



REPORT

Flood Risk Review and Surface Water Drainage Strategy

Cranbrook New Town, Devon

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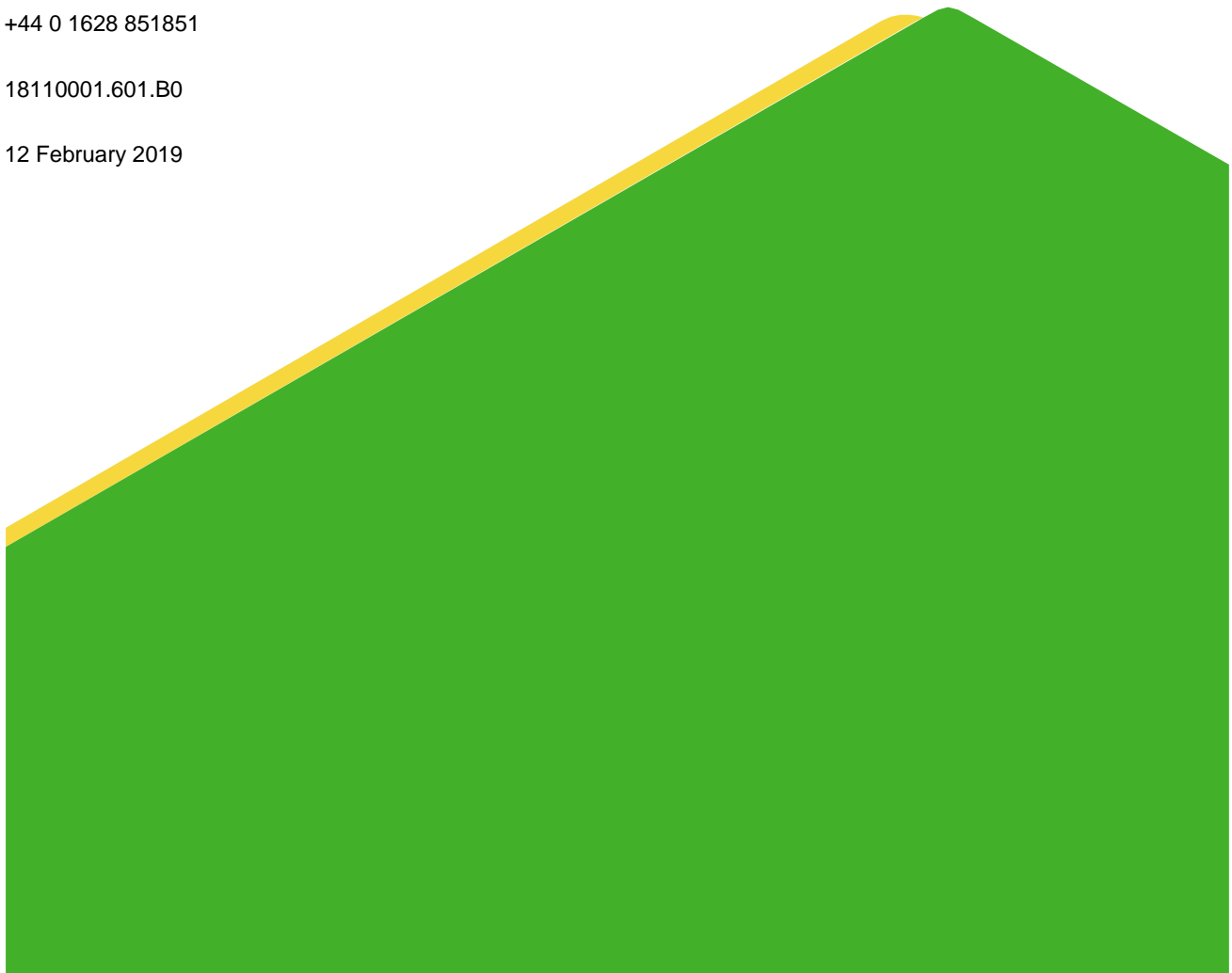
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1.0 INTRODUCTION

Golder Associates (UK) Ltd. (Golder) has been contracted by East Devon District Council (EDDC) to undertake a Flood Risk Review and Surface Water Drainage Strategy for a proposed development at Cranbrook, East Devon (the Site). The scope of work consisted of the following major tasks:

- Review of existing legislation, policy and supporting documents in relation to surface water and drainage;
- Review of all sources which may cause or increase the risk of flooding to the development and the local vicinity including fluvial, pluvial and groundwater sources, and sewers and man-made infrastructure. Identify and examine the residual flood risk to the proposed development and neighbouring areas from these sources.
- Demonstrate through the use of Sustainable Drainage Systems (SuDS) that any potential flooding on the Site can be safely mitigated; and
- Develop a surface water drainage strategy, illustrating that the Site can be drained effectively and in accordance with East Devon District Council (EDDC), Devon County Council (DCC) and Environment Agency (EA) requirements.

This report has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, July 2018), Planning Practice Guidance (PPG), EA guidance on Flood Risk Assessments, The SuDS Manual C753 (CIRIA, 2015), and the Non-Statutory Technical Standards for Sustainable Drainage (Department for Environment, Food & Rural Affairs, March 2015).

2.0 DEVELOPMENT PROPOSAL

The proposed development areas lie within the wider Cranbrook New Town development scheme and are known as the Cranbrook Expansion Areas. These areas are located to the west, south and east of the existing Cranbrook development, as shown indicatively in **Appendix A**.

It is proposed that the development within the Cranbrook 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

The western development area, Bluehayes, is bounded by a railway line and a small number of residential properties to the north, Bluehayes Lane and existing Cranbrook development to the east, Shermoor Farm and Station Road to the west, and a small number of properties and the B3174 London Road to the south.

The southern area, Treasbeare, is bounded by the B3174 London Road to the north, and agricultural fields to the east and south. Exeter Airport is located to the west and southwest. Treasbeare Lane and Parsons Lane pass through the area from the B3174 London Road.

The eastern area is divided into two sub-areas; Cobdens, located to the north of the B3174 London Road, and Grange, located to the south. Cobdens is bounded by the railway line to the north and agricultural land to the east. The B3174 London Road and future Cranbrook development land bounds the site to the south, and Southbrook Lane and existing residential properties are located to the west. There are existing agricultural buildings located within the Cobdens development area. Grange is bounded by the B3174 London Road to

the north, agricultural land to the east, Rewe Lane to the south, and agricultural land to the west. Gribble Lane passes through the development area.

3.2 Geology

British Geological Survey (BGS) mapping indicates that the bedrock geology of the Bluehayes area, and the western extents of the Treasbeare area, consists of Dawlish Sandstone Formation. The bedrock geology of the Cobdens and Grange areas, and the eastern extents of the Treasbeare area, consists of Aylesbeare Mudstone Group.

BGS mapping also shows the presence of superficial deposits across the site. River terrace deposits consisting of sand and gravel are recorded within the Bluehayes, Cobdens and Grange areas. Head deposits of sand, clay and gravel are recorded in all of the development areas. Alluvial deposits are also recorded within the Cobdens area.

BGS data is provided in **Appendix B**.

3.3 Hydrology and Hydrogeology

According to EA mapping, the Cranny Brook and the Rockbeare Stream are Main Rivers which flow within the study area. The Cranny Brook runs from the northeast to the west through the Site. 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 Site. The Rockbeare Stream runs from the southeast of Rockbeare village and flows in a north western direction converging with the Cranny Brook within the existing Cranbrook development boundary.

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

BGS hydrogeological mapping shows that the Bluehayes area and the western extents of the Treasbeare area are located within Permian Rocks, described as a moderately productive aquifer. The mapping also shows that the Cobdens and Grange areas, as well as the remaining land within the Treasbeare area are located within Permian Rocks, described as rocks with essentially no groundwater.

EA groundwater mapping shows that the Site is not located within a Groundwater Source Protection Zone, although it crosses a number of Groundwater Vulnerability Zones, as shown in **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 Bluehayes area generally falls towards the railway line in the north, or west towards Station Road. Levels fall from a high point of approximately 28m AOD to a low point of around 15m AOD.

In the Treasbeare area, the topography varies. The western half of the area falls towards the west and south west. Towards the east, levels fall in a northern direction, towards the B3174 London Road. The most eastern extents of the area fall towards the north and north east. The highest point within the Treasbeare boundary is at approximately 50m AOD and the lowest point is at approximately 19m AOD.

Within the Grange development area, levels fall towards the B3174 London Road. Levels range from approximately 63m AOD to 39m AOD.

Levels in the Cobdens area generally fall towards the Cranny Brook and its tributaries. The highest point within the area boundary is approximately 54m AOD and the lowest point is approximately 25m AOD.

4.0 SUDS LEGISLATION AND POLICY REVIEW

4.1 Legislation

4.1.1 Flood and Water Management Act 2010

The Flood and Water Management Act 2010 (FWMA) received Royal Assent on 8th 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.

4.2 National Policy

4.2.1 National Planning Policy Framework 2018

The NPPF sets out the Government's planning policies for England, and how these should be applied.

As stated in Paragraph 155 of the NPPF, inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future).

Paragraph 163 of the NPPF states that, when determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere.

4.2.2 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 for greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

4.2.3 The Building Regulations 2010 Approved Document H (Drainage and Waste Disposal)

Approved Document H provides guidance on the drainage and waste disposal requirements of the Building Regulations 2010.

Requirement H3(3) states that rainwater from a drainage system must be discharged to one of the following, listed in order of priority:

- a) An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- b) A watercourse; or, where that is not reasonably practicable,
- c) A sewer.

4.3 Local Policy

4.3.1 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.

4.3.2 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.

4.3.3 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 development areas are 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 will 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, flood compensation is to be informed by detailed hydraulic modelling which will be undertaken in order to ensure that flood risk is not exacerbated offsite. The EA flood maps are included within **Appendix C**.

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 Bluehayes 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 development 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 Risk of Flooding from Surface Water (RoFSW) mapping shows that the majority of the Expansion Areas are 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. 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.

The RoFSW is included within **Appendix C**.

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 indicates that the site is at more than 25% and less than 50% susceptibility to groundwater flooding. Figure 5-2 is shown within **Appendix E**.

At the detailed FRA stage, the Finished Floor Levels will be set at least 150mm above existing ground levels, with ground levels altered to ensure that in the unlikely event of groundwater emerging, flood flows will be restricted to the highway and car parking areas.

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 PPG notes that development should take account of climate change and the vulnerability of future uses to flood risk.

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.

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 permeable paving and interconnecting swales to transfer the remaining runoff to the regional control.

The regional control structures will be located at the lowest points 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.

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 Building Regulations 2010. This stipulates that surface water runoff should be discharged as high up the hierarchy of solutions as is practicable:

- 1) Discharge into ground (infiltration);
- 2) Discharge to a surface water body (with written permission from riparian owner);
- 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); and
- 4) Discharge to a combined sewer (with written permission from South West Water Ltd.).

It is therefore recommended that discharge into ground should 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 5l/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; and
- 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 8m 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 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 Report¹, 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	-

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.

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

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 below.

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 preliminary surface water management strategy described below is outlined on Drawings 18110001-1001-DS-001 and 002.

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. In accordance with the aforementioned drainage hierarchy, it is proposed that storm water will be attenuated before gradual discharge to a surface water body.

It is proposed to split the proposed development into 16 discrete 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 provided in Table 4 below.

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	25.39	145.7	15.39	11899	2081
Catchment 1a	0.66	3.8	0.40	289	54
Catchment 2	15.97	91.7	9.85	9044	1309
Catchment 2a	7.63	43.8	5.62	3444	626
Catchment 3	6.07	34.8	3.64	2693	497
Catchment 4	4.24	24.3	2.54	1814	347
Catchment 5	13.07	75.0	7.84	6858	1071
Catchment 5a	3.45	19.8	2.30	1117	283
Catchment 6	19.10	109.7	11.91	8864	1566
Catchment 7	14.91	85.6	9.16	7089	1222
Catchment 8	1.62	9.3	0.97	679	133
Catchment 8a	2.40	13.8	1.44	1023	197
Catchment 9	2.97	17.0	1.78	1251	243
Catchment 10	0.99	5.7	0.60	405	81
Catchment 11	7.22	41.4	4.33	3130	592
Catchment 12	3.73	21.4	2.24	1585	306

The hard-standing areas (roofs, roads, car parks, footpaths etc) within the developable areas are based on the assumptions in Table 5 below. 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%

It is proposed that surface water runoff from the majority of the Bluehayes area will be conveyed via swales and pipes to a detention basin (Basin 1) located within the open space to the west of the development parcels. Surface water from the parcel to the west of Basin 1 will be conveyed to a smaller basin (Basin 1a). Surface water from the two basins will then be discharged at a restricted rate to the ditch located to the west of Station Road, subject to a survey.

Surface water runoff from the Treasbeare area will be conveyed via swales and pipes to four detention basins due to the topography within the area. It is proposed that flows from Basin 2a will be discharged to Basin 2, and surface water will then be discharged to the ditch to the west. 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 detailed FRA stage, liaison between the two schemes 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, it may be possible for the outfall to connect to the network serving the consented site, subject to a capacity check. Basin 4 will discharge surface water to the Rockbeare Stream.

Within the Grange and Cobdens areas, the topography is variable due to the presence of watercourses and ditches. It is proposed that surface water runoff will drain to ten detention basins across the area. 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 swales and detention basins for all the development areas have been designed in accordance with DCC design considerations listed within the SuDS guidance, selected criteria are included in Table 6. 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 4
Length width ratio	3:1 – 5:1
Minimum depth for water open areas	1.0 m

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 400-600 mm. The guidance also states that longitudinal slopes of swales should be between 0.5-6%, 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**.

Following detailed hydraulic modelling of the watercourses, the invert levels of the outfall will be set a level such that no surcharging occurs.

As 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.

9.0 MAINTENANCE OF SUDS FEATURES

9.1 Introduction

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 below.

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 organisation.

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

9.2 Swales

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. Maintenance requirements are outlined in Table 8.

Table 8: Swales Maintenance Activities and Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Debris and litter removal.		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.		Monthly at the start, then as required.
	Inspection for blockages.	Inspect inlets, outlets, and overflows for blockages, and clear if required.	Monthly.
	Inspection for infiltration.	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.
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 10% or more of the treatment area.
Corrective maintenance.	Repair erosion.	Repair erosion by reurfing 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.

9.3 Detention Basins

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; requirements for maintenance and inspection are summarised in Table 9 and Table 10.

Table 9: Detention Basin - Maintenance Activities and Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Debris and litter removal.		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.
	Sediment removal.	Remove sediment from inlets and outlet.	Annually, or as required.
Infrequent maintenance.	Reseed areas of poor vegetation.		Annually, or as required.
	Prune and trim trees and remove cuttings.		Every two years, or as required.
Corrective maintenance.	Repair erosion.	Repair of erosion or other damage by reseeding or re-turfing.	As required.
	Realignment of rip-rap.		As required.
	Repair / rehabilitation of inlets, outlets and overflows.		As required.
	Re-level uneven surfaces and reinstate design levels.		As required.

Table 10: Detention Basin - Inspection and Frequency

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

9.4 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 (maintenance and inspection requirements are shown in Table 11 and Table 12).

Table 11: Flow Control Devices - Maintenance Activities and Frequency

Maintenance Category	Maintenance Activity	Comments	Frequency
Routine maintenance.	Inspect and identify any areas that are not operating correctly.		Monthly (for the first three months), then six-monthly.
	Hose down unit / chamber.		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.

Table 12: Flow Control Devices - Inspection and 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.

9.5 Pipes Systems, Gullies, and Channel Drainage

The maintenance and inspection requirements for the pipe systems, gullies and channel drainage are set out in Table 13 and Table 14 below

Table 13: Pipe Systems, Gullies, Channel Drainage and Manholes - Maintenance Activities and 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.		Annually.
Infrequent maintenance.	Clear blockages.	Piped system.	As required.

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

9.6 Summary

The above section sets out the recommended maintenance and inspection requirements and frequencies for the individual components of the drainage system. The functionality of the system should not be compromised with the appropriate maintenance and inspection regimes recommended above.

10.0 SUMMARY AND CONCLUSIONS

10.1 Conclusions

Golder has been contracted by EDDC to undertake a Flood Risk Review and Surface Water Drainage Strategy for a proposed development at Cranbrook in east Devon.

The EA flood mapping shows that the majority of the development areas are 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. 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.

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 has demonstrated that the surface water drainage proposals within the development areas are fully compliant with the requirements of the NPPF.

Signature Page

Golder Associates (UK) Ltd



David Hybert
Development Director - Environment & Infrastructure



Christine Campbell
Principal Water Resources Engineer

CC/DH/pw

Company Registered in England No.1125149

At Attenborough House, Browns Lane Business Park, Stanton-on-the-Wolds, Nottinghamshire NG12 5BL

VAT No. 209 0084 92

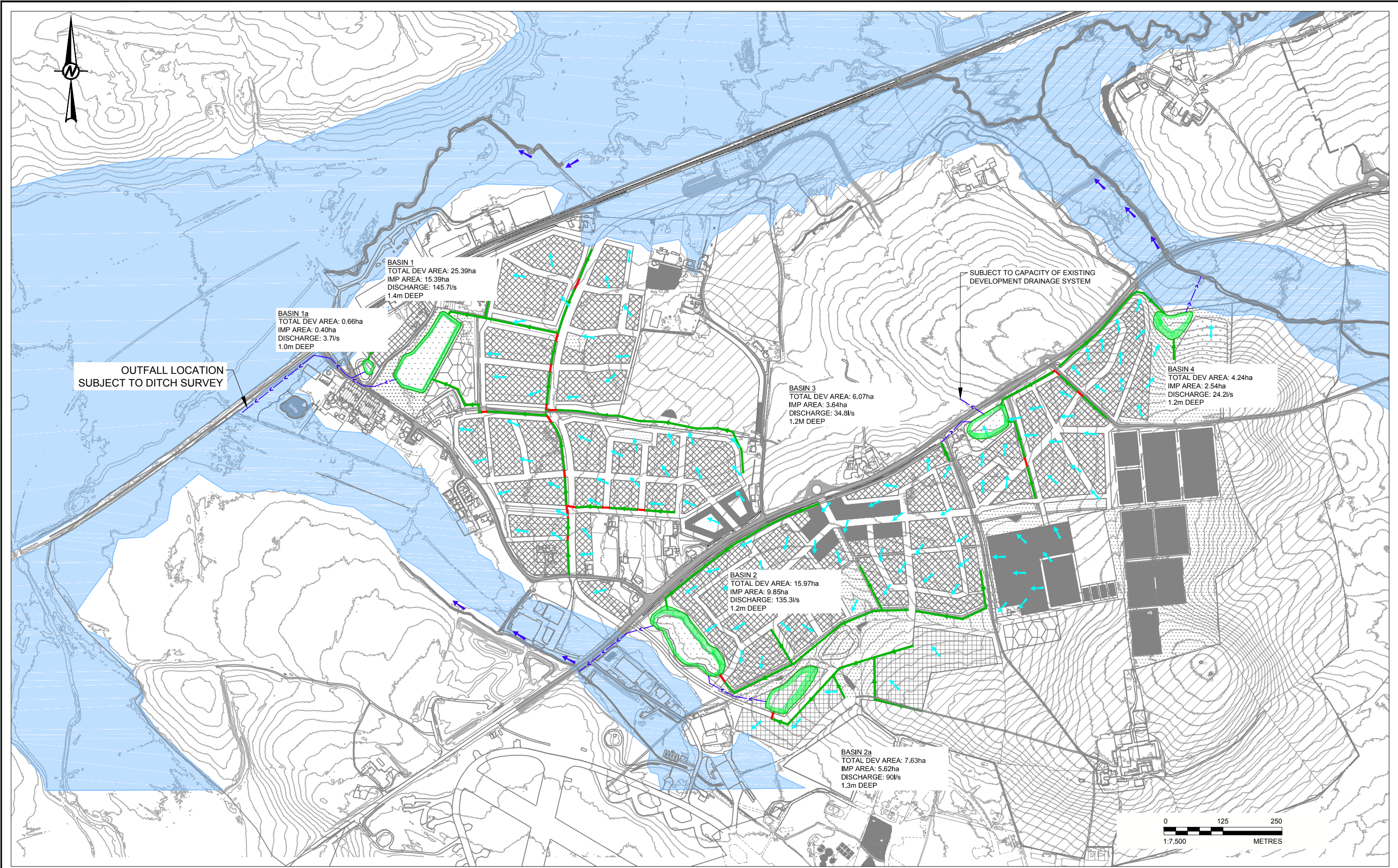
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DRAWINGS

Drawing 1- Strategy 1

Drawing 2- Strategy 2

Path: \\lib01-s-main01\CADD_GIS_CBA\PHSE\East Devon District Council\Cranbrook08_PROJECTS\18110001\1001_Drainage Strategy Update02_PROD\DWG\18110001-1001-DS-001.dwg | Last Edited By: accadden Date: 2019-02-08 Time: 3:05:48 PM | Printed By: accadden Date: 2019-02-08 Time: 3:18:42 PM



LEGEND

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

NOTE(S)

- DO NOT SCALE FROM THIS DRAWING.
- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

REFERENCE(S)

BASE MAP TAKEN FROM SAVILLS URBAN DESIGN DRAWING No. 17-159/002 REV F, DATED JULY 2017.

CLIENT
EAST DEVON DISTRICT COUNCIL

CONSULTANT
GOLDER

YYYY-MM-DD	2019-02-05
DESIGNED	CC
PREPARED	ECS
REVIEWED	CC
APPROVED	DH

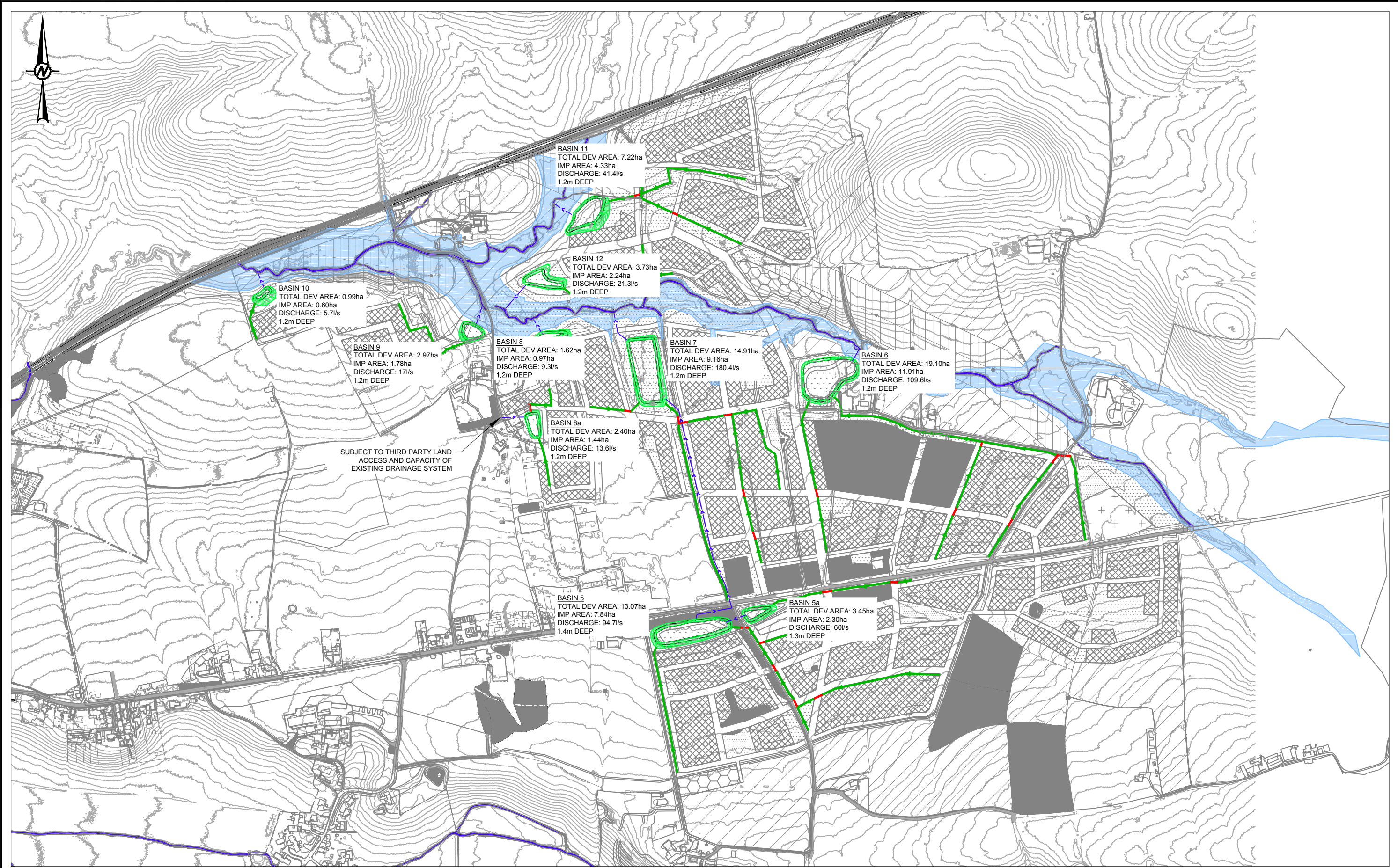
PROJECT
CRANBROOK NEW TOWN, DEVON

TITLE
FLOOD RISK REVIEW AND SURFACE WATER DRAINAGE STRATEGY - UPDATE SHEET 1 OF 2

PROJECT NO.	CONTROL	REV.	DRAWING
18110001	1001-DS-001	A	1

25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

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

BASIN 11
 TOTAL DEV AREA: 7.22ha
 IMP AREA: 4.33ha
 DISCHARGE: 41.4l/s
 1.2m DEEP

BASIN 12
 TOTAL DEV AREA: 3.73ha
 IMP AREA: 2.24ha
 DISCHARGE: 21.3l/s
 1.2m DEEP

BASIN 10
 TOTAL DEV AREA: 0.99ha
 IMP AREA: 0.60ha
 DISCHARGE: 5.7l/s
 1.2m DEEP

BASIN 9
 TOTAL DEV AREA: 2.97ha
 IMP AREA: 1.78ha
 DISCHARGE: 17l/s
 1.2m DEEP

BASIN 8
 TOTAL DEV AREA: 1.62ha
 IMP AREA: 0.97ha
 DISCHARGE: 9.3l/s
 1.2m DEEP

BASIN 7
 TOTAL DEV AREA: 14.91ha
 IMP AREA: 9.16ha
 DISCHARGE: 180.4l/s
 1.2m DEEP

BASIN 6
 TOTAL DEV AREA: 19.10ha
 IMP AREA: 11.91ha
 DISCHARGE: 109.6l/s
 1.2m DEEP

BASIN 8a
 TOTAL DEV AREA: 2.40ha
 IMP AREA: 1.44ha
 DISCHARGE: 13.6l/s
 1.2m DEEP

BASIN 5
 TOTAL DEV AREA: 13.07ha
 IMP AREA: 7.84ha
 DISCHARGE: 94.7l/s
 1.4m DEEP

BASIN 5a
 TOTAL DEV AREA: 3.45ha
 IMP AREA: 2.30ha
 DISCHARGE: 60l/s
 1.3m DEEP

LEGEND

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

NOTE(S)
 1. DO NOT SCALE FROM THIS DRAWING.
 2. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

REFERENCE(S)
 BASE MAP TAKEN FROM SAVILLS URBAN DESIGN DRAWING No. 17-159/003 REV E, DATED JULY 2017.



CLIENT
 EAST DEVON DISTRICT COUNCIL

CONSULTANT



YYYY-MM-DD	2019-02-05
DESIGNED	CC
PREPARED	ECS
REVIEWED	CC
APPROVED	DH

PROJECT
 CRANBROOK NEW TOWN, DEVON

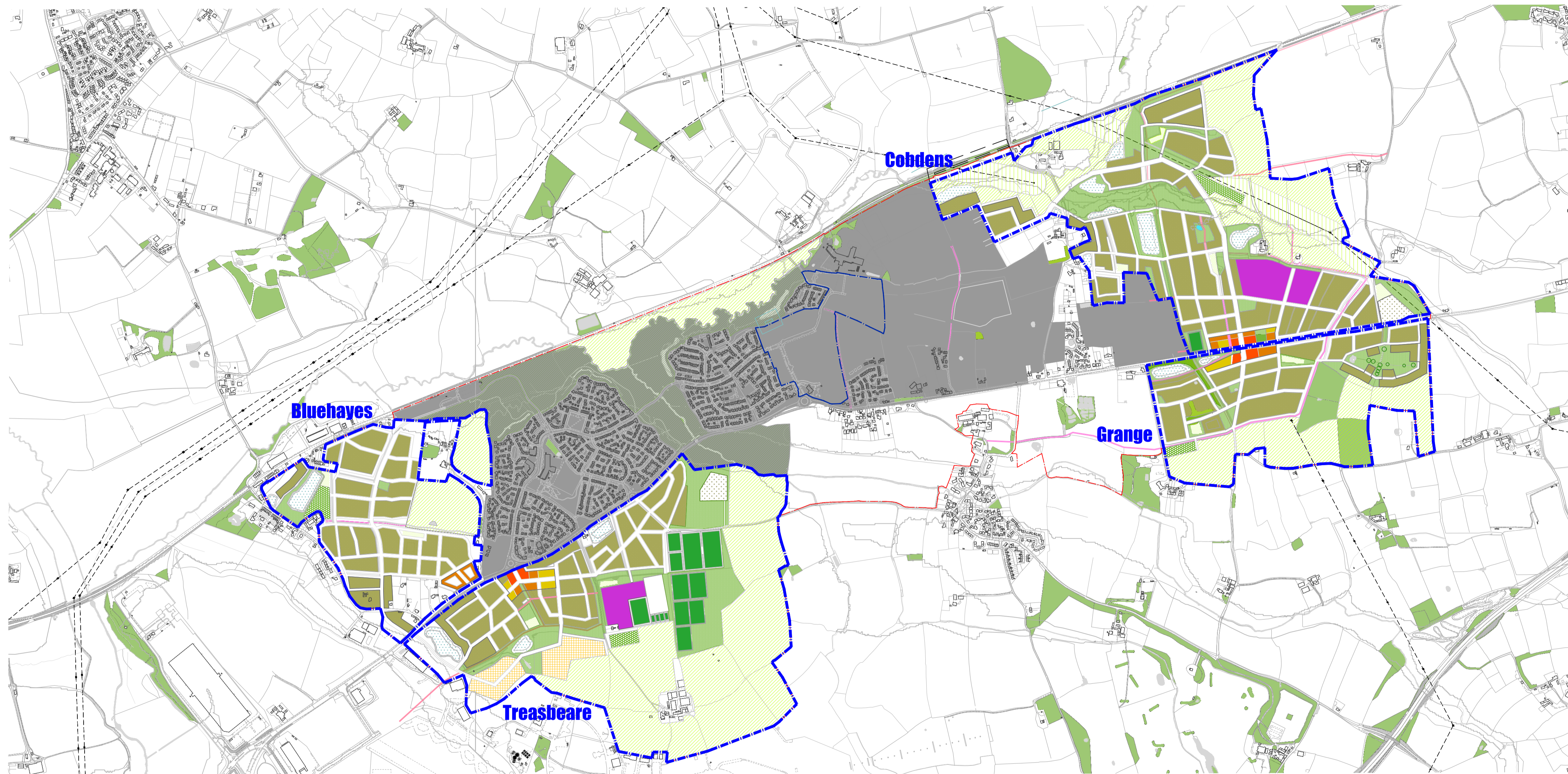
TITLE
FLOOD RISK REVIEW AND SURFACE WATER DRAINAGE STRATEGY UPDATE SHEET 2 OF 2

PROJECT NO.	CONTROL	REV.	DRAWING
18110001	1001-DS-002	A	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3

APPENDIX A

Site Location Plan



KEY

Cranbrook plan DPD proposal areas

- Residential
- School
- Gypsy and Traveller site
- SuDS basin
- Employment
- Formal open space
- Sports pitch
- Masterplan boundary
- Potential SANGS area
- SANGS link below powerlines
- Allotments
- Mixed use area - type A
- Mixed use area - type B
- Mixed use area - type C
- Development area boundary

Cranbrook existing outline permission

- Town Centre boundary
- Existing Cranbrook Development
- Cranbrook Country Park
- Cranbrook Outline Permission

_B	'Grange' area revised to remove land within 'Green Wedge' policy area. Land added to East. 'Cobdens' area road layout revised.	KS	14.12.18
_A	SANGS hatching revised to indicate SuDS basins and areas beneath pylons	KS	21.11.18
REV:	DESCRIPTION:	BY:	DATE:

