Shoreham Cement Works - Drainage and Flood Risk Report

Final Report

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Revision history

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24/09/2018	Draft issue	Kelly Porter, SDNPA
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Contract

This report describes work commissioned by the South Downs National Park Authority, by a letter dated 11 April 2018. Luke Virgo of JBA Consulting carried out this work.

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Purpose

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1 Project Background

The South Downs National Park Authority (SDNPA) has commissioned JBA to undertake a baseline assessment of drainage and flood risk to include in the Area Action Plan for the Shoreham Cement Works site. There are various differing proposals for the site and this work will be used to assist the SDNPA in evaluating such proposals as part of the planning process.

2 Aims and Objectives

The aim of the study is to provide baseline information on drainage and flood risk in order to support the Area Action Plan, and in particular to:

On Flood Risk:

- Prepare updated modelling for fluvial and tidal flood risk;
- Update the flood zone mapping;
- Produce climate change flood zone mapping;
- Undertake modelling of the "actual risk" including the effects of existing defences;
- Undertake an evaluation of the effects of strategic responses to flood risk;
- Undertake an assessment of the need for long term commitment to managing flood risk at the site;
- Evaluate the vulnerability of existing and proposed development to understand compatibility across the site.

On Drainage:

- Conduct investigations to establish infiltration rates and groundwater levels below the site;
- Prepare an assessment of the Suitability for infiltration SuDs, including consideration of the presence of contaminated ground;
- Confirm SuDs could be discharged into the River Adur and what restrictions there could be on this discharge (for example tide-locking and effect of change in mean sea level as a consequence of climate change);
- Liaise with Environment Agency to seek to secure their agreement in principle to the contents of the report.

JBA presents conclusions and recommendations based upon these assessments within this document.

3 Limitations

This report is intended to contribute to the Area Action Plan and enable the SDNPA to make informed decisions regarding future planning applications. It does not constitute a design, and the calculations and information produced cannot be used for design.

4 The Existing Site

The site is located at approximate grid reference TQ 20036 08633, off the A283 south of Upper Beeding, adjacent and to the east of the River Adur.

In the documentation for the 2002 planning application commissioned by Hargreaves[1], the site was divided up into four areas.

- Area A comprises the site to the west of the A283.
- Area B comprises the main buildings of the cement works and the main paved areas to the east of the A283.
- Area C comprises the lower quarry.
- Area D comprises the upper quarry in the easternmost part of the site.

A drawing showing the site areas is included as Appendix B to this document.

4.1 Topography

The site is approximately 1.36km long from the easternmost part of Area D to the westernmost part of Area A. The approximate topography of each of the site areas is given below:

Table 4-1: Site Topography

Area	High point (m AOD)	Low point (m AOD)	Area (ha)
A	10	4	3.9
B	15	6	5.6
C	81	7	20.2
D	121	42	14.8

Area A comprises the area to the west of the A283. This part of the site has a gentle slope towards the south and west, with the high point at the highway embankment to the east. At the western boundary of the site there is a bridleway and a steep river bank, sheet piled in some places, leading to the River Adur and its flood plain. The site boundary includes some of the bridleway and river bank which lies outside the developable area of the site. Most of the area is above 4.5m AOD, with the exception of a small area around the southern access road which goes down to a level of 3.7m AOD.

Area B comprises the industrial buildings, and is on a fairly gentle slope towards the west, with the slope becoming steeper in the easternmost part of Area B.

Area C comprises the lower quarry, with an undulating terrain, terraces and a switchback track in the northern part for access to the upper quarry.

Area D comprises the upper quarry, a large plateau surrounded by terraces and high vertical rock faces which includes a small amount of the grassed area at the top of the vertical faces.

The river bank in the vicinity of Area A has flood embankments along its length.

4.2 Land Use

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1 Alliance Environment and Planning (2002) Planning Application for Adur Valley Park - Environmental Statement

An estimate of the existing impermeable areas covering large portions of Areas A and B, based on aerial photographs, OS mapping and ground truthing, is roughly 7.5 ha.

Area A is currently rented to different companies including bus companies, storage/distribution companies, refuse companies and scaffolders. It is used for parking and storage of vehicles, vehicular washdown, vehicle workshops, fuel storage, storage of refuse bins and warehousing. There is a large derelict building known as the packing sheds, and also a large derelict office building.

Area B comprises the main cement works buildings which are largely derelict. There is a portable site office near the site entrance. To the north there is an office block which is still partly in use. There is also a temporary welfare cabin, as well as parking for cement lorries and stockpiles of aggregate.

Areas C and D are disused open land, the former quarry areas.

5 Updated flood zone mapping - fluvial and tidal flood risk

JBA has produced updated flood risk modelling and mapping for both defended and undefended flood events using the Environment Agency's existing Flood Modeller-TUFLOW 1D-2D linked hydraulic model of the River Adur. This model is informed from modelling that JBA has been undertaking for the Environment Agency to evaluate flood risk management measures at Shoreham Airport.

The defended case modelling represents the 'actual risk' to the site, as it includes current flood risk defence infrastructure. The undefended case modelling aligns with the information required to inform the Flood Map for Planning (Flood Zones 2 and 3a), in which the presence of defences is removed. This is achieved by lowering the defence levels to those of the surrounding ground (at the toe of the defences). The Flood Zone 3b event (5% Annual Exceedance Probability [AEP] defended case event) has also been modelled.

Adjacent to the site, the River Adur is modelled using Flood Modeller 1D River Sections (cross-sections) which describe the geometry and hydraulic roughness of the channel. The floodplain, including defences adjacent to the channel and on the floodplain (which are removed for undefended case models), is modelled using a TUFLOW 2D domain with a grid size of 5m (ground levels are defined elevations of 5m). The ground levels within the model are informed by 1m resolution LIDAR data obtained from the Environment Agency.

The mapping prepared displaying predicted flood information includes:

- Present day Flood Zone mapping (Flood Zones 3b, 3a and 2).
- Climate change Flood Zone mapping (Flood Zone 3a).
    - Climate change for fluvial flood risk was assessed by increasing flows by 105%, which represents the Upper End climate change allowances recommended by current guidance. The Mean High Water Spring tidal boundary used for this event was uplifted by the sea-level rise allowances to the year 2117 following the same guidance.
    - Climate change for Tidal flood risk was assessed by increasing the water level for the 0.5% AEP tidal event boundary condition in accordance with

the Environment Agency's guidance[2]. Fluvial inflows (50% AEP event) were unadjusted.

- Present day "actual risk" mapping – the 5%, 1% and 0.1% AEP events (which align with the events used for preparation of Flood Zones.
- Climate change "actual risk" mapping - for the 1% AEP event.
    - The same adjustments for climate change to fluvial and tidal inputs were made, as per the Flood Zone mapping (see above).

Predicted flood extents for the Flood Zones (showing both fluvial and tidal risk) and for the defended and undefended 0.5% AEP climate change scenarios, are displayed in Figure 5-1 and Figure 5-2.

Some key observations made following the flood mapping exercise are as follows:

- Tidal risk appears to provide the greater flood risk to the site on an event rarity basis e.g. the 0.5% AEP tidal event is larger than the 0.5% fluvial event.
- There is no encroachment of Flood Zone 3b (Functional Floodplain) predicted on any of the site areas.
- There is no encroachment of Flood Zone 3a predicted on any of the site areas.
- There is no encroachment of Flood Zone 2 predicted on any of the site areas.
- Flood Zone 3a, when climate change allowances are applied, is predicted to encroach on the southern part of Area A, at an access road into the area. The flood extents from this event are larger than present day Flood Zone 2 extents. While both fluvial and tidal Flood Zone 3a climate change outputs intersect this part of the site, the extent is larger in the tidal event.
- The flood defences along the River Adur reduce flood risk to the site, so the 'actual risk' is less than indicated by the Flood Zone modelling.
    - These raised defences act to keep water within the channel. When their level is exceeded, the previously dry floodplain fills with water. The volume filling the floodplain is only that which is above the defence crest levels, and not the full volume of tidal ingress, so for events tested other than those considering climate change, flood water does not reach the site. In the climate change events, flood volumes are sufficient that the volume of floodplain is filled to above the site level and encroachment of flood water onto the site commences.
    - When defences are removed, the tidal flood water can propagate across the full width of floodplain, removing the available storage and encouraging the tide to propagate inland. Adjacent to the site, water levels therefore rise to a high level.
- If defence crest levels reduce over time, or setting back of defences was taken forward, this may tend flood predictions towards the undefended scenario. The magnitude of this change would be dependent on what level the defences adjusted to and where they were positioned.

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2 Environment Agency (2016). Flood Risk Assessments: climate change allowances. Published 19 Feb 2016, updated 3 Feb 2017. Available: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Figure 5-1: Fluvial and tidal flood zone extents

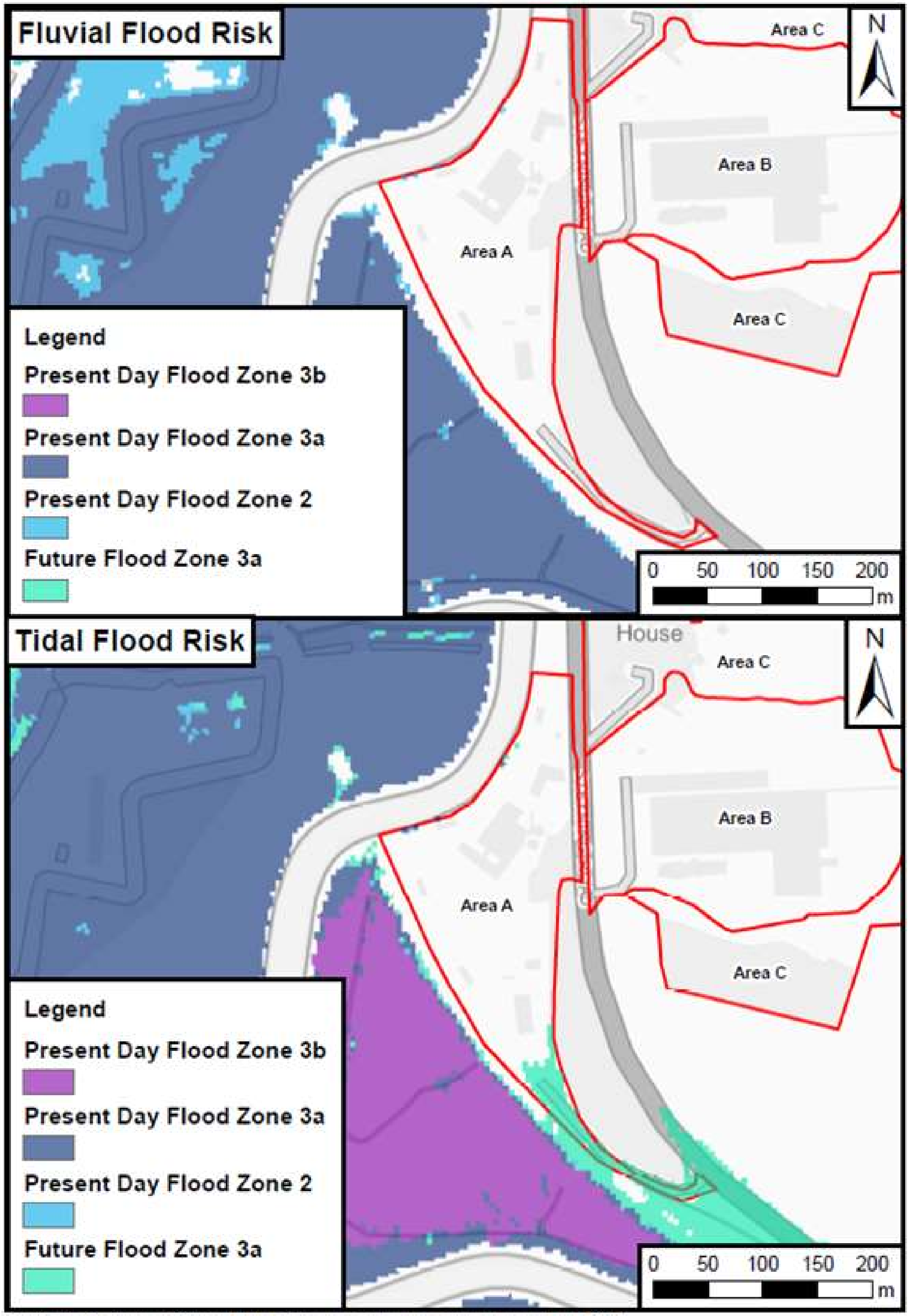
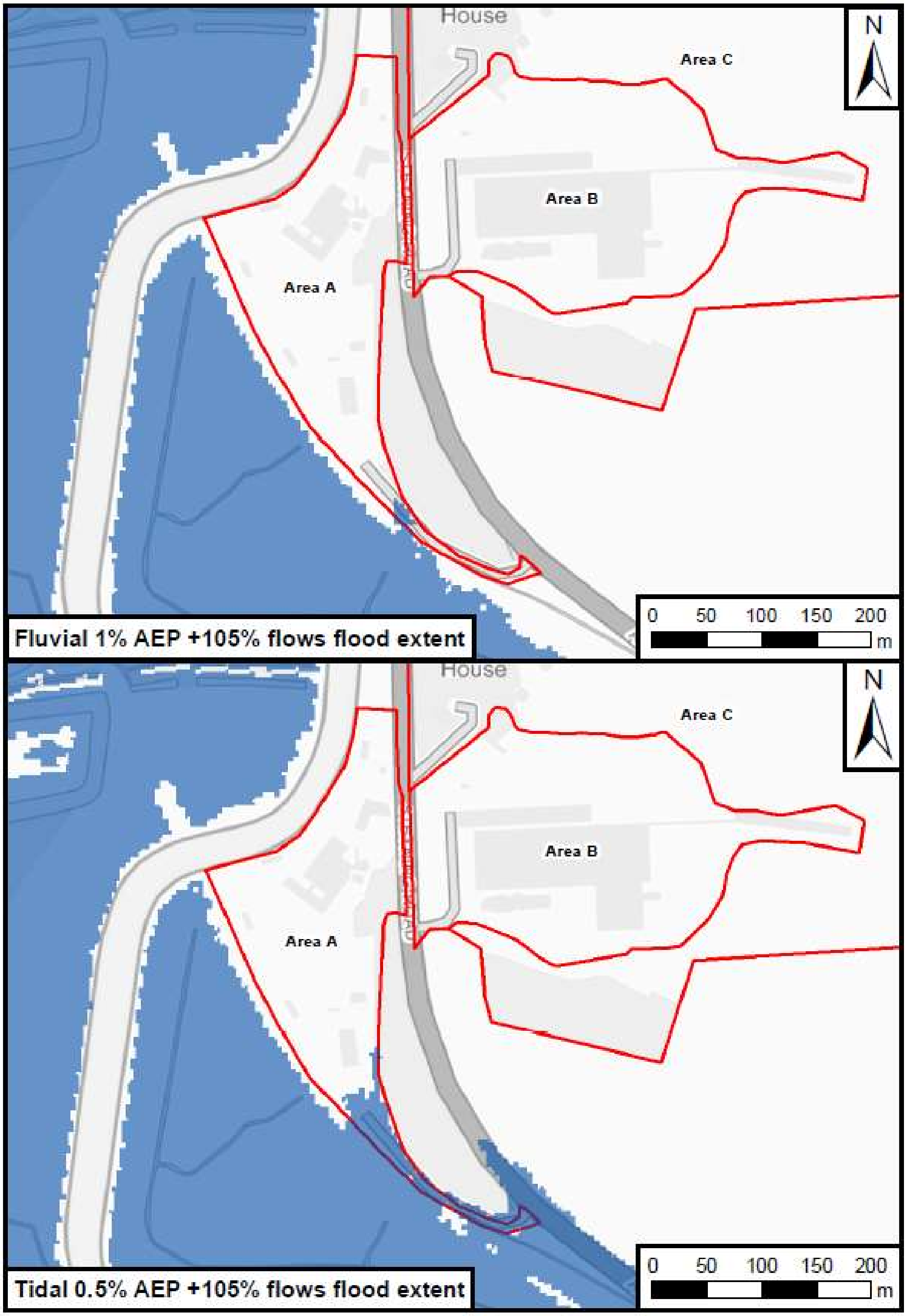


