winter	29.474	0.074	0.0	3.1	3.1	0.1	O K
1440 min Winter	29.463	0.063	0.0	2.3	2.3	0.1	O K
2160 min Winter	29.453	0.053	0.0	1.6	1.6	0.0	O K
2880 min Winter	29.447	0.047	0.0	1.3	1.3	0.0	O K
4320 min Winter	29.440	0.040	0.0	1.0	1.0	0.0	O K
5760 min Winter	29.436	0.036	0.0	0.8	0.8	0.0	O K
7200 min Winter	29.433	0.033	0.0	0.7	0.7	0.0	O K
8640 min Winter	29.431	0.031	0.0	0.6	0.6	0.0	O K
10080 min Winter	29.429	0.029	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	96.8	4296
10080 min Summer	1.218	0.0	99.7	4960
15 min Winter	178.502	0.0	24.4	12
30 min Winter	106.565	0.0	29.1	20
60 min Winter	63.619	0.0	34.7	36
120 min Winter	37.980	0.0	41.5	64
180 min Winter	28.087	0.0	46.0	94
240 min Winter	22.674	0.0	49.5	122
360 min Winter	16.768	0.0	54.9	184
480 min Winter	13.536	0.0	59.1	244
600 min Winter	11.465	0.0	62.6	304
720 min Winter	10.011	0.0	65.6	358
960 min Winter	7.973	0.0	69.6	490
1440 min Winter	5.785	0.0	75.8	728
2160 min Winter	4.197	0.0	82.5	1088
2880 min Winter	3.343	0.0	87.6	1472
4320 min Winter	2.411	0.0	94.8	2140
5760 min Winter	1.912	0.0	100.2	2784
7200 min Winter	1.597	0.0	104.6	3544
8640 min Winter	1.379	0.0	108.4	4088
10080 min Winter	1.218	0.0	111.7	4696

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Cascade Rainfall Details for 2017-08-30 Swale 11.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 301950 96300 SY 01950 96300
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.065

Time (mins) From:	To:	Area (ha)
0	4	0.065

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Cascade Model Details for 2017-08-30 Swale 11.srcx

Storage is Online Cover Level (m) 30.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	132.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	40.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	29.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 29.400

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Cascade Summary of Results for 2017-08-30 Basin 11.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 11.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	29.468	0.668	9.2	317.0	O K
30 min Summer	29.565	0.765	9.2	374.9	O K
60 min Summer	29.665	0.865	9.2	438.2	O K
120 min Summer	29.762	0.962	9.2	502.4	Flood Risk
180 min Summer	29.811	1.011	9.2	536.6	Flood Risk
240 min Summer	29.839	1.039	9.2	556.8	Flood Risk
360 min Summer	29.865	1.065	9.2	575.5	Flood Risk
480 min Summer	29.870	1.070	9.2	578.6	Flood Risk
600 min Summer	29.865	1.065	9.2	575.3	Flood Risk
720 min Summer	29.859	1.059	9.2	571.1	Flood Risk
960 min Summer	29.830	1.030	9.2	550.3	Flood Risk
1440 min Summer	29.774	0.974	9.2	511.2	Flood Risk
2160 min Summer	29.692	0.892	9.2	455.6	O K
2880 min Summer	29.607	0.807	9.2	401.1	O K
4320 min Summer	29.406	0.606	9.2	281.2	O K
5760 min Summer	29.245	0.445	9.2	195.5	O K
7200 min Summer	29.125	0.325	9.2	137.1	O K
8640 min Summer	29.044	0.244	9.0	99.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	320.9	20
30 min Summer	106.565	0.0	383.2	34
60 min Summer	63.619	0.0	461.2	64
120 min Summer	37.980	0.0	550.8	122
180 min Summer	28.087	0.0	611.0	182
240 min Summer	22.674	0.0	657.7	242
360 min Summer	16.768	0.0	729.6	360
480 min Summer	13.536	0.0	785.3	480
600 min Summer	11.465	0.0	831.3	536
720 min Summer	10.011	0.0	870.9	598
960 min Summer	7.973	0.0	924.5	722
1440 min Summer	5.785	0.0	1005.0	994
2160 min Summer	4.197	0.0	1098.2	1408
2880 min Summer	3.343	0.0	1166.1	1820
4320 min Summer	2.411	0.0	1260.5	2552
5760 min Summer	1.912	0.0	1334.6	3232
7200 min Summer	1.597	0.0	1393.4	3896
8640 min Summer	1.379	0.0	1443.2	4576