STATUS: INFORMATION ONLY

	EDDC - Urban Design Knowle Sidmouth Devon EX10 8HL
--	--

CLIENT: EDDC - PLANNING

PROJECT NAME: Cranbrook DPD - Master Plan

SITE: Cranbrook master plan area

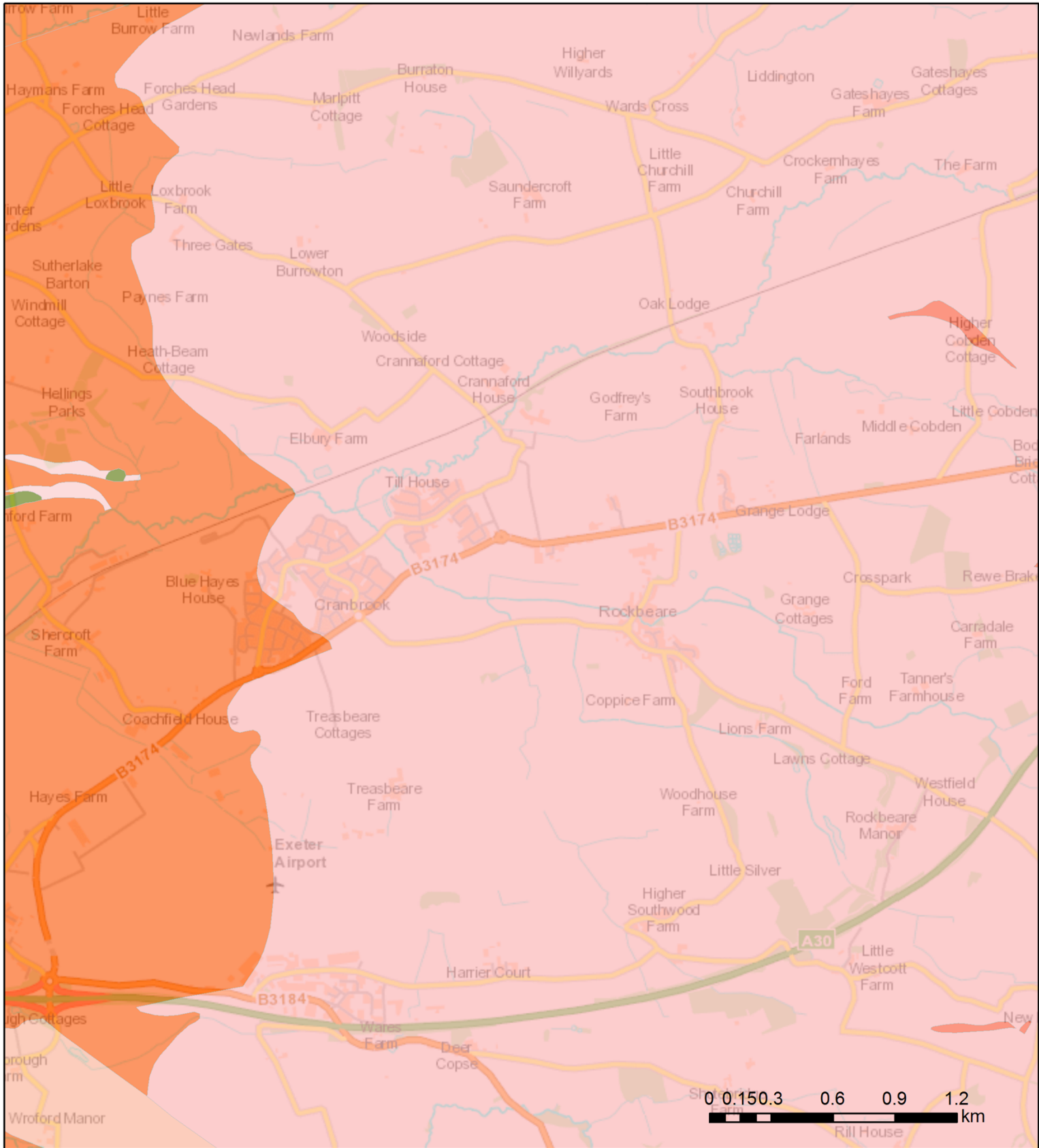
TITLE: Strategy Framework Plan

SCALE @ A1: 1:10,000	DATE: 05.09.18	DRAWN BY: KS	CHECKED BY: /
PROJECT NO: K_004	DRAWING NUMBER: _X_001_010_	REVISION: _B	

APPENDIX B

British Geological Survey Data

Bedrock Geology



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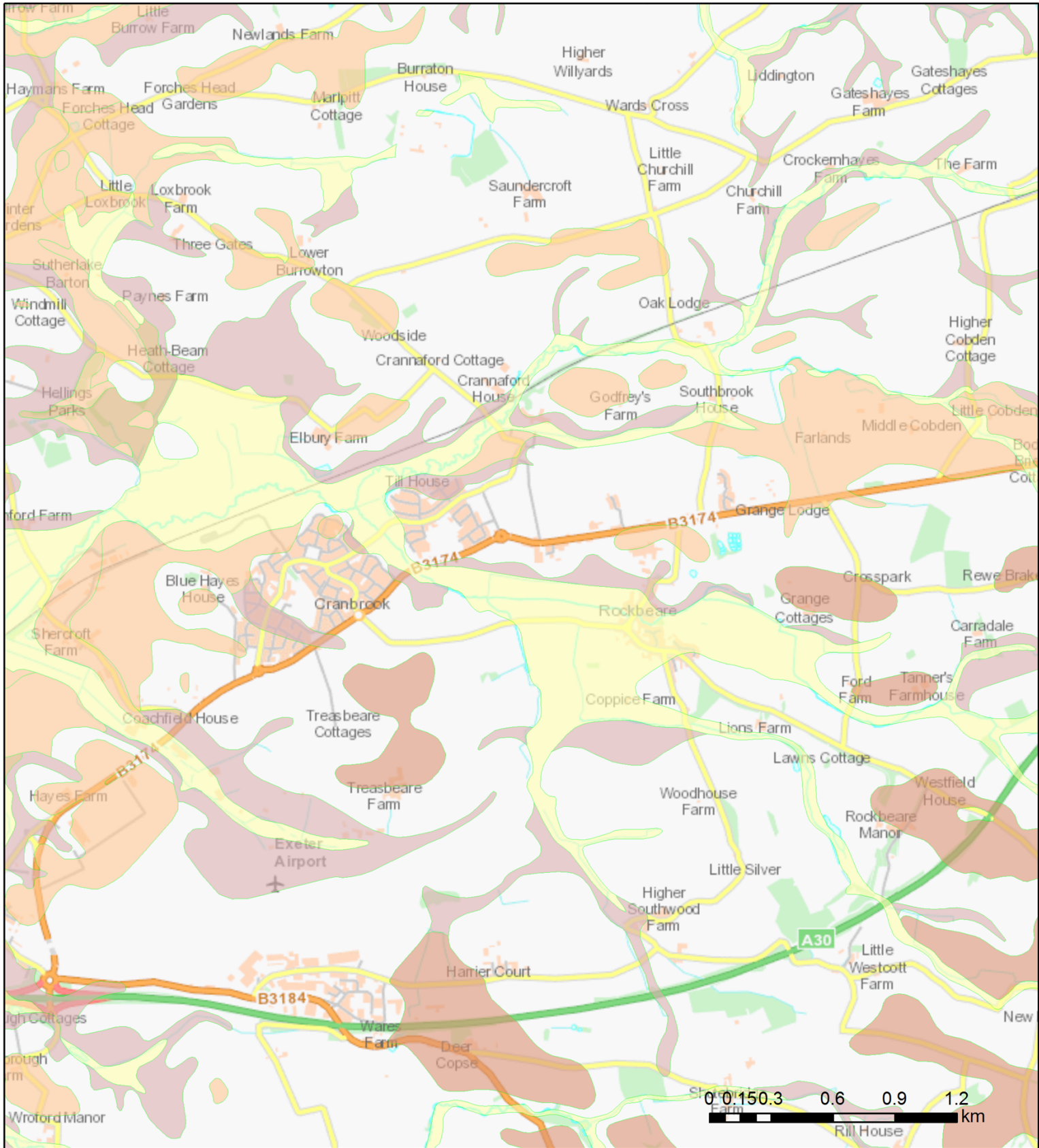
GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

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








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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

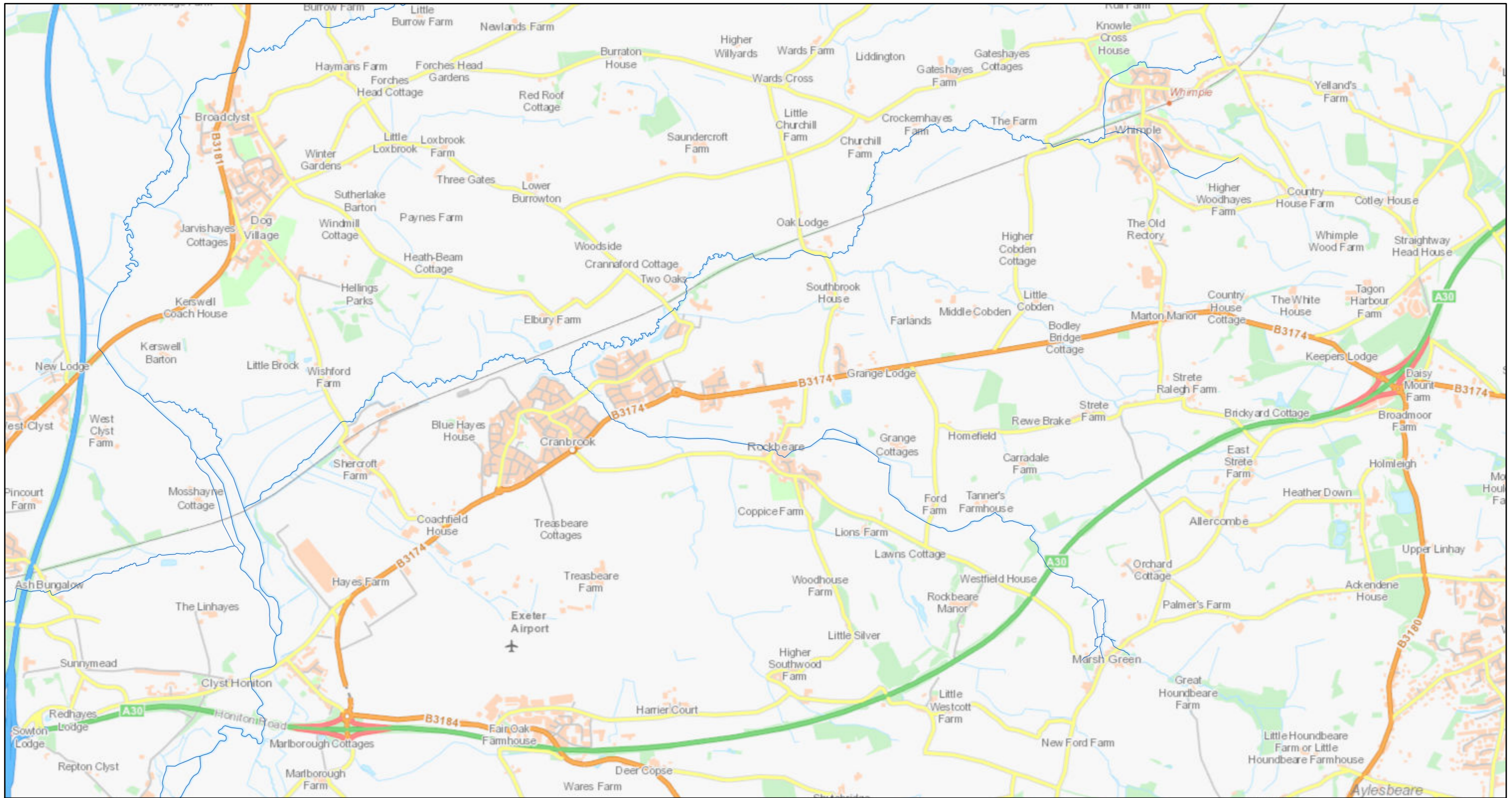
Aquifers in which flow is virtually all through fractures and other discontinuities

-  Highly productive aquifer
-  Moderately productive aquifer
-  Low productivity aquifer
-  Rocks with essentially no groundwater

APPENDIX C

Environment Agency Data

Main River Map



25/01/2019, 12:59:10

1:25,000

Statutory Main River Map Variations: Rationalising the Main River Network

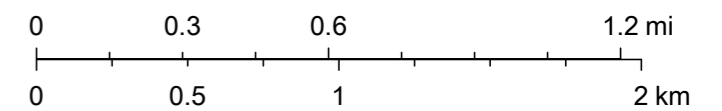
— Consultation - De-mainment

— Pending Determination

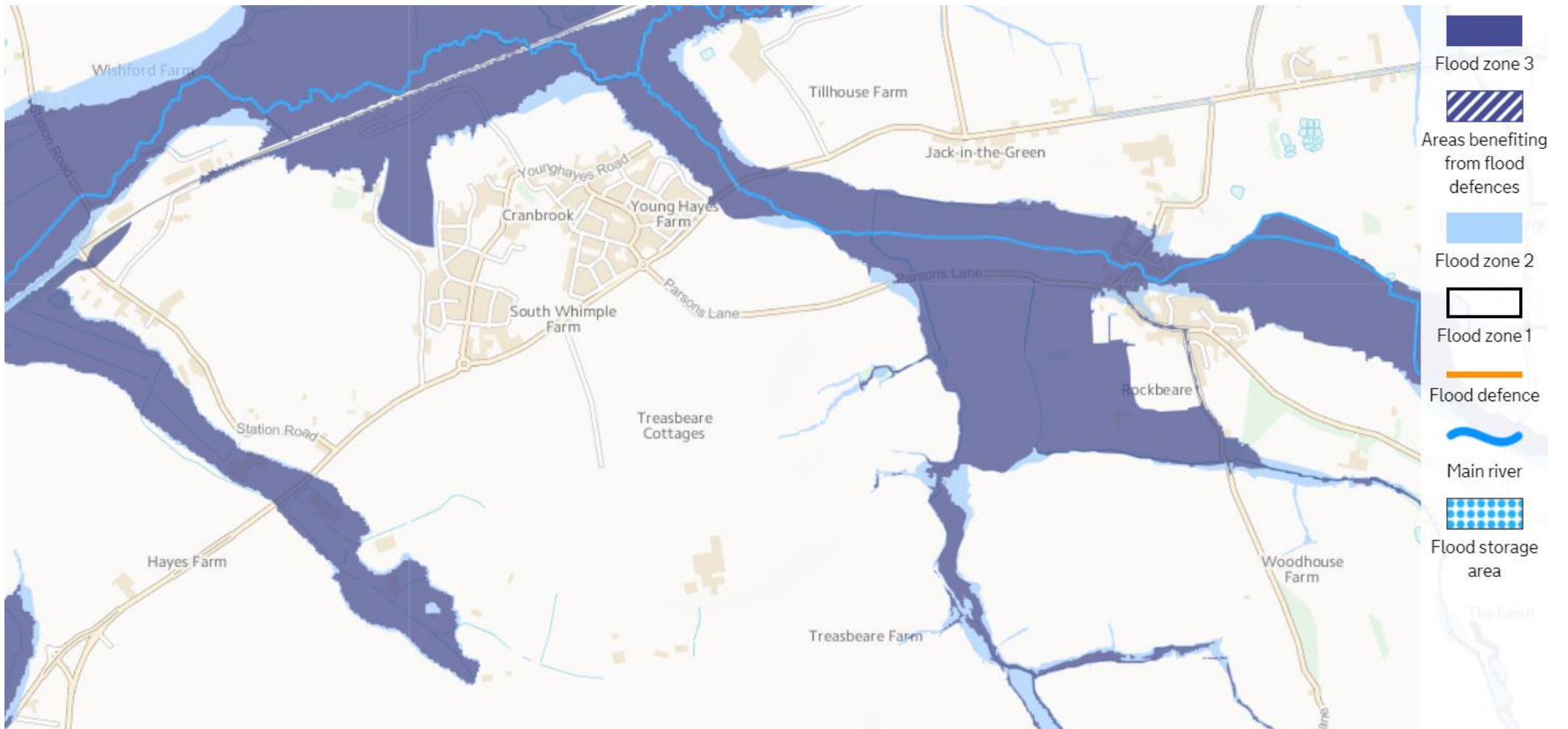
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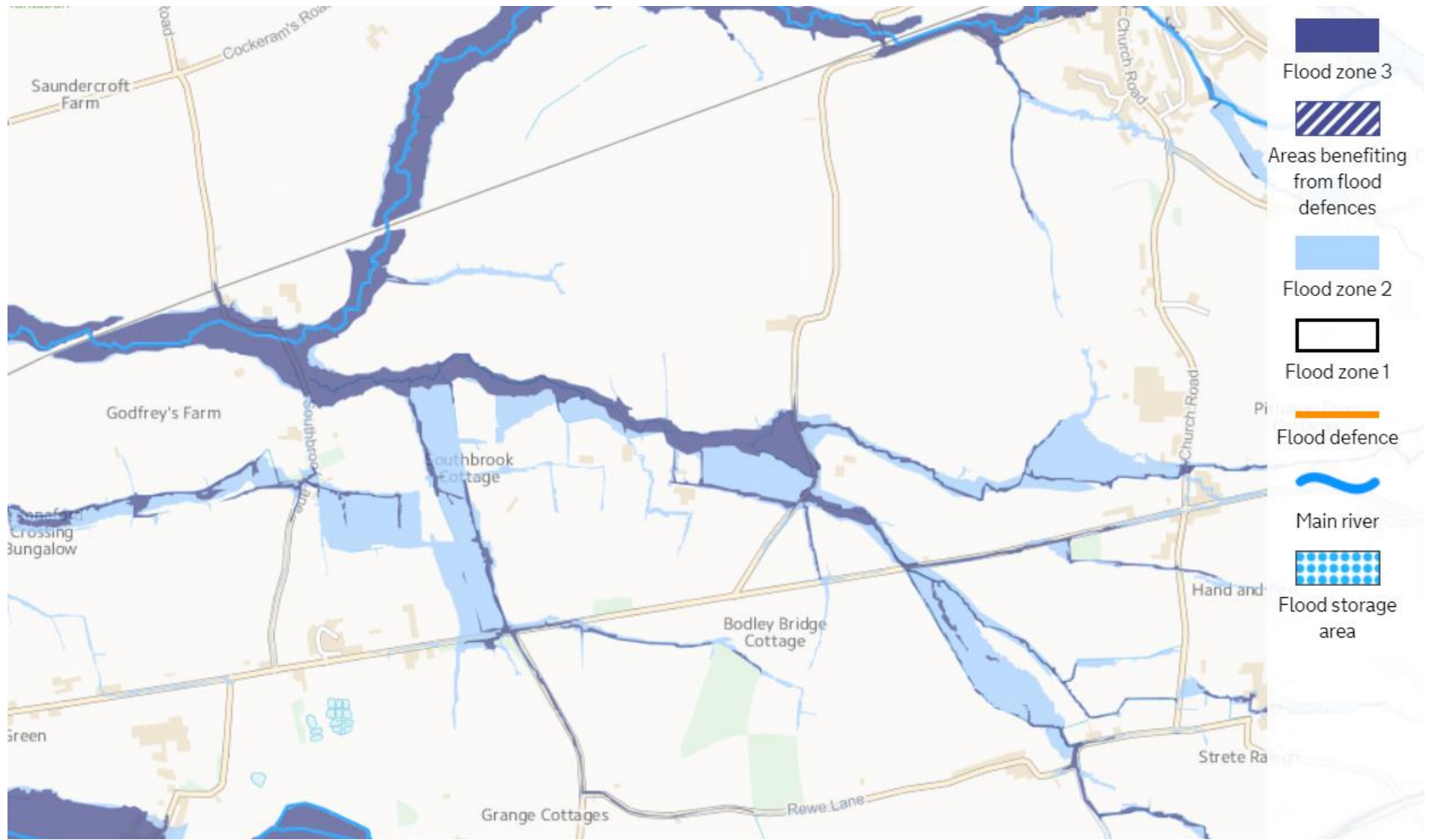
— Pending Appeals

— Statutory_Main_River_Map




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-  Flood zone 3
-  Areas benefiting from flood defences
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Flood storage area

 Flood risk from rivers or the sea

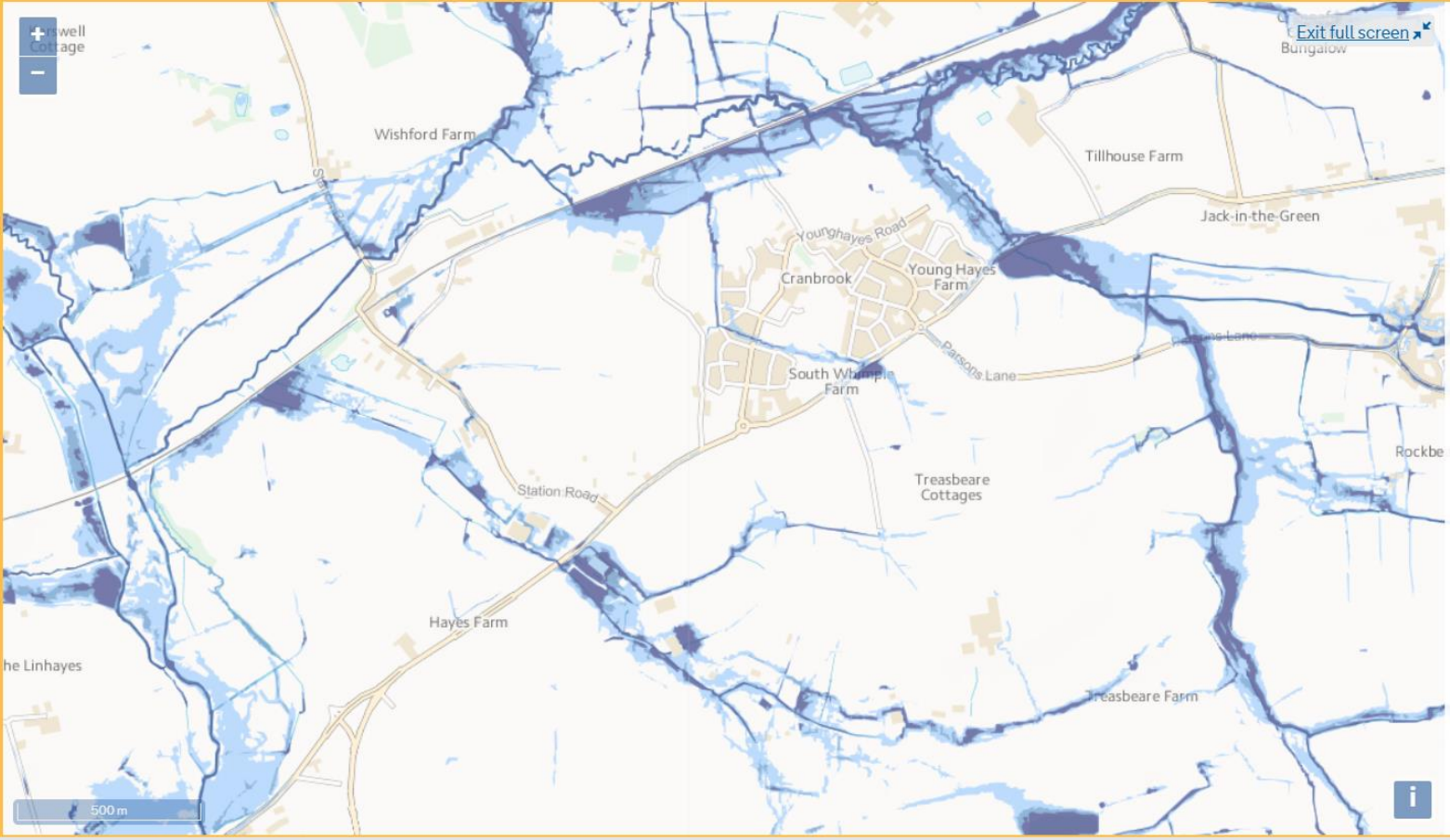
Extent of flooding

 Flood risk from surface water

Extent of flooding

 Flood risk from reservoirs

Extent of flooding



Flood risk

 High


 Medium

 Low


 Very low

 Location you selected


 Higher South West

 Flood risk from rivers or the sea

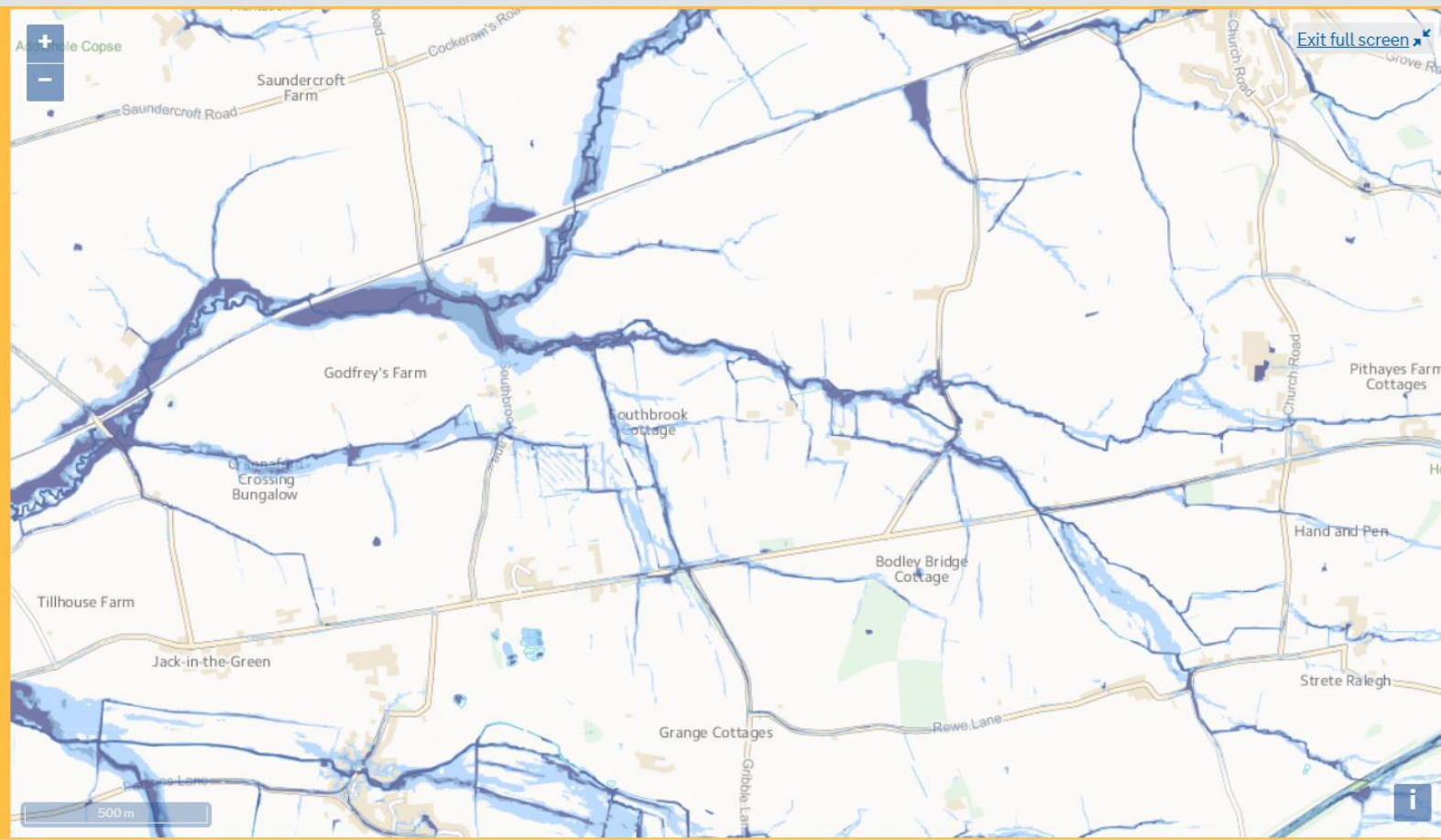
Extent of flooding

 Flood risk from surface water

Extent of flooding

 Flood risk from reservoirs

Extent of flooding



Flood risk



High



Medium



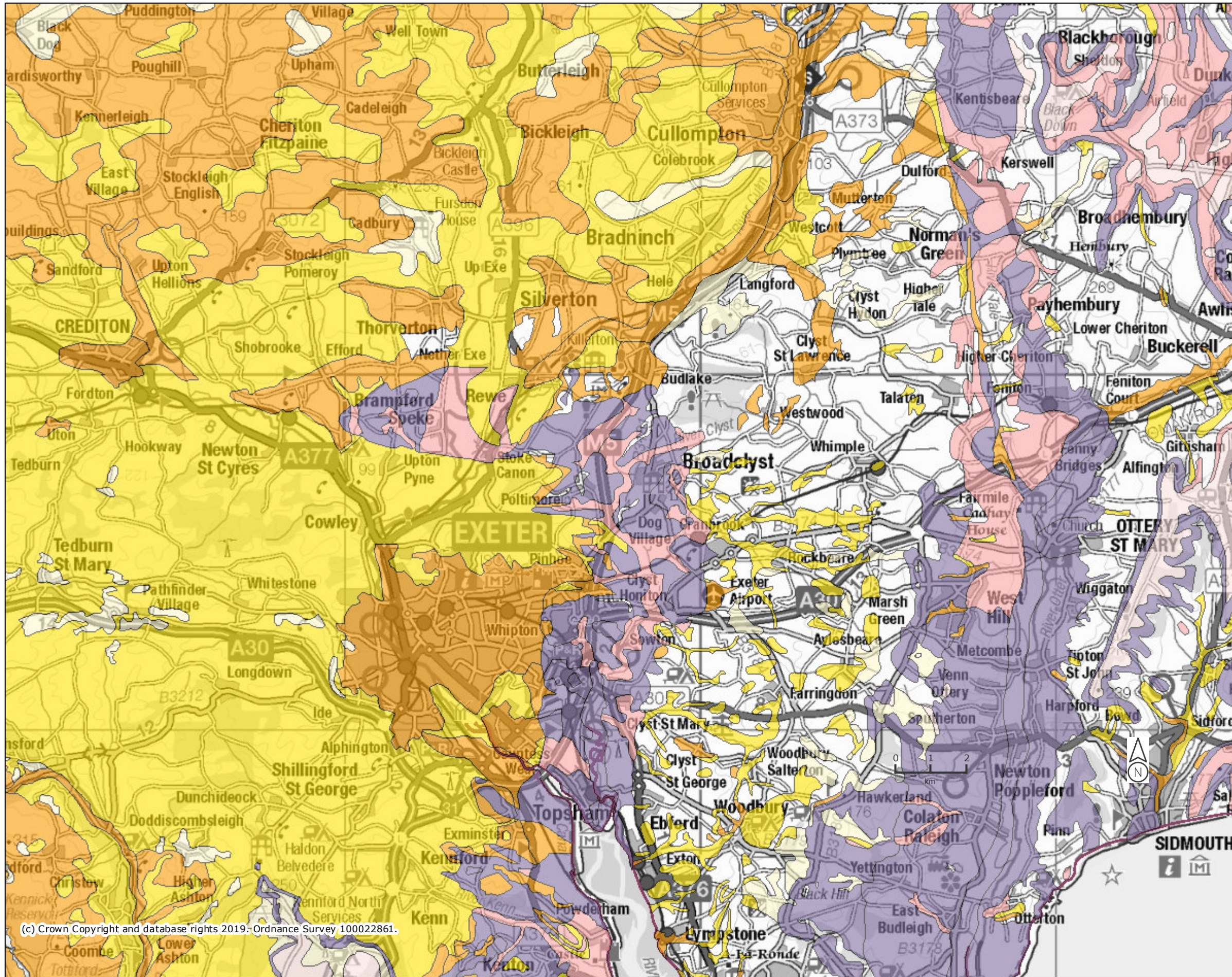
Low



Very low



Location you selected



Legend

Groundwater Vulnerability Map (England)

- Major Aquifer High
- Major Aquifer Intermediate
- Major Aquifer Low
- Minor Aquifer High
- Minor Aquifer Intermediate
- Minor Aquifer Low