Figure 5-2: Fluvial and tidal extents for the 0.5% AEP defended climate change scenarios



6 Other sources of flooding

6.1 Surface water flooding

The site areas are predominantly at 'very low' risk from surface water flooding and it is considered unlikely that flooding from this source alone would preclude development of any of the sites. There is a surface water flow path in Area B at 'high' risk of flooding, located close to the road passing under the A283. It is possible this is an artefact of the national scale surface water mapping available, and the existing culvert under the A283 may not have been explicitly represented in this. Surface water flood risk to the site, and appropriate management of this, should be considered in detail prior to development of the site.

6.2 Groundwater flooding

The South Downs National Park Updated Level 1 and Level 2 SFRA identifies Shoreham Cement Works as being located in an area susceptible to groundwater flooding due to the underlying geology (Alluvium deposits overlying Chalk) and its proximity to the River Adur which could result in tidal locking preventing the drainage of groundwater. The SFRA identifies that risk of groundwater flooding at the site is deemed to be 'low' overall, however, it is recommended that further investigation is carried out into the likelihood of groundwater flooding, particularly where basement development is proposed.

7 Evaluation of requirements for flood risk management

JBA has also used the updated flood zone mapping in order to evaluate the effectiveness of the existing strategic responses to flood risk, and the ongoing requirements in order to manage flood risk on the developed site. The modelling shows that most of the site is at a "very low" risk of flooding, with only the southern part of Area A requiring any form of flood mitigation to enable development. The low levels around the southern access road off the A283 mean that future tidal levels would cause flooding requiring mitigation. This is likely to be fairly simple to solve with a small amount of land raising. The cost of this has been estimated and included alongside the outline schedule of costs for SuDS.

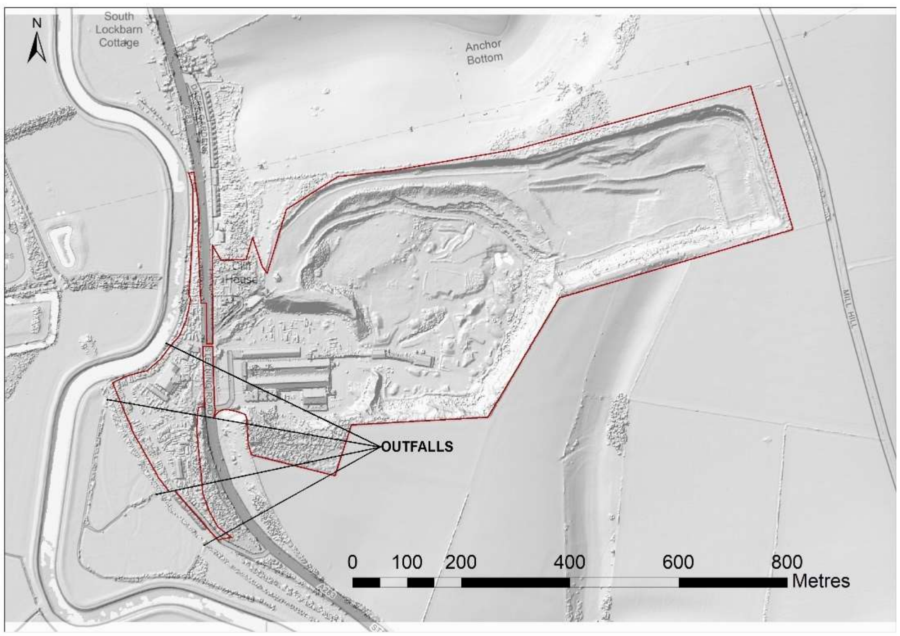
8 Evaluation of suitability of development types

An assessment of the different types of development currently found on the site, and the different development types proposed, with regard to their vulnerability classes and the flood risk in the different areas of the site, has been undertaken in table form and included in appendix A. The types of development have been classified in accordance with planning use classes and have been evaluated on the basis of the vulnerability classes which apply to the different land uses which fall within each use class. An assessment of the suitability of different development types with respect to drainage has also been undertaken.

9 Assessment of existing drainage provisions

A site visit was undertaken on 12th July 2018. From the site visit it was observed that the impermeable areas of the site are served by a traditional pipe-and-gully drainage system. The site manager showed JBA a hard-copy drawing of the existing drainage system in Area B, however it has not been possible to obtain a copy of this. It is understood site access will not be permitted for the purpose of carrying out surveys of the existing drainage. The drawing seen by JBA showed two drainage runs flowing westwards along the north- and south- sides of the main cement works building, which then joined at a point to the north west of the main building, and flowed under the A283 at a point just south of the vehicular underpass. No drawings were seen of the drainage in Area A, however manholes which appear to follow the line of the drainage from Area B are seen to flow to an outfall roughly at grid reference TQ 19833 08698. The outfall appears to comprise two pipes, estimated to be 225mm and 300mm in diameter. Further outfalls, thought to be receiving flows from Area A, are located to the south, at TQ 19714 08564, TQ 19807 08403 and TQ 19889 08309.

Figure 9-1: Outfall locations



Gullies and manhole covers can be seen on the more southerly portions of Area A indicating flows are collected in a traditional pipe-and-gully system and directed into the aforementioned outfalls.

The vehicular underpass provides vehicular access between Areas A and B, and would provide a route for surface water flows to pass beneath the A283 in the event of a flood. The underpass is approximately 4.5m wide by 4.2m high at the eastern end, becoming wider at the western end.

Figure 9-2: Vehicular underpass between Areas A and B

Staff indicated that there is a working cesspit located approximately at TQ 19780 08497 which receives the foul drainage from the surrounding buildings. It is not believed that there is any connection to a public foul sewer. Temporary chemical toilet and kitchenette facilities are present in Area B.

There is no indication of any soakaways on the site from the drainage plans seen by JBA or through conversation with the site manager. However, the possible presence of existing soakaways cannot be ruled out in the absence of full details of the existing drainage system.

10 Surface Water Drainage Hierarchy

In accordance with the Building Regulations, Approved Document H, surface water from the development should be drained to;

1. The ground, via infiltration, or if that is not feasible;
2. A watercourse, or if that is not feasible;
3. A surface water sewer, or if that is not feasible;
4. A combined sewer.

11 Ground conditions

From JBA's geo-environmental assessment which is being undertaken alongside this commission, the site is underlain by permeable chalk bedrock. Superficial deposits are only present in Area A in the form of alluvium. Made ground is also present across much of the site, and Area C is a registered landfill site containing various fill, cement kiln dust (CKD) and refuse from the cement works.

11.1 Ground investigation works

Due to the constraints surrounding access to the existing site, no intrusive ground investigation or soakage testing was carried out to support the recommendations of this report. JBA recommends that intrusive ground investigations are undertaken in order to support or to rule out the use of infiltration drainage and soakaways on the site. A desktop study is normally acceptable at the outline planning stage, with intrusive soakage testing and groundwater monitoring required for detailed planning and discharge of conditions. However, due to the variety of made ground, the potential for contamination and the likely permeable strata beneath the site, it is JBA's opinion that infiltration drainage cannot be either supported or ruled out on the basis of desktop information alone.

JBA therefore recommends that the planning authority should stipulate that:

- Any outline planning application should be supported, as a minimum, by window samples, falling-head permeability testing, observations on any groundwater encountered and any made ground or obvious signs of contamination, at the location and level of any proposed infiltration features. If the applicant claims that infiltration measures are not feasible, the investigation should be sufficient to support their reasoning.
- Any detailed planning application should be accompanied by a full geotechnical investigation including BRE 365 soakage testing, boreholes, a full suite of contamination testing and groundwater level monitoring, including an interpretive report stating the suitability of the site for infiltration drainage and the likelihood of encountering dissolution features in the chalk local to any proposed infiltration features. The boreholes and trial pits should be at the location and level of any proposed infiltration features. If the applicant claims that infiltration measures are not feasible, the investigation should be sufficient to support their reasoning.

11.2 Infiltration Rates

It was not possible to undertake permeability testing as part of this commission. However, it is probable that favourable infiltration rates will be encountered within the chalk bedrock on site. It is not possible to say what the infiltration rates in the made ground will be.

11.3 Groundwater Levels

These will need to be ascertained through intrusive site investigations. However, as the site is well above the normal level of the river it is not expected that groundwater levels would be a barrier to shallow infiltration systems.

11.4 Contamination and pollution

The site does not lie within a source protection zone. In line with the Environment Agency's groundwater protection policy,[3] it is likely that surface water can be discharged to ground if appropriate treatment is provided, such as petrol interceptors and / or a SuDS treatment train for paved and trafficked areas, and an assessment of the risk of mobilising any contaminants encountered during the testing of soil and groundwater. Deep bored soakaways are not the

3 Environment Agency (2008) The Environment Agency's approach to groundwater protection

Environment Agency's preferred option, and are normally only used where shallow soakaways cannot be employed. They are subject to a specific risk assessment among various other requirements.

11.5 Dissolution Risk

As the site is largely located on chalk bedrock, any developer proposing soakaways within the chalk will need to provide an assessment of the risk of dissolution of the chalk causing sinkholes. Specific intrusive boreholes would need to be undertaken in the locations of any proposed soakaways to ascertain the depth and quality of the bedrock, and an interpretive report and risk assessment undertaken by an appropriately qualified geotechnical engineer in order to support the use of soakaways or deep bored soakaways in the chalk.

If sufficient risk assessment were to determine that soakaways can be used within the chalk, current regulations[4] and guidance[5] would require that soakaways or infiltration features (such as infiltration basins or permeable paving) receiving flows from areas other than the ground directly above the soakaway itself, should be subject to an adequate structural assessment and should be located at least 5m from buildings or roads in the case of a shallow soakaway, and 10m in the case of a deep bored soakaway. Soakaways should never be constructed within the bearing zone of building foundations, retaining structures, embankments or other structural elements.

12 Peak flow rates and volumes - baseline conditions

12.1 Greenfield Runoff

Areas C and D have not had buildings constructed on them, therefore it may be appropriate to treat them as "greenfield" areas for the purposes of surface water drainage calculations if they are to be developed.

The greenfield runoff rates for the site have been calculated using the IH 124 method utilising the latest rainfall data from the FEH CD-ROM and high-resolution soils data from the 1:250,000 England and Wales national soil maps, and are included in the tables below:

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4 Building Regulations 2010 - Approved Document H - Drainage and Waste Disposal

5 Kent County Council (2000) The Soakaway Design Guide

Table 12-1: Greenfield Runoff Rates (per hectare)

	Greenfield runoff rate (l/s/ha)
QBAR	0.05
1 year	0.04
30 year	0.11
100 year	0.16

Table 12-2: Greenfield Runoff Rates (per area)

	Area A (3.9 ha)	Area B (5.6 ha)	Area C (20.2 ha)	Area D (14.8 ha)	Whole Site (44.5 ha)
QBAR (l/s)	0.20	0.28	1.01	0.74	2.23
1-year greenfield runoff rate (l/s)	0.16	0.22	0.81	0.59	1.78
30-year greenfield runoff rate (l/s)	0.43	0.62	2.22	1.63	4.90
100-year greenfield runoff rate (l/s)	0.62	0.90	3.23	2.37	7.12
Greenfield runoff volume in the 100-year 6-hour event (m3)	301	432	1558	1141	3431

12.2 Brownfield Runoff

The existing impermeable areas for each area of the site have been evaluated and are as follows:

Table 12-3: Existing impermeable areas

	Existing impermeable area (ha)
Area A	3.24
Area B	4.23
Area C	0.05
Area D	0.00

The existing brownfield runoff rates have been calculated using a nominal pipe network in the Micro Drainage software, simulating a hypothetical drainage network in the absence of definitive information on the existing drainage network.

The peak runoff rates and runoff volumes for each area are given below:

Table 12-4: Existing brownfield runoff rates

	Area A (3.24 ha)	Area B (4.23 ha)	Area C (0.05 ha)	Whole site
1-year peak rate of runoff (l/s)	359	469	5	833
30-year peak rate of runoff (l/s)	778	1016	12	1806
100-year peak rate of runoff (l/s)	846	1104	13	1963
100-year 6-hour volume of runoff (m3)	340	443	5	788

Brownfield runoff rates were not calculated for Area D as it has no man-made impermeable area.