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Cascade Summary of Results for 2017-08-30 Basin 11.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	28.991	0.191	8.6	76.9	O K
15 min Winter	29.533	0.733	9.2	355.5	O K
30 min Winter	29.639	0.839	9.2	421.5	O K
60 min Winter	29.748	0.948	9.2	493.2	Flood Risk
120 min Winter	29.854	1.054	9.2	567.7	Flood Risk
180 min Winter	29.910	1.110	9.2	608.6	Flood Risk
240 min Winter	29.944	1.144	9.2	634.0	Flood Risk
360 min Winter	29.980	1.180	9.2	660.9	Flood Risk
480 min Winter	29.992	1.192	9.2	670.1	Flood Risk
600 min Winter	29.991	1.191	9.2	669.8	Flood Risk
720 min Winter	29.983	1.183	9.2	663.7	Flood Risk
960 min Winter	29.947	1.147	9.2	636.3	Flood Risk
1440 min Winter	29.876	1.076	9.2	583.3	Flood Risk
2160 min Winter	29.760	0.960	9.2	501.3	Flood Risk
2880 min Winter	29.635	0.835	9.2	418.7	O K
4320 min Winter	29.324	0.524	9.2	236.8	O K
5760 min Winter	29.106	0.306	9.2	128.0	O K
7200 min Winter	28.989	0.189	8.6	75.7	O K
8640 min Winter	28.946	0.146	7.8	57.9	O K
10080 min Winter	28.930	0.130	6.9	51.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	1486.0	5240
15 min Winter	178.502	0.0	359.5	21
30 min Winter	106.565	0.0	429.1	33
60 min Winter	63.619	0.0	516.6	62
120 min Winter	37.980	0.0	616.9	120
180 min Winter	28.087	0.0	684.4	180
240 min Winter	22.674	0.0	736.7	236
360 min Winter	16.768	0.0	817.2	352
480 min Winter	13.536	0.0	879.5	462
600 min Winter	11.465	0.0	931.0	570
720 min Winter	10.011	0.0	975.2	672
960 min Winter	7.973	0.0	1035.1	760
1440 min Winter	5.785	0.0	1124.7	1068
2160 min Winter	4.197	0.0	1230.0	1532
2880 min Winter	3.343	0.0	1306.1	1984
4320 min Winter	2.411	0.0	1412.1	2680
5760 min Winter	1.912	0.0	1494.8	3288
7200 min Winter	1.597	0.0	1560.7	3888
8640 min Winter	1.379	0.0	1616.5	4416
10080 min Winter	1.218	0.0	1664.7	5144

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Cascade Rainfall Details for 2017-08-30 Basin 11.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 301950 96300 SY 01950 96300
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.905

Time (mins) From:	To:	Area (ha)
0	4	0.905

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Cascade Model Details for 2017-08-30 Basin 11.srcx

Storage is Online Cover Level (m) 30.000

Tank or Pond Structure

Invert Level (m) 28.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	375.0	1.200	776.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0137-9200-1200-9200
Design Head (m)	1.200
Design Flow (l/s)	9.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	28.800
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	9.2
Flush-Flo™	0.352	9.2
Kick-Flo®	0.769	7.5
Mean Flow over Head Range	-	8.0

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	4.9	1.200	9.2	3.000	14.2	7.000	21.3
0.200	8.7	1.400	9.9	3.500	15.3	7.500	22.0
0.300	9.1	1.600	10.5	4.000	16.3	8.000	22.7
0.400	9.2	1.800	11.1	4.500	17.2	8.500	23.4
0.500	9.0	2.000	11.7	5.000	18.1	9.000	24.0
0.600	8.7	2.200	12.2	5.500	18.9	9.500	24.6
0.800	7.6	2.400	12.8	6.000	19.8		
1.000	8.4	2.600	13.3	6.500	20.5		