Projection = OSGB36
 xmin = 275900
 ymin = 85770
 xmax = 319900
 ymax = 107600



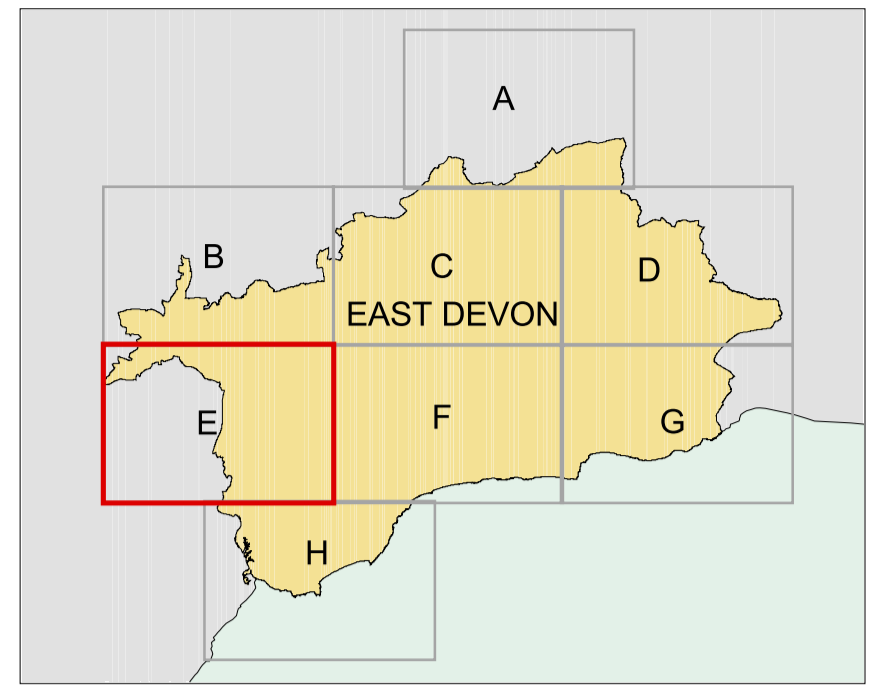
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APPENDIX D

**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.

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

Title: **3E - HISTORICAL FLOODING**

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

www.halcrow.com

Ash House
Falcon Road
Sowton
Exeter
EX2 7LB

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







APPENDIX E

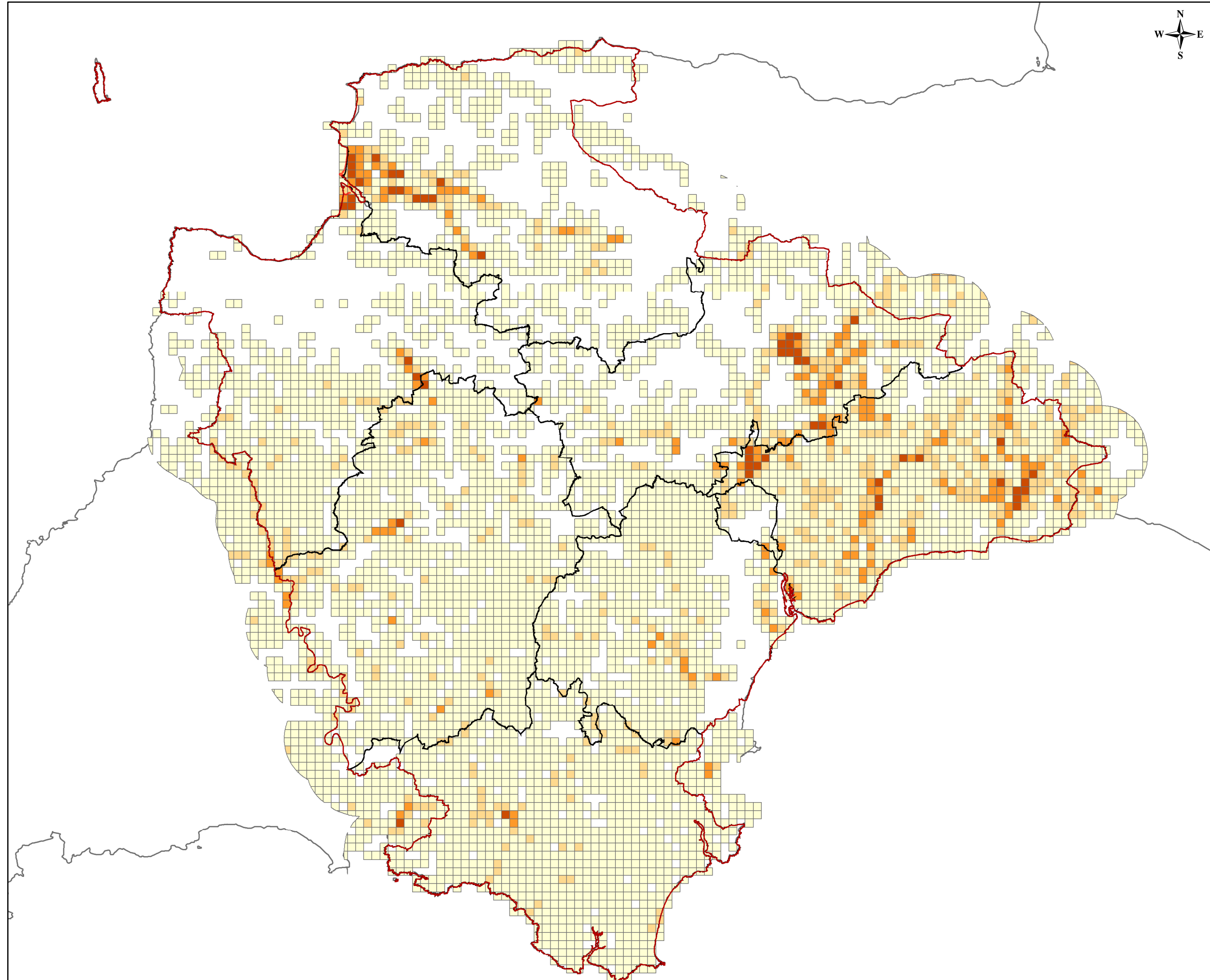
**Devon County Council
Preliminary Flood Risk Assessment Extracts**



Devon County Council Preliminary Flood Risk Assessment

Areas Susceptible to Groundwater Flooding

-  Devon Boundary
-  District Council Boundaries
- Areas Susceptible to Groundwater Flooding RISK**
-  $\geq 75\%$
-  $\geq 50\% < 75\%$
-  $\geq 25\% < 50\%$
-  $< 25\%$



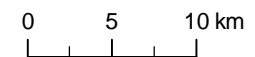
Date: 16/03/2011	Author: Flood Risk Management (RR)
Scale: 1:450,000 @ A3	File:\GIS\PFRA Maps\ AStGWF DCC 2.mxd



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



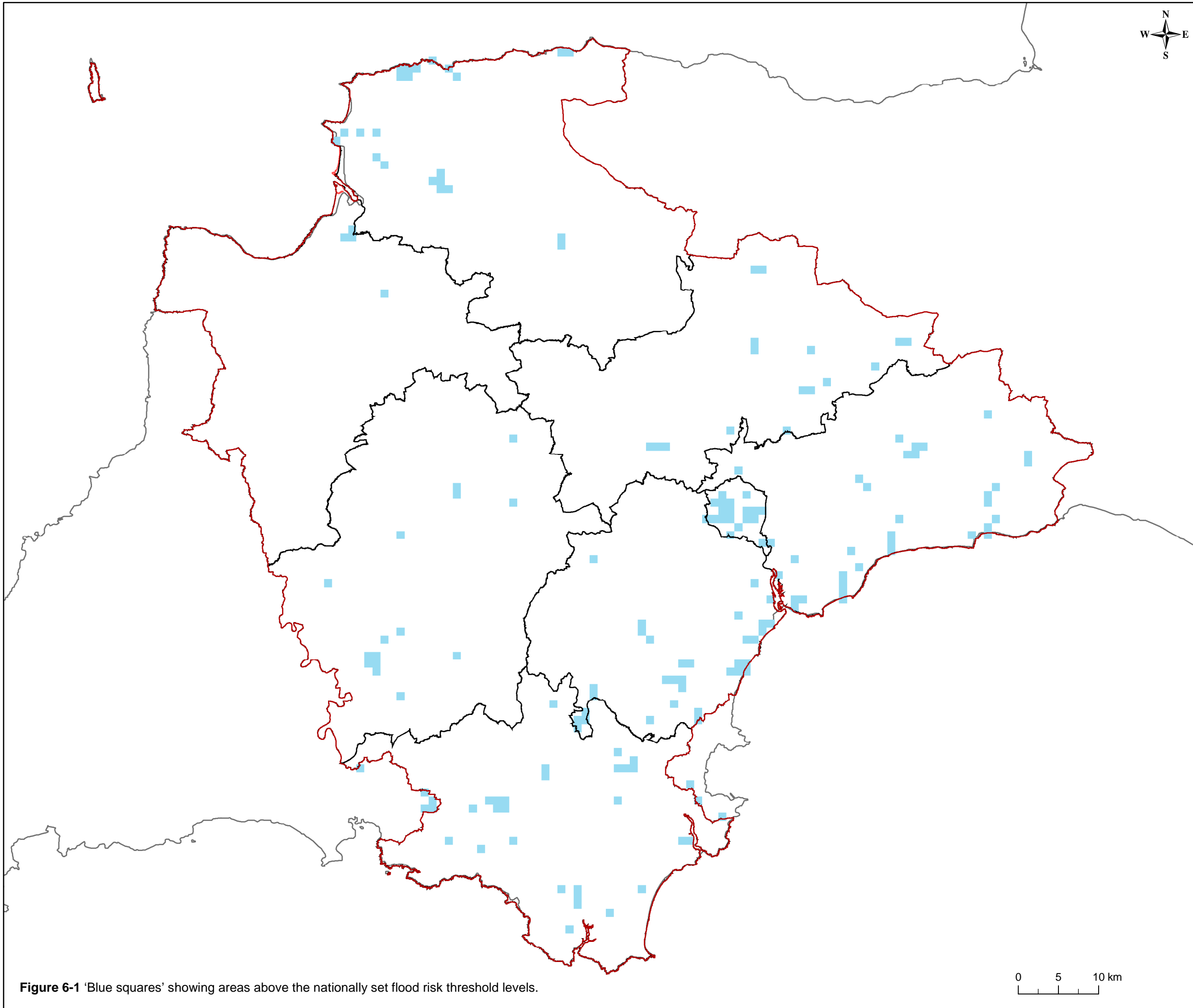


Figure 6-1 'Blue squares' showing areas above the nationally set flood risk threshold levels.

**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

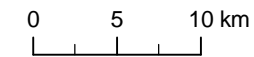
Indicators calculated using the Environment Agency's detailed method of counting (based on property outlines) for the new Flood Map for Surface Water (deep – for 1 in 200 annual probability rainfall).

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



Highway Management
Devon County Council
Environment, Economy & Culture
Lucombe House, County Hall
Exeter, EX2 4QW
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APPENDIX F

Micro Drainage Calculations

Swale 1
CranbrookDate 14/01/2019 17:25
File Catchment 1 Cascade.casxDesigned by NA
Checked by GG

XP Solutions

Source Control 2018.1

Cascade Summary of Results for Swale 1.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 1.srcx (None)

Half Drain Time : 6 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	15.477	0.477	0.0	29.8	29.8	18.2	Flood Risk
30 min Summer	15.458	0.458	0.0	29.1	29.1	16.2	Flood Risk
60 min Summer	15.413	0.413	0.0	27.3	27.3	12.3	Flood Risk
120 min Summer	15.336	0.336	0.0	24.0	24.0	7.1	Flood Risk
180 min Summer	15.277	0.277	0.0	21.1	21.1	4.3	O K
240 min Summer	15.235	0.235	0.0	18.8	18.8	2.8	O K
360 min Summer	15.192	0.192	0.0	15.0	15.0	1.7	O K
480 min Summer	15.168	0.168	0.0	12.4	12.4	1.2	O K
600 min Summer	15.152	0.152	0.0	10.6	10.6	0.9	O K
720 min Summer	15.140	0.140	0.0	9.3	9.3	0.8	O K
960 min Summer	15.123	0.123	0.0	7.4	7.4	0.6	O K
1440 min Summer	15.098	0.098	0.0	5.4	5.4	0.3	O K
2160 min Summer	15.082	0.082	0.0	3.9	3.9	0.2	O K
2880 min Summer	15.074	0.074	0.0	3.1	3.1	0.2	O K
4320 min Summer	15.063	0.063	0.0	2.2	2.2	0.1	O K
5760 min Summer	15.055	0.055	0.0	1.7	1.7	0.1	O K
7200 min Summer	15.050	0.050	0.0	1.5	1.5	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.334	0.0	35.3	13
30 min Summer	103.613	0.0	42.7	21
60 min Summer	62.659	0.0	51.7	38
120 min Summer	37.893	0.0	62.5	68
180 min Summer	28.235	0.0	69.9	96
240 min Summer	22.916	0.0	75.6	126
360 min Summer	17.075	0.0	84.5	184
480 min Summer	13.858	0.0	91.5	244
600 min Summer	11.786	0.0	97.2	306
720 min Summer	10.326	0.0	102.2	366
960 min Summer	8.216	0.0	108.5	482
1440 min Summer	5.953	0.0	117.9	730
2160 min Summer	4.313	0.0	128.1	1068
2880 min Summer	3.432	0.0	135.9	1444
4320 min Summer	2.444	0.0	145.2	2144
5760 min Summer	1.920	0.0	152.1	2840
7200 min Summer	1.593	0.0	157.7	3608

Swale 1
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Cascade Summary of Results for 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 (m ³)	Status
8640 min Summer	15.047	0.047	0.0	1.3	1.3	0.1	O K
10080 min Summer	15.044	0.044	0.0	1.1	1.1	0.1	O K
15 min Winter	15.501	0.501	0.0	30.7	30.7	20.8	Flood Risk
30 min Winter	15.472	0.472	0.0	29.6	29.6	17.7	Flood Risk
60 min Winter	15.403	0.403	0.0	26.9	26.9	11.5	Flood Risk
120 min Winter	15.291	0.291	0.0	21.8	21.8	4.9	O K
180 min Winter	15.219	0.219	0.0	17.8	17.8	2.3	O K
240 min Winter	15.189	0.189	0.0	14.7	14.7	1.6	O K
360 min Winter	15.157	0.157	0.0	11.1	11.1	1.0	O K
480 min Winter	15.138	0.138	0.0	9.0	9.0	0.7	O K
600 min Winter	15.125	0.125	0.0	7.7	7.7	0.6	O K
720 min Winter	15.115	0.115	0.0	6.7	6.7	0.5	O K
960 min Winter	15.098	0.098	0.0	5.4	5.4	0.3	O K
1440 min Winter	15.082	0.082	0.0	3.9	3.9	0.2	O K
2160 min Winter	15.071	0.071	0.0	2.8	2.8	0.2	O K
2880 min Winter	15.063	0.063	0.0	2.3	2.3	0.1	O K
4320 min Winter	15.053	0.053	0.0	1.6	1.6	0.1	O K
5760 min Winter	15.047	0.047	0.0	1.3	1.3	0.1	O K
7200 min Winter	15.043	0.043	0.0	1.1	1.1	0.1	O K
8640 min Winter	15.039	0.039	0.0	0.9	0.9	0.0	O K
10080 min Winter	15.037	0.037	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.367	0.0	162.4	4360
10080 min Summer	1.202	0.0	166.6	4952
15 min Winter	171.334	0.0	39.6	14
30 min Winter	103.613	0.0	47.9	22
60 min Winter	62.659	0.0	57.9	38
120 min Winter	37.893	0.0	70.0	68
180 min Winter	28.235	0.0	78.3	96
240 min Winter	22.916	0.0	84.7	124
360 min Winter	17.075	0.0	94.7	184
480 min Winter	13.858	0.0	102.4	244
600 min Winter	11.786	0.0	108.9	300
720 min Winter	10.326	0.0	114.5	366
960 min Winter	8.216	0.0	121.5	482
1440 min Winter	5.953	0.0	132.0	718
2160 min Winter	4.313	0.0	143.5	1068
2880 min Winter	3.432	0.0	152.2	1432
4320 min Winter	2.444	0.0	162.6	2132
5760 min Winter	1.920	0.0	170.3	2968
7200 min Winter	1.593	0.0	176.6	3576
8640 min Winter	1.367	0.0	181.9	4304
10080 min Winter	1.202	0.0	186.6	5240

Swale 1
Cranbrook



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Cascade Rainfall Details for Swale 1.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299250 95300 SX 99250 95300
C (1km)	-0.026
D1 (1km)	0.394
D2 (1km)	0.325
D3 (1km)	0.282
E (1km)	0.282
F (1km)	2.504
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)	Area
From:	To: (ha)
0	4 0.110

Swale 1
Cranbrook



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Cascade Model Details for Swale 1.srcx

Storage is Online Cover Level (m) 15.600

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	2081.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	90.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	15.000	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) 15.000

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Cascade Summary of Results for Basin 1.srcx

Upstream Outflow To Overflow To
Structures

Swale 1.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	14.162	0.562	144.7	4845.2	O K
30 min Summer	14.267	0.667	145.7	5810.9	O K
60 min Summer	14.384	0.784	145.7	6907.9	O K
120 min Summer	14.509	0.909	145.7	8102.5	O K
180 min Summer	14.581	0.981	145.7	8805.3	O K
240 min Summer	14.629	1.029	145.7	9279.8	O K
360 min Summer	14.688	1.088	145.7	9867.8	O K
480 min Summer	14.720	1.120	145.7	10185.9	Flood Risk
600 min Summer	14.735	1.135	145.7	10339.3	Flood Risk
720 min Summer	14.744	1.144	145.7	10433.8	Flood Risk
960 min Summer	14.728	1.128	145.7	10267.8	Flood Risk
1440 min Summer	14.682	1.082	145.7	9810.6	O K
2160 min Summer	14.600	1.000	145.7	8989.9	O K
2880 min Summer	14.514	0.914	145.7	8151.0	O K
4320 min Summer	14.337	0.737	145.7	6459.0	O K
5760 min Summer	14.201	0.601	145.3	5201.2	O K
7200 min Summer	14.104	0.504	143.1	4316.8	O K
8640 min Summer	14.038	0.438	140.2	3728.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.334	0.0	4281.3	19
30 min Summer	103.613	0.0	5252.5	34
60 min Summer	62.659	0.0	6872.6	64
120 min Summer	37.893	0.0	8356.7	122
180 min Summer	28.235	0.0	9360.2	182
240 min Summer	22.916	0.0	10139.6	242
360 min Summer	17.075	0.0	11339.5	360
480 min Summer	13.858	0.0	12265.9	480
600 min Summer	11.786	0.0	13028.1	570
720 min Summer	10.326	0.0	13678.5	620
960 min Summer	8.216	0.0	14463.1	742
1440 min Summer	5.953	0.0	15576.7	996
2160 min Summer	4.313	0.0	17660.2	1388
2880 min Summer	3.432	0.0	18718.2	1788
4320 min Summer	2.444	0.0	19857.2	2548
5760 min Summer	1.920	0.0	21139.2	3232
7200 min Summer	1.593	0.0	21888.2	3896
8640 min Summer	1.367	0.0	22488.5	4576

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Cascade Summary of Results for Basin 1.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	14.002	0.402	130.7	3407.2	O K
15 min Winter	14.226	0.626	145.5	5431.3	O K
30 min Winter	14.344	0.744	145.7	6522.1	O K
60 min Winter	14.474	0.874	145.7	7768.8	O K
120 min Winter	14.614	1.014	145.7	9135.3	O K
180 min Winter	14.697	1.097	145.7	9958.8	O K
240 min Winter	14.753	1.153	145.7	10527.7	Flood Risk
360 min Winter	14.822	1.222	145.7	11231.4	Flood Risk
480 min Winter	14.860	1.260	145.7	11614.6	Flood Risk
600 min Winter	14.879	1.279	145.7	11815.3	Flood Risk
720 min Winter	14.887	1.287	145.7	11899.2	Flood Risk
960 min Winter	14.859	1.259	145.7	11610.9	Flood Risk
1440 min Winter	14.801	1.201	145.7	11009.2	Flood Risk
2160 min Winter	14.679	1.079	145.7	9778.9	O K
2880 min Winter	14.544	0.944	145.7	8445.3	O K
4320 min Winter	14.283	0.683	145.7	5954.4	O K
5760 min Winter	14.104	0.504	143.1	4314.8	O K
7200 min Winter	14.012	0.412	134.6	3501.1	O K
8640 min Winter	13.971	0.371	118.4	3132.9	O K
10080 min Winter	13.941	0.341	105.3	2874.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	22931.3	5248
15 min Winter	171.334	0.0	4841.0	19
30 min Winter	103.613	0.0	5921.2	33
60 min Winter	62.659	0.0	7725.6	62
120 min Winter	37.893	0.0	9384.6	120
180 min Winter	28.235	0.0	10505.0	180
240 min Winter	22.916	0.0	11373.9	238
360 min Winter	17.075	0.0	12711.8	352
480 min Winter	13.858	0.0	13744.3	464
600 min Winter	11.786	0.0	14592.1	574
720 min Winter	10.326	0.0	15313.1	678
960 min Winter	8.216	0.0	16175.0	778
1440 min Winter	5.953	0.0	17346.5	1082
2160 min Winter	4.313	0.0	19795.3	1532
2880 min Winter	3.432	0.0	20984.5	1932
4320 min Winter	2.444	0.0	22292.0	2676
5760 min Winter	1.920	0.0	23692.8	3296
7200 min Winter	1.593	0.0	24537.0	3888
8640 min Winter	1.367	0.0	25219.3	4584
10080 min Winter	1.202	0.0	25739.8	5344

Basin 1
Cranbrook



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Cascade Rainfall Details for Basin 1.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299250 95300 SX 99250 95300
C (1km)	-0.026
D1 (1km)	0.394
D2 (1km)	0.325
D3 (1km)	0.282
E (1km)	0.282
F (1km)	2.504
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) 15.278

Time (mins)	Area
From:	To: (ha)
0	4 15.278

Basin 1
Cranbrook



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File Catchment 1 Cascade.casx

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Cascade Model Details for Basin 1.srcx

Storage is Online Cover Level (m) 15.000

Tank or Pond Structure

Invert Level (m) 13.600

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	8148.0	1.400	10598.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0456-1457-1400-1457
Design Head (m)	1.400
Design Flow (l/s)	145.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	456
Invert Level (m)	13.600
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)	1.400	145.7
Flush-Flo™	0.669	145.7
Kick-Flo®	1.123	130.8
Mean Flow over Head Range	-	115.3

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	11.9	1.200	135.1	3.000	211.3	7.000	320.2
0.200	43.4	1.400	145.7	3.500	227.9	7.500	331.3
0.300	86.6	1.600	155.5	4.000	243.3	8.000	341.9
0.400	130.1	1.800	164.7	4.500	257.8	8.500	352.3
0.500	142.9	2.000	173.3	5.000	271.4	9.000	362.3
0.600	145.3	2.200	181.6	5.500	284.4	9.500	372.1
0.800	144.5	2.400	189.5	6.000	296.9		
1.000	138.4	2.600	197.0	6.500	308.8		

Swale 1a
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Source Control 2018.1

Cascade Summary of Results for Swale 1a.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 1a.srcx (None)

Half Drain Time : 8 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	13.839	0.439	0.0	28.3	28.3	16.1	Flood Risk
30 min Summer	13.821	0.421	0.0	27.6	27.6	14.3	Flood Risk
60 min Summer	13.776	0.376	0.0	25.8	25.8	10.6	Flood Risk
120 min Summer	13.703	0.303	0.0	22.4	22.4	6.0	Flood Risk
180 min Summer	13.651	0.251	0.0	19.7	19.7	3.7	O K
240 min Summer	13.614	0.214	0.0	17.5	17.5	2.5	O K
360 min Summer	13.580	0.180	0.0	13.6	13.6	1.6	O K
480 min Summer	13.558	0.158	0.0	11.2	11.2	1.2	O K
600 min Summer	13.544	0.144	0.0	9.6	9.6	0.9	O K
720 min Summer	13.533	0.133	0.0	8.5	8.5	0.7	O K
960 min Summer	13.516	0.116	0.0	6.7	6.7	0.5	O K
1440 min Summer	13.492	0.092	0.0	4.9	4.9	0.3	O K
2160 min Summer	13.478	0.078	0.0	3.5	3.5	0.2	O K
2880 min Summer	13.471	0.071	0.0	2.8	2.8	0.2	O K
4320 min Summer	13.459	0.059	0.0	2.0	2.0	0.1	O K
5760 min Summer	13.452	0.052	0.0	1.6	1.6	0.1	O K
7200 min Summer	13.448	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	171.334	0.0	32.1	13
30 min Summer	103.613	0.0	38.9	21
60 min Summer	62.659	0.0	47.0	36
120 min Summer	37.893	0.0	56.8	68
180 min Summer	28.235	0.0	63.5	96
240 min Summer	22.916	0.0	68.8	124
360 min Summer	17.075	0.0	76.8	184
480 min Summer	13.858	0.0	83.2	244
600 min Summer	11.786	0.0	88.4	306
720 min Summer	10.326	0.0	92.9	366
960 min Summer	8.216	0.0	98.6	484
1440 min Summer	5.953	0.0	107.2	726
2160 min Summer	4.313	0.0	116.5	1068
2880 min Summer	3.432	0.0	123.6	1420
4320 min Summer	2.444	0.0	132.0	2136
5760 min Summer	1.920	0.0	138.3	2856
7200 min Summer	1.593	0.0	143.4	3592

Swale 1a
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Cascade Summary of Results for Swale 1a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
8640 min Summer	13.445	0.045	0.0	1.1	1.1	0.1	O K
10080 min Summer	13.442	0.042	0.0	1.0	1.0	0.1	O K
15 min Winter	13.861	0.461	0.0	29.2	29.2	18.4	Flood Risk
30 min Winter	13.833	0.433	0.0	28.1	28.1	15.5	Flood Risk
60 min Winter	13.766	0.366	0.0	25.3	25.3	9.9	Flood Risk
120 min Winter	13.661	0.261	0.0	20.2	20.2	4.1	O K
180 min Winter	13.603	0.203	0.0	16.3	16.3	2.2	O K
240 min Winter	13.578	0.178	0.0	13.4	13.4	1.5	O K
360 min Winter	13.548	0.148	0.0	10.1	10.1	1.0	O K
480 min Winter	13.530	0.130	0.0	8.2	8.2	0.7	O K
600 min Winter	13.519	0.119	0.0	7.0	7.0	0.6	O K
720 min Winter	13.508	0.108	0.0	6.1	6.1	0.5	O K
960 min Winter	13.492	0.092	0.0	4.9	4.9	0.3	O K
1440 min Winter	13.478	0.078	0.0	3.5	3.5	0.2	O K
2160 min Winter	13.468	0.068	0.0	2.6	2.6	0.2	O K
2880 min Winter	13.460	0.060	0.0	2.0	2.0	0.1	O K
4320 min Winter	13.450	0.050	0.0	1.5	1.5	0.1	O K
5760 min Winter	13.445	0.045	0.0	1.2	1.2	0.1	O K
7200 min Winter	13.440	0.040	0.0	1.0	1.0	0.1	O K
8640 min Winter	13.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Winter	13.435	0.035	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.367	0.0	147.7	4288
10080 min Summer	1.202	0.0	151.4	5000
15 min Winter	171.334	0.0	36.0	13
30 min Winter	103.613	0.0	43.5	22
60 min Winter	62.659	0.0	52.6	38
120 min Winter	37.893	0.0	63.7	68
180 min Winter	28.235	0.0	71.2	96
240 min Winter	22.916	0.0	77.0	124
360 min Winter	17.075	0.0	86.1	184
480 min Winter	13.858	0.0	93.1	242
600 min Winter	11.786	0.0	99.0	306
720 min Winter	10.326	0.0	104.1	366
960 min Winter	8.216	0.0	110.4	482
1440 min Winter	5.953	0.0	120.0	714
2160 min Winter	4.313	0.0	130.4	1096
2880 min Winter	3.432	0.0	138.4	1456
4320 min Winter	2.444	0.0	147.8	2140
5760 min Winter	1.920	0.0	154.9	2944
7200 min Winter	1.593	0.0	160.6	3736
8640 min Winter	1.367	0.0	165.4	4304
10080 min Winter	1.202	0.0	169.6	5104

Swale 1a
Cranbrook



Date 14/01/2019 17:27

Designed by NA

File Catchment 1a Cascade.casx

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XP Solutions

Source Control 2018.1

Cascade Rainfall Details for Swale 1a.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299250 95300 SX 99250 95300
C (1km)	-0.026
D1 (1km)	0.394
D2 (1km)	0.325
D3 (1km)	0.282
E (1km)	0.282
F (1km)	2.504
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)	Area
From:	To: (ha)
0	4 0.100

Swale 1a
Cranbrook



Date 14/01/2019 17:27

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File Catchment 1a Cascade.casx

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Source Control 2018.1

Cascade Model Details for Swale 1a.srcx

Storage is Online Cover Level (m) 14.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	54.0
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)	0.000
Invert Level (m)	13.400	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) 13.400

Basin 1a
CranbrookDate 14/01/2019 17:26
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Cascade Summary of Results for Basin 1a.srcx

Upstream Outflow To Overflow To
Structures

Swale 1a.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	13.455	0.455	3.7	122.4	O K
30 min Summer	13.530	0.530	3.7	147.9	O K
60 min Summer	13.608	0.608	3.7	176.4	O K
120 min Summer	13.685	0.685	3.7	205.8	O K
180 min Summer	13.726	0.726	3.7	222.3	Flood Risk
240 min Summer	13.751	0.751	3.7	232.7	Flood Risk
360 min Summer	13.778	0.778	3.7	243.9	Flood Risk
480 min Summer	13.788	0.788	3.7	248.2	Flood Risk
600 min Summer	13.789	0.789	3.7	248.6	Flood Risk
720 min Summer	13.787	0.787	3.7	247.9	Flood Risk
960 min Summer	13.766	0.766	3.7	239.0	Flood Risk
1440 min Summer	13.726	0.726	3.7	222.2	Flood Risk
2160 min Summer	13.665	0.665	3.7	198.2	O K
2880 min Summer	13.597	0.597	3.7	172.3	O K
4320 min Summer	13.453	0.453	3.7	122.0	O K
5760 min Summer	13.337	0.337	3.7	85.6	O K
7200 min Summer	13.250	0.250	3.7	60.7	O K
8640 min Summer	13.189	0.189	3.6	44.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.334	0.0	126.0	29
30 min Summer	103.613	0.0	152.5	38
60 min Summer	62.659	0.0	185.9	64
120 min Summer	37.893	0.0	224.9	124
180 min Summer	28.235	0.0	251.4	182
240 min Summer	22.916	0.0	272.0	242
360 min Summer	17.075	0.0	304.1	362
480 min Summer	13.858	0.0	329.0	480
600 min Summer	11.786	0.0	349.7	574
720 min Summer	10.326	0.0	367.6	626
960 min Summer	8.216	0.0	389.8	752
1440 min Summer	5.953	0.0	423.0	1012
2160 min Summer	4.313	0.0	461.9	1428
2880 min Summer	3.432	0.0	490.0	1820
4320 min Summer	2.444	0.0	523.0	2552
5760 min Summer	1.920	0.0	548.7	3232
7200 min Summer	1.593	0.0	568.9	3896
8640 min Summer	1.367	0.0	585.8	4584

Basin 1a
CranbrookDate 14/01/2019 17:26
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Source Control 2018.1

Cascade Summary of Results for Basin 1a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	13.148	0.148	3.4	34.3	O K
15 min Winter	13.499	0.499	3.7	137.3	O K
30 min Winter	13.580	0.580	3.7	166.1	O K
60 min Winter	13.667	0.667	3.7	198.8	O K
120 min Winter	13.751	0.751	3.7	232.6	Flood Risk
180 min Winter	13.796	0.796	3.7	252.0	Flood Risk
240 min Winter	13.826	0.826	3.7	264.7	Flood Risk
360 min Winter	13.859	0.859	3.7	279.5	Flood Risk
480 min Winter	13.874	0.874	3.7	286.5	Flood Risk
600 min Winter	13.880	0.880	3.7	289.1	Flood Risk
720 min Winter	13.880	0.880	3.7	288.9	Flood Risk
960 min Winter	13.853	0.853	3.7	276.7	Flood Risk
1440 min Winter	13.803	0.803	3.7	255.0	Flood Risk
2160 min Winter	13.722	0.722	3.7	220.7	Flood Risk
2880 min Winter	13.627	0.627	3.7	183.6	O K
4320 min Winter	13.405	0.405	3.7	106.5	O K
5760 min Winter	13.246	0.246	3.7	59.7	O K
7200 min Winter	13.154	0.154	3.4	35.8	O K
8640 min Winter	13.111	0.111	3.2	25.2	O K
10080 min Winter	13.097	0.097	2.8	21.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	600.3	5248
15 min Winter	171.334	0.0	141.2	30
30 min Winter	103.613	0.0	170.8	40
60 min Winter	62.659	0.0	208.2	64
120 min Winter	37.893	0.0	251.9	122
180 min Winter	28.235	0.0	281.6	180
240 min Winter	22.916	0.0	304.7	238
360 min Winter	17.075	0.0	340.5	352
480 min Winter	13.858	0.0	368.4	466
600 min Winter	11.786	0.0	391.6	576
720 min Winter	10.326	0.0	411.6	682
960 min Winter	8.216	0.0	436.3	796
1440 min Winter	5.953	0.0	473.0	1086
2160 min Winter	4.313	0.0	517.3	1556
2880 min Winter	3.432	0.0	548.8	2016
4320 min Winter	2.444	0.0	585.9	2684
5760 min Winter	1.920	0.0	614.6	3336
7200 min Winter	1.593	0.0	637.2	3896
8640 min Winter	1.367	0.0	656.2	4424
10080 min Winter	1.202	0.0	672.5	5144