12.3 Flow and volume restrictions

From Defra's non-statutory SuDS standards[6], the following requirements apply to peak flow and volume from new developments:

*S2. 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.*

*S3. For developments which were **previously developed**, the **peak runoff rate** from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should be **as close as reasonably practicable to the greenfield runoff rate** from the development for the same rainfall event, but should **never exceed the rate of discharge** from the development **prior to redevelopment** for that event.*

*S4. Where reasonably practicable, for **greenfield development**, the **runoff volume** from the development to any highway drain, sewer or surface water body in the 1 in 100-year, 6-hour rainfall event should **never exceed the greenfield runoff volume** for the same event.*

*S5. Where reasonably practicable, for developments which have been **previously developed**, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as **close as is reasonably practicable to the greenfield runoff volume** for the same event, but should **never exceed the runoff volume** from the development site **prior to redevelopment** for that event.*

*S6. Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the **runoff volume** must be discharged **at a rate that does not adversely affect flood risk**.*

The calculated greenfield runoff rates in section 12.1 are low due to the permeability of the soils and chalk bedrock on the site. The Environment Agency[7] requires that runoff rates be limited to no more than greenfield runoff rates where a greenfield site is developed, however if runoff is very low due to permeable soils a minimum value of 2 l/s/ha is normally applied. The requirement to limit runoff to greenfield rates would be appropriate for development in Areas C and D.

The definition of "a rate which does not adversely affect flood risk" is something which could be agreed upon, however a common requirement, where local authorities wish to be more prescriptive, is to restrict flows in all return periods up to the 100 year, to the greenfield QBar or 2 l/s/ha, whichever is the greater.

12.4 Climate change allowances

It is assumed that the final development will have a design life in excess of 60 years, therefore the climate change allowances for the "2080s" from the EA

6 Defra (2015) Sustainable Drainage Systems: Non-statutory technical standards for sustainable drainage systems

7 Environment Agency (2013) Rainfall runoff management for developments Report – SC030219

guidance on climate change[8] will be used. The surface water drainage system for any future development will need to be designed to accommodate the "central" allowance of 20% uplift on rainfall intensities without overflow, and without exceeding the flow and volume limits given in section 14. The "upper" 40% climate change allowance is then used for sensitivity testing, and it should be demonstrated that any flooding does not endanger buildings or emergency access routes.

12.5 Minimum discharge

Where small areas of development would have a low discharge rate, a minimum flow restriction is normally applied to avoid impractically small flow controls leading to blockage. This is not likely to be the case on this development, however a common minimum flow control is 5 l/s.

13 Impacts of climate change and mean sea level rise

13.1 Surcharged outfalls

The level of the existing outfalls is unknown, and a topographical survey would need to be undertaken in order to ascertain whether probable levels in the river would cause "tide locking" in the existing drainage. The outfalls (except for the northernmost one) are surrounded by dense vegetation which would need to be cleared in order to conduct the survey. The northernmost outfall is on a very steep bank and would require special access, probably involving boat access.

From the ISIS TUFLOW modelling which accompanies the flood risk items, a time series for river levels during a 100-year fluvial flow and a Mean High Water Springs tidal event for 2117 has been produced, which shows a peak level of approximately 4.0m AOD at high tide. Due to the relative levels on site A, it may be that any future outfalls are subject to short duration tide-locking during high tides towards the end of the design life of the development. If discharges are to be made to the river, it is recommended that the system is sensitivity-tested for a surcharged outfall of 4.0m AOD for three hours coinciding with the peak discharge from the drainage system, in order to check that no unacceptable flooding of buildings or emergency access routes occurs.

14 Runoff rates and volumes from proposed developments

The requirements given in section 12.3 result in relatively large and costly attenuation volumes. Therefore a number of different scenarios have been investigated as part of this work, from which the SDNPA can select whichever appears most reasonable as the requirement for any future planning application. It should be noted that, when making this decision, the fluvial and tidal flood risk modelling undertaken as part of this work has shown that the overwhelming flood mechanism for the site (and therefore for areas downstream of the site) is tidal. Therefore the likelihood of the development of the site increasing flood risk downstream, provided discharges are reduced compared to existing rates, would appear to be low.

8 Environment Agency (2017) Flood risk assessments: climate change allowances

- The first scenario is discharge to the Adur with attenuation to achieve 2 l/s/ha discharge rates, in line with requirement S4 given above;
- The second scenario is infiltration of all runoff with shallow infiltration features, with an assumed soil infiltration rate of 10^{-5} m/s. The feasibility of this will depend on the results of ground investigations.
- The third scenario is discharge to the Adur with attenuation to achieve 50% betterment (in all design return periods up to the 100-year plus 20% climate change) on the existing 1-year brownfield runoff rates, in line with requirement S5 given above;
- The fourth scenario is discharge to the Adur with attenuation to achieve 30% betterment (in all design return periods up to the 100-year plus 20% climate change) on the existing 1-year brownfield runoff rates, in line with requirement S5 given above.

The anticipated storage volumes for each of these scenarios have been calculated using the Micro Drainage software, and are provided in the table below:

Table 14-1: Anticipated approximate storage volumes

	Attenuation and discharge to Adur at 2 l/s/ha developed	All flows disposed of via soakaways at an infiltration rate of 10^{-5} m/s.	All flows up to 100yr+20% CC disposed of at 1yr brownfield rate with 50% betterment	All flows up to 100yr+20% CC disposed of at 1yr brownfield rate with 30% betterment
10% of site impermeable (4.5ha)	5375	3568	1441	1219
Current situation - 16.9% of site impermeable (7.5ha)	8958	5946	2961	2585
25% of site impermeable (11.1ha)	13258	8800	5134	4490
50% of site impermeable (22.3ha)	26634	17670	13463	11880

15 Outline drainage strategy

Due to the fact that ground investigations cannot yet be undertaken, JBA has produced indicative costings for the different SuDS implementation scenarios outlined in section 16.

In line with current planning policy guidelines, priority should be given to sustainable drainage systems wherever reasonably practicable. A full treatment train should be implemented to achieve acceptable water quality either directed to the ground or to the river Adur, and maximise benefits in terms of biodiversity and amenity value. JBA recommends that the Simple Index Approach (outlined in section 26.7.1 of the CIRIA SuDS Manual 2015) is used in order to assess whether a suitable treatment train is in place for the type of development proposed.

15.1 Environment Agency consultation

JBA consulted the Environment Agency's Sustainable Places Department on 23rd October 2018, who stated that they would not normally comment on drainage strategies, and that this would be the remit of the Lead Local Flood Authority. However, they stated that they would be willing to comment on the final report once complete, if it were submitted via email to planningssd@environment-agency.gov.uk.

15.2 Foul water drainage

JBA has not seen any evidence of foul water sewers being present near the site. This would mean that a packaged treatment plant would be required, either discharging to a soakaway or to the Adur. An environmental permit would be needed in order to achieve this. This is included in the final schedule of budget costs.

16 Schedule of budget costs

To support the Outline Drainage Strategy we have prepared a schedule of budget costs of the proposed measures that can be used in the assessment of the viability of the AAP.

The schedule of indicative budget costs for the capital costs associated with implementing the storage volumes given in Table 14 1 has been calculated using figures from Spons Civil Engineering and Highway Works Price Book (2014) for below ground onsite storage of runoff, and is given below:

Table 16-1: Indicative costs to achieve anticipated storage volumes

	Attenuation and discharge to Adur at 2 l/s/ha developed	All flows disposed of via soakaways at an infiltration rate of 10^{-5} m/s.	All flows up to 100yr+20% CC disposed of at 1yr brownfield rate with 50% betterment	All flows up to 100yr+20% CC disposed of at 1yr brownfield rate with 30% betterment
10% of site impermeable (4.5ha)	£1,700,000	£1,100,000	£500,000	£400,000
Current situation - 16.9% of site impermeable (7.5ha)	£2,900,000	£1,900,000	£1,000,000	£800,000
25% of site impermeable (11.1ha)	£4,300,000	£2,800,000	£1,700,000	£1,400,000
50% of site impermeable (22.3ha)	£8,600,000	£5,700,000	£4,300,000	£3,800,000

With respect to foul drainage, an indicative price for a wastewater treatment plant for a population of 18 from Spons 2009 is around £7,000. It is envisaged that a number of these would be required in order to serve any proposed development.

To achieve land raising to enable development to the southern part of Area A, an approximate volume of fill of 4,800 m3 would be required, costing approximately £135,000 at subsoil fill rates given in Spons 2014.

Please note that the costs given are taken from generic unit costs and are indicative and for the purposes of comparison only. As such, they are likely to differ from the actual project outturn costs. SuDS features with a lower capital cost may be used in the final design. Also, storage of flows above the 30-year event may be achieved above ground which would reduce costs.

17 Conclusions

From the investigations into flood risk and drainage to date, it would appear that there are no significant barriers to development of the site in this respect. The options and scenarios presented in the outline drainage strategy and schedule of budget costs will enable the SDNPA to undertake an informed assessment of the feasibility of providing drainage and flood risk management measures to the site.

Appendix A - Suitability of types of development

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TOPOGRAPHY OF SOUTH DOWNS SITE - INFORMED FROM ENVIRONMENT AGENCY 1m LIDAR

Scale: 1:2,500	Drawn	AB 21/08/2018
	Checked	IJ 21/08/2018
	Approved	IJ 21/08/2019

Digital File Name: Site_topo_A1.MXD

Drawing Number:	Sheet No.:	Status:	Rev.:
001	1 of 1	Final	A

Original @ A1

Appendix B - Map of site areas

Suitability of development types the four areas of the site with regards to flood risk

Use Class	Vulnerability Class	Area A	Area B	Area C	Area D
A & B	Less Vulnerable	Less vulnerable development is appropriate within Area A.	Less vulnerable development is appropriate within Area B.	Less vulnerable development is appropriate within Area C.	Less vulnerable development is appropriate within Area D.
C	Highly Vulnerable (With Basements or temporary dwellings)	Highly vulnerable development is considered appropriate for Area A given that the area is not located within present day Flood Zone 2. When future Flood Zone 3a is considered, a small extent of Area A is predicted to be within the zone, but this is confined to the southern area of the site. Management of future fluvial and tidal flood risk and the safety of the intended development should be considered. Highly vulnerable development where basement levels are proposed should consider further investigation into groundwater and surface water flooding.	Highly vulnerable development (with basements or temporary dwellings) is considered appropriate within Area B. Present day Flood Zone 2 and future Flood Zone 3a do not encroach onto the site area. Highly vulnerable development where basement levels are proposed should consider further investigation into groundwater and surface water flooding.	Highly vulnerable development (with basements or temporary dwellings) is considered appropriate within Area C. Present day Flood Zone 2 and future Flood Zone 3a do not encroach onto the site area. Highly vulnerable development where basement levels are proposed should consider further investigation into groundwater and surface water flooding.	Highly vulnerable development (with basements or temporary dwellings) is considered appropriate within Area D. Present day Flood Zone 2 and future Flood Zone 3a do not encroach onto the site area. Highly vulnerable development where basement levels are proposed should consider further investigation into groundwater and surface water flooding.
	More Vulnerable (Without Basements)	More vulnerable development (without basements) is considered appropriate given that the area is not located within present day Flood Zone 3a. When future Flood Zone 3a is considered, a small extent of Area A is predicted to be within the zone, but this is confined to the southern area of the site. Management of future fluvial and tidal flood risk and the safety of the intended development should be considered.	More vulnerable development (without basements) is considered appropriate within Area B. Present day and future (2117) Flood Zone 3a do not encroach onto the site area.	More vulnerable development (without basements) is considered appropriate within Area C. Present day and future (2117) Flood Zone 3a do not encroach onto the site area.	More vulnerable development (without basements) is considered appropriate within Area D. Present day and future (2117) Flood Zone 3a do not encroach onto the site area.
D1	More Vulnerable (Based on educational / training uses)	More vulnerable development is considered appropriate given that the area is not located within present day Flood Zone 3a. When future Flood Zone 3a is considered, a small extent of Area A is predicted to be within the zone, but this is confined to the southern area of the site. Management of future fluvial and tidal flood risk and the safety of the intended development should be considered.	More vulnerable development is considered acceptable within Area B. Present day and future (2117) Flood Zone 3a do not encroach onto the site area.	More vulnerable development is considered appropriate within Area C. Present day and future (2117) Flood Zone 3a do not encroach onto the site area.	More vulnerable development is considered appropriate within Area D. Present day and future (2117) Flood Zone 3a do not encroach onto the site area.
D2	Less Vulnerable	Less vulnerable development is appropriate within Area A given that the area is not located within present day Flood Zone 3b.	Less vulnerable development is appropriate within Area B.	Less vulnerable development is appropriate within Area C.	Less vulnerable development is appropriate within Area D.

Use Class	Vulnerability Class	Area A	Area B	Area C	Area D
	Water Compatible if outdoor recreation	Water compatible development is appropriate within Area A.	Water compatible development is appropriate within Area B.	Water compatible development is appropriate within Area C.	Water compatible development is appropriate within Area D.