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Cascade Summary of Results for 2017-08-30 Swale 12.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 12.srcx	(None)

Half Drain Time : 3 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	29.870	0.470	0.0	29.5	29.5	5.8	Flood Risk
30 min Summer	29.818	0.418	0.0	27.5	27.5	4.2	Flood Risk
60 min Summer	29.723	0.323	0.0	23.4	23.4	2.1	Flood Risk
120 min Summer	29.613	0.213	0.0	17.4	17.4	0.7	O K
180 min Summer	29.578	0.178	0.0	13.4	13.4	0.5	O K
240 min Summer	29.557	0.157	0.0	11.1	11.1	0.3	O K
360 min Summer	29.531	0.131	0.0	8.3	8.3	0.2	O K
480 min Summer	29.516	0.116	0.0	6.7	6.7	0.2	O K
600 min Summer	29.502	0.102	0.0	5.7	5.7	0.1	O K
720 min Summer	29.493	0.093	0.0	5.0	5.0	0.1	O K
960 min Summer	29.482	0.082	0.0	4.0	4.0	0.1	O K
1440 min Summer	29.472	0.072	0.0	2.9	2.9	0.1	O K
2160 min Summer	29.460	0.060	0.0	2.1	2.1	0.0	O K
2880 min Summer	29.454	0.054	0.0	1.7	1.7	0.0	O K
4320 min Summer	29.446	0.046	0.0	1.2	1.2	0.0	O K
5760 min Summer	29.441	0.041	0.0	1.0	1.0	0.0	O K
7200 min Summer	29.437	0.037	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	177.092	0.0	20.0	12
30 min Summer	106.091	0.0	23.9	19
60 min Summer	63.556	0.0	28.6	34
120 min Summer	38.074	0.0	34.3	64
180 min Summer	28.214	0.0	38.1	92
240 min Summer	22.809	0.0	41.1	122
360 min Summer	16.902	0.0	45.6	184
480 min Summer	13.664	0.0	49.2	242
600 min Summer	11.586	0.0	52.1	300
720 min Summer	10.126	0.0	54.7	364
960 min Summer	8.043	0.0	57.9	484
1440 min Summer	5.815	0.0	62.8	730
2160 min Summer	4.204	0.0	68.1	1064
2880 min Summer	3.339	0.0	72.1	1468
4320 min Summer	2.428	0.0	78.7	2124
5760 min Summer	1.936	0.0	83.6	2856
7200 min Summer	1.625	0.0	87.7	3664

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Cascade Summary of Results for 2017-08-30 Swale 12.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	29.435	0.035	0.0	0.7	0.7	0.0	O K
10080 min Summer	29.433	0.033	0.0	0.6	0.6	0.0	O K
15 min Winter	29.889	0.489	0.0	30.2	30.2	6.5	Flood Risk
30 min Winter	29.806	0.406	0.0	27.0	27.0	3.9	Flood Risk
60 min Winter	29.671	0.271	0.0	20.8	20.8	1.3	O K
120 min Winter	29.577	0.177	0.0	13.4	13.4	0.5	O K
180 min Winter	29.547	0.147	0.0	10.0	10.0	0.3	O K
240 min Winter	29.529	0.129	0.0	8.1	8.1	0.2	O K
360 min Winter	29.506	0.106	0.0	6.0	6.0	0.1	O K
480 min Winter	29.492	0.092	0.0	4.9	4.9	0.1	O K
600 min Winter	29.484	0.084	0.0	4.1	4.1	0.1	O K
720 min Winter	29.479	0.079	0.0	3.7	3.7	0.1	O K
960 min Winter	29.472	0.072	0.0	2.9	2.9	0.1	O K
1440 min Winter	29.460	0.060	0.0	2.1	2.1	0.0	O K
2160 min Winter	29.451	0.051	0.0	1.5	1.5	0.0	O K
2880 min Winter	29.446	0.046	0.0	1.2	1.2	0.0	O K
4320 min Winter	29.439	0.039	0.0	0.9	0.9	0.0	O K
5760 min Winter	29.434	0.034	0.0	0.7	0.7	0.0	O K
7200 min Winter	29.433	0.033	0.0	0.6	0.6	0.0	O K
8640 min Winter	29.430	0.030	0.0	0.5	0.5	0.0	O K
10080 min Winter	29.428	0.028	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.408	0.0	91.2	4272
10080 min Summer	1.247	0.0	94.3	5056
15 min Winter	177.092	0.0	22.3	12
30 min Winter	106.091	0.0	26.7	20
60 min Winter	63.556	0.0	32.0	34
120 min Winter	38.074	0.0	38.4	62
180 min Winter	28.214	0.0	42.7	94
240 min Winter	22.809	0.0	46.0	122
360 min Winter	16.902	0.0	51.1	184
480 min Winter	13.664	0.0	55.1	244
600 min Winter	11.586	0.0	58.4	304
720 min Winter	10.126	0.0	61.2	370
960 min Winter	8.043	0.0	64.9	484
1440 min Winter	5.815	0.0	70.3	730
2160 min Winter	4.204	0.0	76.3	1108
2880 min Winter	3.339	0.0	80.8	1432
4320 min Winter	2.428	0.0	88.1	2228
5760 min Winter	1.936	0.0	93.7	2904
7200 min Winter	1.625	0.0	98.3	3720
8640 min Winter	1.408	0.0	102.2	4312
10080 min Winter	1.247	0.0	105.6	5304