Basin 1a
Cranbrook



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File Catchment 1a Cascade.casx

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Source Control 2018.1

Cascade Rainfall Details for Basin 1a.srcx

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 299250 95300 SX 99250 95300
C (1km)	-0.026
D1 (1km)	0.394
D2 (1km)	0.325
D3 (1km)	0.282
E (1km)	0.282
F (1km)	2.504
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) 0.297

Time (mins)	Area
From:	To: (ha)
0	4 0.297

Basin 1a
Cranbrook



Date 14/01/2019 17:26
File Catchment 1a Cascade.casx

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Source Control 2018.1

Cascade Model Details for Basin 1a.srcx

Storage is Online Cover Level (m) 14.000

Tank or Pond Structure

Invert Level (m) 13.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	214.0	1.000	499.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0091-3700-1000-3700
 Design Head (m) 1.000
 Design Flow (l/s) 3.7
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 91
 Invert Level (m) 13.000
 Minimum Outlet Pipe Diameter (mm) 150
 Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.7
Flush-Flo™	0.299	3.7
Kick-Flo®	0.631	3.0
Mean Flow over Head Range	-	3.2

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	2.9	1.200	4.0	3.000	6.2	7.000	9.2
0.200	3.6	1.400	4.3	3.500	6.6	7.500	9.5
0.300	3.7	1.600	4.6	4.000	7.1	8.000	9.8
0.400	3.6	1.800	4.9	4.500	7.5	8.500	10.1
0.500	3.5	2.000	5.1	5.000	7.8	9.000	10.4
0.600	3.2	2.200	5.3	5.500	8.2	9.500	10.6
0.800	3.3	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	8.9		

Swale 2
CranbrookDate 17/01/2019 11:21
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Source Control 2018.1

Cascade Summary of Results for Swale 2.srcx**Upstream Outflow To Overflow To
Structures**

(None) Pond 2.srcx (None)

Half Drain Time : 5 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow (l/s)	Max Volume (m ³)	Status
15 min Summer	19.878	0.478	0.0	29.8	29.8	10.2	Flood Risk	
30 min Summer	19.844	0.444	0.0	28.5	28.5	8.3	Flood Risk	
60 min Summer	19.774	0.374	0.0	25.7	25.7	5.2	Flood Risk	
120 min Summer	19.670	0.270	0.0	20.8	20.8	2.2	O K	
180 min Summer	19.614	0.214	0.0	17.5	17.5	1.2	O K	
240 min Summer	19.587	0.187	0.0	14.5	14.5	0.9	O K	
360 min Summer	19.555	0.155	0.0	10.9	10.9	0.6	O K	
480 min Summer	19.537	0.137	0.0	8.9	8.9	0.4	O K	
600 min Summer	19.525	0.125	0.0	7.6	7.6	0.3	O K	
720 min Summer	19.514	0.114	0.0	6.6	6.6	0.3	O K	
960 min Summer	19.497	0.097	0.0	5.3	5.3	0.2	O K	
1440 min Summer	19.481	0.081	0.0	3.8	3.8	0.1	O K	
2160 min Summer	19.471	0.071	0.0	2.8	2.8	0.1	O K	
2880 min Summer	19.463	0.063	0.0	2.2	2.2	0.1	O K	
4320 min Summer	19.452	0.052	0.0	1.6	1.6	0.0	O K	
5760 min Summer	19.447	0.047	0.0	1.3	1.3	0.0	O K	
7200 min Summer	19.442	0.042	0.0	1.0	1.0	0.0	O K	

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
15 min Summer	171.494	0.0	25.7	12
30 min Summer	103.351	0.0	31.0	20
60 min Summer	62.285	0.0	37.4	36
120 min Summer	37.536	0.0	45.0	64
180 min Summer	27.912	0.0	50.2	94
240 min Summer	22.621	0.0	54.3	124
360 min Summer	16.821	0.0	60.6	184
480 min Summer	13.633	0.0	65.4	244
600 min Summer	11.582	0.0	69.5	302
720 min Summer	10.137	0.0	73.0	366
960 min Summer	8.038	0.0	77.2	488
1440 min Summer	5.796	0.0	83.5	728
2160 min Summer	4.179	0.0	90.3	1072
2880 min Summer	3.314	0.0	95.4	1428
4320 min Summer	2.386	0.0	103.1	2164
5760 min Summer	1.891	0.0	108.9	2880
7200 min Summer	1.578	0.0	113.6	3672

Swale 2
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Source Control 2018.1

Cascade Summary of Results for Swale 2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
8640 min Summer	19.439	0.039	0.0	0.9	0.9	0.0	O K
10080 min Summer	19.437	0.037	0.0	0.8	0.8	0.0	O K
15 min Winter	19.901	0.501	0.0	30.6	30.6	11.5	Flood Risk
30 min Winter	19.846	0.446	0.0	28.6	28.6	8.4	Flood Risk
60 min Winter	19.741	0.341	0.0	24.2	24.2	4.1	Flood Risk
120 min Winter	19.613	0.213	0.0	17.4	17.4	1.2	O K
180 min Winter	19.575	0.175	0.0	13.1	13.1	0.7	O K
240 min Winter	19.553	0.153	0.0	10.6	10.6	0.5	O K
360 min Winter	19.528	0.128	0.0	8.0	8.0	0.3	O K
480 min Winter	19.512	0.112	0.0	6.5	6.5	0.3	O K
600 min Winter	19.500	0.100	0.0	5.5	5.5	0.2	O K
720 min Winter	19.491	0.091	0.0	4.8	4.8	0.2	O K
960 min Winter	19.481	0.081	0.0	3.8	3.8	0.1	O K
1440 min Winter	19.471	0.071	0.0	2.8	2.8	0.1	O K
2160 min Winter	19.459	0.059	0.0	2.0	2.0	0.1	O K
2880 min Winter	19.453	0.053	0.0	1.6	1.6	0.0	O K
4320 min Winter	19.445	0.045	0.0	1.1	1.1	0.0	O K
5760 min Winter	19.439	0.039	0.0	0.9	0.9	0.0	O K
7200 min Winter	19.436	0.036	0.0	0.8	0.8	0.0	O K
8640 min Winter	19.434	0.034	0.0	0.7	0.7	0.0	O K
10080 min Winter	19.432	0.032	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	117.6	4320
10080 min Summer	1.202	0.0	121.1	5128
15 min Winter	171.494	0.0	28.8	13
30 min Winter	103.351	0.0	34.7	21
60 min Winter	62.285	0.0	41.9	36
120 min Winter	37.536	0.0	50.4	64
180 min Winter	27.912	0.0	56.3	94
240 min Winter	22.621	0.0	60.8	124
360 min Winter	16.821	0.0	67.8	182
480 min Winter	13.633	0.0	73.3	242
600 min Winter	11.582	0.0	77.8	304
720 min Winter	10.137	0.0	81.7	360
960 min Winter	8.038	0.0	86.4	484
1440 min Winter	5.796	0.0	93.5	708
2160 min Winter	4.179	0.0	101.1	1080
2880 min Winter	3.314	0.0	106.9	1420
4320 min Winter	2.386	0.0	115.5	2160
5760 min Winter	1.891	0.0	122.0	2904
7200 min Winter	1.578	0.0	127.3	3408
8640 min Winter	1.362	0.0	131.8	4320
10080 min Winter	1.202	0.0	135.7	5032

Swale 2
Cranbrook



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Source Control 2018.1

Cascade Rainfall Details for 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) 0.080

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

Swale 2
Cranbrook



Date 17/01/2019 11:21
File Catchment 2 Cascade.casx

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Source Control 2018.1

Cascade Model Details for Swale 2.srcx

Storage is Online Cover Level (m) 20.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1309.0
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)	0.000
Invert Level (m)	19.400	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) 19.400

Basin 2
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Cascade Summary of Results for Pond 2.srcx

Upstream Outflow To Overflow To
Structures

Swale 2.srcx (None) (None)
Pond 2a.srcx
Swale 2a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	18.247	0.447	131.5	3151.6	O K
30 min Summer	18.332	0.532	134.3	3785.5	O K
60 min Summer	18.429	0.629	135.3	4529.2	O K
120 min Summer	18.539	0.739	135.3	5386.2	O K
180 min Summer	18.608	0.808	135.3	5933.6	O K
240 min Summer	18.659	0.859	135.3	6344.0	O K
360 min Summer	18.732	0.932	135.3	6940.6	Flood Risk
480 min Summer	18.783	0.983	135.3	7362.5	Flood Risk
600 min Summer	18.820	1.020	135.3	7671.3	Flood Risk
720 min Summer	18.847	1.047	135.3	7893.7	Flood Risk
960 min Summer	18.864	1.064	135.3	8033.7	Flood Risk
1440 min Summer	18.864	1.064	135.3	8036.7	Flood Risk
2160 min Summer	18.828	1.028	135.3	7736.5	Flood Risk
2880 min Summer	18.771	0.971	135.3	7260.6	Flood Risk
4320 min Summer	18.620	0.820	135.3	6032.9	O K
5760 min Summer	18.471	0.671	135.3	4850.1	O K
7200 min Summer	18.355	0.555	134.8	3963.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	4360.9	19
30 min Summer	103.351	0.0	5326.9	34
60 min Summer	62.285	0.0	6910.6	64
120 min Summer	37.536	0.0	8368.7	124
180 min Summer	27.912	0.0	9352.3	182
240 min Summer	22.621	0.0	10114.9	242
360 min Summer	16.821	0.0	11287.0	362
480 min Summer	13.633	0.0	12189.7	482
600 min Summer	11.582	0.0	12930.0	602
720 min Summer	10.137	0.0	13561.3	722
960 min Summer	8.038	0.0	14289.0	962
1440 min Summer	5.796	0.0	15294.9	1370
2160 min Summer	4.179	0.0	17227.8	1652
2880 min Summer	3.314	0.0	18192.4	1960
4320 min Summer	2.386	0.0	19517.7	2632
5760 min Summer	1.891	0.0	20929.8	3336
7200 min Summer	1.578	0.0	21809.3	4000

Basin 2
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Source Control 2018.1

Cascade Summary of Results for Pond 2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
8640 min Summer	18.272	0.472	132.6	3341.9	O K
10080 min Summer	18.217	0.417	130.0	2928.2	O K
15 min Winter	18.297	0.497	133.4	3527.4	O K
30 min Winter	18.392	0.592	135.2	4241.0	O K
60 min Winter	18.499	0.699	135.3	5074.8	O K
120 min Winter	18.622	0.822	135.3	6046.0	O K
180 min Winter	18.701	0.901	135.3	6682.2	Flood Risk
240 min Winter	18.759	0.959	135.3	7162.9	Flood Risk
360 min Winter	18.844	1.044	135.3	7866.3	Flood Risk
480 min Winter	18.900	1.100	135.3	8339.2	Flood Risk
600 min Winter	18.938	1.138	135.3	8671.1	Flood Risk
720 min Winter	18.966	1.166	135.3	8906.0	Flood Risk
960 min Winter	18.973	1.173	135.3	8970.3	Flood Risk
1440 min Winter	18.982	1.182	135.3	9044.1	Flood Risk
2160 min Winter	18.941	1.141	135.3	8693.7	Flood Risk
2880 min Winter	18.856	1.056	135.3	7973.5	Flood Risk
4320 min Winter	18.578	0.778	135.3	5691.3	O K
5760 min Winter	18.363	0.563	134.9	4021.1	O K
7200 min Winter	18.231	0.431	130.8	3037.9	O K
8640 min Winter	18.180	0.380	118.6	2662.0	O K
10080 min Winter	18.149	0.349	106.2	2434.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	22524.4	4664
10080 min Summer	1.202	0.0	23066.9	5328
15 min Winter	171.494	0.0	4929.3	19
30 min Winter	103.351	0.0	6002.0	33
60 min Winter	62.285	0.0	7765.5	62
120 min Winter	37.536	0.0	9395.6	122
180 min Winter	27.912	0.0	10494.0	180
240 min Winter	22.621	0.0	11344.2	240
360 min Winter	16.821	0.0	12647.7	358
480 min Winter	13.633	0.0	13652.2	474
600 min Winter	11.582	0.0	14476.9	590
720 min Winter	10.137	0.0	15177.6	702
960 min Winter	8.038	0.0	15975.8	926
1440 min Winter	5.796	0.0	17044.2	1370
2160 min Winter	4.179	0.0	19312.4	1708
2880 min Winter	3.314	0.0	20394.5	2044
4320 min Winter	2.386	0.0	21910.5	2764
5760 min Winter	1.891	0.0	23456.7	3408
7200 min Winter	1.578	0.0	24447.2	3968
8640 min Winter	1.362	0.0	25258.5	4608
10080 min Winter	1.202	0.0	25892.7	5344

Basin 2
Cranbrook



Date 17/01/2019 11:21
File Catchment 2 Cascade.casx

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Source Control 2018.1

Cascade Rainfall Details for Pond 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) 9.769

Time (mins) Area
From: To: (ha)

0 4 9.769

Basin 2
CranbrookDate 17/01/2019 11:21
File Catchment 2 Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Model Details for Pond 2.srcx

Storage is Online Cover Level (m) 19.000

Tank or Pond Structure

Invert Level (m) 17.800

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	6704.0	1.200	8674.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0445-1355-1200-1355
Design Head (m)	1.200
Design Flow (l/s)	135.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	445
Invert Level (m)	17.800
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	135.5
Flush-Flo™	0.631	135.3
Kick-Flo®	0.997	123.8
Mean Flow over Head Range	-	104.5

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	11.7	1.200	135.5	3.000	211.9	7.000	321.1
0.200	42.7	1.400	146.1	3.500	228.5	7.500	332.2
0.300	84.6	1.600	155.9	4.000	244.0	8.000	342.9
0.400	125.9	1.800	165.1	4.500	258.5	8.500	353.3
0.500	133.5	2.000	173.8	5.000	272.2	9.000	363.4
0.600	135.3	2.200	182.1	5.500	285.3	9.500	373.2
0.800	133.0	2.400	190.0	6.000	297.7		
1.000	124.1	2.600	197.6	6.500	309.7		

Swale 2a
CranbrookDate 17/01/2019 11:21
File Catchment 2 Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Summary of Results for Swale 2a.srcx**Upstream Outflow To Overflow To**
Structures

(None) Pond 2a.srcx (None)

Half Drain Time : 3 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	23.886	0.486	0.0	30.1	30.1	6.3	Flood Risk
30 min Summer	23.835	0.435	0.0	28.2	28.2	4.7	Flood Risk
60 min Summer	23.742	0.342	0.0	24.3	24.3	2.5	Flood Risk
120 min Summer	23.628	0.228	0.0	18.4	18.4	0.9	O K
180 min Summer	23.586	0.186	0.0	14.4	14.4	0.5	O K
240 min Summer	23.564	0.164	0.0	11.9	11.9	0.4	O K
360 min Summer	23.537	0.137	0.0	8.9	8.9	0.2	O K
480 min Summer	23.522	0.122	0.0	7.3	7.3	0.2	O K
600 min Summer	23.509	0.109	0.0	6.2	6.2	0.1	O K
720 min Summer	23.499	0.099	0.0	5.4	5.4	0.1	O K
960 min Summer	23.486	0.086	0.0	4.3	4.3	0.1	O K
1440 min Summer	23.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Summer	23.463	0.063	0.0	2.3	2.3	0.0	O K
2880 min Summer	23.456	0.056	0.0	1.8	1.8	0.0	O K
4320 min Summer	23.447	0.047	0.0	1.3	1.3	0.0	O K
5760 min Summer	23.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Summer	23.439	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	171.494	0.0	21.0	12
30 min Summer	103.351	0.0	25.2	20
60 min Summer	62.285	0.0	30.4	34
120 min Summer	37.536	0.0	36.6	64
180 min Summer	27.912	0.0	40.8	92
240 min Summer	22.621	0.0	44.1	122
360 min Summer	16.821	0.0	49.2	182
480 min Summer	13.633	0.0	53.2	242
600 min Summer	11.582	0.0	56.5	300
720 min Summer	10.137	0.0	59.3	358
960 min Summer	8.038	0.0	62.7	488
1440 min Summer	5.796	0.0	67.8	716
2160 min Summer	4.179	0.0	73.3	1100
2880 min Summer	3.314	0.0	77.5	1468
4320 min Summer	2.386	0.0	83.8	2204
5760 min Summer	1.891	0.0	88.5	2904
7200 min Summer	1.578	0.0	92.3	3552

Swale 2a
CranbrookDate 17/01/2019 11:21
File Catchment 2 Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Summary of Results for Swale 2a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
8640 min Summer	23.436	0.036	0.0	0.8	0.8	0.0	O K
10080 min Summer	23.434	0.034	0.0	0.7	0.7	0.0	O K
15 min Winter	23.905	0.505	0.0	30.8	30.8	7.1	Flood Risk
30 min Winter	23.825	0.425	0.0	27.8	27.8	4.4	Flood Risk
60 min Winter	23.690	0.290	0.0	21.8	21.8	1.6	O K
120 min Winter	23.585	0.185	0.0	14.2	14.2	0.5	O K
180 min Winter	23.553	0.153	0.0	10.7	10.7	0.3	O K
240 min Winter	23.535	0.135	0.0	8.7	8.7	0.2	O K
360 min Winter	23.512	0.112	0.0	6.5	6.5	0.1	O K
480 min Winter	23.497	0.097	0.0	5.2	5.2	0.1	O K
600 min Winter	23.487	0.087	0.0	4.5	4.5	0.1	O K
720 min Winter	23.482	0.082	0.0	3.9	3.9	0.1	O K
960 min Winter	23.474	0.074	0.0	3.1	3.1	0.1	O K
1440 min Winter	23.463	0.063	0.0	2.3	2.3	0.0	O K
2160 min Winter	23.453	0.053	0.0	1.6	1.6	0.0	O K
2880 min Winter	23.448	0.048	0.0	1.3	1.3	0.0	O K
4320 min Winter	23.440	0.040	0.0	1.0	1.0	0.0	O K
5760 min Winter	23.436	0.036	0.0	0.8	0.8	0.0	O K
7200 min Winter	23.433	0.033	0.0	0.6	0.6	0.0	O K
8640 min Winter	23.430	0.030	0.0	0.5	0.5	0.0	O K
10080 min Winter	23.428	0.028	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	95.6	4320
10080 min Summer	1.202	0.0	98.4	5000
15 min Winter	171.494	0.0	23.4	12
30 min Winter	103.351	0.0	28.2	20
60 min Winter	62.285	0.0	34.0	34
120 min Winter	37.536	0.0	41.0	64
180 min Winter	27.912	0.0	45.7	92
240 min Winter	22.621	0.0	49.4	124
360 min Winter	16.821	0.0	55.1	184
480 min Winter	13.633	0.0	59.5	244
600 min Winter	11.582	0.0	63.2	300
720 min Winter	10.137	0.0	66.4	364
960 min Winter	8.038	0.0	70.2	476
1440 min Winter	5.796	0.0	75.9	722
2160 min Winter	4.179	0.0	82.1	1068
2880 min Winter	3.314	0.0	86.8	1424
4320 min Winter	2.386	0.0	93.8	2148
5760 min Winter	1.891	0.0	99.1	2896
7200 min Winter	1.578	0.0	103.4	3608
8640 min Winter	1.362	0.0	107.1	4272
10080 min Winter	1.202	0.0	110.2	5152

Swale 2a
Cranbrook



Date 17/01/2019 11:21
File Catchment 2 Cascade.casx

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Source Control 2018.1

Cascade Rainfall Details for Swale 2a.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) 0.065

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

Swale 2a
Cranbrook



Date 17/01/2019 11:21
File Catchment 2 Cascade.casx

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Source Control 2018.1

Cascade Model Details for Swale 2a.srcx

Storage is Online Cover Level (m) 24.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	626.0
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)	0.000
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

Basin 2a
CranbrookDate 17/01/2019 11:21
File Catchment 2 Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Summary of Results for Pond 2a.srcx

Upstream Outflow To Overflow To
Structures

Swale 2a.srcx Pond 2.srcx (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	19.866	0.666	90.0	1745.8	O K
30 min Summer	19.973	0.773	90.0	2068.4	O K
60 min Summer	20.083	0.883	90.0	2412.5	O K
120 min Summer	20.186	0.986	90.0	2745.6	O K
180 min Summer	20.233	1.033	90.0	2903.6	Flood Risk
240 min Summer	20.255	1.055	90.0	2975.0	Flood Risk
360 min Summer	20.267	1.067	90.0	3015.4	Flood Risk
480 min Summer	20.267	1.067	90.0	3017.3	Flood Risk
600 min Summer	20.261	1.061	90.0	2996.1	Flood Risk
720 min Summer	20.250	1.050	90.0	2958.7	Flood Risk
960 min Summer	20.190	0.990	90.0	2760.0	O K
1440 min Summer	20.067	0.867	90.0	2362.8	O K
2160 min Summer	19.902	0.702	90.0	1855.3	O K
2880 min Summer	19.769	0.569	90.0	1465.8	O K
4320 min Summer	19.598	0.398	87.7	991.9	O K
5760 min Summer	19.528	0.328	78.8	805.4	O K
7200 min Summer	19.492	0.292	68.1	713.9	O K
8640 min Summer	19.468	0.268	59.9	650.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	1742.9	19
30 min Summer	103.351	0.0	2109.6	33
60 min Summer	62.285	0.0	2592.3	62
120 min Summer	37.536	0.0	3129.2	122
180 min Summer	27.912	0.0	3492.8	180
240 min Summer	22.621	0.0	3775.9	240
360 min Summer	16.821	0.0	4213.8	304
480 min Summer	13.633	0.0	4554.4	368
600 min Summer	11.582	0.0	4837.1	434
720 min Summer	10.137	0.0	5080.9	502
960 min Summer	8.038	0.0	5370.9	636
1440 min Summer	5.796	0.0	5805.3	896
2160 min Summer	4.179	0.0	6316.2	1276
2880 min Summer	3.314	0.0	6674.3	1616
4320 min Summer	2.386	0.0	7192.3	2292
5760 min Summer	1.891	0.0	7631.8	2992
7200 min Summer	1.578	0.0	7959.8	3680
8640 min Summer	1.362	0.0	8234.5	4408

Basin 2a
CranbrookDate 17/01/2019 11:21
File Catchment 2 Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Summary of Results for Pond 2a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	19.449	0.249	53.5	601.8	O K
15 min Winter	19.937	0.737	90.0	1960.1	O K
30 min Winter	20.056	0.856	90.0	2326.9	O K
60 min Winter	20.179	0.979	90.0	2723.8	O K
120 min Winter	20.296	1.096	90.0	3115.4	Flood Risk
180 min Winter	20.350	1.150	90.0	3301.3	Flood Risk
240 min Winter	20.377	1.177	90.0	3395.0	Flood Risk
360 min Winter	20.391	1.191	90.0	3443.8	Flood Risk
480 min Winter	20.384	1.184	90.0	3420.6	Flood Risk
600 min Winter	20.373	1.173	90.0	3383.7	Flood Risk
720 min Winter	20.356	1.156	90.0	3322.5	Flood Risk
960 min Winter	20.279	1.079	90.0	3056.1	Flood Risk
1440 min Winter	20.095	0.895	90.0	2451.1	O K
2160 min Winter	19.845	0.645	90.0	1685.4	O K
2880 min Winter	19.663	0.463	89.2	1167.3	O K
4320 min Winter	19.519	0.319	76.2	782.0	O K
5760 min Winter	19.472	0.272	61.4	662.4	O K
7200 min Winter	19.443	0.243	51.6	587.8	O K
8640 min Winter	19.423	0.223	44.7	536.1	O K
10080 min Winter	19.407	0.207	39.5	496.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	8463.3	5144
15 min Winter	171.494	0.0	1957.5	18
30 min Winter	103.351	0.0	2367.9	33
60 min Winter	62.285	0.0	2906.3	62
120 min Winter	37.536	0.0	3507.6	120
180 min Winter	27.912	0.0	3914.9	176
240 min Winter	22.621	0.0	4231.9	232
360 min Winter	16.821	0.0	4722.3	338
480 min Winter	13.633	0.0	5103.9	386
600 min Winter	11.582	0.0	5420.6	462
720 min Winter	10.137	0.0	5693.5	540
960 min Winter	8.038	0.0	6018.0	694
1440 min Winter	5.796	0.0	6505.5	970
2160 min Winter	4.179	0.0	7076.7	1340
2880 min Winter	3.314	0.0	7478.4	1668
4320 min Winter	2.386	0.0	8061.9	2288
5760 min Winter	1.891	0.0	8549.3	3000
7200 min Winter	1.578	0.0	8917.3	3680
8640 min Winter	1.362	0.0	9226.3	4416
10080 min Winter	1.202	0.0	9486.5	5144

Basin 2a
Cranbrook



Date 17/01/2019 11:21
File Catchment 2 Cascade.casx

Designed by NA
Checked by GG

Innovyze

Source Control 2018.1

Cascade Rainfall Details for Pond 2a.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) 5.551

Time (mins)	Area
From:	To: (ha)
0	4 5.551

Basin 2a
Cranbrook



Date 17/01/2019 11:21
File Catchment 2 Cascade.casx

Designed by NA
Checked by GG

Innovyze

Source Control 2018.1

Cascade Model Details for Pond 2a.srcx

Storage is Online Cover Level (m) 20.500

Tank or Pond Structure

Invert Level (m) 19.200

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	2305.0	1.300	3648.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0374-9000-1300-9000
Design Head (m)	1.300
Design Flow (l/s)	90.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	374
Invert Level (m)	19.200
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)	1.300	90.0
Flush-Flo™	0.570	90.0
Kick-Flo®	1.014	79.7
Mean Flow over Head Range	-	72.6

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	10.6	1.200	86.5	3.000	135.1	7.000	204.5
0.200	37.3	1.400	93.2	3.500	145.7	7.500	211.5
0.300	70.6	1.600	99.5	4.000	155.5	8.000	218.3
0.400	87.7	1.800	105.3	4.500	164.7	8.500	224.9
0.500	89.6	2.000	110.9	5.000	173.4	9.000	231.3
0.600	89.9	2.200	116.1	5.500	181.7	9.500	237.5
0.800	87.5	2.400	121.2	6.000	189.6		
1.000	80.6	2.600	126.0	6.500	197.2		

Swale 3
CranbrookDate 14/01/2019 17:31
File Catchment 3 Cascade.casxDesigned by NA
Checked by GG

XP Solutions

Source Control 2018.1

Cascade Summary of Results for Swale 3.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 3.srcx (None)

Half Drain Time : 3 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	27.886	0.486	0.0	30.1	30.1	6.3	Flood Risk
30 min Summer	27.835	0.435	0.0	28.2	28.2	4.7	Flood Risk
60 min Summer	27.742	0.342	0.0	24.3	24.3	2.5	Flood Risk
120 min Summer	27.628	0.228	0.0	18.4	18.4	0.9	O K
180 min Summer	27.586	0.186	0.0	14.4	14.4	0.5	O K
240 min Summer	27.564	0.164	0.0	11.9	11.9	0.4	O K
360 min Summer	27.537	0.137	0.0	8.9	8.9	0.2	O K
480 min Summer	27.522	0.122	0.0	7.3	7.3	0.2	O K
600 min Summer	27.509	0.109	0.0	6.2	6.2	0.1	O K
720 min Summer	27.499	0.099	0.0	5.4	5.4	0.1	O K
960 min Summer	27.486	0.086	0.0	4.3	4.3	0.1	O K
1440 min Summer	27.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Summer	27.463	0.063	0.0	2.3	2.3	0.0	O K
2880 min Summer	27.456	0.056	0.0	1.8	1.8	0.0	O K
4320 min Summer	27.447	0.047	0.0	1.3	1.3	0.0	O K
5760 min Summer	27.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Summer	27.439	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	171.494	0.0	21.0	12
30 min Summer	103.351	0.0	25.2	20
60 min Summer	62.285	0.0	30.4	34
120 min Summer	37.536	0.0	36.6	64
180 min Summer	27.912	0.0	40.8	92
240 min Summer	22.621	0.0	44.1	122
360 min Summer	16.821	0.0	49.2	182
480 min Summer	13.633	0.0	53.2	242
600 min Summer	11.582	0.0	56.5	300
720 min Summer	10.137	0.0	59.3	358
960 min Summer	8.038	0.0	62.7	488
1440 min Summer	5.796	0.0	67.8	716
2160 min Summer	4.179	0.0	73.3	1100
2880 min Summer	3.314	0.0	77.5	1468
4320 min Summer	2.386	0.0	83.8	2204
5760 min Summer	1.891	0.0	88.5	2904
7200 min Summer	1.578	0.0	92.3	3552

Swale 3
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Cascade Summary of Results for Swale 3.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
8640 min Summer	27.436	0.036	0.0	0.8	0.8	0.0	O K
10080 min Summer	27.434	0.034	0.0	0.7	0.7	0.0	O K
15 min Winter	27.905	0.505	0.0	30.8	30.8	7.1	Flood Risk
30 min Winter	27.825	0.425	0.0	27.8	27.8	4.4	Flood Risk
60 min Winter	27.690	0.290	0.0	21.8	21.8	1.6	O K
120 min Winter	27.585	0.185	0.0	14.2	14.2	0.5	O K
180 min Winter	27.553	0.153	0.0	10.7	10.7	0.3	O K
240 min Winter	27.535	0.135	0.0	8.7	8.7	0.2	O K
360 min Winter	27.512	0.112	0.0	6.5	6.5	0.1	O K
480 min Winter	27.497	0.097	0.0	5.2	5.2	0.1	O K
600 min Winter	27.487	0.087	0.0	4.5	4.5	0.1	O K
720 min Winter	27.482	0.082	0.0	3.9	3.9	0.1	O K
960 min Winter	27.474	0.074	0.0	3.1	3.1	0.1	O K
1440 min Winter	27.463	0.063	0.0	2.3	2.3	0.0	O K
2160 min Winter	27.453	0.053	0.0	1.6	1.6	0.0	O K
2880 min Winter	27.448	0.048	0.0	1.3	1.3	0.0	O K
4320 min Winter	27.440	0.040	0.0	1.0	1.0	0.0	O K
5760 min Winter	27.436	0.036	0.0	0.8	0.8	0.0	O K
7200 min Winter	27.433	0.033	0.0	0.6	0.6	0.0	O K
8640 min Winter	27.430	0.030	0.0	0.5	0.5	0.0	O K
10080 min Winter	27.428	0.028	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	95.6	4320
10080 min Summer	1.202	0.0	98.4	5000
15 min Winter	171.494	0.0	23.4	12
30 min Winter	103.351	0.0	28.2	20
60 min Winter	62.285	0.0	34.0	34
120 min Winter	37.536	0.0	41.0	64
180 min Winter	27.912	0.0	45.7	92
240 min Winter	22.621	0.0	49.4	124
360 min Winter	16.821	0.0	55.1	184
480 min Winter	13.633	0.0	59.5	244
600 min Winter	11.582	0.0	63.2	300
720 min Winter	10.137	0.0	66.4	364
960 min Winter	8.038	0.0	70.2	476
1440 min Winter	5.796	0.0	75.9	722
2160 min Winter	4.179	0.0	82.1	1068
2880 min Winter	3.314	0.0	86.8	1424
4320 min Winter	2.386	0.0	93.8	2148
5760 min Winter	1.891	0.0	99.1	2896
7200 min Winter	1.578	0.0	103.4	3608
8640 min Winter	1.362	0.0	107.1	4272
10080 min Winter	1.202	0.0	110.2	5152

Swale 3
Cranbrook



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Cascade Rainfall Details for Swale 3.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) 0.065

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

Swale 3
Cranbrook



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File Catchment 3 Cascade.casx

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Cascade Model Details for Swale 3.srcx

Storage is Online Cover Level (m) 28.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	497.0
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)	0.000
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 Basin 3.srcx