Suitability of development types the four areas of the site with regard to drainage

Use Class	Area A	Area B	Area C	Area D
A & B	Shops, retail and business would be appropriate in Area A with regard to drainage. Space is likely to be required in order to locate attenuation, soakaways and SuDS elements as Area A is at the lowest part of the site, therefore this should be allowed for from the earliest stages of concept design. Area A is an area with a high potential for made ground, and which is likely to be founded more on alluvium than chalk, therefore it is unknown whether there will be opportunity to utilise infiltration drainage. Proximity of SuDS features to the highway will also need to be considered, with regard to stability of the embankment.	Shops, retail and business would be appropriate in Area B with regard to drainage. Space is likely to be required in order to locate attenuation, soakaways and SuDS elements as Area B is at the lower end of the site, therefore this should be allowed for from the earliest stages of concept design. Area B is an area with a high potential for made ground, therefore it is unknown whether there will be opportunity to utilise infiltration drainage. Proximity of SuDS features to the highway will also need to be considered, with regard to stability of the embankment. If it is not possible to achieve infiltration, a connection would need to be made to the existing drainage system on site (which would require investigations into its condition and capacity) or new pipework would need to be laid through area A to achieve an outfall to the Adur, increasing potential costs.	Shops, retail and business would be appropriate in Area C with regard to drainage. Space for attenuation and / or soakaways should be allowed for at the earliest stages of concept design. Area C is an area of landfill with a very high potential for contamination and made ground, therefore it is the least likely area to be able to utilise infiltration drainage. Proximity of SuDS features to the existing quarry sides and terraces will also need to be considered, with regard to stability. If it is not possible to achieve infiltration, a connection would need to be made to the existing drainage system in Area B (which would require investigations into its condition and capacity) or new pipework would need to be laid through areas A and B to achieve an outfall to the Adur, increasing potential costs.	Shops, retail and business would be appropriate in Area D with regard to drainage. Space for attenuation and / or soakaways should be allowed for at the earliest stages of concept design. Dissolution features were identified in area D during the site visit, therefore it is possible that a risk assessment would advise against infiltration in this area. Proximity of SuDS features to the existing quarry sides and terraces will also need to be considered, with regard to stability. If it is not possible to achieve infiltration, a connection would need to be made to the existing drainage system in Area B (which would require investigations into its condition and capacity) or new pipework would need to be laid through areas A, B and C to achieve an outfall to the Adur, increasing potential costs.
C	Dwellings would be appropriate in Area A with regard to drainage. Foul discharges are also likely to be higher for residential, therefore space would be needed to incorporate this element, i.e. packaged treatment plant. Further considerations would be the same as for use class A.	Dwellings would be appropriate in Area B with regard to drainage. Foul discharges are also likely to be higher for residential, therefore space would be needed to incorporate this element, i.e. packaged treatment plant. Further considerations would be the same as for use class A.	Dwellings would be appropriate in Area C with regard to drainage. Foul discharges are also likely to be higher for residential, therefore space would be needed to incorporate this element, i.e. packaged treatment plant. Further considerations would be the same as for use class A.	Dwellings would be appropriate in Area D with regard to drainage. Foul discharges are also likely to be higher for residential, therefore space would be needed to incorporate this element, i.e. packaged treatment plant. Further considerations would be the same as for use class A.
D1	Non-residential institutions such as educational buildings/visitor centres would be appropriate for use in Area A with respect to drainage. Further considerations would be the same as for use class A.	Non-residential institutions such as educational buildings/visitor centres would be appropriate for use in Area B with respect to drainage. Further considerations would be the same as for use class A.	Non-residential institutions such as educational buildings/visitor centres would be appropriate for use in Area C with respect to drainage. Further considerations would be the same as for use class A.	Non-residential institutions such as educational buildings/visitor centres would be appropriate for use in Area D with respect to drainage. Further considerations would be the same as for use class A.
D2	Leisure uses would be appropriate for use in Area A with respect to drainage.	Leisure uses would be appropriate for use in Area B with respect to drainage.	Leisure uses would be appropriate for use in Area C with respect to drainage.	Leisure uses would be appropriate for use in Area D with respect to drainage.

Use Class	Area A	Area B	Area C	Area D
	Further considerations would be the same as for use class A.	Further considerations would be the same as for use class A.	Further considerations would be the same as for use class A.	Further considerations would be the same as for use class A.

Use Class	Definition
A1 Shops	Shops, retail warehouses, hairdressers, undertakers, travel and ticket agencies, post offices, pet shops, sandwich bars, showrooms, domestic hire shops, dry cleaners, funeral directors and internet cafes.
A2 Financial and professional services	Financial services such as banks and building societies, professional services (other than health and medical services) and including estate and employment agencies. It does not include betting offices or pay day loan shops - these are classed as “sui generis” uses (see footnote).
A3 Restaurants and cafes	For the sale of food and drink for consumption on the premises - restaurants, snack bars and cafes.
A4 drinking establishments	Public houses, wine bars or other drinking establishments (but not night clubs) including drinking establishments with expanded food provision.
A5 Hot food takeaways	For the sale of hot food for consumption off the premises.
B1 Business	Offices (other than those that fall within A2), research and development of products and processes, light industry appropriate in a residential area.
B2 General industrial	Use for industrial process other than one falling within class B1 (excluding incineration purposes, chemical treatment or landfill or hazardous waste).
B8 Storage or distribution	This class includes open air storage.
C1 Hotels	Hotels, boarding and guest houses where no significant element of care is provided (excludes hostels).
C2 Residential institutions	Residential care homes, hospitals, nursing homes, boarding schools, residential colleges and training centres.
C2A Secure Residential institution	Use for a provision of secure residential accommodation, including use as a prison, young offenders' institution, detention centre, secure training centre, custody centre, short term holding centre, secure hospital, secure local authority accommodation or use as a military barracks.
C3 Dwelling houses	This class is formed of 3 parts: -C3(a) covers use by a single person or a family (a couple whether married or not, a person related to one another with members of the family of one of the couple to be treated as members of the family of the other), an employer and certain domestic employees (such as an au pair, nanny, nurse, governess, servant, chauffeur, gardener, secretary and personal assistant), a carer and the person receiving the care and a foster parent and foster child. -C3(b): up to six people living together as a single household and receiving care e.g. supported housing schemes such as those for people with learning disabilities or mental health problems. -C3(c) allows for groups of people (up to six) living together as a single household. This allows for those groupings that do not fall within the C4 HMO definition, but which fell within the previous C3 use class, to be provided for i.e. a small religious community may fall into this section as could a homeowner who is living with a lodger.
C4 Houses in multiple occupation	Small shared houses occupied by between three and six unrelated individuals, as their only or main residence, who share basic amenities such as a kitchen or bathroom.
D1 Non-residential institutions	Clinics, health centres, crèches, day nurseries, day centres, schools, art galleries (other than for sale or hire), museums, libraries, halls, places of worship, church halls, law court. Non-residential education and training centres.
D2 Assembly and leisure	Cinemas, music and concert halls, bingo and dance halls (but not night clubs), swimming baths, skating rinks, gymnasiums or area for indoor or outdoor sports and recreations (except for motor sports, or where firearms are used).

Notes

Certain uses do not fall within any use class and are considered 'sui generis'. Such uses include: betting offices/shops, pay day loan shops, theatres, larger houses in multiple occupation, hostels providing no significant element of care, scrap yards. Petrol filling stations and shops selling and/or displaying motor vehicles. Retail warehouse clubs, nightclubs, launderettes, taxi businesses and casinos.

Appendix C - Micro Drainage Calculations

FEH Mean Annual Flood

Input

Site Location	GB 519850 109100 TQ 19850 09100
Area (ha)	44.500
SAAR (mm)	851
URBEXT (1990)	0.0000
SPRHOST	4.990
BFIHOST	0.967
FARL	1.000

Results

QMED Rural (l/s) 9.0 QMED Urban (l/s) 9.0

Greenfield Runoff Volume

FEH Data

Return Period (years)	100
Storm Duration (mins)	360
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Areal Reduction Factor	1.00
Area (ha)	1.000
SAAR (mm)	851
CWI	119.812
SPR Host	4.990
URBEXT (1990)	0.0000

Results

Percentage Runoff (%)	9.64
Greenfield Runoff Volume (m^3)	77.109

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes UK Std Manhole Sizes SfS

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	15.000	0.150	100.0	7.520	5.00	0.0	0.600	o	750	Pipe/Conduit	
1.001	15.000	0.150	100.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.09	3.125	7.520	0.0	0.0	0.0	2.80	1236.4	1018.3
1.001	50.00	5.18	2.975	7.520	0.0	0.0	0.0	2.80	1236.4	1018.3

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		5.000	2.825	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 0 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 100.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Overflow (l/s)
1.000	1	15 minute 1 year Winter I+0%	6.000	4.128	0.253	0.000	
1.001	2	15 minute 1 year Winter I+0%	6.000	3.831	0.106	0.000	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	429.184	835.0	SURCHARGED
1.001	2	429.198	833.0	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Overflow (l/s)
1.000	1	15 minute 30 year Winter I+0%	6.000	6.204	2.329	204.056	
1.001	2	15 minute 30 year Winter I+0%	6.000	4.869	1.144	0.000	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	1379.631	1806.8	FLOOD
1.001	2	1379.646	1806.6	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Overflow (l/s)
1.000	1	15 minute 100 year Winter I+0%	6.000	6.685	2.810	685.598	
1.001	2	15 minute 100 year Winter I+0%	6.000	5.109	1.384	0.000	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	2098.631	1962.9	FLOOD
1.001	2	2098.632	1962.7	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes UK Std Manhole Sizes SfS

FEH Rainfall Model

Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	15.000	0.150	100.0	7.520	5.00	0.0	0.600	o	750	Pipe/Conduit	
1.001	15.000	0.150	100.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.09	3.125	7.520	0.0	0.0	0.0	2.80	1236.4	1018.3
1.001	50.00	5.18	2.975	7.520	0.0	0.0	0.0	2.80	1236.4	1018.3

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.001		5.000	2.825	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Storm Duration (mins)	30

Summary Wizard of 360 minute 100 year Summer I+0% for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Overflow (l/s)
1.000	1	360 minute 100 year Summer I+0%	6.000	4.047	0.172	0.000	
1.001	2	360 minute 100 year Summer I+0%	6.000	3.792	0.067	0.000	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	4510.215	789.7	SURCHARGED
1.001	2	4506.481	787.9	SURCHARGED

Summary Wizard of 360 minute 100 year Winter I+0% for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	0	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

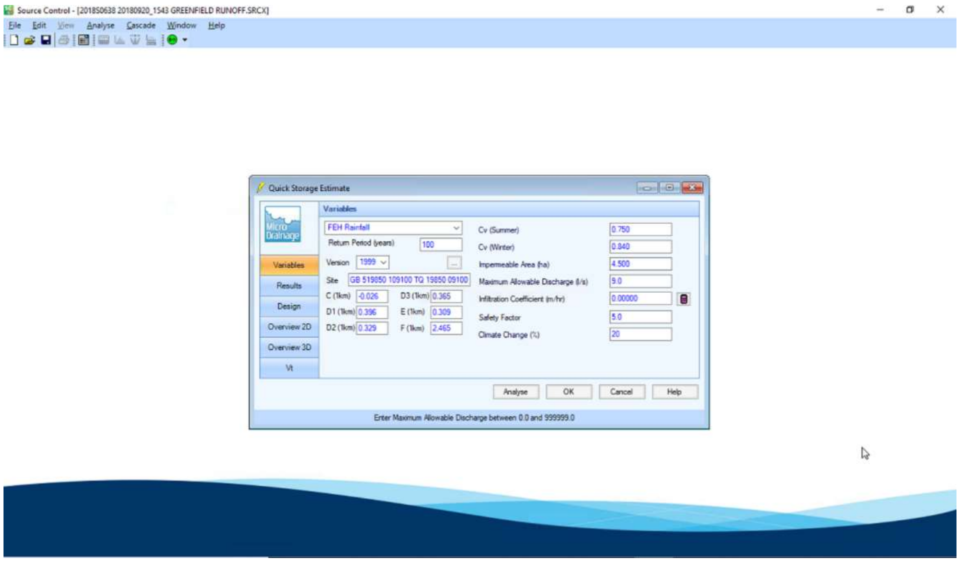
Rainfall Model	FEH
FEH Rainfall Version	1999
Site Location	GB 519850 109100 TQ 19850 09100
C (1km)	-0.026
D1 (1km)	0.396
D2 (1km)	0.329
D3 (1km)	0.365
E (1km)	0.309
F (1km)	2.465
Cv (Summer)	0.750
Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	100.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

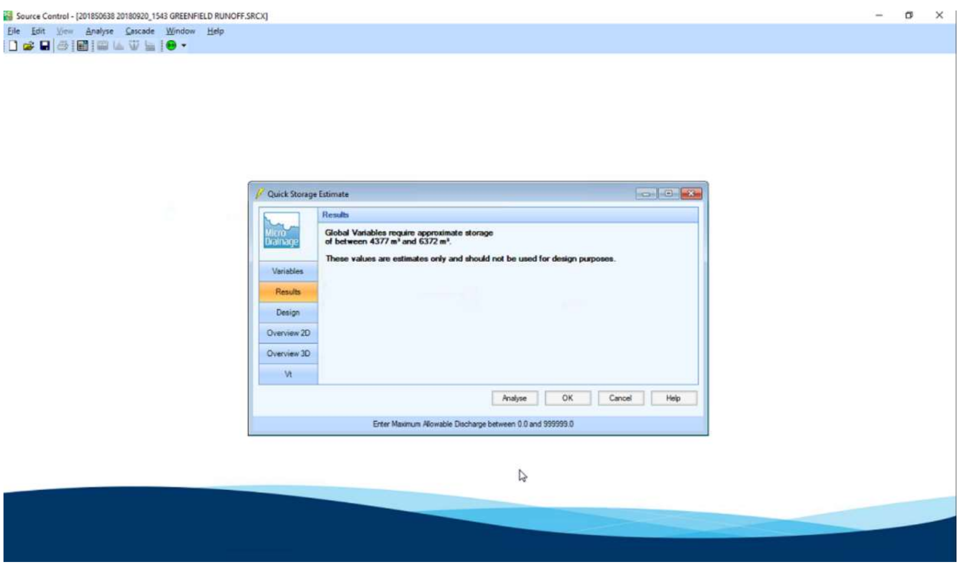
Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Overflow (l/s)
1.000	1	360 minute 100 year Winter I+0%	6.000	3.711	-0.164	0.000	
1.001	2	360 minute 100 year Winter I+0%	6.000	3.562	-0.163	0.000	

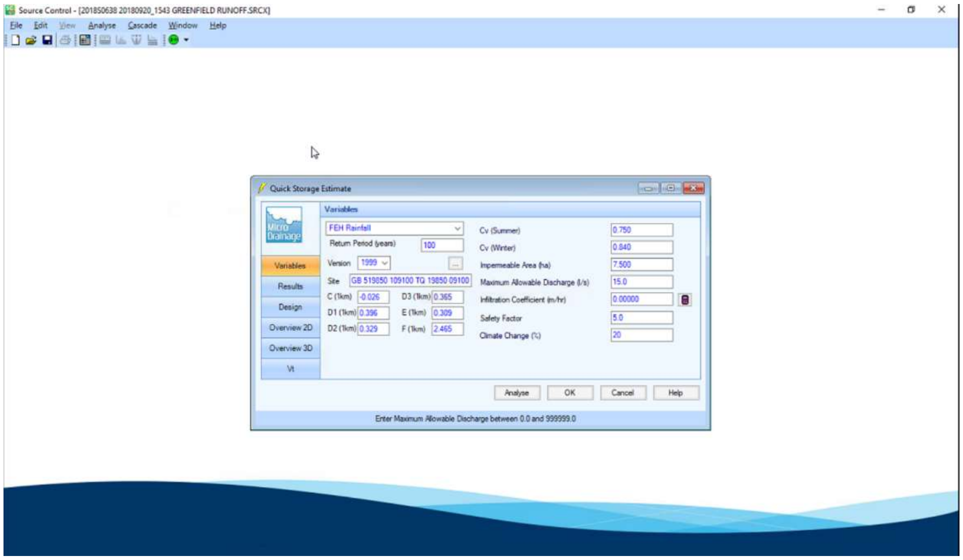
PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
1.000	1	5051.237	588.3	OK
1.001	2	5053.606	588.3	OK