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Cascade Rainfall Details for 2017-08-30 Swale 12.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302550 96450 SY 02550 96450
C (1km)	-0.027
D1 (1km)	0.385
D2 (1km)	0.324
D3 (1km)	0.338
E (1km)	0.289
F (1km)	2.486
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.060

Time (mins) From:	To:	Area (ha)
0	4	0.060

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Cascade Model Details for 2017-08-30 Swale 12.srcx

Storage is Online Cover Level (m) 30.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	630.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	30.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	29.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 29.400

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Cascade Summary of Results for 2017-08-30 Basin 12.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 12.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	29.376	0.576	44.0	1500.8	O K
30 min Summer	29.474	0.674	44.0	1779.2	O K
60 min Summer	29.580	0.780	44.0	2091.3	O K
120 min Summer	29.691	0.891	44.0	2425.9	O K
180 min Summer	29.753	0.953	44.0	2615.8	Flood Risk
240 min Summer	29.791	0.991	44.0	2734.7	Flood Risk
360 min Summer	29.831	1.031	44.0	2862.3	Flood Risk
480 min Summer	29.846	1.046	44.0	2909.5	Flood Risk
600 min Summer	29.849	1.049	44.0	2919.8	Flood Risk
720 min Summer	29.850	1.050	44.0	2922.0	Flood Risk
960 min Summer	29.825	1.025	44.0	2842.8	Flood Risk
1440 min Summer	29.770	0.970	44.0	2669.4	Flood Risk
2160 min Summer	29.676	0.876	44.0	2380.8	O K
2880 min Summer	29.578	0.778	44.0	2086.2	O K
4320 min Summer	29.415	0.615	44.0	1610.2	O K
5760 min Summer	29.284	0.484	44.0	1243.7	O K
7200 min Summer	29.187	0.387	43.8	981.5	O K
8640 min Summer	29.120	0.320	43.1	803.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	177.092	0.0	1442.5	19
30 min Summer	106.091	0.0	1735.3	33
60 min Summer	63.556	0.0	2153.8	64
120 min Summer	38.074	0.0	2585.0	122
180 min Summer	28.214	0.0	2875.2	182
240 min Summer	22.809	0.0	3100.2	242
360 min Summer	16.902	0.0	3446.5	360
480 min Summer	13.664	0.0	3714.2	480
600 min Summer	11.586	0.0	3935.2	538
720 min Summer	10.126	0.0	4124.5	600
960 min Summer	8.043	0.0	4362.0	722
1440 min Summer	5.815	0.0	4707.7	994
2160 min Summer	4.204	0.0	5202.5	1404
2880 min Summer	3.339	0.0	5508.6	1788
4320 min Summer	2.428	0.0	5988.4	2548
5760 min Summer	1.936	0.0	6411.1	3232
7200 min Summer	1.625	0.0	6720.5	3896
8640 min Summer	1.408	0.0	6980.0	4584