Upstream Outflow To Overflow To
Structures

Swale 3.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	26.569	0.469	34.8	1147.4	O K
30 min Summer	26.651	0.551	34.8	1368.3	O K
60 min Summer	26.742	0.642	34.8	1617.3	O K
120 min Summer	26.836	0.736	34.8	1884.8	O K
180 min Summer	26.890	0.790	34.8	2038.8	O K
240 min Summer	26.924	0.824	34.8	2140.7	O K
360 min Summer	26.966	0.866	34.8	2262.7	O K
480 min Summer	26.985	0.885	34.8	2320.7	O K
600 min Summer	26.991	0.891	34.8	2339.4	O K
720 min Summer	26.993	0.893	34.8	2346.0	O K
960 min Summer	26.970	0.870	34.8	2274.3	O K
1440 min Summer	26.915	0.815	34.8	2113.8	O K
2160 min Summer	26.833	0.733	34.8	1874.9	O K
2880 min Summer	26.754	0.654	34.8	1651.7	O K
4320 min Summer	26.614	0.514	34.8	1267.9	O K
5760 min Summer	26.505	0.405	34.7	980.2	O K
7200 min Summer	26.426	0.326	34.4	779.8	O K
8640 min Summer	26.373	0.273	33.7	646.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	1090.7	19
30 min Summer	103.351	0.0	1322.0	33
60 min Summer	62.285	0.0	1660.2	64
120 min Summer	37.536	0.0	2005.7	122
180 min Summer	27.912	0.0	2239.2	182
240 min Summer	22.621	0.0	2420.6	242
360 min Summer	16.821	0.0	2700.2	362
480 min Summer	13.633	0.0	2916.9	480
600 min Summer	11.582	0.0	3096.0	572
720 min Summer	10.137	0.0	3249.5	622
960 min Summer	8.038	0.0	3429.5	748
1440 min Summer	5.796	0.0	3693.0	994
2160 min Summer	4.179	0.0	4079.7	1384
2880 min Summer	3.314	0.0	4311.3	1784
4320 min Summer	2.386	0.0	4639.8	2512
5760 min Summer	1.891	0.0	4939.9	3224
7200 min Summer	1.578	0.0	5150.7	3888
8640 min Summer	1.362	0.0	5325.6	4576

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Cascade Summary of Results for Basin 3.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	26.344	0.244	32.2	574.4	O K
15 min Winter	26.621	0.521	34.8	1286.5	O K
30 min Winter	26.713	0.613	34.8	1536.8	O K
60 min Winter	26.814	0.714	34.8	1819.7	O K
120 min Winter	26.920	0.820	34.8	2127.8	O K
180 min Winter	26.982	0.882	34.8	2311.5	O K
240 min Winter	27.023	0.923	34.8	2433.7	Flood Risk
360 min Winter	27.070	0.970	34.8	2579.7	Flood Risk
480 min Winter	27.094	0.994	34.8	2653.6	Flood Risk
600 min Winter	27.105	1.005	34.8	2686.4	Flood Risk
720 min Winter	27.107	1.007	34.8	2693.2	Flood Risk
960 min Winter	27.075	0.975	34.8	2592.8	Flood Risk
1440 min Winter	27.011	0.911	34.8	2398.7	Flood Risk
2160 min Winter	26.889	0.789	34.8	2037.0	O K
2880 min Winter	26.768	0.668	34.8	1689.4	O K
4320 min Winter	26.558	0.458	34.8	1118.3	O K
5760 min Winter	26.414	0.314	34.3	749.2	O K
7200 min Winter	26.345	0.245	32.3	577.0	O K
8640 min Winter	26.317	0.217	28.4	510.0	O K
10080 min Winter	26.299	0.199	25.3	464.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	5467.1	5240
15 min Winter	171.494	0.0	1226.4	19
30 min Winter	103.351	0.0	1484.0	33
60 min Winter	62.285	0.0	1862.5	62
120 min Winter	37.536	0.0	2248.9	120
180 min Winter	27.912	0.0	2509.8	180
240 min Winter	22.621	0.0	2712.5	238
360 min Winter	16.821	0.0	3024.9	352
480 min Winter	13.633	0.0	3266.8	464
600 min Winter	11.582	0.0	3466.3	574
720 min Winter	10.137	0.0	3637.0	680
960 min Winter	8.038	0.0	3835.9	782
1440 min Winter	5.796	0.0	4118.2	1082
2160 min Winter	4.179	0.0	4571.0	1516
2880 min Winter	3.314	0.0	4831.0	1928
4320 min Winter	2.386	0.0	5203.4	2640
5760 min Winter	1.891	0.0	5534.6	3280
7200 min Winter	1.578	0.0	5771.4	3824
8640 min Winter	1.362	0.0	5968.7	4504
10080 min Winter	1.202	0.0	6131.0	5240

Basin 3
Cranbrook



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Cascade Rainfall Details for Basin 3.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) 3.575

Time (mins)	Area
From:	To: (ha)
0	4 3.575

Basin 3
Cranbrook



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File Catchment 3 Cascade.casx

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Cascade Model Details for Basin 3.srcx

Storage is Online Cover Level (m) 27.300

Tank or Pond Structure

Invert Level (m) 26.100

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	2262.0	1.200	3287.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0250-3480-1200-3480
 Design Head (m) 1.200
 Design Flow (l/s) 34.8
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 250
 Invert Level (m) 26.100
 Minimum Outlet Pipe Diameter (mm) 300
 Suggested Manhole Diameter (mm) 1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	34.8
Flush-Flo™	0.418	34.8
Kick-Flo®	0.867	29.8
Mean Flow over Head Range	-	29.1

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	8.1	1.200	34.8	3.000	54.1	7.000	81.6
0.200	25.6	1.400	37.5	3.500	58.3	7.500	84.4
0.300	34.1	1.600	40.0	4.000	62.2	8.000	87.1
0.400	34.7	1.800	42.3	4.500	65.9	8.500	89.7
0.500	34.6	2.000	44.5	5.000	69.3	9.000	92.3
0.600	34.0	2.200	46.6	5.500	72.6	9.500	94.8
0.800	31.7	2.400	48.6	6.000	75.7		
1.000	31.9	2.600	50.5	6.500	78.7		

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Cascade Summary of Results for Swale 4.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 4.srcx (None)

Half Drain Time : 3 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	22.886	0.486	0.0	30.1	30.1	6.3	Flood Risk
30 min Summer	22.835	0.435	0.0	28.2	28.2	4.7	Flood Risk
60 min Summer	22.742	0.342	0.0	24.3	24.3	2.5	Flood Risk
120 min Summer	22.628	0.228	0.0	18.4	18.4	0.9	O K
180 min Summer	22.586	0.186	0.0	14.4	14.4	0.5	O K
240 min Summer	22.564	0.164	0.0	11.9	11.9	0.4	O K
360 min Summer	22.537	0.137	0.0	8.9	8.9	0.2	O K
480 min Summer	22.522	0.122	0.0	7.3	7.3	0.2	O K
600 min Summer	22.509	0.109	0.0	6.2	6.2	0.1	O K
720 min Summer	22.499	0.099	0.0	5.4	5.4	0.1	O K
960 min Summer	22.486	0.086	0.0	4.3	4.3	0.1	O K
1440 min Summer	22.474	0.074	0.0	3.1	3.1	0.1	O K
2160 min Summer	22.463	0.063	0.0	2.3	2.3	0.0	O K
2880 min Summer	22.456	0.056	0.0	1.8	1.8	0.0	O K
4320 min Summer	22.447	0.047	0.0	1.3	1.3	0.0	O K
5760 min Summer	22.442	0.042	0.0	1.0	1.0	0.0	O K
7200 min Summer	22.439	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	171.494	0.0	21.0	12
30 min Summer	103.351	0.0	25.2	20
60 min Summer	62.285	0.0	30.4	34
120 min Summer	37.536	0.0	36.6	64
180 min Summer	27.912	0.0	40.8	92
240 min Summer	22.621	0.0	44.1	122
360 min Summer	16.821	0.0	49.2	182
480 min Summer	13.633	0.0	53.2	242
600 min Summer	11.582	0.0	56.5	300
720 min Summer	10.137	0.0	59.3	358
960 min Summer	8.038	0.0	62.7	488
1440 min Summer	5.796	0.0	67.8	716
2160 min Summer	4.179	0.0	73.3	1100
2880 min Summer	3.314	0.0	77.5	1468
4320 min Summer	2.386	0.0	83.8	2204
5760 min Summer	1.891	0.0	88.5	2904
7200 min Summer	1.578	0.0	92.3	3552

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Source Control 2018.1

Cascade Summary of Results for Swale 4.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
8640 min Summer	22.436	0.036	0.0	0.8	0.8	0.0	O K
10080 min Summer	22.434	0.034	0.0	0.7	0.7	0.0	O K
15 min Winter	22.905	0.505	0.0	30.8	30.8	7.1	Flood Risk
30 min Winter	22.825	0.425	0.0	27.8	27.8	4.4	Flood Risk
60 min Winter	22.690	0.290	0.0	21.8	21.8	1.6	O K
120 min Winter	22.585	0.185	0.0	14.2	14.2	0.5	O K
180 min Winter	22.553	0.153	0.0	10.7	10.7	0.3	O K
240 min Winter	22.535	0.135	0.0	8.7	8.7	0.2	O K
360 min Winter	22.512	0.112	0.0	6.5	6.5	0.1	O K
480 min Winter	22.497	0.097	0.0	5.2	5.2	0.1	O K
600 min Winter	22.487	0.087	0.0	4.5	4.5	0.1	O K
720 min Winter	22.482	0.082	0.0	3.9	3.9	0.1	O K
960 min Winter	22.474	0.074	0.0	3.1	3.1	0.1	O K
1440 min Winter	22.463	0.063	0.0	2.3	2.3	0.0	O K
2160 min Winter	22.453	0.053	0.0	1.6	1.6	0.0	O K
2880 min Winter	22.448	0.048	0.0	1.3	1.3	0.0	O K
4320 min Winter	22.440	0.040	0.0	1.0	1.0	0.0	O K
5760 min Winter	22.436	0.036	0.0	0.8	0.8	0.0	O K
7200 min Winter	22.433	0.033	0.0	0.6	0.6	0.0	O K
8640 min Winter	22.430	0.030	0.0	0.5	0.5	0.0	O K
10080 min Winter	22.428	0.028	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.362	0.0	95.6	4320
10080 min Summer	1.202	0.0	98.4	5000
15 min Winter	171.494	0.0	23.4	12
30 min Winter	103.351	0.0	28.2	20
60 min Winter	62.285	0.0	34.0	34
120 min Winter	37.536	0.0	41.0	64
180 min Winter	27.912	0.0	45.7	92
240 min Winter	22.621	0.0	49.4	124
360 min Winter	16.821	0.0	55.1	184
480 min Winter	13.633	0.0	59.5	244
600 min Winter	11.582	0.0	63.2	300
720 min Winter	10.137	0.0	66.4	364
960 min Winter	8.038	0.0	70.2	476
1440 min Winter	5.796	0.0	75.9	722
2160 min Winter	4.179	0.0	82.1	1068
2880 min Winter	3.314	0.0	86.8	1424
4320 min Winter	2.386	0.0	93.8	2148
5760 min Winter	1.891	0.0	99.1	2896
7200 min Winter	1.578	0.0	103.4	3608
8640 min Winter	1.362	0.0	107.1	4272
10080 min Winter	1.202	0.0	110.2	5152

Swale 4
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Cascade Rainfall Details for Swale 4.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) 0.065

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

Swale 4
Cranbrook



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File Catchment 4 Cascade.casx

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Cascade Model Details for Swale 4.srcx

Storage is Online Cover Level (m) 23.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	347.0
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)	0.000
Invert Level (m)	22.400	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) 22.400

Basin 4
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Cascade Summary of Results for Basin 4.srcx

Upstream Outflow To Overflow To
Structures

Swale 4.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	21.401	0.601	24.2	800.3	O K
30 min Summer	21.499	0.699	24.2	953.7	O K
60 min Summer	21.605	0.805	24.2	1126.5	O K
120 min Summer	21.713	0.913	24.2	1311.5	Flood Risk
180 min Summer	21.770	0.970	24.2	1413.5	Flood Risk
240 min Summer	21.805	1.005	24.2	1477.1	Flood Risk
360 min Summer	21.842	1.042	24.2	1544.2	Flood Risk
480 min Summer	21.854	1.054	24.2	1567.3	Flood Risk
600 min Summer	21.856	1.056	24.2	1570.5	Flood Risk
720 min Summer	21.855	1.055	24.2	1569.4	Flood Risk
960 min Summer	21.825	1.025	24.2	1513.6	Flood Risk
1440 min Summer	21.764	0.964	24.2	1403.6	Flood Risk
2160 min Summer	21.672	0.872	24.2	1240.7	O K
2880 min Summer	21.569	0.769	24.2	1068.0	O K
4320 min Summer	21.389	0.589	24.2	781.2	O K
5760 min Summer	21.244	0.444	24.2	567.8	O K
7200 min Summer	21.138	0.338	24.1	421.4	O K
8640 min Summer	21.067	0.267	23.6	326.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.494	0.0	793.0	19
30 min Summer	103.351	0.0	957.5	33
60 min Summer	62.285	0.0	1176.2	64
120 min Summer	37.536	0.0	1418.8	122
180 min Summer	27.912	0.0	1583.1	182
240 min Summer	22.621	0.0	1710.9	242
360 min Summer	16.821	0.0	1908.5	360
480 min Summer	13.633	0.0	2062.1	480
600 min Summer	11.582	0.0	2189.4	538
720 min Summer	10.137	0.0	2298.9	600
960 min Summer	8.038	0.0	2428.4	722
1440 min Summer	5.796	0.0	2619.5	994
2160 min Summer	4.179	0.0	2861.5	1408
2880 min Summer	3.314	0.0	3024.8	1788
4320 min Summer	2.386	0.0	3261.8	2548
5760 min Summer	1.891	0.0	3457.3	3232
7200 min Summer	1.578	0.0	3606.3	3888
8640 min Summer	1.362	0.0	3731.4	4576

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Cascade Summary of Results for Basin 4.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	21.025	0.225	23.0	271.9	O K
15 min Winter	21.464	0.664	24.2	897.4	O K
30 min Winter	21.572	0.772	24.2	1071.8	O K
60 min Winter	21.688	0.888	24.2	1269.0	O K
120 min Winter	21.806	1.006	24.2	1479.0	Flood Risk
180 min Winter	21.871	1.071	24.2	1598.3	Flood Risk
240 min Winter	21.912	1.112	24.2	1675.4	Flood Risk
360 min Winter	21.957	1.157	24.2	1763.3	Flood Risk
480 min Winter	21.977	1.177	24.2	1802.5	Flood Risk
600 min Winter	21.983	1.183	24.2	1814.2	Flood Risk
720 min Winter	21.981	1.181	24.2	1809.1	Flood Risk
960 min Winter	21.942	1.142	24.2	1734.7	Flood Risk
1440 min Winter	21.866	1.066	24.2	1588.8	Flood Risk
2160 min Winter	21.738	0.938	24.2	1356.8	Flood Risk
2880 min Winter	21.589	0.789	24.2	1100.1	O K
4320 min Winter	21.311	0.511	24.2	665.7	O K
5760 min Winter	21.118	0.318	24.0	393.9	O K
7200 min Winter	21.021	0.221	23.0	267.0	O K
8640 min Winter	20.994	0.194	20.1	232.7	O K
10080 min Winter	20.976	0.176	17.9	209.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.202	0.0	3836.7	5152
15 min Winter	171.494	0.0	889.3	19
30 min Winter	103.351	0.0	1072.9	33
60 min Winter	62.285	0.0	1318.1	62
120 min Winter	37.536	0.0	1589.8	120
180 min Winter	27.912	0.0	1773.7	180
240 min Winter	22.621	0.0	1916.7	236
360 min Winter	16.821	0.0	2137.8	352
480 min Winter	13.633	0.0	2309.5	462
600 min Winter	11.582	0.0	2451.7	572
720 min Winter	10.137	0.0	2573.9	672
960 min Winter	8.038	0.0	2718.2	760
1440 min Winter	5.796	0.0	2929.1	1068
2160 min Winter	4.179	0.0	3205.4	1532
2880 min Winter	3.314	0.0	3388.4	1956
4320 min Winter	2.386	0.0	3655.4	2640
5760 min Winter	1.891	0.0	3872.8	3280
7200 min Winter	1.578	0.0	4039.8	3752
8640 min Winter	1.362	0.0	4180.5	4488
10080 min Winter	1.202	0.0	4299.8	5144

Basin 4
Cranbrook



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Cascade Rainfall Details for Basin 4.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) 2.478

Time (mins)	Area
From:	To: (ha)
0	4 2.478

Basin 4
Cranbrook



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Cascade Model Details for Basin 4.srcx

Storage is Online Cover Level (m) 22.000

Tank or Pond Structure

Invert Level (m) 20.800

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1142.0	1.200	1974.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0214-2430-1200-2430
 Design Head (m) 1.200
 Design Flow (l/s) 24.3
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 214
 Invert Level (m) 20.800
 Minimum Outlet Pipe Diameter (mm) 300
 Suggested Manhole Diameter (mm) 1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	24.3
Flush-Flo™	0.390	24.2
Kick-Flo®	0.842	20.5
Mean Flow over Head Range	-	20.6

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	7.2	1.200	24.3	3.000	37.7	7.000	56.8
0.200	20.8	1.400	26.1	3.500	40.6	7.500	58.7
0.300	23.9	1.600	27.9	4.000	43.3	8.000	60.6
0.400	24.2	1.800	29.5	4.500	45.8	8.500	62.4
0.500	24.0	2.000	31.0	5.000	48.2	9.000	64.1
0.600	23.6	2.200	32.5	5.500	50.5	9.500	65.8
0.800	21.5	2.400	33.8	6.000	52.7		
1.000	22.3	2.600	35.2	6.500	54.8		

Swale 5
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Cascade Summary of Results for Swale 5.srcx

Upstream Outflow To Overflow To
Structures

(None) Pond 5.srcx (None)

Half Drain Time : 4 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	39.891	0.491	0.0	30.3	30.3	8.7	Flood Risk	
30 min Summer	39.849	0.449	0.0	28.7	28.7	6.9	Flood Risk	
60 min Summer	39.765	0.365	0.0	25.3	25.3	3.9	Flood Risk	
120 min Summer	39.656	0.256	0.0	20.0	20.0	1.6	O K	
180 min Summer	39.603	0.203	0.0	16.2	16.2	0.9	O K	
240 min Summer	39.577	0.177	0.0	13.4	13.4	0.6	O K	
360 min Summer	39.548	0.148	0.0	10.1	10.1	0.4	O K	
480 min Summer	39.530	0.130	0.0	8.2	8.2	0.3	O K	
600 min Summer	39.518	0.118	0.0	6.9	6.9	0.2	O K	
720 min Summer	39.507	0.107	0.0	6.1	6.1	0.2	O K	
960 min Summer	39.492	0.092	0.0	4.9	4.9	0.1	O K	
1440 min Summer	39.478	0.078	0.0	3.5	3.5	0.1	O K	
2160 min Summer	39.469	0.069	0.0	2.6	2.6	0.1	O K	
2880 min Summer	39.460	0.060	0.0	2.0	2.0	0.0	O K	
4320 min Summer	39.451	0.051	0.0	1.5	1.5	0.0	O K	
5760 min Summer	39.445	0.045	0.0	1.2	1.2	0.0	O K	
7200 min Summer	39.441	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	171.205	0.0	24.1	12
30 min Summer	102.749	0.0	28.9	20
60 min Summer	61.665	0.0	34.7	36
120 min Summer	37.008	0.0	41.6	64
180 min Summer	27.453	0.0	46.3	94
240 min Summer	22.210	0.0	50.0	124
360 min Summer	16.476	0.0	55.6	184
480 min Summer	13.330	0.0	60.0	244
600 min Summer	11.309	0.0	63.6	300
720 min Summer	9.888	0.0	66.7	362
960 min Summer	7.881	0.0	70.9	476
1440 min Summer	5.724	0.0	77.3	716
2160 min Summer	4.158	0.0	84.2	1092
2880 min Summer	3.314	0.0	89.5	1424
4320 min Summer	2.388	0.0	96.7	2176
5760 min Summer	1.893	0.0	102.2	2904
7200 min Summer	1.581	0.0	106.7	3592

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Cascade Summary of Results for 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 (m ³)	Status
8640 min Summer	39.438	0.038	0.0	0.8	0.8	0.0	O K
10080 min Summer	39.436	0.036	0.0	0.8	0.8	0.0	O K
15 min Winter	39.911	0.511	0.0	31.0	31.0	9.7	Flood Risk
30 min Winter	39.847	0.447	0.0	28.6	28.6	6.7	Flood Risk
60 min Winter	39.726	0.326	0.0	23.5	23.5	2.9	Flood Risk
120 min Winter	39.602	0.202	0.0	16.1	16.1	0.8	O K
180 min Winter	39.566	0.166	0.0	12.1	12.1	0.5	O K
240 min Winter	39.545	0.145	0.0	9.8	9.8	0.4	O K
360 min Winter	39.522	0.122	0.0	7.3	7.3	0.2	O K
480 min Winter	39.505	0.105	0.0	5.9	5.9	0.2	O K
600 min Winter	39.494	0.094	0.0	5.0	5.0	0.1	O K
720 min Winter	39.487	0.087	0.0	4.4	4.4	0.1	O K
960 min Winter	39.478	0.078	0.0	3.5	3.5	0.1	O K
1440 min Winter	39.468	0.068	0.0	2.6	2.6	0.1	O K
2160 min Winter	39.457	0.057	0.0	1.9	1.9	0.0	O K
2880 min Winter	39.451	0.051	0.0	1.5	1.5	0.0	O K
4320 min Winter	39.443	0.043	0.0	1.1	1.1	0.0	O K
5760 min Winter	39.438	0.038	0.0	0.9	0.9	0.0	O K
7200 min Winter	39.436	0.036	0.0	0.8	0.8	0.0	O K
8640 min Winter	39.433	0.033	0.0	0.6	0.6	0.0	O K
10080 min Winter	39.431	0.031	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.365	0.0	110.6	4248
10080 min Summer	1.205	0.0	113.9	4984
15 min Winter	171.205	0.0	27.0	13
30 min Winter	102.749	0.0	32.4	21
60 min Winter	61.665	0.0	38.9	36
120 min Winter	37.008	0.0	46.6	64
180 min Winter	27.453	0.0	51.9	94
240 min Winter	22.210	0.0	56.0	124
360 min Winter	16.476	0.0	62.3	184
480 min Winter	13.330	0.0	67.2	244
600 min Winter	11.309	0.0	71.2	300
720 min Winter	9.888	0.0	74.8	368
960 min Winter	7.881	0.0	79.4	482
1440 min Winter	5.724	0.0	86.6	722
2160 min Winter	4.158	0.0	94.3	1068
2880 min Winter	3.314	0.0	100.2	1424
4320 min Winter	2.388	0.0	108.3	2168
5760 min Winter	1.893	0.0	114.5	2808
7200 min Winter	1.581	0.0	119.5	3632
8640 min Winter	1.365	0.0	123.8	4408
10080 min Winter	1.205	0.0	127.5	4968

Swale 5
Cranbrook



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Cascade Rainfall Details for Swale 5.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) 0.075

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

Swale 5
Cranbrook



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Cascade Model Details for Swale 5.srcx

Storage is Online Cover Level (m) 40.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1071.0
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)	0.000
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 Pond 5.srcx

Upstream Outflow To Overflow To
Structures

Swale 5.srcx Basin 7.srcx (None)
Pond 5a.srcx
Swale 5a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	37.565	0.565	94.7	2499.7	O K
30 min Summer	37.666	0.666	94.7	2988.8	O K
60 min Summer	37.780	0.780	94.7	3564.1	O K
120 min Summer	37.908	0.908	94.7	4230.5	O K
180 min Summer	37.988	0.988	94.7	4657.8	O K
240 min Summer	38.046	1.046	94.7	4972.6	O K
360 min Summer	38.124	1.124	94.7	5407.9	Flood Risk
480 min Summer	38.173	1.173	94.7	5680.3	Flood Risk
600 min Summer	38.207	1.207	94.7	5874.7	Flood Risk
720 min Summer	38.232	1.232	94.7	6018.1	Flood Risk
960 min Summer	38.227	1.227	94.7	5989.0	Flood Risk
1440 min Summer	38.186	1.186	94.7	5755.8	Flood Risk
2160 min Summer	38.097	1.097	94.7	5255.2	O K
2880 min Summer	37.989	0.989	94.7	4661.8	O K
4320 min Summer	37.781	0.781	94.7	3568.0	O K
5760 min Summer	37.616	0.616	94.7	2744.4	O K
7200 min Summer	37.495	0.495	94.2	2166.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	3039.2	19
30 min Summer	102.749	0.0	3667.9	34
60 min Summer	61.665	0.0	4584.2	64
120 min Summer	37.008	0.0	5514.4	124
180 min Summer	27.453	0.0	6141.1	184
240 min Summer	22.210	0.0	6626.7	242
360 min Summer	16.476	0.0	7374.0	362
480 min Summer	13.330	0.0	7952.7	482
600 min Summer	11.309	0.0	8430.5	602
720 min Summer	9.888	0.0	8839.7	722
960 min Summer	7.881	0.0	9378.3	852
1440 min Summer	5.724	0.0	10161.1	1046
2160 min Summer	4.158	0.0	11314.2	1424
2880 min Summer	3.314	0.0	12018.5	1812
4320 min Summer	2.388	0.0	12944.0	2552
5760 min Summer	1.893	0.0	13789.9	3232
7200 min Summer	1.581	0.0	14384.7	3896

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Cascade Summary of Results for Pond 5.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
8640 min Summer	37.412	0.412	92.5	1782.2	O K
10080 min Summer	37.362	0.362	90.5	1552.4	O K
15 min Winter	37.627	0.627	94.7	2798.3	O K
30 min Winter	37.738	0.738	94.7	3350.6	O K
60 min Winter	37.864	0.864	94.7	3998.4	O K
120 min Winter	38.006	1.006	94.7	4756.5	O K
180 min Winter	38.096	1.096	94.7	5250.5	O K
240 min Winter	38.160	1.160	94.7	5609.2	Flood Risk
360 min Winter	38.245	1.245	94.7	6095.5	Flood Risk
480 min Winter	38.298	1.298	94.7	6401.6	Flood Risk
600 min Winter	38.332	1.332	94.7	6604.3	Flood Risk
720 min Winter	38.359	1.359	94.7	6763.2	Flood Risk
960 min Winter	38.375	1.375	94.7	6857.8	Flood Risk
1440 min Winter	38.315	1.315	94.7	6504.2	Flood Risk
2160 min Winter	38.181	1.181	94.7	5728.0	Flood Risk
2880 min Winter	38.021	1.021	94.7	4835.4	O K
4320 min Winter	37.702	0.702	94.7	3169.5	O K
5760 min Winter	37.480	0.480	94.0	2096.3	O K
7200 min Winter	37.363	0.363	90.7	1555.8	O K
8640 min Winter	37.323	0.323	79.4	1377.8	O K
10080 min Winter	37.296	0.296	70.8	1257.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.365	0.0	14878.5	4584
10080 min Summer	1.205	0.0	15277.3	5240
15 min Winter	171.205	0.0	3417.3	19
30 min Winter	102.749	0.0	4117.5	33
60 min Winter	61.665	0.0	5142.4	64
120 min Winter	37.008	0.0	6182.9	122
180 min Winter	27.453	0.0	6882.9	182
240 min Winter	22.210	0.0	7425.9	240
360 min Winter	16.476	0.0	8262.4	358
480 min Winter	13.330	0.0	8909.0	472
600 min Winter	11.309	0.0	9441.9	590
720 min Winter	9.888	0.0	9897.7	706
960 min Winter	7.881	0.0	10495.5	904
1440 min Winter	5.724	0.0	11352.0	1086
2160 min Winter	4.158	0.0	12676.8	1536
2880 min Winter	3.314	0.0	13466.8	1960
4320 min Winter	2.388	0.0	14516.5	2680
5760 min Winter	1.893	0.0	15449.9	3296
7200 min Winter	1.581	0.0	16118.0	3824
8640 min Winter	1.365	0.0	16674.9	4504
10080 min Winter	1.205	0.0	17132.8	5240

Basin 5
Cranbrook



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Cascade Rainfall Details for Pond 5.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) 7.767

Time (mins)	Area
From:	To: (ha)
0	4 7.767

Basin 5
Cranbrook



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Cascade Model Details for Pond 5.srcx

Storage is Online Cover Level (m) 38.400

Tank or Pond Structure

Invert Level (m) 37.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	4054.0	1.400	6026.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0381-9480-1400-9480
Design Head (m)	1.400
Design Flow (l/s)	94.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	381
Invert Level (m)	37.000
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)	1.400	94.8
Flush-Flo™	0.585	94.7
Kick-Flo®	1.071	83.2
Mean Flow over Head Range	-	77.1

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	10.7	1.200	87.9	3.000	137.3	7.000	207.8
0.200	37.9	1.400	94.8	3.500	148.0	7.500	214.9
0.300	72.1	1.600	101.1	4.000	158.0	8.000	221.9
0.400	92.1	1.800	107.1	4.500	167.4	8.500	228.6
0.500	94.3	2.000	112.7	5.000	176.2	9.000	235.1
0.600	94.7	2.200	118.0	5.500	184.6	9.500	241.4
0.800	92.7	2.400	123.1	6.000	192.7		
1.000	87.1	2.600	128.0	6.500	200.4		

Swale 5a
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Cascade Summary of Results for Swale 5a.srcx

Upstream Outflow To Overflow To
Structures

(None) Pond 5a.srcx (None)

Half Drain Time : 4 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	39.874	0.474	0.0	29.7	29.7	8.9	Flood Risk	
30 min Summer	39.836	0.436	0.0	28.2	28.2	7.1	Flood Risk	
60 min Summer	39.757	0.357	0.0	25.0	25.0	4.2	Flood Risk	
120 min Summer	39.653	0.253	0.0	19.8	19.8	1.7	O K	
180 min Summer	39.602	0.202	0.0	16.2	16.2	1.0	O K	
240 min Summer	39.577	0.177	0.0	13.4	13.4	0.7	O K	
360 min Summer	39.548	0.148	0.0	10.1	10.1	0.4	O K	
480 min Summer	39.530	0.130	0.0	8.2	8.2	0.3	O K	
600 min Summer	39.518	0.118	0.0	6.9	6.9	0.3	O K	
720 min Summer	39.507	0.107	0.0	6.1	6.1	0.2	O K	
960 min Summer	39.492	0.092	0.0	4.9	4.9	0.1	O K	
1440 min Summer	39.478	0.078	0.0	3.5	3.5	0.1	O K	
2160 min Summer	39.468	0.068	0.0	2.6	2.6	0.1	O K	
2880 min Summer	39.460	0.060	0.0	2.0	2.0	0.1	O K	
4320 min Summer	39.451	0.051	0.0	1.5	1.5	0.0	O K	
5760 min Summer	39.445	0.045	0.0	1.2	1.2	0.0	O K	
7200 min Summer	39.441	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	171.205	0.0	24.1	12
30 min Summer	102.749	0.0	28.9	20
60 min Summer	61.665	0.0	34.7	36
120 min Summer	37.008	0.0	41.6	64
180 min Summer	27.453	0.0	46.3	94
240 min Summer	22.210	0.0	50.0	124
360 min Summer	16.476	0.0	55.6	184
480 min Summer	13.330	0.0	60.0	244
600 min Summer	11.309	0.0	63.6	300
720 min Summer	9.888	0.0	66.7	364
960 min Summer	7.881	0.0	70.9	484
1440 min Summer	5.724	0.0	77.3	716
2160 min Summer	4.158	0.0	84.2	1092
2880 min Summer	3.314	0.0	89.5	1420
4320 min Summer	2.388	0.0	96.7	2164
5760 min Summer	1.893	0.0	102.2	2920
7200 min Summer	1.581	0.0	106.7	3616

Swale 5a
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Cascade Summary of Results for Swale 5a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
8640 min Summer	39.438	0.038	0.0	0.9	0.9	0.0	O K
10080 min Summer	39.436	0.036	0.0	0.8	0.8	0.0	O K
15 min Winter	39.895	0.495	0.0	30.4	30.4	10.0	Flood Risk
30 min Winter	39.835	0.435	0.0	28.2	28.2	7.0	Flood Risk
60 min Winter	39.721	0.321	0.0	23.3	23.3	3.1	Flood Risk
120 min Winter	39.602	0.202	0.0	16.1	16.1	1.0	O K
180 min Winter	39.566	0.166	0.0	12.1	12.1	0.6	O K
240 min Winter	39.545	0.145	0.0	9.8	9.8	0.4	O K
360 min Winter	39.522	0.122	0.0	7.3	7.3	0.3	O K
480 min Winter	39.505	0.105	0.0	5.9	5.9	0.2	O K
600 min Winter	39.494	0.094	0.0	5.0	5.0	0.1	O K
720 min Winter	39.486	0.086	0.0	4.4	4.4	0.1	O K
960 min Winter	39.478	0.078	0.0	3.5	3.5	0.1	O K
1440 min Winter	39.468	0.068	0.0	2.6	2.6	0.1	O K
2160 min Winter	39.457	0.057	0.0	1.9	1.9	0.0	O K
2880 min Winter	39.451	0.051	0.0	1.5	1.5	0.0	O K
4320 min Winter	39.443	0.043	0.0	1.1	1.1	0.0	O K
5760 min Winter	39.438	0.038	0.0	0.9	0.9	0.0	O K
7200 min Winter	39.436	0.036	0.0	0.8	0.8	0.0	O K
8640 min Winter	39.433	0.033	0.0	0.6	0.6	0.0	O K
10080 min Winter	39.431	0.031	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.365	0.0	110.5	4392
10080 min Summer	1.205	0.0	113.9	5112
15 min Winter	171.205	0.0	27.0	13
30 min Winter	102.749	0.0	32.4	21
60 min Winter	61.665	0.0	38.9	36
120 min Winter	37.008	0.0	46.6	64
180 min Winter	27.453	0.0	51.9	94
240 min Winter	22.210	0.0	56.0	124
360 min Winter	16.476	0.0	62.3	184
480 min Winter	13.330	0.0	67.2	244
600 min Winter	11.309	0.0	71.2	304
720 min Winter	9.888	0.0	74.8	358
960 min Winter	7.881	0.0	79.4	488
1440 min Winter	5.724	0.0	86.6	732
2160 min Winter	4.158	0.0	94.3	1096
2880 min Winter	3.314	0.0	100.2	1420
4320 min Winter	2.388	0.0	108.3	2184
5760 min Winter	1.893	0.0	114.5	2840
7200 min Winter	1.581	0.0	119.5	3616
8640 min Winter	1.365	0.0	123.8	4240
10080 min Winter	1.205	0.0	127.5	5032