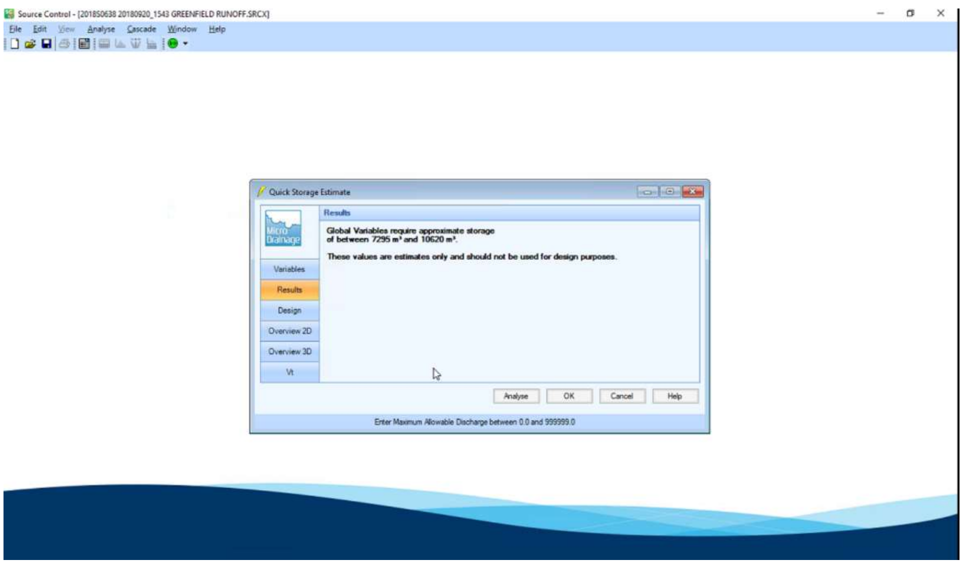


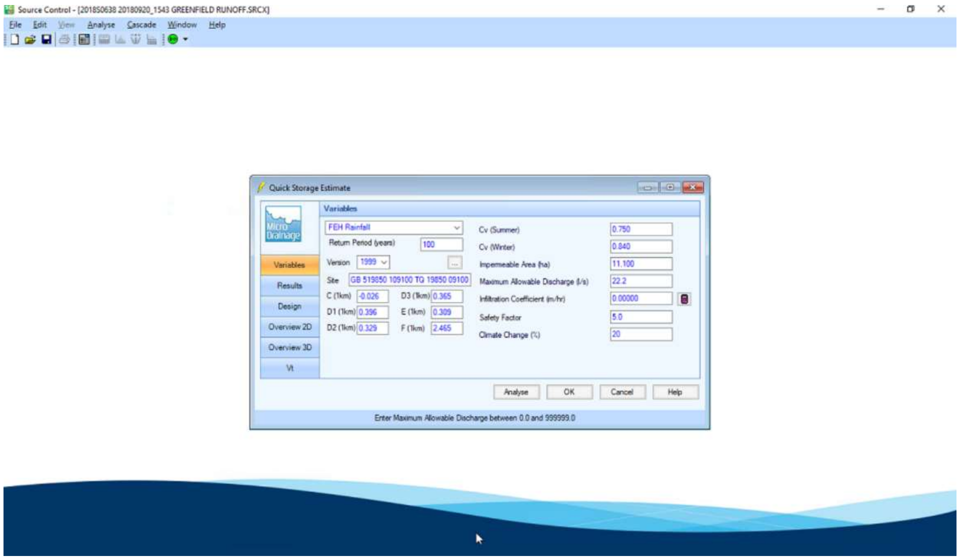
Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519050 109100 TQ 19050 09100
C (1km) -0.026 D3 (1km) 0.365
D1 (1km) 0.396 E (1km) 0.309
D2 (1km) 0.329 F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 4.500
Maximum Allowable Discharge (l/s) 9.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 5.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse OK Cancel Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

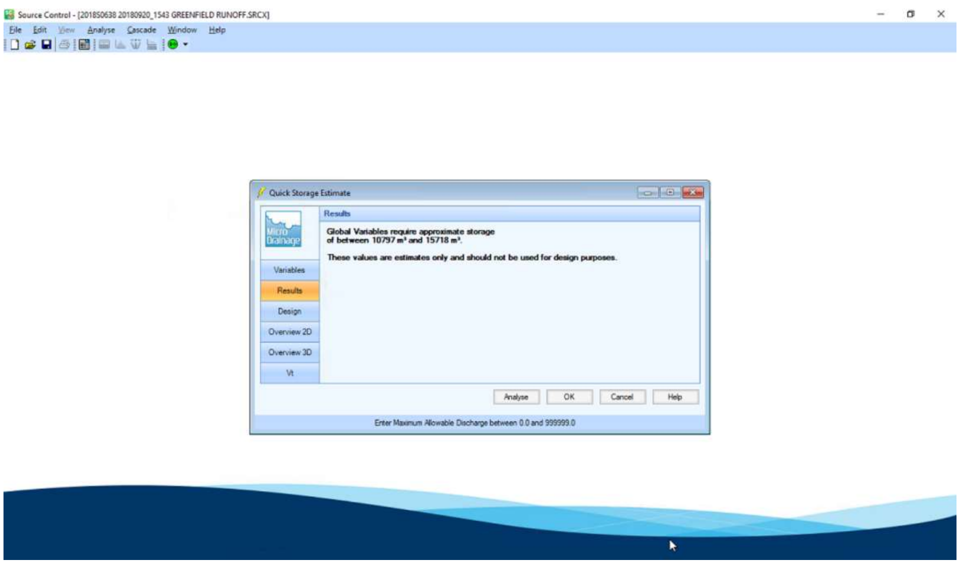


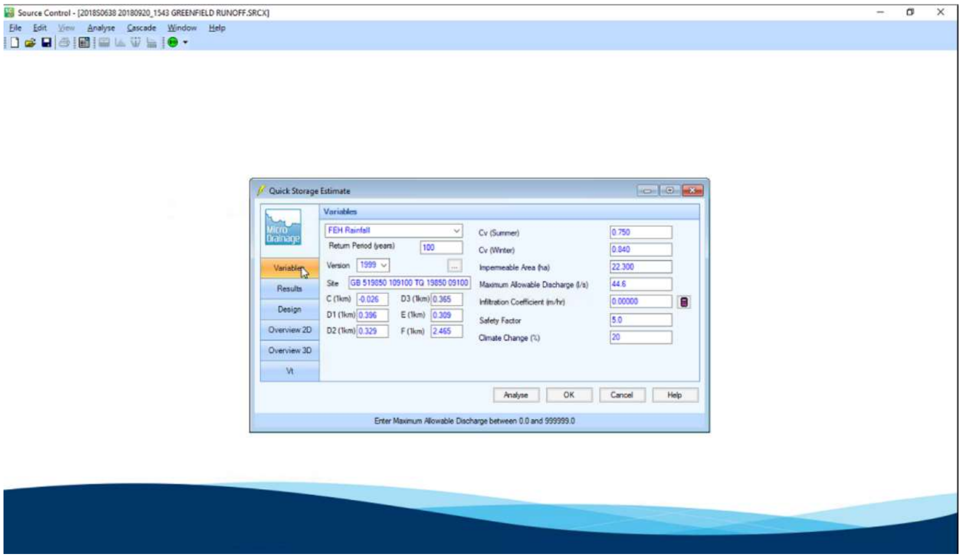
Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 4377 m³ and 6372 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse OK Cancel Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

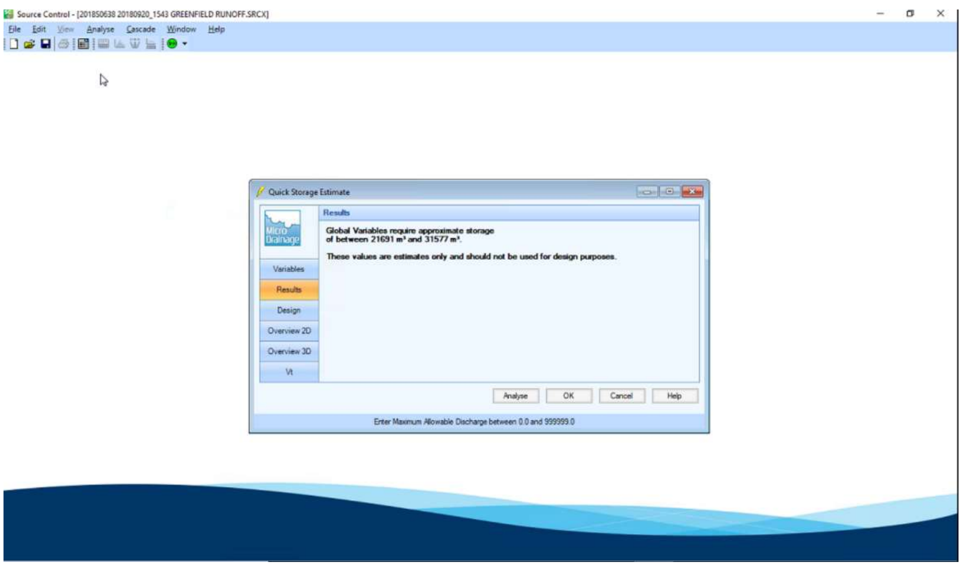

Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 7.500
Maximum Allowable Discharge (l/s) 15.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 5.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

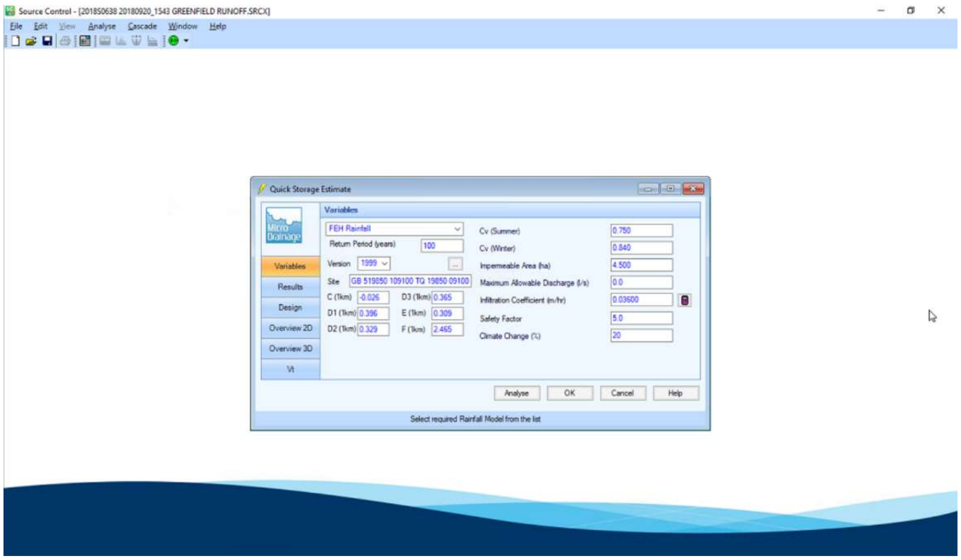

Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 7295 m³ and 10620 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

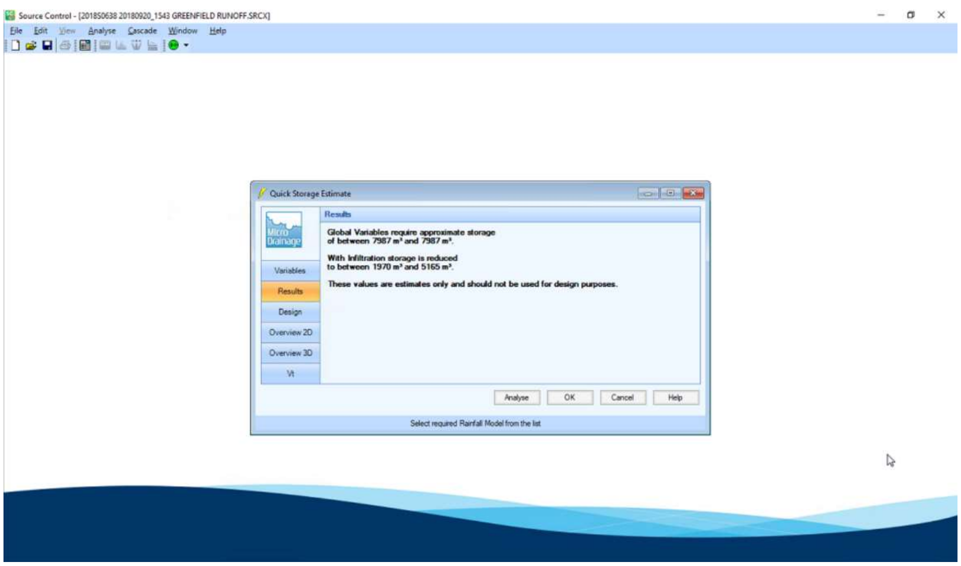

Source Control - [2018S0638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 11.100
Maximum Allowable Discharge (l/s) 22.2
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 5.0
Climate Change (%) 20
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