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Cascade Summary of Results for 2017-08-30 Basin 12.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	29.077	0.277	42.3	692.4	O K
15 min Winter	29.440	0.640	44.0	1683.3	O K
30 min Winter	29.549	0.749	44.0	1998.5	O K
60 min Winter	29.667	0.867	44.0	2353.8	O K
120 min Winter	29.791	0.991	44.0	2735.8	Flood Risk
180 min Winter	29.859	1.059	44.0	2952.4	Flood Risk
240 min Winter	29.903	1.103	44.0	3092.8	Flood Risk
360 min Winter	29.953	1.153	44.0	3254.0	Flood Risk
480 min Winter	29.975	1.175	44.0	3327.2	Flood Risk
600 min Winter	29.982	1.182	44.0	3350.8	Flood Risk
720 min Winter	29.980	1.180	44.0	3343.9	Flood Risk
960 min Winter	29.946	1.146	44.0	3232.3	Flood Risk
1440 min Winter	29.874	1.074	44.0	2999.2	Flood Risk
2160 min Winter	29.748	0.948	44.0	2600.2	Flood Risk
2880 min Winter	29.598	0.798	44.0	2145.1	O K
4320 min Winter	29.347	0.547	44.0	1418.1	O K
5760 min Winter	29.170	0.370	43.7	936.6	O K
7200 min Winter	29.075	0.275	42.2	686.4	O K
8640 min Winter	29.044	0.244	37.3	606.7	O K
10080 min Winter	29.023	0.223	33.4	552.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.247	0.0	7194.7	5240
15 min Winter	177.092	0.0	1620.4	19
30 min Winter	106.091	0.0	1946.6	33
60 min Winter	63.556	0.0	2415.3	62
120 min Winter	38.074	0.0	2897.8	120
180 min Winter	28.214	0.0	3222.6	180
240 min Winter	22.809	0.0	3474.2	238
360 min Winter	16.902	0.0	3861.4	352
480 min Winter	13.664	0.0	4160.5	462
600 min Winter	11.586	0.0	4407.1	572
720 min Winter	10.126	0.0	4617.9	672
960 min Winter	8.043	0.0	4881.6	760
1440 min Winter	5.815	0.0	5260.0	1068
2160 min Winter	4.204	0.0	5828.6	1532
2880 min Winter	3.339	0.0	6172.0	1932
4320 min Winter	2.428	0.0	6714.6	2676
5760 min Winter	1.936	0.0	7182.5	3288
7200 min Winter	1.625	0.0	7529.8	3824
8640 min Winter	1.408	0.0	7822.0	4496
10080 min Winter	1.247	0.0	8066.9	5240

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Cascade Rainfall Details for 2017-08-30 Basin 12.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302550 96450 SY 02550 96450
C (1km)	-0.027
D1 (1km)	0.385
D2 (1km)	0.324
D3 (1km)	0.338
E (1km)	0.289
F (1km)	2.486
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 4.550

Time (mins) From:	To:	Area (ha)
0	4	4.550

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Cascade Model Details for 2017-08-30 Basin 12.srcx

Storage is Online Cover Level (m) 30.000

Tank or Pond Structure

Invert Level (m) 28.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2400.0	1.200	3306.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0277-4410-1200-4410
Design Head (m)	1.200
Design Flow (l/s)	44.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	277
Invert Level (m)	28.800
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	44.1
Flush-Flo™	0.450	44.0
Kick-Flo®	0.890	38.2
Mean Flow over Head Range	-	36.6

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	8.7	1.200	44.1	3.000	68.6	7.000	103.6
0.200	28.5	1.400	47.5	3.500	74.0	7.500	107.2
0.300	42.8	1.600	50.6	4.000	78.9	8.000	110.6
0.400	43.9	1.800	53.6	4.500	83.6	8.500	114.0
0.500	43.9	2.000	56.4	5.000	88.0	9.000	117.2
0.600	43.4	2.200	59.1	5.500	92.1	9.500	120.3
0.800	40.9	2.400	61.6	6.000	96.1		
1.000	40.4	2.600	64.0	6.500	100.0		