Swale 5a
Cranbrook



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Cascade Rainfall Details for Swale 5a.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) 0.075

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

Swale 5a
Cranbrook



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Cascade Model Details for Swale 5a.srcx

Storage is Online Cover Level (m) 40.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	283.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	45.0
Porosity	1.00	Cap Volume Depth (m)	0.000
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

Basin 5a
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Cascade Summary of Results for Pond 5a.srcx

Upstream Outflow To Overflow To
Structures

Swale 5a.srcx Pond 5.srcx (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	38.589	0.889	60.0	694.0	O K
30 min Summer	38.700	1.000	60.0	810.9	O K
60 min Summer	38.792	1.092	60.0	913.5	Flood Risk
120 min Summer	38.841	1.141	60.0	970.4	Flood Risk
180 min Summer	38.843	1.143	60.0	971.8	Flood Risk
240 min Summer	38.835	1.135	60.0	963.2	Flood Risk
360 min Summer	38.807	1.107	60.0	931.0	Flood Risk
480 min Summer	38.771	1.071	60.0	889.2	Flood Risk
600 min Summer	38.730	1.030	60.0	843.6	Flood Risk
720 min Summer	38.685	0.985	60.0	795.0	O K
960 min Summer	38.564	0.864	60.0	668.8	O K
1440 min Summer	38.351	0.651	60.0	468.3	O K
2160 min Summer	38.125	0.425	59.7	282.3	O K
2880 min Summer	38.012	0.312	57.6	198.3	O K
4320 min Summer	37.946	0.246	44.1	152.6	O K
5760 min Summer	37.912	0.212	35.3	129.9	O K
7200 min Summer	37.890	0.190	29.6	115.5	O K
8640 min Summer	37.874	0.174	25.7	105.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	735.5	19
30 min Summer	102.749	0.0	883.5	33
60 min Summer	61.665	0.0	1063.6	62
120 min Summer	37.008	0.0	1277.0	120
180 min Summer	27.453	0.0	1421.1	150
240 min Summer	22.210	0.0	1533.1	182
360 min Summer	16.476	0.0	1706.0	250
480 min Summer	13.330	0.0	1840.4	320
600 min Summer	11.309	0.0	1951.9	390
720 min Summer	9.888	0.0	2048.0	458
960 min Summer	7.881	0.0	2176.3	586
1440 min Summer	5.724	0.0	2370.5	824
2160 min Summer	4.158	0.0	2585.0	1164
2880 min Summer	3.314	0.0	2746.9	1472
4320 min Summer	2.388	0.0	2968.3	2204
5760 min Summer	1.893	0.0	3139.9	2936
7200 min Summer	1.581	0.0	3277.3	3672
8640 min Summer	1.365	0.0	3393.8	4400

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Cascade Summary of Results for Pond 5a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	37.862	0.162	22.7	97.5	O K
15 min Winter	38.672	0.972	60.0	781.0	O K
30 min Winter	38.794	1.094	60.0	915.3	Flood Risk
60 min Winter	38.896	1.196	60.0	1035.3	Flood Risk
120 min Winter	38.960	1.260	60.0	1113.7	Flood Risk
180 min Winter	38.963	1.263	60.0	1117.3	Flood Risk
240 min Winter	38.950	1.250	60.0	1101.1	Flood Risk
360 min Winter	38.911	1.211	60.0	1053.6	Flood Risk
480 min Winter	38.857	1.157	60.0	988.9	Flood Risk
600 min Winter	38.795	1.095	60.0	917.3	Flood Risk
720 min Winter	38.728	1.028	60.0	841.6	Flood Risk
960 min Winter	38.540	0.840	60.0	645.2	O K
1440 min Winter	38.220	0.520	60.0	356.7	O K
2160 min Winter	37.995	0.295	55.2	186.8	O K
2880 min Winter	37.948	0.248	44.6	154.0	O K
4320 min Winter	37.901	0.201	32.4	122.4	O K
5760 min Winter	37.874	0.174	25.7	105.5	O K
7200 min Winter	37.857	0.157	21.5	94.3	O K
8640 min Winter	37.845	0.145	18.6	86.4	O K
10080 min Winter	37.835	0.135	16.4	80.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.205	0.0	3494.6	5136
15 min Winter	171.205	0.0	824.2	18
30 min Winter	102.749	0.0	989.9	32
60 min Winter	61.665	0.0	1191.5	60
120 min Winter	37.008	0.0	1430.4	116
180 min Winter	27.453	0.0	1591.8	170
240 min Winter	22.210	0.0	1717.3	192
360 min Winter	16.476	0.0	1911.0	270
480 min Winter	13.330	0.0	2061.5	348
600 min Winter	11.309	0.0	2186.3	422
720 min Winter	9.888	0.0	2293.9	498
960 min Winter	7.881	0.0	2437.8	626
1440 min Winter	5.724	0.0	2655.4	850
2160 min Winter	4.158	0.0	2895.4	1124
2880 min Winter	3.314	0.0	3076.7	1472
4320 min Winter	2.388	0.0	3325.0	2204
5760 min Winter	1.893	0.0	3516.7	2936
7200 min Winter	1.581	0.0	3670.8	3672
8640 min Winter	1.365	0.0	3801.4	4368
10080 min Winter	1.205	0.0	3914.5	5136

Basin 5a
Cranbrook



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File Catchment 7 Cascade.casx

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Cascade Rainfall Details for Pond 5a.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) 2.229

Time (mins)	Area
From:	To: (ha)
0	4 2.229

Basin 5a
Cranbrook



Date 14/01/2019 17:35
File Catchment 7 Cascade.casx

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Cascade Model Details for Pond 5a.srcx

Storage is Online Cover Level (m) 39.000

Tank or Pond Structure

Invert Level (m) 37.700

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	566.0	1.300	1272.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0315-6000-1300-6000
Design Head (m)	1.300
Design Flow (l/s)	60.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	315
Invert Level (m)	37.700
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.300	60.0
Flush-Flo™	0.504	60.0
Kick-Flo®	0.974	52.2
Mean Flow over Head Range	-	49.5

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	9.5	1.200	57.7	3.000	90.0	7.000	136.0
0.200	32.2	1.400	62.2	3.500	97.0	7.500	140.7
0.300	56.1	1.600	66.3	4.000	103.5	8.000	145.2
0.400	59.4	1.800	70.2	4.500	109.6	8.500	149.5
0.500	60.0	2.000	73.9	5.000	115.4	9.000	153.8
0.600	59.7	2.200	77.4	5.500	120.9	9.500	157.9
0.800	57.4	2.400	80.7	6.000	126.1		
1.000	52.9	2.600	83.9	6.500	131.2		

Swale 6
CranbrookDate 14/01/2019 17:37
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Source Control 2018.1

Cascade Summary of Results for Swale 6.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 6.srcx (None)

Half Drain Time : 5 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	35.872	0.472	0.0	29.6	29.6	9.8	Flood Risk	
30 min Summer	35.835	0.435	0.0	28.2	28.2	7.8	Flood Risk	
60 min Summer	35.760	0.360	0.0	25.1	25.1	4.7	Flood Risk	
120 min Summer	35.657	0.257	0.0	20.0	20.0	2.0	O K	
180 min Summer	35.605	0.205	0.0	16.5	16.5	1.1	O K	
240 min Summer	35.579	0.179	0.0	13.6	13.6	0.8	O K	
360 min Summer	35.549	0.149	0.0	10.2	10.2	0.5	O K	
480 min Summer	35.531	0.131	0.0	8.3	8.3	0.4	O K	
600 min Summer	35.520	0.120	0.0	7.1	7.1	0.3	O K	
720 min Summer	35.508	0.108	0.0	6.1	6.1	0.2	O K	
960 min Summer	35.492	0.092	0.0	4.9	4.9	0.2	O K	
1440 min Summer	35.479	0.079	0.0	3.6	3.6	0.1	O K	
2160 min Summer	35.469	0.069	0.0	2.6	2.6	0.1	O K	
2880 min Summer	35.460	0.060	0.0	2.1	2.1	0.1	O K	
4320 min Summer	35.451	0.051	0.0	1.5	1.5	0.0	O K	
5760 min Summer	35.446	0.046	0.0	1.2	1.2	0.0	O K	
7200 min Summer	35.441	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

Swale 6
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Source Control 2018.1

Cascade Summary of Results for 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 (m ³)	Status
8640 min Summer	35.438	0.038	0.0	0.9	0.9	0.0	O K
10080 min Summer	35.436	0.036	0.0	0.8	0.8	0.0	O K
15 min Winter	35.893	0.493	0.0	30.4	30.4	11.0	Flood Risk
30 min Winter	35.836	0.436	0.0	28.2	28.2	7.9	Flood Risk
60 min Winter	35.727	0.327	0.0	23.6	23.6	3.7	Flood Risk
120 min Winter	35.605	0.205	0.0	16.5	16.5	1.1	O K
180 min Winter	35.568	0.168	0.0	12.4	12.4	0.7	O K
240 min Winter	35.547	0.147	0.0	10.0	10.0	0.5	O K
360 min Winter	35.523	0.123	0.0	7.4	7.4	0.3	O K
480 min Winter	35.506	0.106	0.0	6.0	6.0	0.2	O K
600 min Winter	35.495	0.095	0.0	5.1	5.1	0.2	O K
720 min Winter	35.487	0.087	0.0	4.4	4.4	0.1	O K
960 min Winter	35.478	0.078	0.0	3.5	3.5	0.1	O K
1440 min Winter	35.469	0.069	0.0	2.6	2.6	0.1	O K
2160 min Winter	35.457	0.057	0.0	1.9	1.9	0.1	O K
2880 min Winter	35.451	0.051	0.0	1.5	1.5	0.0	O K
4320 min Winter	35.443	0.043	0.0	1.1	1.1	0.0	O K
5760 min Winter	35.438	0.038	0.0	0.9	0.9	0.0	O K
7200 min Winter	35.435	0.035	0.0	0.7	0.7	0.0	O K
8640 min Winter	35.433	0.033	0.0	0.6	0.6	0.0	O K
10080 min Winter	35.431	0.031	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	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

Swale 6
Cranbrook



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Cascade Rainfall Details for Swale 6.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)	Area
From:	To: (ha)
0	4 0.075

Swale 6
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Cascade Model Details for Swale 6.srcx

Storage is Online Cover Level (m) 36.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1566.0
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)	0.000
Invert Level (m)	35.400	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) 35.400

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Cascade Summary of Results for Basin 6.srcx

Upstream Outflow To Overflow To
Structures

Swale 6.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	34.352	0.552	109.5	3915.6	O K
30 min Summer	34.447	0.647	109.6	4632.8	O K
60 min Summer	34.552	0.752	109.6	5435.7	O K
120 min Summer	34.662	0.862	109.6	6297.5	O K
180 min Summer	34.725	0.925	109.6	6796.4	Flood Risk
240 min Summer	34.766	0.966	109.6	7128.7	Flood Risk
360 min Summer	34.814	1.014	109.6	7517.4	Flood Risk
480 min Summer	34.836	1.036	109.6	7690.2	Flood Risk
600 min Summer	34.843	1.043	109.6	7752.8	Flood Risk
720 min Summer	34.848	1.048	109.6	7790.3	Flood Risk
960 min Summer	34.834	1.034	109.6	7679.1	Flood Risk
1440 min Summer	34.796	0.996	109.6	7372.2	Flood Risk
2160 min Summer	34.720	0.920	109.6	6759.8	Flood Risk
2880 min Summer	34.640	0.840	109.6	6124.2	O K
4320 min Summer	34.486	0.686	109.6	4932.2	O K
5760 min Summer	34.364	0.564	109.5	4009.4	O K
7200 min Summer	34.274	0.474	108.3	3340.0	O K
8640 min Summer	34.211	0.411	106.4	2878.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	3489.8	19
30 min Summer	106.565	0.0	4213.4	33
60 min Summer	63.619	0.0	5417.6	64
120 min Summer	37.980	0.0	6497.2	122
180 min Summer	28.087	0.0	7219.8	182
240 min Summer	22.674	0.0	7777.1	242
360 min Summer	16.768	0.0	8630.1	360
480 min Summer	13.536	0.0	9285.6	480
600 min Summer	11.465	0.0	9822.7	550
720 min Summer	10.011	0.0	10279.4	608
960 min Summer	7.973	0.0	10880.8	732
1440 min Summer	5.785	0.0	11729.1	996
2160 min Summer	4.197	0.0	13305.5	1404
2880 min Summer	3.343	0.0	14117.4	1788
4320 min Summer	2.411	0.0	15175.0	2548
5760 min Summer	1.912	0.0	16290.5	3232
7200 min Summer	1.597	0.0	16988.4	3960
8640 min Summer	1.379	0.0	17557.7	4584

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Cascade Summary of Results for Basin 6.srcx

Storm Event		Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer		34.172	0.372	102.5	2598.5	O K
15 min Winter		34.415	0.615	109.6	4389.3	O K
30 min Winter		34.521	0.721	109.6	5201.7	O K
60 min Winter		34.638	0.838	109.6	6112.2	O K
120 min Winter		34.763	0.963	109.6	7101.6	Flood Risk
180 min Winter		34.835	1.035	109.6	7681.9	Flood Risk
240 min Winter		34.881	1.081	109.6	8063.3	Flood Risk
360 min Winter		34.937	1.137	109.6	8518.6	Flood Risk
480 min Winter		34.964	1.164	109.6	8746.5	Flood Risk
600 min Winter		34.976	1.176	109.6	8845.6	Flood Risk
720 min Winter		34.978	1.178	109.6	8863.6	Flood Risk
960 min Winter		34.954	1.154	109.6	8666.6	Flood Risk
1440 min Winter		34.901	1.101	109.6	8228.2	Flood Risk
2160 min Winter		34.796	0.996	109.6	7368.7	Flood Risk
2880 min Winter		34.669	0.869	109.6	6355.2	O K
4320 min Winter		34.437	0.637	109.6	4557.5	O K
5760 min Winter		34.272	0.472	108.3	3327.6	O K
7200 min Winter		34.179	0.379	104.5	2646.9	O K
8640 min Winter		34.141	0.341	92.3	2370.8	O K
10080 min Winter		34.114	0.314	82.7	2176.2	O K

Storm Event		Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer		1.218	0.0	17996.1	5248
15 min Winter		178.502	0.0	3940.2	19
30 min Winter		106.565	0.0	4743.8	33
60 min Winter		63.619	0.0	6087.7	62
120 min Winter		37.980	0.0	7293.9	120
180 min Winter		28.087	0.0	8100.7	180
240 min Winter		22.674	0.0	8723.3	238
360 min Winter		16.768	0.0	9676.0	352
480 min Winter		13.536	0.0	10406.7	464
600 min Winter		11.465	0.0	11004.3	572
720 min Winter		10.011	0.0	11511.0	676
960 min Winter		7.973	0.0	12174.1	768
1440 min Winter		5.785	0.0	13082.5	1070
2160 min Winter		4.197	0.0	14913.2	1536
2880 min Winter		3.343	0.0	15825.7	1936
4320 min Winter		2.411	0.0	17034.1	2680
5760 min Winter		1.912	0.0	18257.7	3344
7200 min Winter		1.597	0.0	19043.2	3888
8640 min Winter		1.379	0.0	19688.3	4584
10080 min Winter		1.218	0.0	20198.0	5336

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Cascade Rainfall Details for Basin 6.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) 11.833

Time (mins)	Area
From:	To: (ha)
0	4 11.833

Basin 6
Cranbrook



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Cascade Model Details for Basin 6.srcx

Storage is Online Cover Level (m) 35.000

Tank or Pond Structure

Invert Level (m) 33.800

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	6737.0	1.200	8371.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0407-1096-1200-1096
Design Head (m)	1.200
Design Flow (l/s)	109.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	407
Invert Level (m)	33.800
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	109.6
Flush-Flo™	0.592	109.6
Kick-Flo®	0.975	99.1
Mean Flow over Head Range	-	86.0

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	11.1	1.200	109.6	3.000	171.3	7.000	259.4
0.200	39.9	1.400	118.1	3.500	184.7	7.500	268.4
0.300	77.4	1.600	126.1	4.000	197.2	8.000	277.0
0.400	105.9	1.800	133.5	4.500	208.9	8.500	285.4
0.500	108.8	2.000	140.5	5.000	219.9	9.000	293.5
0.600	109.6	2.200	147.2	5.500	230.5	9.500	301.4
0.800	106.7	2.400	153.6	6.000	240.5		
1.000	100.3	2.600	159.7	6.500	250.2		

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Cascade Summary of Results for Swale 7.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 7.srcx (None)

Half Drain Time : 8 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow (m³)	Status
15 min Summer	30.854	0.454	0.0	28.9	28.9	15.8	Flood Risk
30 min Summer	30.831	0.431	0.0	28.0	28.0	13.8	Flood Risk
60 min Summer	30.782	0.382	0.0	26.0	26.0	10.0	Flood Risk
120 min Summer	30.703	0.303	0.0	22.4	22.4	5.4	Flood Risk
180 min Summer	30.647	0.247	0.0	19.5	19.5	3.2	O K
240 min Summer	30.611	0.211	0.0	17.1	17.1	2.1	O K
360 min Summer	30.576	0.176	0.0	13.2	13.2	1.4	O K
480 min Summer	30.555	0.155	0.0	10.9	10.9	1.0	O K
600 min Summer	30.540	0.140	0.0	9.2	9.2	0.8	O K
720 min Summer	30.529	0.129	0.0	8.1	8.1	0.6	O K
960 min Summer	30.512	0.112	0.0	6.5	6.5	0.5	O K
1440 min Summer	30.490	0.090	0.0	4.7	4.7	0.3	O K
2160 min Summer	30.477	0.077	0.0	3.4	3.4	0.2	O K
2880 min Summer	30.471	0.071	0.0	2.8	2.8	0.2	O K
4320 min Summer	30.459	0.059	0.0	2.0	2.0	0.1	O K
5760 min Summer	30.452	0.052	0.0	1.6	1.6	0.1	O K
7200 min Summer	30.448	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	171.205	0.0	32.1	13
30 min Summer	102.749	0.0	38.5	21
60 min Summer	61.665	0.0	46.3	36
120 min Summer	37.008	0.0	55.5	66
180 min Summer	27.453	0.0	61.8	96
240 min Summer	22.210	0.0	66.6	124
360 min Summer	16.476	0.0	74.1	184
480 min Summer	13.330	0.0	80.0	244
600 min Summer	11.309	0.0	84.8	306
720 min Summer	9.888	0.0	89.0	362
960 min Summer	7.881	0.0	94.6	486
1440 min Summer	5.724	0.0	103.0	734
2160 min Summer	4.158	0.0	112.3	1100
2880 min Summer	3.314	0.0	119.3	1464
4320 min Summer	2.388	0.0	129.0	2196
5760 min Summer	1.893	0.0	136.3	2920
7200 min Summer	1.581	0.0	142.3	3560

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Cascade Summary of Results for 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 (m ³)	Status
8640 min Summer	30.444	0.044	0.0	1.1	1.1	0.1	O K
10080 min Summer	30.441	0.041	0.0	1.0	1.0	0.0	O K
15 min Winter	30.876	0.476	0.0	29.7	29.7	18.1	Flood Risk
30 min Winter	30.843	0.443	0.0	28.5	28.5	14.9	Flood Risk
60 min Winter	30.770	0.370	0.0	25.5	25.5	9.2	Flood Risk
120 min Winter	30.657	0.257	0.0	20.0	20.0	3.5	O K
180 min Winter	30.600	0.200	0.0	15.9	15.9	1.9	O K
240 min Winter	30.574	0.174	0.0	13.0	13.0	1.3	O K
360 min Winter	30.544	0.144	0.0	9.7	9.7	0.8	O K
480 min Winter	30.527	0.127	0.0	7.9	7.9	0.6	O K
600 min Winter	30.515	0.115	0.0	6.7	6.7	0.5	O K
720 min Winter	30.504	0.104	0.0	5.8	5.8	0.4	O K
960 min Winter	30.489	0.089	0.0	4.7	4.7	0.3	O K
1440 min Winter	30.477	0.077	0.0	3.4	3.4	0.2	O K
2160 min Winter	30.467	0.067	0.0	2.5	2.5	0.1	O K
2880 min Winter	30.459	0.059	0.0	2.0	2.0	0.1	O K
4320 min Winter	30.450	0.050	0.0	1.4	1.4	0.1	O K
5760 min Winter	30.444	0.044	0.0	1.1	1.1	0.1	O K
7200 min Winter	30.440	0.040	0.0	1.0	1.0	0.0	O K
8640 min Winter	30.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Winter	30.435	0.035	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.365	0.0	147.4	4328
10080 min Summer	1.205	0.0	151.8	5096
15 min Winter	171.205	0.0	36.0	13
30 min Winter	102.749	0.0	43.2	22
60 min Winter	61.665	0.0	51.8	38
120 min Winter	37.008	0.0	62.2	68
180 min Winter	27.453	0.0	69.2	94
240 min Winter	22.210	0.0	74.6	124
360 min Winter	16.476	0.0	83.0	184
480 min Winter	13.330	0.0	89.6	242
600 min Winter	11.309	0.0	95.0	306
720 min Winter	9.888	0.0	99.7	366
960 min Winter	7.881	0.0	105.9	482
1440 min Winter	5.724	0.0	115.4	716
2160 min Winter	4.158	0.0	125.7	1092
2880 min Winter	3.314	0.0	133.6	1420
4320 min Winter	2.388	0.0	144.5	2184
5760 min Winter	1.893	0.0	152.7	2880
7200 min Winter	1.581	0.0	159.4	3608
8640 min Winter	1.365	0.0	165.1	4424
10080 min Winter	1.205	0.0	170.0	4952

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Cascade Rainfall Details for Swale 7.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) 0.100

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

Swale 7
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Cascade Model Details for Swale 7.srcx

Storage is Online Cover Level (m) 31.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	1212.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	90.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	30.400	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) 30.400

Basin 7
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File Catchment 7 Cascade.casxDesigned by NA
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XP Solutions

Source Control 2018.1

Cascade Summary of Results for Basin 7.srcx

Upstream Outflow To Overflow To
Structures

Pond 5.srcx (None) (None)
Swale 5.srcx
Pond 5a.srcx
Swale 5a.srcx
Swale 7.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	29.261	0.461	173.1	2900.8	O K
30 min Summer	29.345	0.545	177.6	3456.7	O K
60 min Summer	29.437	0.637	180.0	4085.1	O K
120 min Summer	29.536	0.736	180.4	4769.5	O K
180 min Summer	29.593	0.793	180.4	5169.5	O K
240 min Summer	29.630	0.830	180.4	5433.7	O K
360 min Summer	29.674	0.874	180.4	5751.8	O K
480 min Summer	29.699	0.899	180.4	5931.5	O K
600 min Summer	29.717	0.917	180.4	6061.8	Flood Risk
720 min Summer	29.730	0.930	180.4	6156.3	Flood Risk
960 min Summer	29.730	0.930	180.4	6151.8	Flood Risk
1440 min Summer	29.708	0.908	180.4	5998.9	Flood Risk
2160 min Summer	29.654	0.854	180.4	5604.6	O K
2880 min Summer	29.597	0.797	180.4	5199.4	O K
4320 min Summer	29.483	0.683	180.4	4403.4	O K
5760 min Summer	29.392	0.592	179.2	3772.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	171.205	0.0	5433.1	19
30 min Summer	102.749	0.0	6592.5	34
60 min Summer	61.665	0.0	8545.7	64
120 min Summer	37.008	0.0	10299.8	122
180 min Summer	27.453	0.0	11478.5	182
240 min Summer	22.210	0.0	12389.6	242
360 min Summer	16.476	0.0	13787.4	360
480 min Summer	13.330	0.0	14866.7	450
600 min Summer	11.309	0.0	15753.7	510
720 min Summer	9.888	0.0	16509.4	574
960 min Summer	7.881	0.0	17490.2	700
1440 min Summer	5.724	0.0	18867.0	966
2160 min Summer	4.158	0.0	21406.9	1360
2880 min Summer	3.314	0.0	22732.0	1760
4320 min Summer	2.388	0.0	24411.6	2512
5760 min Summer	1.893	0.0	26176.9	3232

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Cascade Summary of Results for Basin 7.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
7200 min Summer	29.320	0.520	176.5	3289.0	O K
8640 min Summer	29.268	0.468	173.6	2945.2	O K
10080 min Summer	29.239	0.439	165.0	2749.6	O K
15 min Winter	29.313	0.513	176.2	3245.8	O K
30 min Winter	29.407	0.607	179.5	3875.1	O K
60 min Winter	29.510	0.710	180.4	4589.9	O K
120 min Winter	29.621	0.821	180.4	5366.9	O K
180 min Winter	29.684	0.884	180.4	5825.2	O K
240 min Winter	29.729	0.929	180.4	6145.1	Flood Risk
360 min Winter	29.787	0.987	180.4	6574.2	Flood Risk
480 min Winter	29.823	1.023	180.4	6840.2	Flood Risk
600 min Winter	29.845	1.045	180.4	7004.7	Flood Risk
720 min Winter	29.856	1.056	180.4	7089.1	Flood Risk
960 min Winter	29.843	1.043	180.4	6986.2	Flood Risk
1440 min Winter	29.802	1.002	180.4	6685.3	Flood Risk
2160 min Winter	29.706	0.906	180.4	5980.9	Flood Risk
2880 min Winter	29.615	0.815	180.4	5328.8	O K
4320 min Winter	29.450	0.650	180.2	4169.2	O K
5760 min Winter	29.321	0.521	176.6	3297.6	O K
7200 min Winter	29.247	0.447	168.7	2808.8	O K
8640 min Winter	29.204	0.404	148.9	2525.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
7200 min Summer	1.581	0.0	27290.5	3960
8640 min Summer	1.365	0.0	28197.6	4584
10080 min Summer	1.205	0.0	28886.9	5296
15 min Winter	171.205	0.0	6132.6	19
30 min Winter	102.749	0.0	7418.4	33
60 min Winter	61.665	0.0	9600.0	62
120 min Winter	37.008	0.0	11559.5	120
180 min Winter	27.453	0.0	12873.3	178
240 min Winter	22.210	0.0	13890.8	236
360 min Winter	16.476	0.0	15454.6	352
480 min Winter	13.330	0.0	16657.4	466
600 min Winter	11.309	0.0	17643.3	576
720 min Winter	9.888	0.0	18480.5	684
960 min Winter	7.881	0.0	19560.6	864
1440 min Winter	5.724	0.0	21039.1	1080
2160 min Winter	4.158	0.0	23992.9	1492
2880 min Winter	3.314	0.0	25480.7	1876
4320 min Winter	2.388	0.0	27404.4	2640
5760 min Winter	1.893	0.0	29336.5	3344
7200 min Winter	1.581	0.0	30590.1	3896
8640 min Winter	1.365	0.0	31618.9	4592

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Cascade Summary of Results for Basin 7.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Winter	29.174	0.374	133.1	2325.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Winter	1.205	0.0	32425.2	5344

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Cascade Rainfall Details for Basin 7.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) 9.062

Time (mins)	Area
From:	To: (ha)
0	4 9.062

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Cascade Model Details for Basin 7.srcx

Storage is Online Cover Level (m) 30.000

Tank or Pond Structure

Invert Level (m) 28.800

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	5970.0	1.200	7697.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0503-1804-1200-1804
Design Head (m)	1.200
Design Flow (l/s)	180.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	503
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	180.2
Flush-Flo™	0.691	180.4
Kick-Flo®	1.036	167.8
Mean Flow over Head Range	-	135.5

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	12.6	1.200	180.2	3.000	282.1	7.000	427.9
0.200	46.5	1.400	194.3	3.500	304.3	7.500	442.7
0.300	94.4	1.600	207.4	4.000	324.9	8.000	457.0
0.400	146.8	1.800	219.7	4.500	344.3	8.500	470.8
0.500	175.5	2.000	231.3	5.000	362.6	9.000	484.3
0.600	179.4	2.200	242.4	5.500	380.0	9.500	497.3
0.800	179.1	2.400	252.9	6.000	396.6		
1.000	170.4	2.600	263.0	6.500	412.5		

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Cascade Summary of Results for Swale 8.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 8.srcx (None)

Half Drain Time : 4 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	28.883	0.483	0.0	30.0	30.0	30.0	8.3	Flood Risk
30 min Summer	28.839	0.439	0.0	28.3	28.3	28.3	6.5	Flood Risk
60 min Summer	28.752	0.352	0.0	24.7	24.7	24.7	3.6	Flood Risk
120 min Summer	28.645	0.245	0.0	19.4	19.4	19.4	1.4	O K
180 min Summer	28.596	0.196	0.0	15.5	15.5	15.5	0.8	O K
240 min Summer	28.572	0.172	0.0	12.7	12.7	12.7	0.6	O K
360 min Summer	28.543	0.143	0.0	9.6	9.6	9.6	0.4	O K
480 min Summer	28.526	0.126	0.0	7.8	7.8	7.8	0.3	O K
600 min Summer	28.514	0.114	0.0	6.6	6.6	6.6	0.2	O K
720 min Summer	28.503	0.103	0.0	5.8	5.8	5.8	0.2	O K
960 min Summer	28.488	0.088	0.0	4.6	4.6	4.6	0.1	O K
1440 min Summer	28.476	0.076	0.0	3.3	3.3	3.3	0.1	O K
2160 min Summer	28.466	0.066	0.0	2.4	2.4	2.4	0.1	O K
2880 min Summer	28.458	0.058	0.0	1.9	1.9	1.9	0.0	O K
4320 min Summer	28.449	0.049	0.0	1.4	1.4	1.4	0.0	O K
5760 min Summer	28.444	0.044	0.0	1.1	1.1	1.1	0.0	O K
7200 min Summer	28.440	0.040	0.0	0.9	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	23.4	12
30 min Summer	106.565	0.0	28.0	20
60 min Summer	63.619	0.0	33.4	36
120 min Summer	37.980	0.0	39.9	64
180 min Summer	28.087	0.0	44.2	94
240 min Summer	22.674	0.0	47.6	124
360 min Summer	16.768	0.0	52.8	182
480 min Summer	13.536	0.0	56.9	244
600 min Summer	11.465	0.0	60.2	306
720 min Summer	10.011	0.0	63.1	364
960 min Summer	7.973	0.0	67.0	490
1440 min Summer	5.785	0.0	72.9	712
2160 min Summer	4.197	0.0	79.3	1076
2880 min Summer	3.343	0.0	84.2	1460
4320 min Summer	2.411	0.0	91.1	2184
5760 min Summer	1.912	0.0	96.4	2840
7200 min Summer	1.597	0.0	100.6	3576