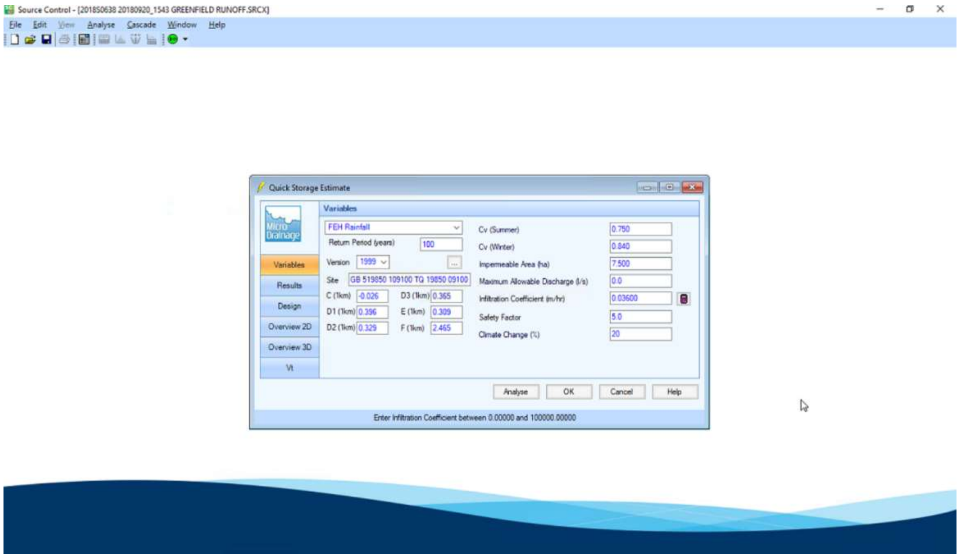

Source Control - [2018S0638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Results
Global Variables require approximate storage
of between 10797 m³ and 15718 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

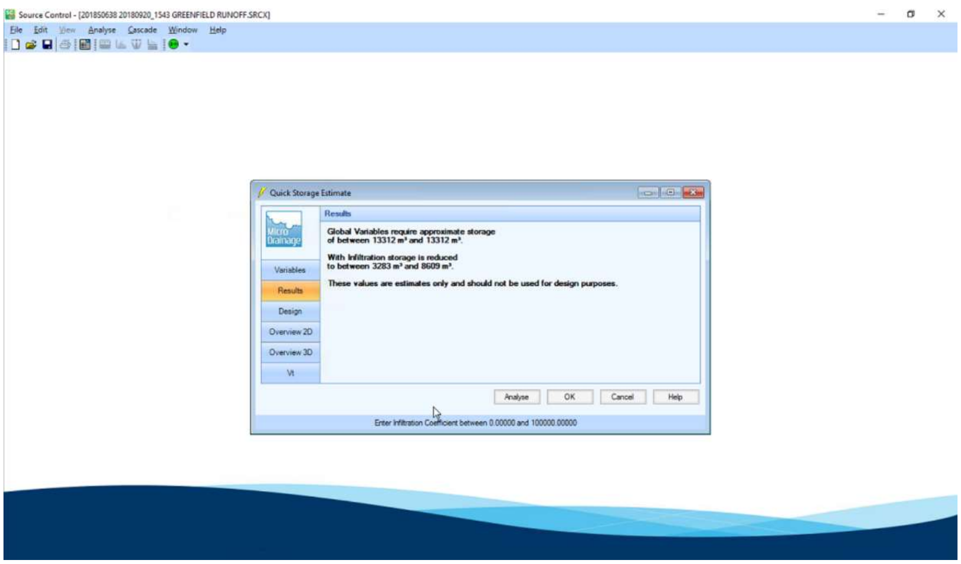

Source Control - [20185063B 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D1 (1km) 0.396
D2 (1km) 0.329
D3 (1km) 0.365
E (1km) 0.309
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 22.300
Maximum Allowable Discharge (l/s) 44.6
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 5.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

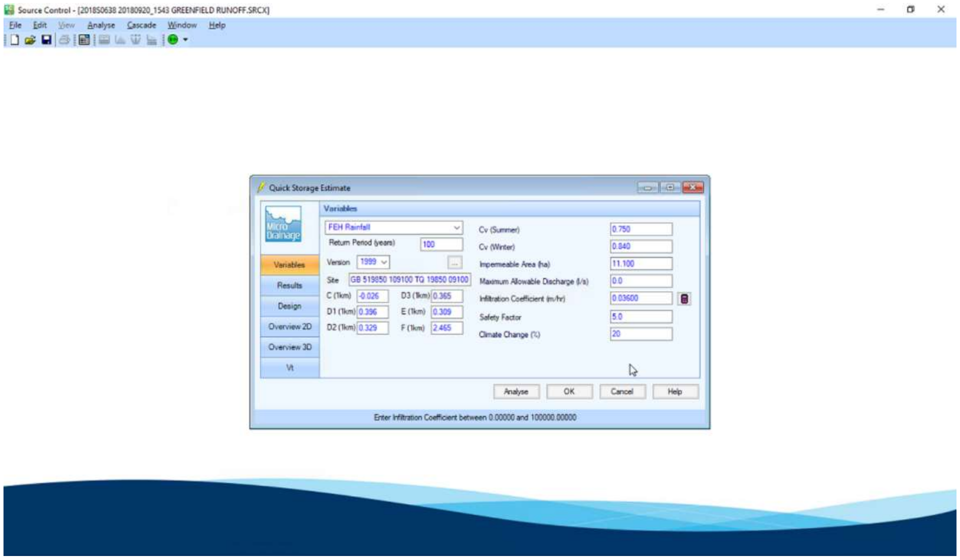

Source Control - [20185063B 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 21691 m³ and 31577 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

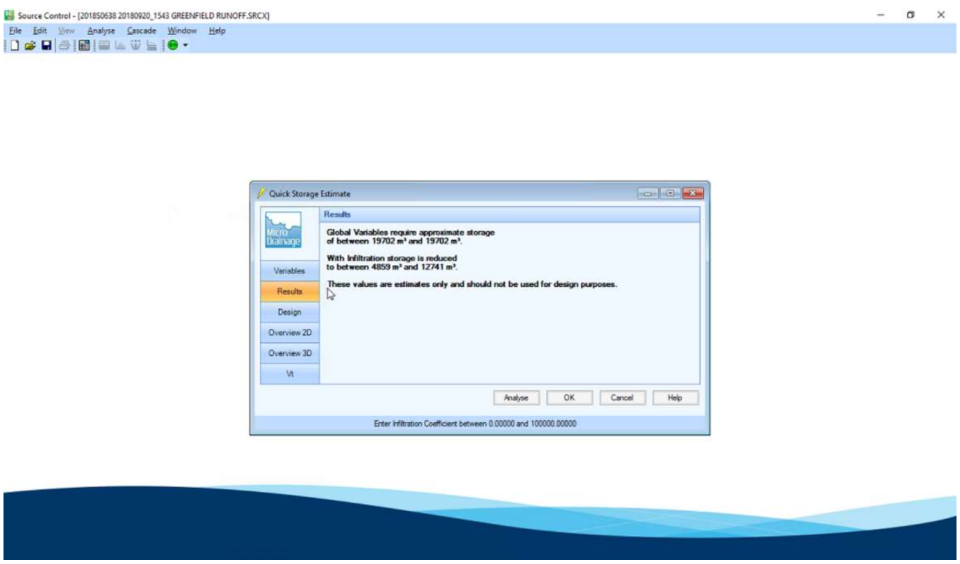

Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D1 (1km) 0.396
D2 (1km) 0.329
D3 (1km) 0.365
E (1km) 0.309
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 4.500
Maximum Allowable Discharge (l/s) 0.0
Infiltration Coefficient (m/hr) 0.03600
Safety Factor 5.0
Climate Change (%) 20
Analyse OK Cancel Help
Select required Rainfall Model from the list

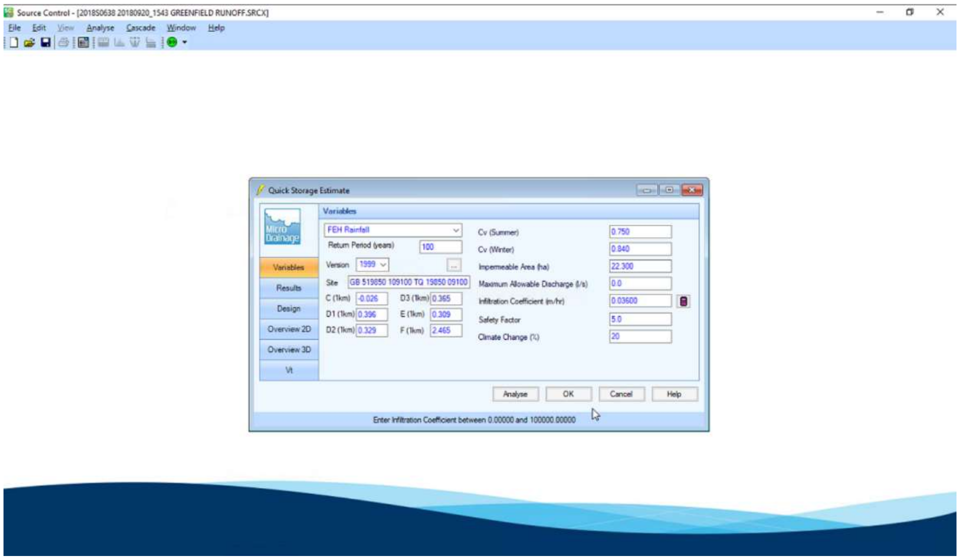

Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
Quick Storage Estimate
Results
Global Variables require approximate storage of between 7987 m³ and 7987 m³.
With Infiltration storage is reduced to between 1970 m³ and 5165 m³.
These values are estimates only and should not be used for design purposes.
Analyse OK Cancel Help
Select required Rainfall Model from the list

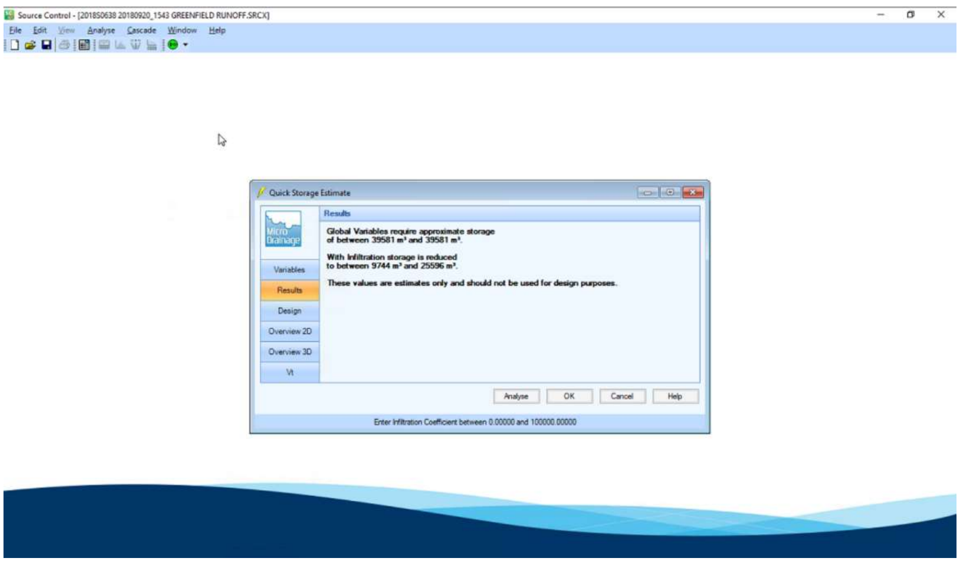

Source Control - [2018S0638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D1 (1km) 0.396
D2 (1km) 0.329
D3 (1km) 0.365
E (1km) 0.309
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 7.500
Maximum Allowable Discharge (l/s) 0.0
Infiltration Coefficient (m/hr) 0.03600
Safety Factor 5.0
Climate Change (%) 20
Analyse
OK
Cancel
Help
Enter Infiltration Coefficient between 0.00000 and 100000.00000

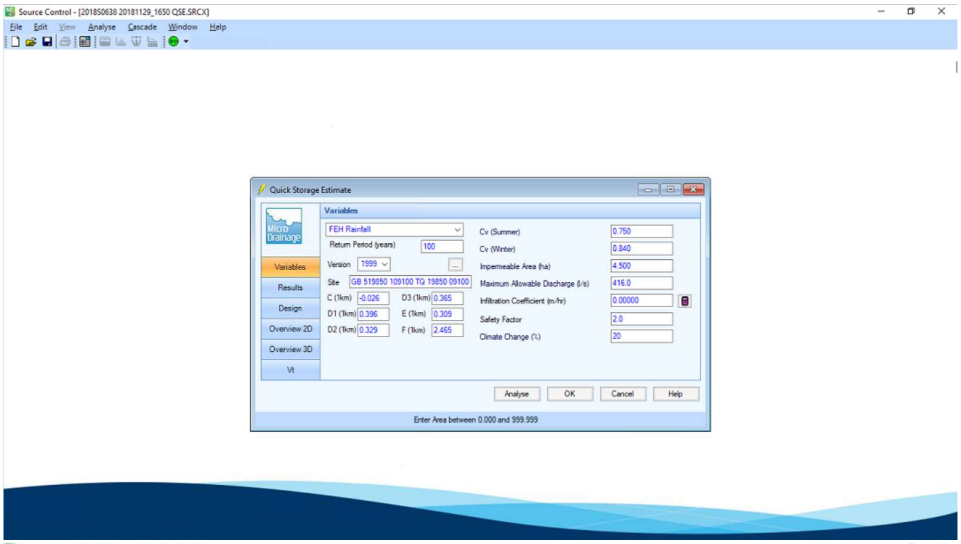

Source Control - [2018S0638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Results
Global Variables require approximate storage
of between 13312 m³ and 13312 m³.
With Infiltration storage is reduced
to between 3283 m³ and 8609 m³.
These values are estimates only and should not be used for design purposes.
Analyse
OK
Cancel
Help
Enter Infiltration Coefficient between 0.00000 and 100000.00000

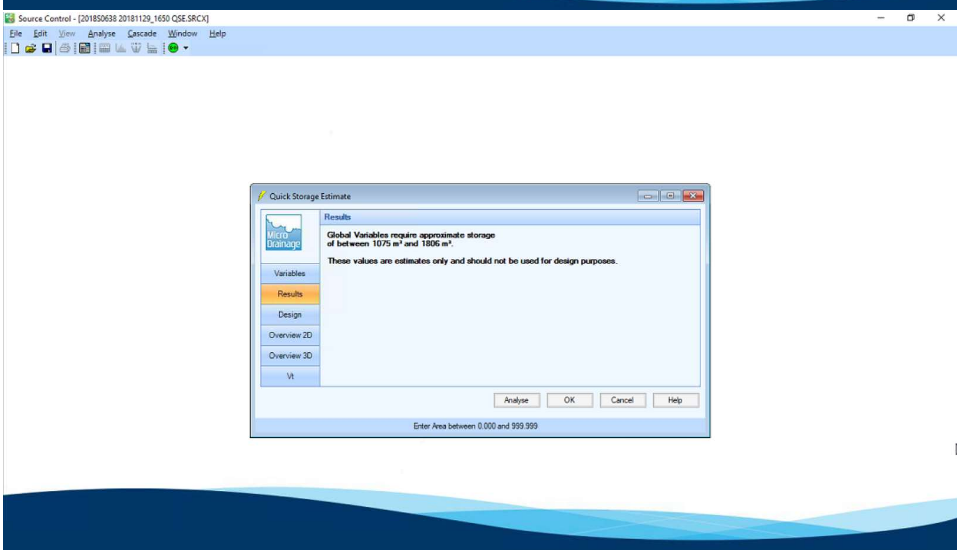

Source Control - [20185063820180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 11.100
Maximum Allowable Discharge (l/s) 0.0
Infiltration Coefficient (m/hr) 0.03600
Safety Factor 5.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Infiltration Coefficient between 0.00000 and 100000.00000