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Cascade Summary of Results for 2017-08-30 Swale 14.srcx

Upstream Structures	Outflow To	Overflow To
(None)	2017-08-30 Basin 14.srcx	(None)

Half Drain Time : 3 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	29.861	0.461	0.0	29.2	29.2	7.3	Flood Risk
30 min Summer	29.816	0.416	0.0	27.4	27.4	5.6	Flood Risk
60 min Summer	29.731	0.331	0.0	23.8	23.8	3.0	Flood Risk
120 min Summer	29.628	0.228	0.0	18.4	18.4	1.1	O K
180 min Summer	29.587	0.187	0.0	14.4	14.4	0.7	O K
240 min Summer	29.564	0.164	0.0	11.9	11.9	0.5	O K
360 min Summer	29.537	0.137	0.0	8.9	8.9	0.3	O K
480 min Summer	29.521	0.121	0.0	7.2	7.2	0.2	O K
600 min Summer	29.508	0.108	0.0	6.1	6.1	0.2	O K
720 min Summer	29.498	0.098	0.0	5.3	5.3	0.1	O K
960 min Summer	29.485	0.085	0.0	4.3	4.3	0.1	O K
1440 min Summer	29.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Summer	29.463	0.063	0.0	2.3	2.3	0.1	O K
2880 min Summer	29.456	0.056	0.0	1.8	1.8	0.0	O K
4320 min Summer	29.448	0.048	0.0	1.3	1.3	0.0	O K
5760 min Summer	29.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Summer	29.438	0.038	0.0	0.9	0.9	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	21.8	12
30 min Summer	106.565	0.0	26.0	20
60 min Summer	63.619	0.0	31.0	34
120 min Summer	37.980	0.0	37.0	64
180 min Summer	28.087	0.0	41.1	94
240 min Summer	22.674	0.0	44.2	124
360 min Summer	16.768	0.0	49.0	184
480 min Summer	13.536	0.0	52.8	242
600 min Summer	11.465	0.0	55.9	304
720 min Summer	10.011	0.0	58.6	366
960 min Summer	7.973	0.0	62.2	484
1440 min Summer	5.785	0.0	67.7	730
2160 min Summer	4.197	0.0	73.7	1092
2880 min Summer	3.343	0.0	78.2	1432
4320 min Summer	2.411	0.0	84.6	2200
5760 min Summer	1.912	0.0	89.5	2848
7200 min Summer	1.597	0.0	93.4	3656

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Cascade Summary of Results for 2017-08-30 Swale 14.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	29.436	0.036	0.0	0.8	0.8	0.0	O K
10080 min Summer	29.434	0.034	0.0	0.7	0.7	0.0	O K
15 min Winter	29.879	0.479	0.0	29.9	29.9	8.2	Flood Risk
30 min Winter	29.810	0.410	0.0	27.2	27.2	5.3	Flood Risk
60 min Winter	29.688	0.288	0.0	21.7	21.7	2.1	O K
120 min Winter	29.586	0.186	0.0	14.4	14.4	0.7	O K
180 min Winter	29.554	0.154	0.0	10.7	10.7	0.4	O K
240 min Winter	29.535	0.135	0.0	8.7	8.7	0.3	O K
360 min Winter	29.512	0.112	0.0	6.4	6.4	0.2	O K
480 min Winter	29.496	0.096	0.0	5.2	5.2	0.1	O K
600 min Winter	29.487	0.087	0.0	4.4	4.4	0.1	O K
720 min Winter	29.481	0.081	0.0	3.9	3.9	0.1	O K
960 min Winter	29.474	0.074	0.0	3.1	3.1	0.1	O K
1440 min Winter	29.463	0.063	0.0	2.3	2.3	0.1	O K
2160 min Winter	29.453	0.053	0.0	1.6	1.6	0.0	O K
2880 min Winter	29.447	0.047	0.0	1.3	1.3	0.0	O K
4320 min Winter	29.440	0.040	0.0	1.0	1.0	0.0	O K
5760 min Winter	29.436	0.036	0.0	0.8	0.8	0.0	O K
7200 min Winter	29.433	0.033	0.0	0.7	0.7	0.0	O K
8640 min Winter	29.431	0.031	0.0	0.6	0.6	0.0	O K
10080 min Winter	29.429	0.029	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	96.8	4296
10080 min Summer	1.218	0.0	99.7	4960
15 min Winter	178.502	0.0	24.4	12
30 min Winter	106.565	0.0	29.1	20
60 min Winter	63.619	0.0	34.7	36
120 min Winter	37.980	0.0	41.5	64
180 min Winter	28.087	0.0	46.0	94
240 min Winter	22.674	0.0	49.5	122
360 min Winter	16.768	0.0	54.9	184
480 min Winter	13.536	0.0	59.1	244
600 min Winter	11.465	0.0	62.6	304
720 min Winter	10.011	0.0	65.6	358
960 min Winter	7.973	0.0	69.6	490
1440 min Winter	5.785	0.0	75.8	728
2160 min Winter	4.197	0.0	82.5	1088
2880 min Winter	3.343	0.0	87.6	1472
4320 min Winter	2.411	0.0	94.8	2140
5760 min Winter	1.912	0.0	100.2	2784
7200 min Winter	1.597	0.0	104.6	3544
8640 min Winter	1.379	0.0	108.4	4088
10080 min Winter	1.218	0.0	111.7	4696