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Cascade Summary of Results for Swale 8.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
8640 min Summer	28.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Summer	28.435	0.035	0.0	0.7	0.7	0.0	O K
15 min Winter	28.902	0.502	0.0	30.7	30.7	9.3	Flood Risk
30 min Winter	28.835	0.435	0.0	28.2	28.2	6.3	Flood Risk
60 min Winter	28.713	0.313	0.0	22.9	22.9	2.6	Flood Risk
120 min Winter	28.596	0.196	0.0	15.4	15.4	0.8	O K
180 min Winter	28.561	0.161	0.0	11.6	11.6	0.5	O K
240 min Winter	28.541	0.141	0.0	9.4	9.4	0.3	O K
360 min Winter	28.518	0.118	0.0	6.9	6.9	0.2	O K
480 min Winter	28.501	0.101	0.0	5.6	5.6	0.2	O K
600 min Winter	28.491	0.091	0.0	4.8	4.8	0.1	O K
720 min Winter	28.484	0.084	0.0	4.2	4.2	0.1	O K
960 min Winter	28.476	0.076	0.0	3.3	3.3	0.1	O K
1440 min Winter	28.466	0.066	0.0	2.4	2.4	0.1	O K
2160 min Winter	28.455	0.055	0.0	1.8	1.8	0.0	O K
2880 min Winter	28.450	0.050	0.0	1.4	1.4	0.0	O K
4320 min Winter	28.442	0.042	0.0	1.0	1.0	0.0	O K
5760 min Winter	28.437	0.037	0.0	0.8	0.8	0.0	O K
7200 min Winter	28.434	0.034	0.0	0.7	0.7	0.0	O K
8640 min Winter	28.432	0.032	0.0	0.6	0.6	0.0	O K
10080 min Winter	28.430	0.030	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	104.2	4384
10080 min Summer	1.218	0.0	107.4	5008
15 min Winter	178.502	0.0	26.3	13
30 min Winter	106.565	0.0	31.3	21
60 min Winter	63.619	0.0	37.4	36
120 min Winter	37.980	0.0	44.7	64
180 min Winter	28.087	0.0	49.5	92
240 min Winter	22.674	0.0	53.3	122
360 min Winter	16.768	0.0	59.2	182
480 min Winter	13.536	0.0	63.7	242
600 min Winter	11.465	0.0	67.4	298
720 min Winter	10.011	0.0	70.6	352
960 min Winter	7.973	0.0	75.0	480
1440 min Winter	5.785	0.0	81.6	726
2160 min Winter	4.197	0.0	88.8	1084
2880 min Winter	3.343	0.0	94.3	1440
4320 min Winter	2.411	0.0	102.1	2172
5760 min Winter	1.912	0.0	107.9	3040
7200 min Winter	1.597	0.0	112.7	3336
8640 min Winter	1.379	0.0	116.7	4240
10080 min Winter	1.218	0.0	120.3	5040

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Cascade Rainfall Details for Swale 8.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) 0.070

Time (mins)	Area
From:	To: (ha)
0	4 0.070

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Cascade Model Details for Swale 8.srcx

Storage is Online Cover Level (m) 29.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	133.0
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)	0.000
Invert Level (m)	28.400	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) 28.400

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Cascade Summary of Results for Basin 8.srcx

Upstream Outflow To Overflow To
Structures

Swale 8.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	27.396	0.596	9.3	317.5	O K
30 min Summer	27.476	0.676	9.3	375.6	O K
60 min Summer	27.559	0.759	9.3	439.0	O K
120 min Summer	27.639	0.839	9.3	504.8	O K
180 min Summer	27.680	0.880	9.3	540.0	O K
240 min Summer	27.704	0.904	9.3	561.2	Flood Risk
360 min Summer	27.727	0.927	9.3	581.7	Flood Risk
480 min Summer	27.732	0.932	9.3	586.5	Flood Risk
600 min Summer	27.728	0.928	9.3	583.3	Flood Risk
720 min Summer	27.723	0.923	9.3	578.7	Flood Risk
960 min Summer	27.699	0.899	9.3	557.2	O K
1440 min Summer	27.652	0.852	9.3	516.2	O K
2160 min Summer	27.579	0.779	9.3	455.4	O K
2880 min Summer	27.496	0.696	9.3	390.5	O K
4320 min Summer	27.339	0.539	9.3	279.4	O K
5760 min Summer	27.207	0.407	9.3	196.5	O K
7200 min Summer	27.105	0.305	9.2	139.6	O K
8640 min Summer	27.033	0.233	9.0	102.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	321.7	20
30 min Summer	106.565	0.0	384.2	34
60 min Summer	63.619	0.0	462.5	64
120 min Summer	37.980	0.0	552.4	122
180 min Summer	28.087	0.0	612.8	182
240 min Summer	22.674	0.0	659.6	242
360 min Summer	16.768	0.0	731.7	360
480 min Summer	13.536	0.0	787.5	480
600 min Summer	11.465	0.0	833.7	560
720 min Summer	10.011	0.0	873.4	614
960 min Summer	7.973	0.0	927.1	740
1440 min Summer	5.785	0.0	1007.8	1008
2160 min Summer	4.197	0.0	1101.5	1424
2880 min Summer	3.343	0.0	1169.6	1792
4320 min Summer	2.411	0.0	1264.3	2548
5760 min Summer	1.912	0.0	1338.7	3232
7200 min Summer	1.597	0.0	1397.6	3896
8640 min Summer	1.379	0.0	1447.6	4576

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Cascade Summary of Results for Basin 8.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	26.986	0.186	8.7	79.8	O K
15 min Winter	27.450	0.650	9.3	355.9	O K
30 min Winter	27.538	0.738	9.3	422.4	O K
60 min Winter	27.627	0.827	9.3	494.9	O K
120 min Winter	27.714	0.914	9.3	570.5	Flood Risk
180 min Winter	27.760	0.960	9.3	612.4	Flood Risk
240 min Winter	27.788	0.988	9.3	638.7	Flood Risk
360 min Winter	27.818	1.018	9.3	667.2	Flood Risk
480 min Winter	27.829	1.029	9.3	678.0	Flood Risk
600 min Winter	27.830	1.030	9.3	678.9	Flood Risk
720 min Winter	27.825	1.025	9.3	673.9	Flood Risk
960 min Winter	27.794	0.994	9.3	644.5	Flood Risk
1440 min Winter	27.736	0.936	9.3	590.4	Flood Risk
2160 min Winter	27.638	0.838	9.3	503.9	O K
2880 min Winter	27.515	0.715	9.3	404.6	O K
4320 min Winter	27.271	0.471	9.3	235.4	O K
5760 min Winter	27.088	0.288	9.2	130.4	O K
7200 min Winter	26.984	0.184	8.6	78.6	O K
8640 min Winter	26.945	0.145	7.8	60.9	O K
10080 min Winter	26.929	0.129	6.9	53.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	1490.5	5240
15 min Winter	178.502	0.0	360.4	21
30 min Winter	106.565	0.0	430.3	33
60 min Winter	63.619	0.0	518.1	62
120 min Winter	37.980	0.0	618.7	120
180 min Winter	28.087	0.0	686.4	180
240 min Winter	22.674	0.0	738.8	238
360 min Winter	16.768	0.0	819.5	352
480 min Winter	13.536	0.0	882.0	464
600 min Winter	11.465	0.0	933.6	574
720 min Winter	10.011	0.0	978.0	678
960 min Winter	7.973	0.0	1038.0	778
1440 min Winter	5.785	0.0	1127.6	1082
2160 min Winter	4.197	0.0	1233.7	1540
2880 min Winter	3.343	0.0	1310.1	1960
4320 min Winter	2.411	0.0	1416.4	2676
5760 min Winter	1.912	0.0	1499.4	3288
7200 min Winter	1.597	0.0	1565.5	3888
8640 min Winter	1.379	0.0	1621.4	4416
10080 min Winter	1.218	0.0	1669.7	5144

Basin 8
Cranbrook



Date 14/01/2019 17:38
File Catchment 8 Cascade.casx

Designed by NA
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Source Control 2018.1

Cascade Rainfall Details for Basin 8.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) 0.903

Time (mins)	Area
From: To:	(ha)
0	4 0.903

Basin 8
Cranbrook



Date 14/01/2019 17:38
File Catchment 8 Cascade.casx

Designed by NA
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Source Control 2018.1

Cascade Model Details for Basin 8.srcx

Storage is Online Cover Level (m) 28.000

Tank or Pond Structure

Invert Level (m) 26.800

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	386.0	1.200	1101.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0138-9300-1200-9300
 Design Head (m) 1.200
 Design Flow (l/s) 9.3
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 138
 Invert Level (m) 26.800
 Minimum Outlet Pipe Diameter (mm) 225
 Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	9.3
Flush-Flo™	0.356	9.3
Kick-Flo®	0.773	7.6
Mean Flow over Head Range	-	8.1

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	5.0	1.200	9.3	3.000	14.3	7.000	21.5
0.200	8.8	1.400	10.0	3.500	15.4	7.500	22.2
0.300	9.2	1.600	10.6	4.000	16.5	8.000	22.9
0.400	9.3	1.800	11.3	4.500	17.4	8.500	23.6
0.500	9.1	2.000	11.8	5.000	18.3	9.000	24.3
0.600	8.9	2.200	12.4	5.500	19.2	9.500	24.9
0.800	7.7	2.400	12.9	6.000	20.0		
1.000	8.5	2.600	13.4	6.500	20.8		

Swale 8a
CranbrookDate 14/01/2019 17:40
File Catchment 8a Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Summary of Results for Swale 8a.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 8a.srcx (None)

Half Drain Time : 7 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	30.872	0.472	0.0	29.6	29.6	19.6	Flood Risk
30 min Summer	30.851	0.451	0.0	28.8	28.8	17.3	Flood Risk
60 min Summer	30.806	0.406	0.0	27.0	27.0	13.0	Flood Risk
120 min Summer	30.730	0.330	0.0	23.7	23.7	7.5	Flood Risk
180 min Summer	30.672	0.272	0.0	20.8	20.8	4.5	O K
240 min Summer	30.631	0.231	0.0	18.5	18.5	3.0	O K
360 min Summer	30.589	0.189	0.0	14.7	14.7	1.8	O K
480 min Summer	30.566	0.166	0.0	12.1	12.1	1.3	O K
600 min Summer	30.550	0.150	0.0	10.3	10.3	1.0	O K
720 min Summer	30.538	0.138	0.0	9.0	9.0	0.8	O K
960 min Summer	30.521	0.121	0.0	7.2	7.2	0.6	O K
1440 min Summer	30.496	0.096	0.0	5.2	5.2	0.4	O K
2160 min Summer	30.481	0.081	0.0	3.8	3.8	0.2	O K
2880 min Summer	30.473	0.073	0.0	3.0	3.0	0.2	O K
4320 min Summer	30.462	0.062	0.0	2.2	2.2	0.1	O K
5760 min Summer	30.455	0.055	0.0	1.7	1.7	0.1	O K
7200 min Summer	30.451	0.051	0.0	1.5	1.5	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	36.8	13
30 min Summer	106.565	0.0	44.0	21
60 min Summer	63.619	0.0	52.5	38
120 min Summer	37.980	0.0	62.7	68
180 min Summer	28.087	0.0	69.5	96
240 min Summer	22.674	0.0	74.8	126
360 min Summer	16.768	0.0	83.0	184
480 min Summer	13.536	0.0	89.3	244
600 min Summer	11.465	0.0	94.6	306
720 min Summer	10.011	0.0	99.1	362
960 min Summer	7.973	0.0	105.2	482
1440 min Summer	5.785	0.0	114.5	728
2160 min Summer	4.197	0.0	124.7	1084
2880 min Summer	3.343	0.0	132.4	1468
4320 min Summer	2.411	0.0	143.2	2136
5760 min Summer	1.912	0.0	151.4	2840
7200 min Summer	1.597	0.0	158.1	3640

Swale 8a
CranbrookDate 14/01/2019 17:40
File Catchment 8a Cascade.casxDesigned by NA
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Cascade Summary of Results for Swale 8a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
8640 min Summer	30.447	0.047	0.0	1.3	1.3	0.1	O K
10080 min Summer	30.444	0.044	0.0	1.1	1.1	0.1	O K
15 min Winter	30.896	0.496	0.0	30.5	30.5	22.4	Flood Risk
30 min Winter	30.866	0.466	0.0	29.4	29.4	18.9	Flood Risk
60 min Winter	30.799	0.399	0.0	26.7	26.7	12.4	Flood Risk
120 min Winter	30.688	0.288	0.0	21.7	21.7	5.3	O K
180 min Winter	30.617	0.217	0.0	17.7	17.7	2.5	O K
240 min Winter	30.588	0.188	0.0	14.5	14.5	1.8	O K
360 min Winter	30.555	0.155	0.0	10.9	10.9	1.1	O K
480 min Winter	30.536	0.136	0.0	8.8	8.8	0.8	O K
600 min Winter	30.523	0.123	0.0	7.4	7.4	0.6	O K
720 min Winter	30.513	0.113	0.0	6.5	6.5	0.5	O K
960 min Winter	30.496	0.096	0.0	5.2	5.2	0.3	O K
1440 min Winter	30.480	0.080	0.0	3.8	3.8	0.2	O K
2160 min Winter	30.471	0.071	0.0	2.8	2.8	0.2	O K
2880 min Winter	30.462	0.062	0.0	2.2	2.2	0.1	O K
4320 min Winter	30.452	0.052	0.0	1.6	1.6	0.1	O K
5760 min Winter	30.447	0.047	0.0	1.3	1.3	0.1	O K
7200 min Winter	30.443	0.043	0.0	1.1	1.1	0.1	O K
8640 min Winter	30.439	0.039	0.0	0.9	0.9	0.0	O K
10080 min Winter	30.437	0.037	0.0	0.8	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	163.8	4320
10080 min Summer	1.218	0.0	168.8	4984
15 min Winter	178.502	0.0	41.2	14
30 min Winter	106.565	0.0	49.2	23
60 min Winter	63.619	0.0	58.8	40
120 min Winter	37.980	0.0	70.2	68
180 min Winter	28.087	0.0	77.9	96
240 min Winter	22.674	0.0	83.8	126
360 min Winter	16.768	0.0	93.0	184
480 min Winter	13.536	0.0	100.1	244
600 min Winter	11.465	0.0	105.9	306
720 min Winter	10.011	0.0	111.0	368
960 min Winter	7.973	0.0	117.9	484
1440 min Winter	5.785	0.0	128.3	712
2160 min Winter	4.197	0.0	139.6	1064
2880 min Winter	3.343	0.0	148.3	1456
4320 min Winter	2.411	0.0	160.4	2244
5760 min Winter	1.912	0.0	169.6	2848
7200 min Winter	1.597	0.0	177.1	3552
8640 min Winter	1.379	0.0	183.4	4384
10080 min Winter	1.218	0.0	189.0	4984

Swale 8a
Cranbrook



Date 14/01/2019 17:40
File Catchment 8a Cascade.casx

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Source Control 2018.1

Cascade Rainfall Details for Swale 8a.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) 0.110

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

Swale 8a
Cranbrook



Date 14/01/2019 17:40
File Catchment 8a Cascade.casx

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Cascade Model Details for Swale 8a.srcx

Storage is Online Cover Level (m) 31.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	197.0
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)	0.000
Invert Level (m)	30.400	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) 30.400

Basin 8a
CranbrookDate 14/01/2019 17:39
File Catchment 8a Cascade.casxDesigned by NA
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Cascade Summary of Results for Basin 8a.srcx

Upstream Outflow To Overflow To
Structures

Swale 8a.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	30.334	0.534	13.6	463.0	O K
30 min Summer	30.421	0.621	13.6	552.5	O K
60 min Summer	30.513	0.713	13.6	651.0	O K
120 min Summer	30.602	0.802	13.6	750.6	O K
180 min Summer	30.650	0.850	13.6	806.1	O K
240 min Summer	30.679	0.879	13.6	840.2	O K
360 min Summer	30.708	0.908	13.6	875.0	Flood Risk
480 min Summer	30.717	0.917	13.6	885.9	Flood Risk
600 min Summer	30.716	0.916	13.6	884.2	Flood Risk
720 min Summer	30.712	0.912	13.6	879.8	Flood Risk
960 min Summer	30.688	0.888	13.6	851.4	O K
1440 min Summer	30.639	0.839	13.6	792.9	O K
2160 min Summer	30.555	0.755	13.6	697.1	O K
2880 min Summer	30.472	0.672	13.6	606.7	O K
4320 min Summer	30.319	0.519	13.6	448.2	O K
5760 min Summer	30.194	0.394	13.6	328.1	O K
7200 min Summer	30.101	0.301	13.6	244.3	O K
8640 min Summer	30.037	0.237	13.2	188.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	469.1	28
30 min Summer	106.565	0.0	560.8	38
60 min Summer	63.619	0.0	680.9	64
120 min Summer	37.980	0.0	813.5	122
180 min Summer	28.087	0.0	902.6	182
240 min Summer	22.674	0.0	971.6	242
360 min Summer	16.768	0.0	1077.8	362
480 min Summer	13.536	0.0	1159.9	480
600 min Summer	11.465	0.0	1227.8	562
720 min Summer	10.011	0.0	1286.0	616
960 min Summer	7.973	0.0	1364.6	742
1440 min Summer	5.785	0.0	1481.5	1010
2160 min Summer	4.197	0.0	1627.0	1408
2880 min Summer	3.343	0.0	1727.5	1788
4320 min Summer	2.411	0.0	1865.8	2548
5760 min Summer	1.912	0.0	1978.6	3232
7200 min Summer	1.597	0.0	2065.5	3896
8640 min Summer	1.379	0.0	2138.7	4576

Basin 8a
CranbrookDate 14/01/2019 17:39
File Catchment 8a Cascade.casxDesigned by NA
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Cascade Summary of Results for Basin 8a.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	29.995	0.195	12.8	153.7	O K
15 min Winter	30.389	0.589	13.6	519.0	O K
30 min Winter	30.484	0.684	13.6	619.6	O K
60 min Winter	30.587	0.787	13.6	733.3	O K
120 min Winter	30.686	0.886	13.6	848.2	O K
180 min Winter	30.739	0.939	13.6	912.4	Flood Risk
240 min Winter	30.772	0.972	13.6	953.4	Flood Risk
360 min Winter	30.809	1.009	13.6	999.2	Flood Risk
480 min Winter	30.824	1.024	13.6	1018.4	Flood Risk
600 min Winter	30.827	1.027	13.6	1022.7	Flood Risk
720 min Winter	30.823	1.023	13.6	1017.8	Flood Risk
960 min Winter	30.792	0.992	13.6	978.1	Flood Risk
1440 min Winter	30.731	0.931	13.6	902.5	Flood Risk
2160 min Winter	30.622	0.822	13.6	773.9	O K
2880 min Winter	30.491	0.691	13.6	626.5	O K
4320 min Winter	30.256	0.456	13.6	386.7	O K
5760 min Winter	30.087	0.287	13.5	232.3	O K
7200 min Winter	29.994	0.194	12.8	152.5	O K
8640 min Winter	29.963	0.163	11.5	126.9	O K
10080 min Winter	29.946	0.146	10.2	113.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	2200.7	5240
15 min Winter	178.502	0.0	526.0	30
30 min Winter	106.565	0.0	628.3	40
60 min Winter	63.619	0.0	762.9	62
120 min Winter	37.980	0.0	911.4	120
180 min Winter	28.087	0.0	1011.1	180
240 min Winter	22.674	0.0	1088.3	238
360 min Winter	16.768	0.0	1207.1	352
480 min Winter	13.536	0.0	1298.9	464
600 min Winter	11.465	0.0	1374.7	574
720 min Winter	10.011	0.0	1439.7	678
960 min Winter	7.973	0.0	1527.2	780
1440 min Winter	5.785	0.0	1656.0	1082
2160 min Winter	4.197	0.0	1822.4	1552
2880 min Winter	3.343	0.0	1935.0	1936
4320 min Winter	2.411	0.0	2090.8	2676
5760 min Winter	1.912	0.0	2216.3	3288
7200 min Winter	1.597	0.0	2313.8	3888
8640 min Winter	1.379	0.0	2396.0	4496
10080 min Winter	1.218	0.0	2466.1	5152

Basin 8a
Cranbrook



Date 14/01/2019 17:39
File Catchment 8a Cascade.casx

Designed by NA
Checked by GG

XP Solutions

Source Control 2018.1

Cascade Rainfall Details for Basin 8a.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) 1.329

Time (mins)	Area
From:	To: (ha)
0	4 1.329

Basin 8a
Cranbrook



Date 14/01/2019 17:39
File Catchment 8a Cascade.casx

Designed by NA
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Source Control 2018.1

Cascade Model Details for Basin 8a.srcx

Storage is Online Cover Level (m) 31.000

Tank or Pond Structure

Invert Level (m) 29.800

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	742.0	1.200	1376.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0165-1370-1200-1370
 Design Head (m) 1.200
 Design Flow (l/s) 13.7
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 165
 Invert Level (m) 29.800
 Minimum Outlet Pipe Diameter (mm) 225
 Suggested Manhole Diameter (mm) 1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	13.7
Flush-Flo™	0.363	13.6
Kick-Flo®	0.797	11.3
Mean Flow over Head Range	-	11.8

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	5.9	1.200	13.7	3.000	21.2	7.000	31.8
0.200	12.9	1.400	14.7	3.500	22.8	7.500	32.9
0.300	13.5	1.600	15.7	4.000	24.3	8.000	33.9
0.400	13.6	1.800	16.6	4.500	25.7	8.500	35.0
0.500	13.4	2.000	17.5	5.000	27.1	9.000	35.9
0.600	13.1	2.200	18.3	5.500	28.3	9.500	36.9
0.800	11.3	2.400	19.0	6.000	29.5		
1.000	12.6	2.600	19.8	6.500	30.7		

Swale 9
CranbrookDate 14/01/2019 17:41
File Catchment 9 Cascade.casxDesigned by NA
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Source Control 2018.1

Cascade Summary of Results for Swale 9.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 9.srcx (None)

Half Drain Time : 6 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	28.879	0.479	0.0	29.9	29.9	12.3	Flood Risk
30 min Summer	28.848	0.448	0.0	28.7	28.7	10.2	Flood Risk
60 min Summer	28.784	0.384	0.0	26.1	26.1	6.7	Flood Risk
120 min Summer	28.685	0.285	0.0	21.5	21.5	3.1	O K
180 min Summer	28.624	0.224	0.0	18.1	18.1	1.7	O K
240 min Summer	28.594	0.194	0.0	15.3	15.3	1.2	O K
360 min Summer	28.561	0.161	0.0	11.6	11.6	0.7	O K
480 min Summer	28.541	0.141	0.0	9.4	9.4	0.5	O K
600 min Summer	28.528	0.128	0.0	8.0	8.0	0.4	O K
720 min Summer	28.519	0.119	0.0	7.0	7.0	0.3	O K
960 min Summer	28.501	0.101	0.0	5.6	5.6	0.2	O K
1440 min Summer	28.483	0.083	0.0	4.1	4.1	0.1	O K
2160 min Summer	28.473	0.073	0.0	3.0	3.0	0.1	O K
2880 min Summer	28.465	0.065	0.0	2.3	2.3	0.1	O K
4320 min Summer	28.454	0.054	0.0	1.7	1.7	0.1	O K
5760 min Summer	28.449	0.049	0.0	1.4	1.4	0.0	O K
7200 min Summer	28.445	0.045	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	28.4	12
30 min Summer	106.565	0.0	34.0	20
60 min Summer	63.619	0.0	40.6	36
120 min Summer	37.980	0.0	48.4	66
180 min Summer	28.087	0.0	53.7	94
240 min Summer	22.674	0.0	57.8	124
360 min Summer	16.768	0.0	64.1	184
480 min Summer	13.536	0.0	69.0	244
600 min Summer	11.465	0.0	73.1	306
720 min Summer	10.011	0.0	76.6	364
960 min Summer	7.973	0.0	81.3	488
1440 min Summer	5.785	0.0	88.5	712
2160 min Summer	4.197	0.0	96.3	1096
2880 min Summer	3.343	0.0	102.3	1420
4320 min Summer	2.411	0.0	110.7	2164
5760 min Summer	1.912	0.0	117.0	2936
7200 min Summer	1.597	0.0	122.2	3576

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Cascade Summary of Results for 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 (m ³)	Status
8640 min Summer	28.441	0.041	0.0	1.0	1.0	0.0	O K
10080 min Summer	28.438	0.038	0.0	0.8	0.8	0.0	O K
15 min Winter	28.904	0.504	0.0	30.8	30.8	14.0	Flood Risk
30 min Winter	28.854	0.454	0.0	28.9	28.9	10.6	Flood Risk
60 min Winter	28.756	0.356	0.0	24.9	24.9	5.5	Flood Risk
120 min Winter	28.627	0.227	0.0	18.3	18.3	1.7	O K
180 min Winter	28.583	0.183	0.0	14.0	14.0	1.0	O K
240 min Winter	28.559	0.159	0.0	11.4	11.4	0.7	O K
360 min Winter	28.532	0.132	0.0	8.4	8.4	0.4	O K
480 min Winter	28.516	0.116	0.0	6.8	6.8	0.3	O K
600 min Winter	28.503	0.103	0.0	5.8	5.8	0.2	O K
720 min Winter	28.494	0.094	0.0	5.1	5.1	0.2	O K
960 min Winter	28.483	0.083	0.0	4.0	4.0	0.1	O K
1440 min Winter	28.472	0.072	0.0	2.9	2.9	0.1	O K
2160 min Winter	28.461	0.061	0.0	2.1	2.1	0.1	O K
2880 min Winter	28.454	0.054	0.0	1.7	1.7	0.1	O K
4320 min Winter	28.446	0.046	0.0	1.2	1.2	0.0	O K
5760 min Winter	28.441	0.041	0.0	1.0	1.0	0.0	O K
7200 min Winter	28.437	0.037	0.0	0.8	0.8	0.0	O K
8640 min Winter	28.435	0.035	0.0	0.7	0.7	0.0	O K
10080 min Winter	28.433	0.033	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	126.6	4344
10080 min Summer	1.218	0.0	130.4	4960
15 min Winter	178.502	0.0	31.9	13
30 min Winter	106.565	0.0	38.0	21
60 min Winter	63.619	0.0	45.4	38
120 min Winter	37.980	0.0	54.2	66
180 min Winter	28.087	0.0	60.2	94
240 min Winter	22.674	0.0	64.8	124
360 min Winter	16.768	0.0	71.8	184
480 min Winter	13.536	0.0	77.3	246
600 min Winter	11.465	0.0	81.9	300
720 min Winter	10.011	0.0	85.8	362
960 min Winter	7.973	0.0	91.1	490
1440 min Winter	5.785	0.0	99.1	718
2160 min Winter	4.197	0.0	107.9	1076
2880 min Winter	3.343	0.0	114.6	1404
4320 min Winter	2.411	0.0	123.9	2144
5760 min Winter	1.912	0.0	131.0	2848
7200 min Winter	1.597	0.0	136.8	3448
8640 min Winter	1.379	0.0	141.7	4376
10080 min Winter	1.218	0.0	146.0	5104

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Cascade Rainfall Details for Swale 9.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) 0.085

Time (mins)	Area
From: To:	(ha)
0	4 0.085

Swale 9
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Cascade Model Details for Swale 9.srcx

Storage is Online Cover Level (m) 29.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	243.0
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)	0.000
Invert Level (m)	28.400	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) 28.400

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Cascade Summary of Results for Basin 9.srcx

Upstream Outflow To Overflow To
Structures

Swale 9.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	27.010	0.610	17.0	579.4	O K
30 min Summer	27.108	0.708	17.0	689.2	O K
60 min Summer	27.209	0.809	17.0	806.8	O K
120 min Summer	27.308	0.908	17.0	929.0	Flood Risk
180 min Summer	27.360	0.960	17.0	994.8	Flood Risk
240 min Summer	27.391	0.991	17.0	1034.6	Flood Risk
360 min Summer	27.422	1.022	17.0	1073.9	Flood Risk
480 min Summer	27.429	1.029	17.0	1083.8	Flood Risk
600 min Summer	27.427	1.027	17.0	1080.7	Flood Risk
720 min Summer	27.423	1.023	17.0	1075.4	Flood Risk
960 min Summer	27.396	0.996	17.0	1040.6	Flood Risk
1440 min Summer	27.341	0.941	17.0	970.1	Flood Risk
2160 min Summer	27.256	0.856	17.0	864.1	O K
2880 min Summer	27.160	0.760	17.0	748.8	O K
4320 min Summer	26.978	0.578	17.0	544.6	O K
5760 min Summer	26.832	0.432	17.0	392.5	O K
7200 min Summer	26.726	0.326	16.9	287.6	O K
8640 min Summer	26.653	0.253	16.6	219.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	582.2	22
30 min Summer	106.565	0.0	695.9	34
60 min Summer	63.619	0.0	843.7	64
120 min Summer	37.980	0.0	1008.0	122
180 min Summer	28.087	0.0	1118.4	182
240 min Summer	22.674	0.0	1203.9	242
360 min Summer	16.768	0.0	1335.5	360
480 min Summer	13.536	0.0	1437.4	480
600 min Summer	11.465	0.0	1521.5	538
720 min Summer	10.011	0.0	1593.8	600
960 min Summer	7.973	0.0	1691.4	722
1440 min Summer	5.785	0.0	1836.7	996
2160 min Summer	4.197	0.0	2015.1	1408
2880 min Summer	3.343	0.0	2139.6	1812
4320 min Summer	2.411	0.0	2311.3	2548
5760 min Summer	1.912	0.0	2450.4	3232
7200 min Summer	1.597	0.0	2558.1	3896
8640 min Summer	1.379	0.0	2648.9	4576

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Cascade Summary of Results for Basin 9.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	26.608	0.208	16.1	177.9	O K
15 min Winter	27.073	0.673	17.0	649.5	O K
30 min Winter	27.181	0.781	17.0	774.0	O K
60 min Winter	27.292	0.892	17.0	908.4	O K
120 min Winter	27.402	1.002	17.0	1048.0	Flood Risk
180 min Winter	27.461	1.061	17.0	1125.6	Flood Risk
240 min Winter	27.497	1.097	17.0	1174.5	Flood Risk
360 min Winter	27.536	1.136	17.0	1227.8	Flood Risk
480 min Winter	27.551	1.151	17.0	1248.3	Flood Risk
600 min Winter	27.553	1.153	17.0	1250.7	Flood Risk
720 min Winter	27.547	1.147	17.0	1242.2	Flood Risk
960 min Winter	27.512	1.112	17.0	1195.2	Flood Risk
1440 min Winter	27.442	1.042	17.0	1100.9	Flood Risk
2160 min Winter	27.323	0.923	17.0	947.6	Flood Risk
2880 min Winter	27.183	0.783	17.0	776.7	O K
4320 min Winter	26.902	0.502	17.0	464.2	O K
5760 min Winter	26.707	0.307	16.9	269.5	O K
7200 min Winter	26.604	0.204	16.0	174.8	O K
8640 min Winter	26.575	0.175	14.3	148.2	O K
10080 min Winter	26.557	0.157	12.7	132.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	2725.9	5240
15 min Winter	178.502	0.0	652.7	24
30 min Winter	106.565	0.0	779.5	34
60 min Winter	63.619	0.0	945.4	62
120 min Winter	37.980	0.0	1129.3	120
180 min Winter	28.087	0.0	1252.9	180
240 min Winter	22.674	0.0	1348.6	238
360 min Winter	16.768	0.0	1495.9	352
480 min Winter	13.536	0.0	1609.8	462
600 min Winter	11.465	0.0	1703.9	572
720 min Winter	10.011	0.0	1784.6	672
960 min Winter	7.973	0.0	1893.3	762
1440 min Winter	5.785	0.0	2054.2	1068
2160 min Winter	4.197	0.0	2257.2	1536
2880 min Winter	3.343	0.0	2396.7	1960
4320 min Winter	2.411	0.0	2589.9	2676
5760 min Winter	1.912	0.0	2744.8	3288
7200 min Winter	1.597	0.0	2865.5	3824
8640 min Winter	1.379	0.0	2967.4	4488
10080 min Winter	1.218	0.0	3054.5	5144

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Cascade Rainfall Details for Basin 9.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) 1.697

Time (mins)	Area
From:	To: (ha)
0	4 1.697

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Cascade Model Details for Basin 9.srcx

Storage is Online Cover Level (m) 27.600

Tank or Pond Structure

Invert Level (m) 26.400

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	811.0	1.200	1411.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0182-1700-1200-1700
Design Head (m)	1.200
Design Flow (l/s)	17.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	182
Invert Level (m)	26.400
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	17.0
Flush-Flo™	0.368	17.0
Kick-Flo®	0.814	14.1
Mean Flow over Head Range	-	14.6

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	6.4	1.200	17.0	3.000	26.3	7.000	39.6
0.200	16.0	1.400	18.3	3.500	28.3	7.500	40.9
0.300	16.9	1.600	19.5	4.000	30.2	8.000	42.2
0.400	17.0	1.800	20.6	4.500	32.0	8.500	43.5
0.500	16.7	2.000	21.7	5.000	33.7	9.000	44.7
0.600	16.4	2.200	22.7	5.500	35.2	9.500	45.9
0.800	14.4	2.400	23.7	6.000	36.8		
1.000	15.6	2.600	24.6	6.500	38.2		

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Cascade Summary of Results for Swale 10.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 10.srcx (None)