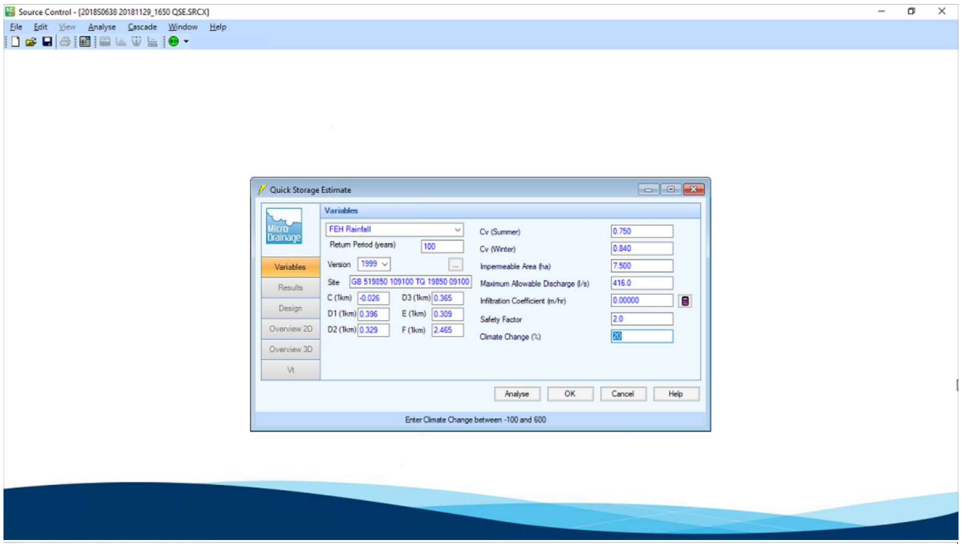

Source Control - [20185063820180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 19702 m³ and 19702 m³.
With Infiltration storage is reduced
to between 4859 m³ and 12741 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Infiltration Coefficient between 0.00000 and 100000.00000

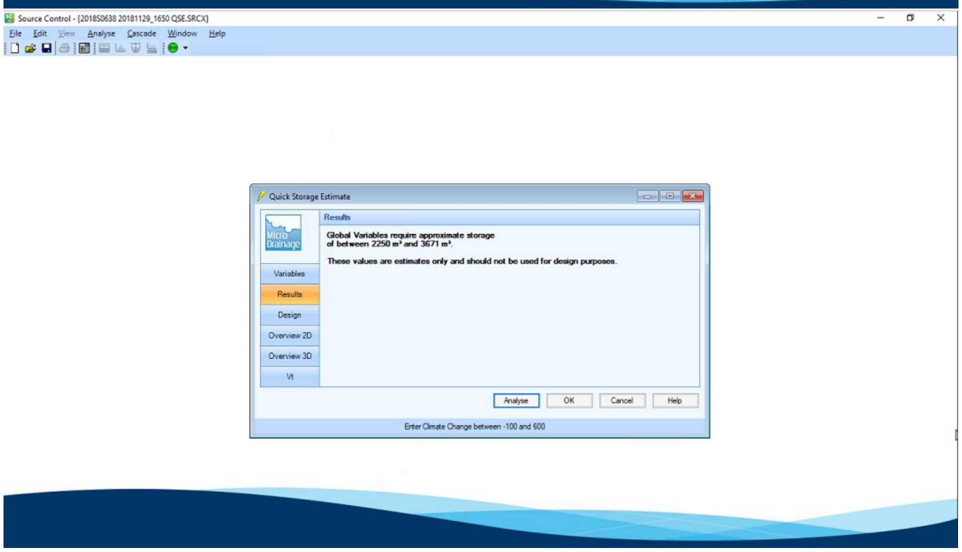

Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 22.300
Maximum Allowable Discharge (l/s) 0.0
Infiltration Coefficient (m/hr) 0.03600
Safety Factor 5.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Infiltration Coefficient between 0.00000 and 100000.00000

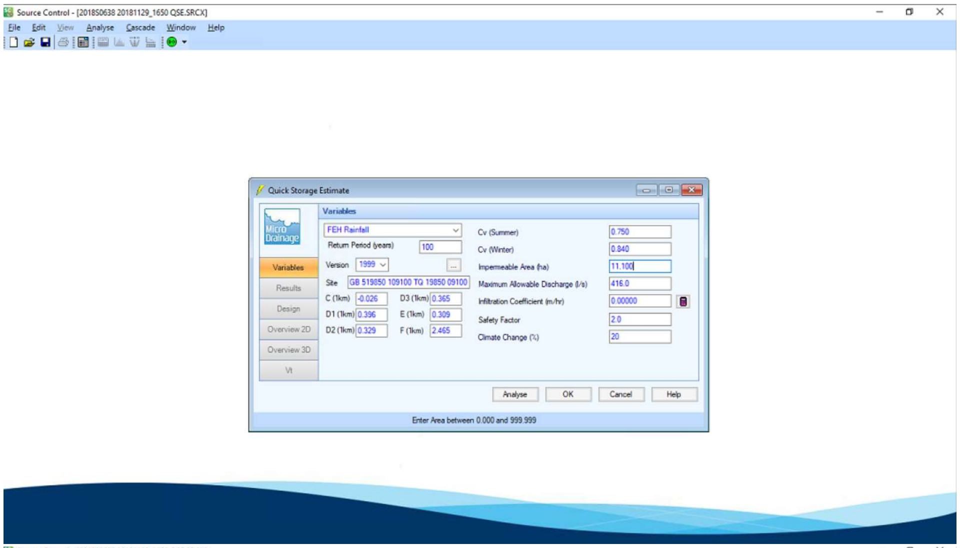

Source Control - [201850638 20180920_1543 GREENFIELD RUNOFF.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 39581 m³ and 39581 m³.
With Infiltration storage is reduced
to between 9744 m³ and 25596 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Infiltration Coefficient between 0.00000 and 100000.00000


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 4.500
Maximum Allowable Discharge (l/s) 416.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999

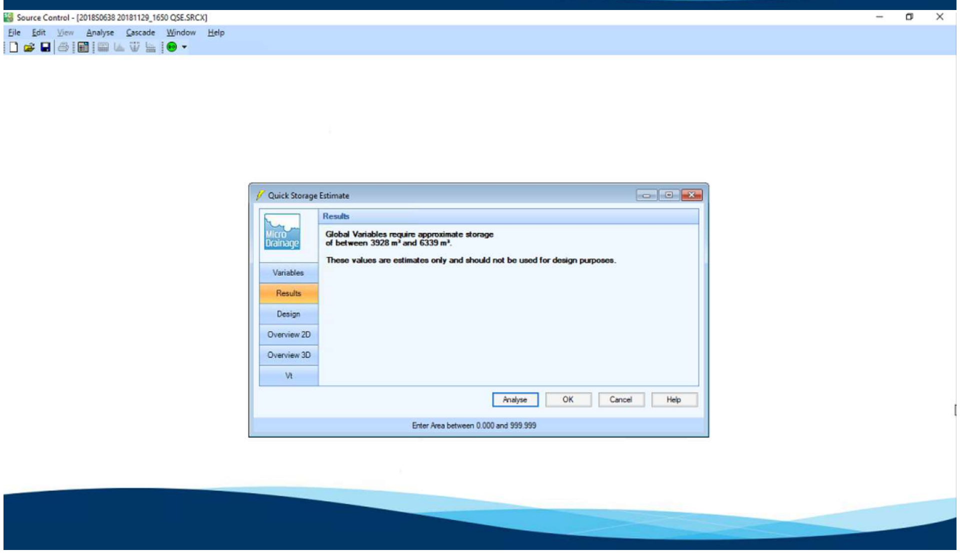

Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Results
Global Variables require approximate storage
of between 1075 m³ and 1806 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D1 (1km) 0.396
D2 (1km) 0.329
D3 (1km) 0.365
E (1km) 0.309
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 7.500
Maximum Allowable Discharge (l/s) 416.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%)
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Climate Change between -100 and 600

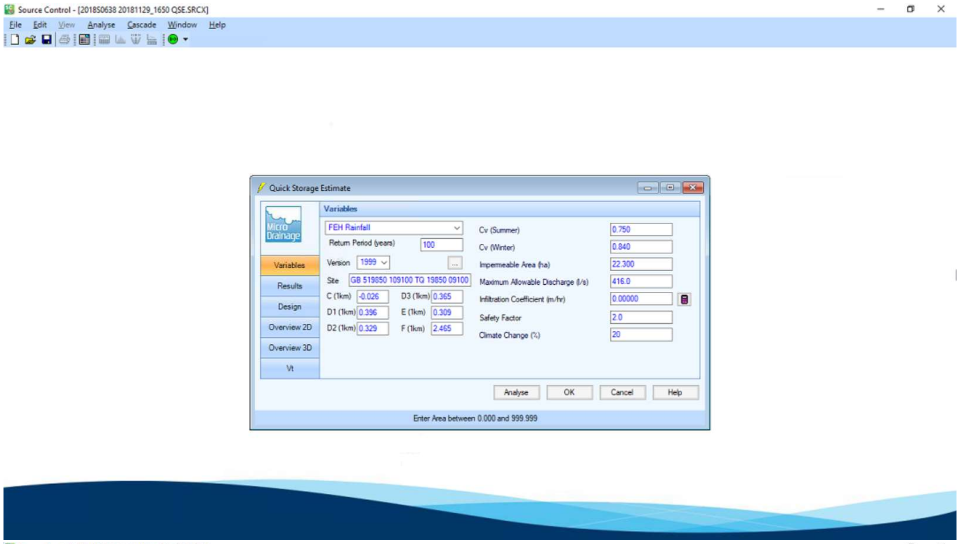

Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 2250 m³ and 3671 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Climate Change between -100 and 600

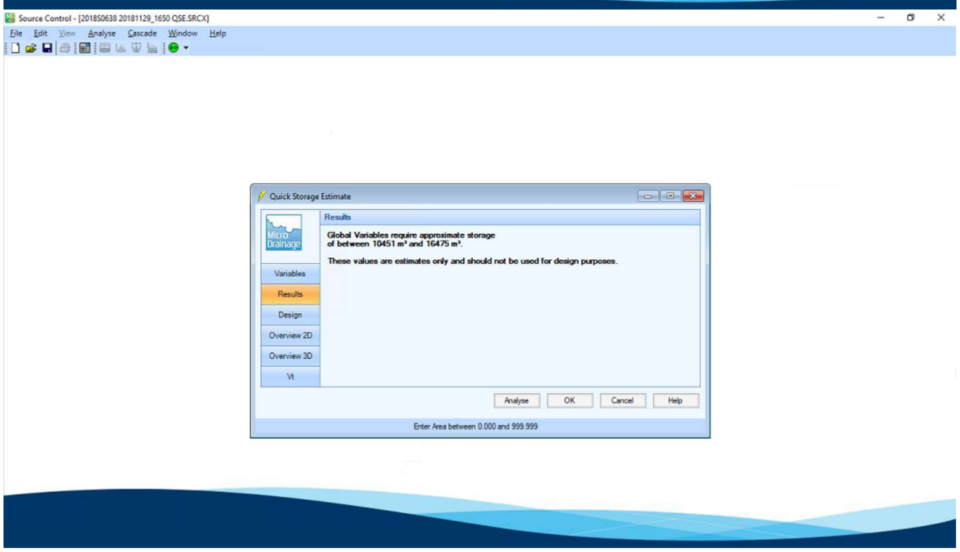


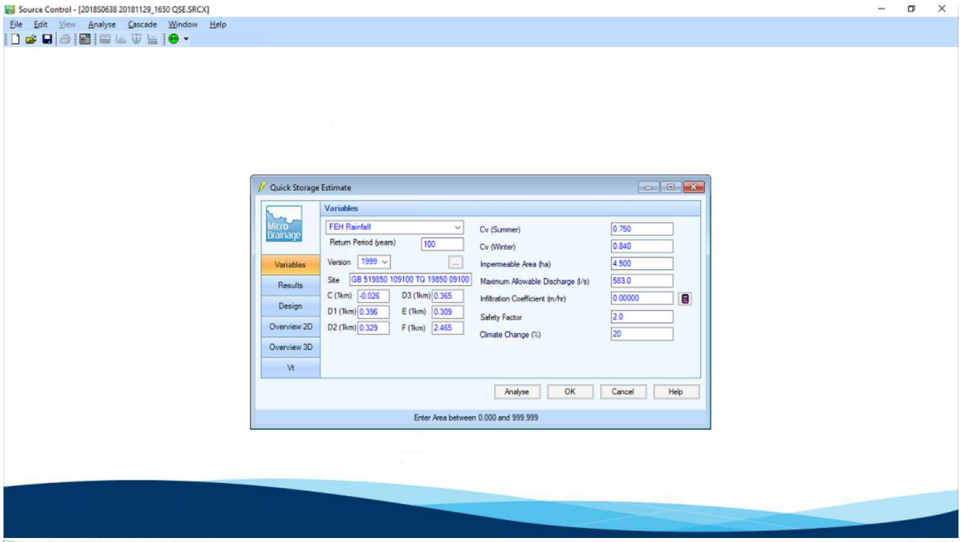
Source Control - [20185063B 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 11.100
Maximum Allowable Discharge (l/s) 416.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999