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Cascade Rainfall Details for 2017-08-30 Swale 14.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302350 96250 SY 02350 96250
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.065

Time (mins) From:	To:	Area (ha)
0	4	0.065

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Cascade Model Details for 2017-08-30 Swale 14.srcx

Storage is Online Cover Level (m) 30.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	376.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	40.0
Porosity	1.00	Cap Volume Depth (m)	0.600
Invert Level (m)	29.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5		

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 29.400

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Cascade Summary of Results for 2017-08-30 Basin 14.srcx

Upstream Structures	Outflow To	Overflow To
2017-08-30 Swale 14.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	29.416	0.616	26.4	900.9	O K
30 min Summer	29.514	0.714	26.4	1064.6	O K
60 min Summer	29.619	0.819	26.4	1246.2	O K
120 min Summer	29.727	0.927	26.4	1437.3	Flood Risk
180 min Summer	29.783	0.983	26.4	1540.6	Flood Risk
240 min Summer	29.817	1.017	26.4	1603.4	Flood Risk
360 min Summer	29.850	1.050	26.4	1666.3	Flood Risk
480 min Summer	29.859	1.059	26.4	1683.4	Flood Risk
600 min Summer	29.858	1.058	26.4	1681.8	Flood Risk
720 min Summer	29.855	1.055	26.4	1676.2	Flood Risk
960 min Summer	29.829	1.029	26.4	1626.7	Flood Risk
1440 min Summer	29.773	0.973	26.4	1521.8	Flood Risk
2160 min Summer	29.683	0.883	26.4	1358.8	O K
2880 min Summer	29.582	0.782	26.4	1181.7	O K
4320 min Summer	29.397	0.597	26.4	871.4	O K
5760 min Summer	29.251	0.451	26.4	639.9	O K
7200 min Summer	29.145	0.345	26.3	480.1	O K
8640 min Summer	29.074	0.274	25.8	376.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	889.0	19
30 min Summer	106.565	0.0	1063.4	34
60 min Summer	63.619	0.0	1297.3	64
120 min Summer	37.980	0.0	1550.3	122
180 min Summer	28.087	0.0	1720.4	182
240 min Summer	22.674	0.0	1852.1	242
360 min Summer	16.768	0.0	2054.6	360
480 min Summer	13.536	0.0	2211.3	480
600 min Summer	11.465	0.0	2340.6	534
720 min Summer	10.011	0.0	2451.6	594
960 min Summer	7.973	0.0	2601.1	720
1440 min Summer	5.785	0.0	2822.6	984
2160 min Summer	4.197	0.0	3106.5	1408
2880 min Summer	3.343	0.0	3298.3	1792
4320 min Summer	2.411	0.0	3560.8	2548
5760 min Summer	1.912	0.0	3779.8	3232
7200 min Summer	1.597	0.0	3945.5	3888
8640 min Summer	1.379	0.0	4084.6	4576