Half Drain Time : 4 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	33.883	0.483	0.0	30.0	30.0	8.3	Flood Risk
30 min Summer	33.839	0.439	0.0	28.3	28.3	6.5	Flood Risk
60 min Summer	33.752	0.352	0.0	24.7	24.7	3.6	Flood Risk
120 min Summer	33.645	0.245	0.0	19.4	19.4	1.4	O K
180 min Summer	33.596	0.196	0.0	15.5	15.5	0.8	O K
240 min Summer	33.572	0.172	0.0	12.7	12.7	0.6	O K
360 min Summer	33.543	0.143	0.0	9.6	9.6	0.4	O K
480 min Summer	33.526	0.126	0.0	7.8	7.8	0.3	O K
600 min Summer	33.514	0.114	0.0	6.6	6.6	0.2	O K
720 min Summer	33.503	0.103	0.0	5.8	5.8	0.2	O K
960 min Summer	33.488	0.088	0.0	4.6	4.6	0.1	O K
1440 min Summer	33.476	0.076	0.0	3.3	3.3	0.1	O K
2160 min Summer	33.466	0.066	0.0	2.4	2.4	0.1	O K
2880 min Summer	33.458	0.058	0.0	1.9	1.9	0.0	O K
4320 min Summer	33.449	0.049	0.0	1.4	1.4	0.0	O K
5760 min Summer	33.444	0.044	0.0	1.1	1.1	0.0	O K
7200 min Summer	33.440	0.040	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	23.4	12
30 min Summer	106.565	0.0	28.0	20
60 min Summer	63.619	0.0	33.4	36
120 min Summer	37.980	0.0	39.9	64
180 min Summer	28.087	0.0	44.2	94
240 min Summer	22.674	0.0	47.6	124
360 min Summer	16.768	0.0	52.8	182
480 min Summer	13.536	0.0	56.9	244
600 min Summer	11.465	0.0	60.2	306
720 min Summer	10.011	0.0	63.1	364
960 min Summer	7.973	0.0	67.0	490
1440 min Summer	5.785	0.0	72.9	712
2160 min Summer	4.197	0.0	79.3	1076
2880 min Summer	3.343	0.0	84.2	1460
4320 min Summer	2.411	0.0	91.1	2184
5760 min Summer	1.912	0.0	96.4	2840
7200 min Summer	1.597	0.0	100.6	3576

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Cascade Summary of Results for 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 (m ³)	Status
8640 min Summer	33.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Summer	33.435	0.035	0.0	0.7	0.7	0.0	O K
15 min Winter	33.902	0.502	0.0	30.7	30.7	9.3	Flood Risk
30 min Winter	33.835	0.435	0.0	28.2	28.2	6.3	Flood Risk
60 min Winter	33.713	0.313	0.0	22.9	22.9	2.6	Flood Risk
120 min Winter	33.596	0.196	0.0	15.4	15.4	0.8	O K
180 min Winter	33.561	0.161	0.0	11.6	11.6	0.5	O K
240 min Winter	33.541	0.141	0.0	9.4	9.4	0.3	O K
360 min Winter	33.518	0.118	0.0	6.9	6.9	0.2	O K
480 min Winter	33.501	0.101	0.0	5.6	5.6	0.2	O K
600 min Winter	33.491	0.091	0.0	4.8	4.8	0.1	O K
720 min Winter	33.484	0.084	0.0	4.2	4.2	0.1	O K
960 min Winter	33.476	0.076	0.0	3.3	3.3	0.1	O K
1440 min Winter	33.466	0.066	0.0	2.4	2.4	0.1	O K
2160 min Winter	33.455	0.055	0.0	1.8	1.8	0.0	O K
2880 min Winter	33.450	0.050	0.0	1.4	1.4	0.0	O K
4320 min Winter	33.442	0.042	0.0	1.0	1.0	0.0	O K
5760 min Winter	33.437	0.037	0.0	0.8	0.8	0.0	O K
7200 min Winter	33.434	0.034	0.0	0.7	0.7	0.0	O K
8640 min Winter	33.432	0.032	0.0	0.6	0.6	0.0	O K
10080 min Winter	33.430	0.030	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	104.2	4384
10080 min Summer	1.218	0.0	107.4	5008
15 min Winter	178.502	0.0	26.3	13
30 min Winter	106.565	0.0	31.3	21
60 min Winter	63.619	0.0	37.4	36
120 min Winter	37.980	0.0	44.7	64
180 min Winter	28.087	0.0	49.5	92
240 min Winter	22.674	0.0	53.3	122
360 min Winter	16.768	0.0	59.2	182
480 min Winter	13.536	0.0	63.7	242
600 min Winter	11.465	0.0	67.4	298
720 min Winter	10.011	0.0	70.6	352
960 min Winter	7.973	0.0	75.0	480
1440 min Winter	5.785	0.0	81.6	726
2160 min Winter	4.197	0.0	88.8	1084
2880 min Winter	3.343	0.0	94.3	1440
4320 min Winter	2.411	0.0	102.1	2172
5760 min Winter	1.912	0.0	107.9	3040
7200 min Winter	1.597	0.0	112.7	3336
8640 min Winter	1.379	0.0	116.7	4240
10080 min Winter	1.218	0.0	120.3	5040

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Cascade Rainfall Details for 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) 0.070

Time (mins)	Area
From:	To: (ha)
0	4 0.070

Swale 10
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Cascade Model Details for Swale 10.srcx

Storage is Online Cover Level (m) 34.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	81.0
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)	0.000
Invert Level (m)	33.400	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) 33.400

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Cascade Summary of Results for Basin 10.srcx

Upstream Outflow To Overflow To
Structures

Swale 10.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	28.031	0.731	5.7	194.3	O K
30 min Summer	28.118	0.818	5.7	229.8	O K
60 min Summer	28.204	0.904	5.7	267.8	Flood Risk
120 min Summer	28.284	0.984	5.7	306.1	Flood Risk
180 min Summer	28.324	1.024	5.7	326.0	Flood Risk
240 min Summer	28.346	1.046	5.7	337.4	Flood Risk
360 min Summer	28.364	1.064	5.7	347.2	Flood Risk
480 min Summer	28.365	1.065	5.7	347.5	Flood Risk
600 min Summer	28.359	1.059	5.7	344.3	Flood Risk
720 min Summer	28.352	1.052	5.7	340.8	Flood Risk
960 min Summer	28.325	1.025	5.7	326.8	Flood Risk
1440 min Summer	28.276	0.976	5.7	302.1	Flood Risk
2160 min Summer	28.204	0.904	5.7	268.1	Flood Risk
2880 min Summer	28.131	0.831	5.7	235.4	O K
4320 min Summer	27.942	0.642	5.7	161.4	O K
5760 min Summer	27.775	0.475	5.7	106.6	O K
7200 min Summer	27.643	0.343	5.7	70.3	O K
8640 min Summer	27.549	0.249	5.6	47.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	198.7	21
30 min Summer	106.565	0.0	237.2	34
60 min Summer	63.619	0.0	284.0	64
120 min Summer	37.980	0.0	339.2	122
180 min Summer	28.087	0.0	376.2	182
240 min Summer	22.674	0.0	405.0	242
360 min Summer	16.768	0.0	449.2	360
480 min Summer	13.536	0.0	483.5	480
600 min Summer	11.465	0.0	511.9	534
720 min Summer	10.011	0.0	536.3	594
960 min Summer	7.973	0.0	569.5	720
1440 min Summer	5.785	0.0	619.6	984
2160 min Summer	4.197	0.0	675.2	1404
2880 min Summer	3.343	0.0	717.0	1816
4320 min Summer	2.411	0.0	775.4	2552
5760 min Summer	1.912	0.0	820.3	3232
7200 min Summer	1.597	0.0	856.5	3888
8640 min Summer	1.379	0.0	887.2	4576

Basin 10
CranbrookDate 14/01/2019 17:42
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Cascade Summary of Results for Basin 10.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	27.489	0.189	5.3	34.6	O K
15 min Winter	28.090	0.790	5.7	218.0	O K
30 min Winter	28.183	0.883	5.7	258.4	O K
60 min Winter	28.275	0.975	5.7	301.8	Flood Risk
120 min Winter	28.363	1.063	5.7	346.7	Flood Risk
180 min Winter	28.409	1.109	5.7	371.0	Flood Risk
240 min Winter	28.435	1.135	5.7	385.8	Flood Risk
360 min Winter	28.462	1.162	5.7	400.9	Flood Risk
480 min Winter	28.470	1.170	5.7	405.4	Flood Risk
600 min Winter	28.467	1.167	5.7	404.0	Flood Risk
720 min Winter	28.459	1.159	5.7	399.1	Flood Risk
960 min Winter	28.426	1.126	5.7	380.6	Flood Risk
1440 min Winter	28.364	1.064	5.7	346.7	Flood Risk
2160 min Winter	28.263	0.963	5.7	295.8	Flood Risk
2880 min Winter	28.155	0.855	5.7	245.7	O K
4320 min Winter	27.856	0.556	5.7	131.8	O K
5760 min Winter	27.617	0.317	5.7	63.9	O K
7200 min Winter	27.485	0.185	5.3	33.9	O K
8640 min Winter	27.429	0.129	4.8	22.6	O K
10080 min Winter	27.413	0.113	4.3	19.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	913.9	5240
15 min Winter	178.502	0.0	222.5	22
30 min Winter	106.565	0.0	265.6	33
60 min Winter	63.619	0.0	318.1	62
120 min Winter	37.980	0.0	379.9	120
180 min Winter	28.087	0.0	421.4	180
240 min Winter	22.674	0.0	453.6	236
360 min Winter	16.768	0.0	503.1	352
480 min Winter	13.536	0.0	541.5	462
600 min Winter	11.465	0.0	573.3	570
720 min Winter	10.011	0.0	600.7	672
960 min Winter	7.973	0.0	637.7	760
1440 min Winter	5.785	0.0	693.7	1068
2160 min Winter	4.197	0.0	756.2	1516
2880 min Winter	3.343	0.0	803.0	1964
4320 min Winter	2.411	0.0	868.5	2680
5760 min Winter	1.912	0.0	918.7	3280
7200 min Winter	1.597	0.0	959.2	3824
8640 min Winter	1.379	0.0	993.7	4408
10080 min Winter	1.218	0.0	1023.6	5136

Basin 10
Cranbrook



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Cascade Rainfall Details for 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) 0.526

Time (mins)	Area
From:	To: (ha)
0	4 0.526

Basin 10
Cranbrook



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File Catchment 10 Cascade.casx

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Source Control 2018.1

Cascade Model Details for Basin 10.srcx

Storage is Online Cover Level (m) 28.500

Tank or Pond Structure

Invert Level (m) 27.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	159.0	1.200	592.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0109-5700-1200-5700
Design Head (m)	1.200
Design Flow (l/s)	5.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	109
Invert Level (m)	27.300
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	5.7
Flush-Flo™	0.353	5.7
Kick-Flo®	0.750	4.6
Mean Flow over Head Range	-	5.0

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	3.8	1.200	5.7	3.000	8.8	7.000	13.1
0.200	5.4	1.400	6.1	3.500	9.4	7.500	13.5
0.300	5.7	1.600	6.5	4.000	10.0	8.000	14.0
0.400	5.7	1.800	6.9	4.500	10.6	8.500	14.4
0.500	5.6	2.000	7.2	5.000	11.2	9.000	14.8
0.600	5.4	2.200	7.6	5.500	11.7	9.500	15.2
0.800	4.7	2.400	7.9	6.000	12.2		
1.000	5.2	2.600	8.2	6.500	12.6		

Swale 11
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Cascade Summary of Results for Swale 11.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 11.srcx (None)

Half Drain Time : 4 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	30.883	0.483	0.0	30.0	30.0	8.3	Flood Risk
30 min Summer	30.839	0.439	0.0	28.3	28.3	6.5	Flood Risk
60 min Summer	30.752	0.352	0.0	24.7	24.7	3.6	Flood Risk
120 min Summer	30.645	0.245	0.0	19.4	19.4	1.4	O K
180 min Summer	30.596	0.196	0.0	15.5	15.5	0.8	O K
240 min Summer	30.572	0.172	0.0	12.7	12.7	0.6	O K
360 min Summer	30.543	0.143	0.0	9.6	9.6	0.4	O K
480 min Summer	30.526	0.126	0.0	7.8	7.8	0.3	O K
600 min Summer	30.514	0.114	0.0	6.6	6.6	0.2	O K
720 min Summer	30.503	0.103	0.0	5.8	5.8	0.2	O K
960 min Summer	30.488	0.088	0.0	4.6	4.6	0.1	O K
1440 min Summer	30.476	0.076	0.0	3.3	3.3	0.1	O K
2160 min Summer	30.466	0.066	0.0	2.4	2.4	0.1	O K
2880 min Summer	30.458	0.058	0.0	1.9	1.9	0.0	O K
4320 min Summer	30.449	0.049	0.0	1.4	1.4	0.0	O K
5760 min Summer	30.444	0.044	0.0	1.1	1.1	0.0	O K
7200 min Summer	30.440	0.040	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	23.4	12
30 min Summer	106.565	0.0	28.0	20
60 min Summer	63.619	0.0	33.4	36
120 min Summer	37.980	0.0	39.9	64
180 min Summer	28.087	0.0	44.2	94
240 min Summer	22.674	0.0	47.6	124
360 min Summer	16.768	0.0	52.8	182
480 min Summer	13.536	0.0	56.9	244
600 min Summer	11.465	0.0	60.2	306
720 min Summer	10.011	0.0	63.1	364
960 min Summer	7.973	0.0	67.0	490
1440 min Summer	5.785	0.0	72.9	712
2160 min Summer	4.197	0.0	79.3	1076
2880 min Summer	3.343	0.0	84.2	1460
4320 min Summer	2.411	0.0	91.1	2184
5760 min Summer	1.912	0.0	96.4	2840
7200 min Summer	1.597	0.0	100.6	3576

Swale 11
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Cascade Summary of Results for Swale 11.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Σ Outflow (1/s)	Max Volume (m ³)	Status
8640 min Summer	30.437	0.037	0.0	0.8	0.8	0.0	O K
10080 min Summer	30.435	0.035	0.0	0.7	0.7	0.0	O K
15 min Winter	30.902	0.502	0.0	30.7	30.7	9.3	Flood Risk
30 min Winter	30.835	0.435	0.0	28.2	28.2	6.3	Flood Risk
60 min Winter	30.713	0.313	0.0	22.9	22.9	2.6	Flood Risk
120 min Winter	30.596	0.196	0.0	15.4	15.4	0.8	O K
180 min Winter	30.561	0.161	0.0	11.6	11.6	0.5	O K
240 min Winter	30.541	0.141	0.0	9.4	9.4	0.3	O K
360 min Winter	30.518	0.118	0.0	6.9	6.9	0.2	O K
480 min Winter	30.501	0.101	0.0	5.6	5.6	0.2	O K
600 min Winter	30.491	0.091	0.0	4.8	4.8	0.1	O K
720 min Winter	30.484	0.084	0.0	4.2	4.2	0.1	O K
960 min Winter	30.476	0.076	0.0	3.3	3.3	0.1	O K
1440 min Winter	30.466	0.066	0.0	2.4	2.4	0.1	O K
2160 min Winter	30.455	0.055	0.0	1.8	1.8	0.0	O K
2880 min Winter	30.450	0.050	0.0	1.4	1.4	0.0	O K
4320 min Winter	30.442	0.042	0.0	1.0	1.0	0.0	O K
5760 min Winter	30.437	0.037	0.0	0.8	0.8	0.0	O K
7200 min Winter	30.434	0.034	0.0	0.7	0.7	0.0	O K
8640 min Winter	30.432	0.032	0.0	0.6	0.6	0.0	O K
10080 min Winter	30.430	0.030	0.0	0.5	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
8640 min Summer	1.379	0.0	104.2	4384
10080 min Summer	1.218	0.0	107.4	5008
15 min Winter	178.502	0.0	26.3	13
30 min Winter	106.565	0.0	31.3	21
60 min Winter	63.619	0.0	37.4	36
120 min Winter	37.980	0.0	44.7	64
180 min Winter	28.087	0.0	49.5	92
240 min Winter	22.674	0.0	53.3	122
360 min Winter	16.768	0.0	59.2	182
480 min Winter	13.536	0.0	63.7	242
600 min Winter	11.465	0.0	67.4	298
720 min Winter	10.011	0.0	70.6	352
960 min Winter	7.973	0.0	75.0	480
1440 min Winter	5.785	0.0	81.6	726
2160 min Winter	4.197	0.0	88.8	1084
2880 min Winter	3.343	0.0	94.3	1440
4320 min Winter	2.411	0.0	102.1	2172
5760 min Winter	1.912	0.0	107.9	3040
7200 min Winter	1.597	0.0	112.7	3336
8640 min Winter	1.379	0.0	116.7	4240
10080 min Winter	1.218	0.0	120.3	5040

Swale 11
Cranbrook



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Cascade Rainfall Details for 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) 0.070

Time (mins)	Area
From:	To: (ha)
0	4 0.070

Swale 11
Cranbrook



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File Catchment 11 Cascade.casx

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Cascade Model Details for Swale 11.srcx

Storage is Online Cover Level (m) 31.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	592.0
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)	0.000
Invert Level (m)	30.400	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) 30.400

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Cascade Summary of Results for Basin 11.srcx

Upstream Outflow To Overflow To
Structures

Swale 11.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	27.846	0.546	41.4	1420.6	O K
30 min Summer	27.935	0.635	41.4	1679.7	O K
60 min Summer	28.032	0.732	41.4	1967.1	O K
120 min Summer	28.131	0.831	41.4	2271.6	O K
180 min Summer	28.186	0.886	41.4	2445.7	O K
240 min Summer	28.221	0.921	41.4	2557.2	Flood Risk
360 min Summer	28.258	0.958	41.4	2676.3	Flood Risk
480 min Summer	28.272	0.972	41.4	2720.2	Flood Risk
600 min Summer	28.274	0.974	41.4	2726.8	Flood Risk
720 min Summer	28.273	0.973	41.4	2725.6	Flood Risk
960 min Summer	28.253	0.953	41.4	2658.6	Flood Risk
1440 min Summer	28.205	0.905	41.4	2503.3	Flood Risk
2160 min Summer	28.118	0.818	41.4	2229.5	O K
2880 min Summer	28.033	0.733	41.4	1970.2	O K
4320 min Summer	27.875	0.575	41.4	1505.3	O K
5760 min Summer	27.751	0.451	41.4	1155.5	O K
7200 min Summer	27.661	0.361	41.1	910.2	O K
8640 min Summer	27.599	0.299	40.3	746.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	1362.8	19
30 min Summer	106.565	0.0	1634.0	33
60 min Summer	63.619	0.0	2024.1	64
120 min Summer	37.980	0.0	2421.1	122
180 min Summer	28.087	0.0	2687.5	182
240 min Summer	22.674	0.0	2893.6	242
360 min Summer	16.768	0.0	3210.1	360
480 min Summer	13.536	0.0	3454.5	480
600 min Summer	11.465	0.0	3655.8	550
720 min Summer	10.011	0.0	3828.1	608
960 min Summer	7.973	0.0	4058.7	732
1440 min Summer	5.785	0.0	4396.4	996
2160 min Summer	4.197	0.0	4880.0	1388
2880 min Summer	3.343	0.0	5180.4	1788
4320 min Summer	2.411	0.0	5585.0	2548
5760 min Summer	1.912	0.0	5946.9	3232
7200 min Summer	1.597	0.0	6205.9	3896
8640 min Summer	1.379	0.0	6421.6	4576

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Cascade Summary of Results for Basin 11.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	27.564	0.264	39.1	653.1	O K
15 min Winter	27.905	0.605	41.4	1592.3	O K
30 min Winter	28.005	0.705	41.4	1886.7	O K
60 min Winter	28.112	0.812	41.4	2213.6	O K
120 min Winter	28.224	0.924	41.4	2565.6	Flood Risk
180 min Winter	28.286	0.986	41.4	2765.7	Flood Risk
240 min Winter	28.325	1.025	41.4	2894.7	Flood Risk
360 min Winter	28.369	1.069	41.4	3042.4	Flood Risk
480 min Winter	28.389	1.089	41.4	3108.9	Flood Risk
600 min Winter	28.395	1.095	41.4	3129.6	Flood Risk
720 min Winter	28.393	1.093	41.4	3121.9	Flood Risk
960 min Winter	28.364	1.064	41.4	3023.7	Flood Risk
1440 min Winter	28.302	1.002	41.4	2817.9	Flood Risk
2160 min Winter	28.185	0.885	41.4	2442.0	O K
2880 min Winter	28.050	0.750	41.4	2023.2	O K
4320 min Winter	27.812	0.512	41.4	1325.6	O K
5760 min Winter	27.647	0.347	41.0	872.8	O K
7200 min Winter	27.564	0.264	39.1	653.8	O K
8640 min Winter	27.534	0.234	34.3	577.3	O K
10080 min Winter	27.514	0.214	30.5	525.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	6597.6	5240
15 min Winter	178.502	0.0	1531.1	19
30 min Winter	106.565	0.0	1833.1	33
60 min Winter	63.619	0.0	2270.0	62
120 min Winter	37.980	0.0	2714.1	120
180 min Winter	28.087	0.0	3012.1	180
240 min Winter	22.674	0.0	3242.6	238
360 min Winter	16.768	0.0	3596.5	352
480 min Winter	13.536	0.0	3869.4	464
600 min Winter	11.465	0.0	4093.9	572
720 min Winter	10.011	0.0	4285.7	676
960 min Winter	7.973	0.0	4541.6	768
1440 min Winter	5.785	0.0	4909.7	1070
2160 min Winter	4.197	0.0	5467.3	1536
2880 min Winter	3.343	0.0	5804.4	1932
4320 min Winter	2.411	0.0	6262.6	2640
5760 min Winter	1.912	0.0	6662.5	3288
7200 min Winter	1.597	0.0	6953.3	3816
8640 min Winter	1.379	0.0	7196.4	4504
10080 min Winter	1.218	0.0	7397.9	5240

Basin 11
Cranbrook



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Cascade Rainfall Details for 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) 4.262

Time (mins)	Area
From: To:	(ha)
0	4 4.262

Basin 11
Cranbrook



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Cascade Model Details for Basin 11.srcx

Storage is Online Cover Level (m) 28.500

Tank or Pond Structure

Invert Level (m) 27.300

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	2365.0	1.200	3487.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0269-4140-1200-4140
 Design Head (m) 1.200
 Design Flow (l/s) 41.4
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 269
 Invert Level (m) 27.300
 Minimum Outlet Pipe Diameter (mm) 300
 Suggested Manhole Diameter (mm) 1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	41.4
Flush-Flo™	0.441	41.4
Kick-Flo®	0.885	35.8
Mean Flow over Head Range	-	34.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.5	1.200	41.4	3.000	64.4	7.000	97.3
0.200	27.7	1.400	44.6	3.500	69.4	7.500	100.6
0.300	40.3	1.600	47.5	4.000	74.1	8.000	103.8
0.400	41.3	1.800	50.3	4.500	78.4	8.500	106.9
0.500	41.3	2.000	52.9	5.000	82.5	9.000	109.9
0.600	40.7	2.200	55.4	5.500	86.5	9.500	112.9
0.800	38.3	2.400	57.8	6.000	90.2		
1.000	37.9	2.600	60.1	6.500	93.8		

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Cascade Summary of Results for Swale 12.srcx

Upstream Outflow To Overflow To
Structures

(None) Basin 12.srcx (None)

Half Drain Time : 5 minutes.

Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max E Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	28.872	0.472	0.0	29.6	29.6	9.8	Flood Risk
30 min Summer	28.835	0.435	0.0	28.2	28.2	7.8	Flood Risk
60 min Summer	28.760	0.360	0.0	25.1	25.1	4.7	Flood Risk
120 min Summer	28.657	0.257	0.0	20.0	20.0	2.0	O K
180 min Summer	28.605	0.205	0.0	16.5	16.5	1.1	O K
240 min Summer	28.579	0.179	0.0	13.6	13.6	0.8	O K
360 min Summer	28.549	0.149	0.0	10.2	10.2	0.5	O K
480 min Summer	28.531	0.131	0.0	8.3	8.3	0.4	O K
600 min Summer	28.520	0.120	0.0	7.1	7.1	0.3	O K
720 min Summer	28.508	0.108	0.0	6.1	6.1	0.2	O K
960 min Summer	28.492	0.092	0.0	4.9	4.9	0.2	O K
1440 min Summer	28.479	0.079	0.0	3.6	3.6	0.1	O K
2160 min Summer	28.469	0.069	0.0	2.6	2.6	0.1	O K
2880 min Summer	28.460	0.060	0.0	2.1	2.1	0.1	O K
4320 min Summer	28.451	0.051	0.0	1.5	1.5	0.0	O K
5760 min Summer	28.446	0.046	0.0	1.2	1.2	0.0	O K
7200 min Summer	28.441	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 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 (m ³)	Status
8640 min Summer	28.438	0.038	0.0	0.9	0.9	0.0	O K
10080 min Summer	28.436	0.036	0.0	0.8	0.8	0.0	O K
15 min Winter	28.893	0.493	0.0	30.4	30.4	11.0	Flood Risk
30 min Winter	28.836	0.436	0.0	28.2	28.2	7.9	Flood Risk
60 min Winter	28.727	0.327	0.0	23.6	23.6	3.7	Flood Risk
120 min Winter	28.605	0.205	0.0	16.5	16.5	1.1	O K
180 min Winter	28.568	0.168	0.0	12.4	12.4	0.7	O K
240 min Winter	28.547	0.147	0.0	10.0	10.0	0.5	O K
360 min Winter	28.523	0.123	0.0	7.4	7.4	0.3	O K
480 min Winter	28.506	0.106	0.0	6.0	6.0	0.2	O K
600 min Winter	28.495	0.095	0.0	5.1	5.1	0.2	O K
720 min Winter	28.487	0.087	0.0	4.4	4.4	0.1	O K
960 min Winter	28.478	0.078	0.0	3.5	3.5	0.1	O K
1440 min Winter	28.469	0.069	0.0	2.6	2.6	0.1	O K
2160 min Winter	28.457	0.057	0.0	1.9	1.9	0.1	O K
2880 min Winter	28.451	0.051	0.0	1.5	1.5	0.0	O K
4320 min Winter	28.443	0.043	0.0	1.1	1.1	0.0	O K
5760 min Winter	28.438	0.038	0.0	0.9	0.9	0.0	O K
7200 min Winter	28.435	0.035	0.0	0.7	0.7	0.0	O K
8640 min Winter	28.433	0.033	0.0	0.6	0.6	0.0	O K
10080 min Winter	28.431	0.031	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	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 Swale 12.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)	Area
From:	To: (ha)
0	4 0.075

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Cascade Model Details for Swale 12.srcx

Storage is Online Cover Level (m) 29.000

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	306.0
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)	0.000
Invert Level (m)	28.400	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) 28.400

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Cascade Summary of Results for Basin 12.srcx

Upstream Outflow To Overflow To
Structures

Swale 12.srcx (None) (None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	28.342	0.592	21.3	731.4	O K
30 min Summer	28.432	0.682	21.3	866.8	O K
60 min Summer	28.526	0.776	21.3	1014.0	O K
120 min Summer	28.621	0.871	21.3	1169.5	O K
180 min Summer	28.671	0.921	21.3	1254.4	Flood Risk
240 min Summer	28.700	0.950	21.3	1306.2	Flood Risk
360 min Summer	28.730	0.980	21.3	1358.5	Flood Risk
480 min Summer	28.739	0.989	21.3	1373.7	Flood Risk
600 min Summer	28.737	0.987	21.3	1371.1	Flood Risk
720 min Summer	28.734	0.984	21.3	1365.3	Flood Risk
960 min Summer	28.710	0.960	21.3	1322.5	Flood Risk
1440 min Summer	28.659	0.909	21.3	1234.2	Flood Risk
2160 min Summer	28.575	0.825	21.3	1093.8	O K
2880 min Summer	28.486	0.736	21.3	949.9	O K
4320 min Summer	28.320	0.570	21.3	700.6	O K
5760 min Summer	28.184	0.434	21.3	512.0	O K
7200 min Summer	28.083	0.333	21.2	380.7	O K
8640 min Summer	28.013	0.263	20.8	294.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	178.502	0.0	728.3	19
30 min Summer	106.565	0.0	870.8	34
60 min Summer	63.619	0.0	1058.9	64
120 min Summer	37.980	0.0	1265.2	122
180 min Summer	28.087	0.0	1403.8	182
240 min Summer	22.674	0.0	1511.2	242
360 min Summer	16.768	0.0	1676.4	360
480 min Summer	13.536	0.0	1804.2	480
600 min Summer	11.465	0.0	1909.7	548
720 min Summer	10.011	0.0	2000.3	606
960 min Summer	7.973	0.0	2122.5	730
1440 min Summer	5.785	0.0	2304.0	996
2160 min Summer	4.197	0.0	2531.9	1408
2880 min Summer	3.343	0.0	2688.3	1788
4320 min Summer	2.411	0.0	2903.1	2548
5760 min Summer	1.912	0.0	3079.6	3232
7200 min Summer	1.597	0.0	3214.8	3896
8640 min Summer	1.379	0.0	3328.6	4576

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Cascade Summary of Results for Basin 12.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
10080 min Summer	27.970	0.220	20.3	242.2	O K
15 min Winter	28.401	0.651	21.3	819.6	O K
30 min Winter	28.501	0.751	21.3	973.9	O K
60 min Winter	28.605	0.855	21.3	1142.4	O K
120 min Winter	28.708	0.958	21.3	1319.7	Flood Risk
180 min Winter	28.764	1.014	21.3	1418.8	Flood Risk
240 min Winter	28.798	1.048	21.3	1481.7	Flood Risk
360 min Winter	28.836	1.086	21.3	1551.3	Flood Risk
480 min Winter	28.851	1.101	21.3	1579.6	Flood Risk
600 min Winter	28.854	1.104	21.3	1584.8	Flood Risk
720 min Winter	28.849	1.099	21.3	1575.9	Flood Risk
960 min Winter	28.817	1.067	21.3	1516.9	Flood Risk
1440 min Winter	28.753	1.003	21.3	1399.6	Flood Risk
2160 min Winter	28.641	0.891	21.3	1204.1	O K
2880 min Winter	28.505	0.755	21.3	980.1	O K
4320 min Winter	28.250	0.500	21.3	601.8	O K
5760 min Winter	28.066	0.316	21.2	358.7	O K
7200 min Winter	27.967	0.217	20.2	238.7	O K
8640 min Winter	27.938	0.188	17.9	205.0	O K
10080 min Winter	27.920	0.170	15.9	184.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
10080 min Summer	1.218	0.0	3424.5	5240
15 min Winter	178.502	0.0	816.6	21
30 min Winter	106.565	0.0	975.6	33
60 min Winter	63.619	0.0	1186.5	62
120 min Winter	37.980	0.0	1417.5	120
180 min Winter	28.087	0.0	1572.7	180
240 min Winter	22.674	0.0	1692.9	238
360 min Winter	16.768	0.0	1877.7	352
480 min Winter	13.536	0.0	2020.6	464
600 min Winter	11.465	0.0	2138.5	572
720 min Winter	10.011	0.0	2239.6	676
960 min Winter	7.973	0.0	2375.6	768
1440 min Winter	5.785	0.0	2575.9	1070
2160 min Winter	4.197	0.0	2836.1	1536
2880 min Winter	3.343	0.0	3011.4	1956
4320 min Winter	2.411	0.0	3253.4	2676
5760 min Winter	1.912	0.0	3449.6	3288
7200 min Winter	1.597	0.0	3601.2	3816
8640 min Winter	1.379	0.0	3729.0	4488
10080 min Winter	1.218	0.0	3837.7	5152

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Cascade Rainfall Details for Basin 12.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) 2.165

Time (mins)	Area
From:	To: (ha)
0	4 2.165

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Cascade Model Details for Basin 12.srcx

Storage is Online Cover Level (m) 28.950

Tank or Pond Structure

Invert Level (m) 27.750

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	1029.0	1.200	1973.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0202-2140-1200-2140
 Design Head (m) 1.200
 Design Flow (l/s) 21.4
 Flush-Flo™ Calculated
 Objective Minimise upstream storage
 Application Surface
 Sump Available Yes
 Diameter (mm) 202
 Invert Level (m) 27.750
 Minimum Outlet Pipe Diameter (mm) 225
 Suggested Manhole Diameter (mm) 1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	21.4
Flush-Flo™	0.382	21.3
Kick-Flo®	0.833	18.0
Mean Flow over Head Range	-	18.2

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	6.9	1.200	21.4	3.000	33.2	7.000	49.9
0.200	19.1	1.400	23.0	3.500	35.7	7.500	51.6
0.300	21.1	1.600	24.5	4.000	38.1	8.000	53.3
0.400	21.3	1.800	25.9	4.500	40.3	8.500	54.9
0.500	21.1	2.000	27.3	5.000	42.4	9.000	56.4
0.600	20.7	2.200	28.6	5.500	44.4	9.500	57.9
0.800	18.7	2.400	29.8	6.000	46.3		
1.000	19.6	2.600	31.0	6.500	48.2		



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