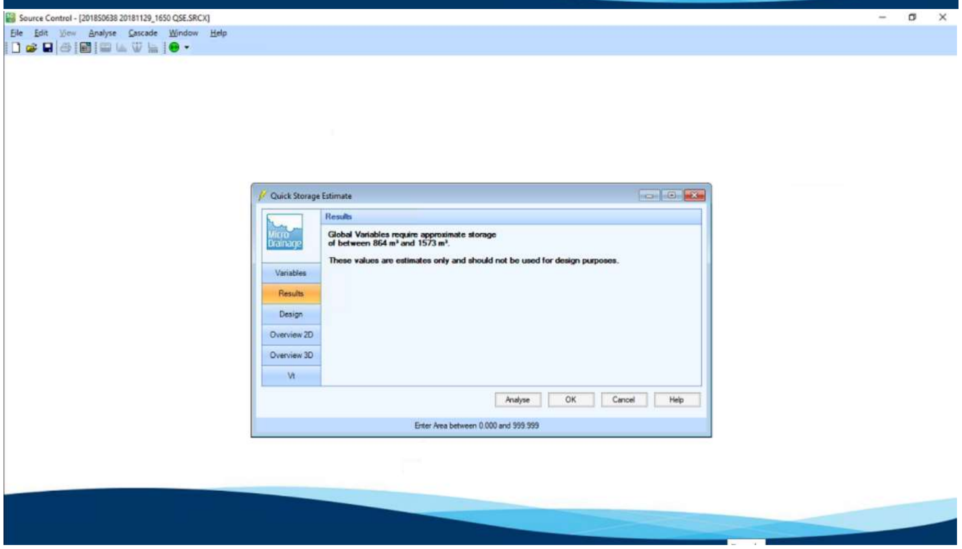


Source Control - [20185063B 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Results
Global Variables require approximate storage
of between 3928 m³ and 6339 m³.
These values are estimates only and should not be used for design purposes.
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 22.300
Maximum Allowable Discharge (l/s) 416.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Results
Global Variables require approximate storage
of between 10451 m³ and 16475 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999


Source Control - [201850638 20181129_1650 QSE.SRCX]
File
Edit
View
Analyse
Cascade
Window
Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
FEH Rainfall
Return Period (years)
100
Version
1999
Site
GB 519850 109100 TQ 19850 09100
C (1km)
-0.026
D3 (1km)
0.365
D1 (1km)
0.396
E (1km)
0.309
D2 (1km)
0.329
F (1km)
2.465
Cv (Summer)
0.750
Cv (Winter)
0.840
Impermeable Area (ha)
4.500
Maximum Allowable Discharge (l/s)
583.0
Infiltration Coefficient (m/hr)
0.00000
Safety Factor
2.0
Climate Change (%)
20
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999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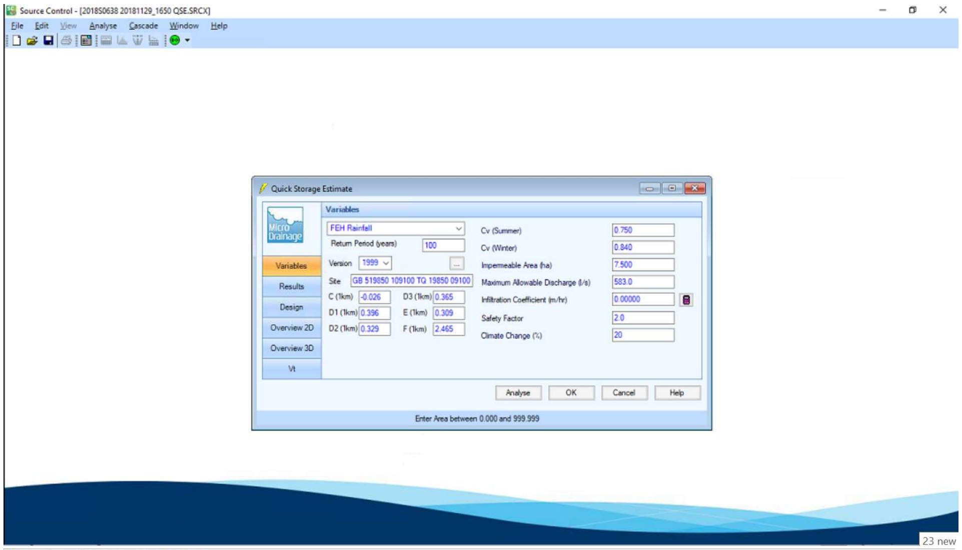
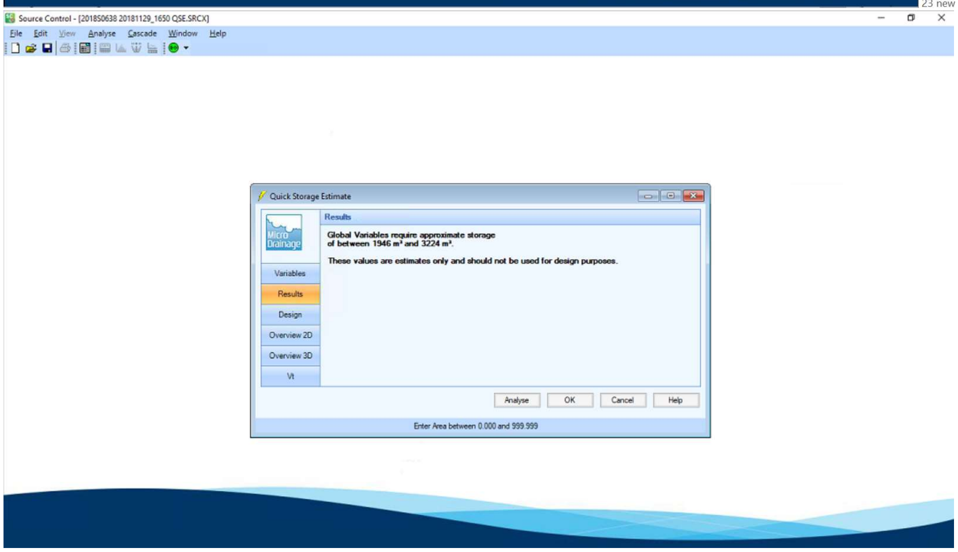
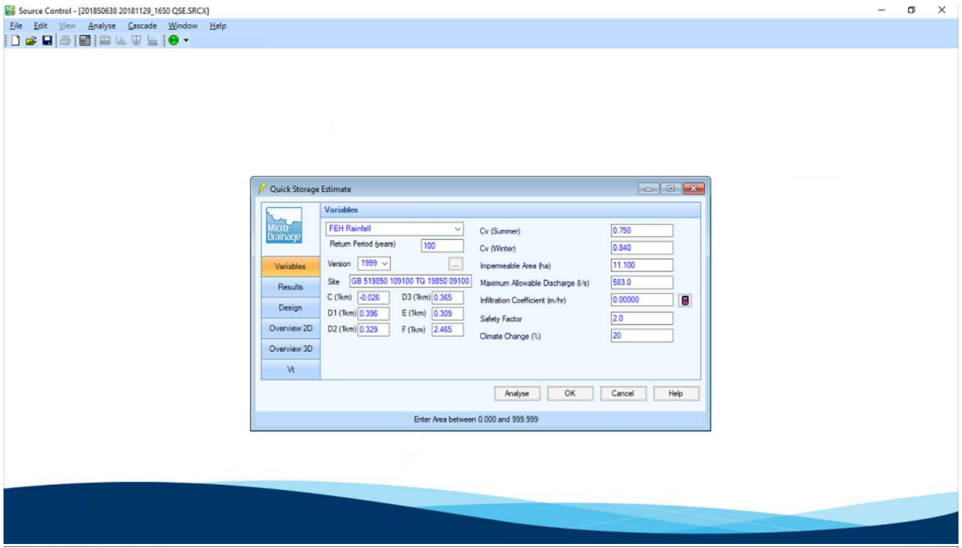
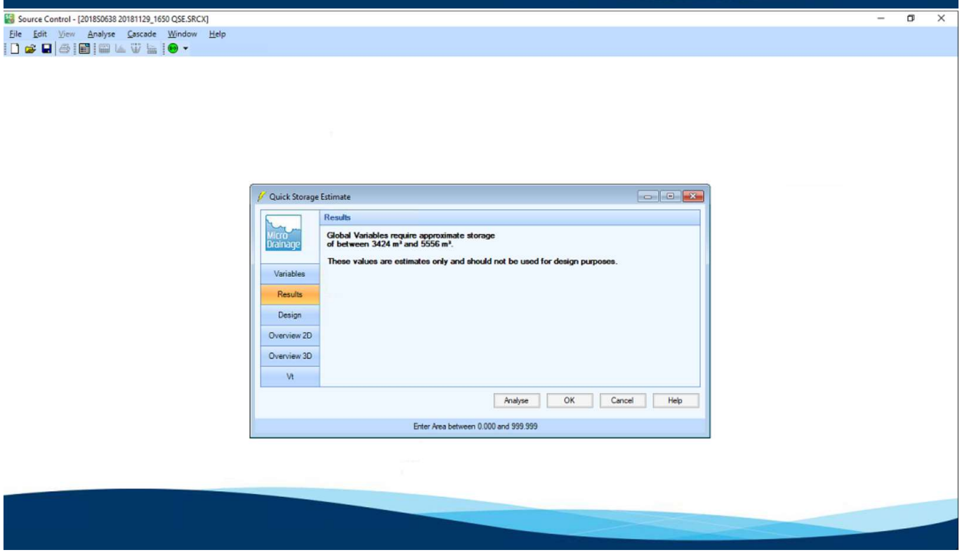
File
Edit
View
Analyse
Cascade
Window
Help
Quick Storage Estimate
Micro Drainage
Results
Global Variables require approximate storage
of between 864 m³ and 1573 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999

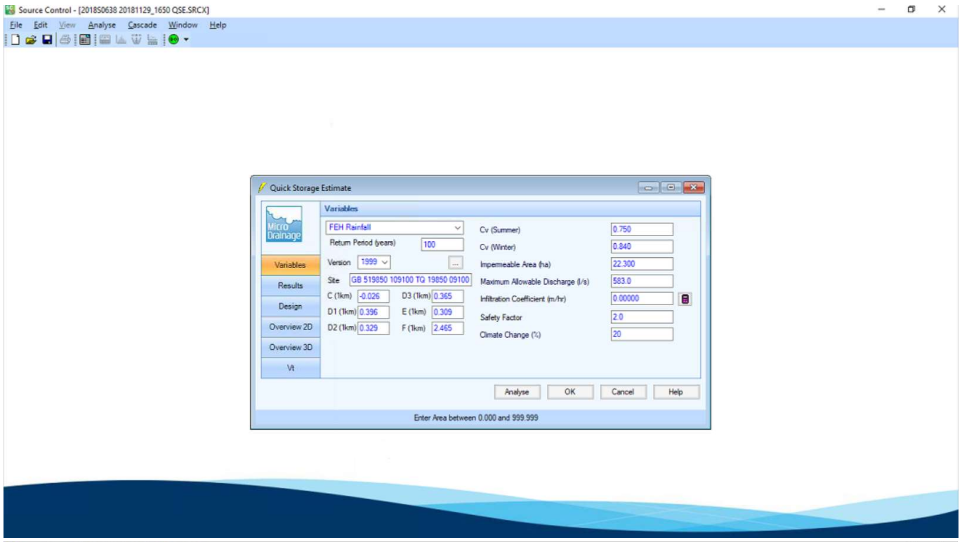


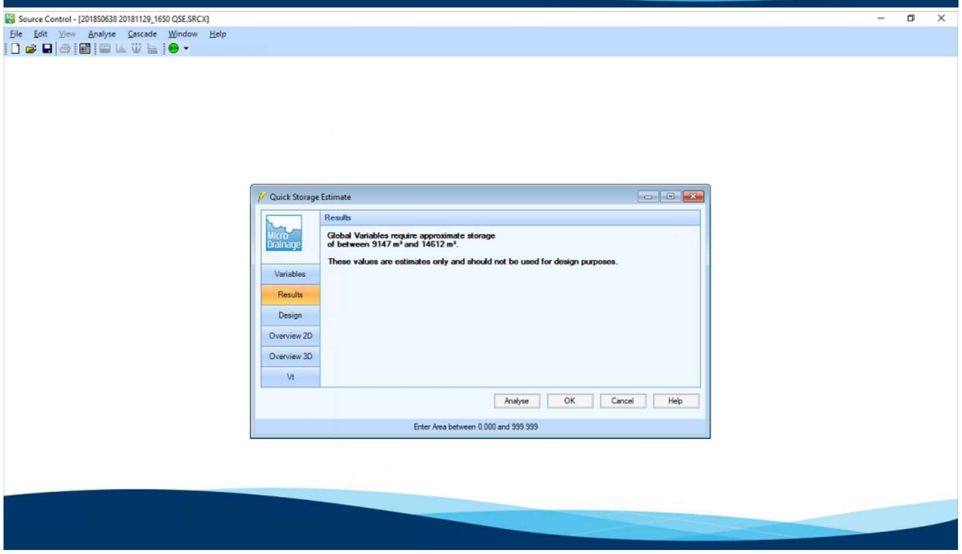
Source Control - [201850638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D1 (1km) 0.396
D2 (1km) 0.329
D3 (1km) 0.365
E (1km) 0.309
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 7.500
Maximum Allowable Discharge (l/s) 583.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Analyse OK Cancel Help
Enter Area between 0.000 and 999.999
23 new



Source Control - [201850638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Micro Drainage
Results
Global Variables require approximate storage
of between 1946 m³ and 3224 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse OK Cancel Help
Enter Area between 0.000 and 999.999


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
Micro Drainage
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026
D3 (1km) 0.365
D1 (1km) 0.396
E (1km) 0.309
D2 (1km) 0.329
F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 11.100
Maximum Allowable Discharge (l/s) 583.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999

Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Micro Drainage
Global Variables require approximate storage
of between 3424 m³ and 5556 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Area between 0.000 and 999.999


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years) 100
Version 1999
Site GB 519850 109100 TQ 19850 09100
C (1km) -0.026 D3 (1km) 0.365
D1 (1km) 0.396 E (1km) 0.309
D2 (1km) 0.329 F (1km) 2.465
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 22.300
Maximum Allowable Discharge (l/s) 583.0
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse OK Cancel Help
Enter Area between 0.000 and 999.999


Source Control - [2018S0638 20181129_1650 QSE.SRCX]
File Edit View Analyse Cascade Window Help
Quick Storage Estimate
Results
Global Variables require approximate storage
of between 9147 m³ and 14612 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse OK Cancel Help
Enter Area between 0.000 and 999.999

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