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Cascade Summary of Results for 2017-08-30 Basin 14.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	29.032	0.232	25.1	314.9	O K
15 min Winter	29.481	0.681	26.4	1009.8	O K
30 min Winter	29.591	0.791	26.4	1196.3	O K
60 min Winter	29.708	0.908	26.4	1403.3	Flood Risk
120 min Winter	29.826	1.026	26.4	1620.3	Flood Risk
180 min Winter	29.889	1.089	26.4	1741.0	Flood Risk
240 min Winter	29.929	1.129	26.4	1817.5	Flood Risk
360 min Winter	29.972	1.172	26.4	1901.1	Flood Risk
480 min Winter	29.988	1.188	26.4	1934.2	Flood Risk
600 min Winter	29.991	1.191	26.4	1939.1	Flood Risk
720 min Winter	29.985	1.185	26.4	1927.0	Flood Risk
960 min Winter	29.951	1.151	26.4	1860.0	Flood Risk
1440 min Winter	29.877	1.077	26.4	1718.3	Flood Risk
2160 min Winter	29.752	0.952	26.4	1483.2	Flood Risk
2880 min Winter	29.604	0.804	26.4	1218.9	O K
4320 min Winter	29.320	0.520	26.4	747.0	O K
5760 min Winter	29.125	0.325	26.2	450.7	O K
7200 min Winter	29.028	0.228	25.1	309.9	O K
8640 min Winter	29.001	0.201	22.0	271.1	O K
10080 min Winter	28.982	0.182	19.5	244.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	4201.3	5152
15 min Winter	178.502	0.0	997.2	19
30 min Winter	106.565	0.0	1191.6	33
60 min Winter	63.619	0.0	1453.9	62
120 min Winter	37.980	0.0	1737.2	120
180 min Winter	28.087	0.0	1927.6	178
240 min Winter	22.674	0.0	2075.0	236
360 min Winter	16.768	0.0	2301.6	352
480 min Winter	13.536	0.0	2476.7	462
600 min Winter	11.465	0.0	2621.2	570
720 min Winter	10.011	0.0	2745.1	670
960 min Winter	7.973	0.0	2911.6	758
1440 min Winter	5.785	0.0	3156.2	1068
2160 min Winter	4.197	0.0	3479.9	1532
2880 min Winter	3.343	0.0	3694.8	1960
4320 min Winter	2.411	0.0	3990.8	2640
5760 min Winter	1.912	0.0	4234.1	3280
7200 min Winter	1.597	0.0	4419.9	3768
8640 min Winter	1.379	0.0	4576.3	4488
10080 min Winter	1.218	0.0	4708.7	5152

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Cascade Rainfall Details for 2017-08-30 Basin 14.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 302350 96250 SY 02350 96250
C (1km)	-0.027
D1 (1km)	0.380
D2 (1km)	0.333
D3 (1km)	0.318
E (1km)	0.289
F (1km)	2.487
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.685

Time (mins) From:	To:	Area (ha)
0	4	2.685

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Cascade Model Details for 2017-08-30 Basin 14.srcx

Storage is Online Cover Level (m) 30.000

Tank or Pond Structure

Invert Level (m) 28.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1300.0	1.200	1985.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0222-2640-1200-2640
Design Head (m)	1.200
Design Flow (l/s)	26.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	222
Invert Level (m)	28.800
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	26.4
Flush-Flo™	0.396	26.4
Kick-Flo®	0.849	22.4
Mean Flow over Head Range	-	22.3

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	7.4	1.200	26.4	3.000	41.0	7.000	61.8
0.200	21.9	1.400	28.4	3.500	44.2	7.500	63.9
0.300	26.0	1.600	30.3	4.000	47.1	8.000	65.9
0.400	26.4	1.800	32.1	4.500	49.9	8.500	67.9
0.500	26.1	2.000	33.7	5.000	52.5	9.000	69.8
0.600	25.7	2.200	35.3	5.500	54.9	9.500	71.7
0.800	23.6	2.400	36.8	6.000	57.3		
1.000	24.2	2.600	38.3	6.500	59.6		

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