

## 2. Site Setting

2.1 The site is approximately 109.93 hectares and is located directly south of the Arborfield Garrison (a British Army Garrison). The site is bounded to the west by Reading Road (A327), Park Lane to the east, south-east and north-east and Sheerlands Road to the north-west. Hogwood Lane is present at the sites northern boundary which provides access to pedestrians between Sheerlands Road and Hogwood Industrial Estate. Hogwood Industrial Estate setting and the southern farmhouse setting, west court. All of the sites boundaries are marked by woodland and hedgerows.

2.2 The site co-ordinates and the nearest site post-code are given below:

 N477056

 E164329

 RG404QY

2.3 A plan of the site area is provided below in Figure 1. A larger plan of the site is provided in Appendix B.

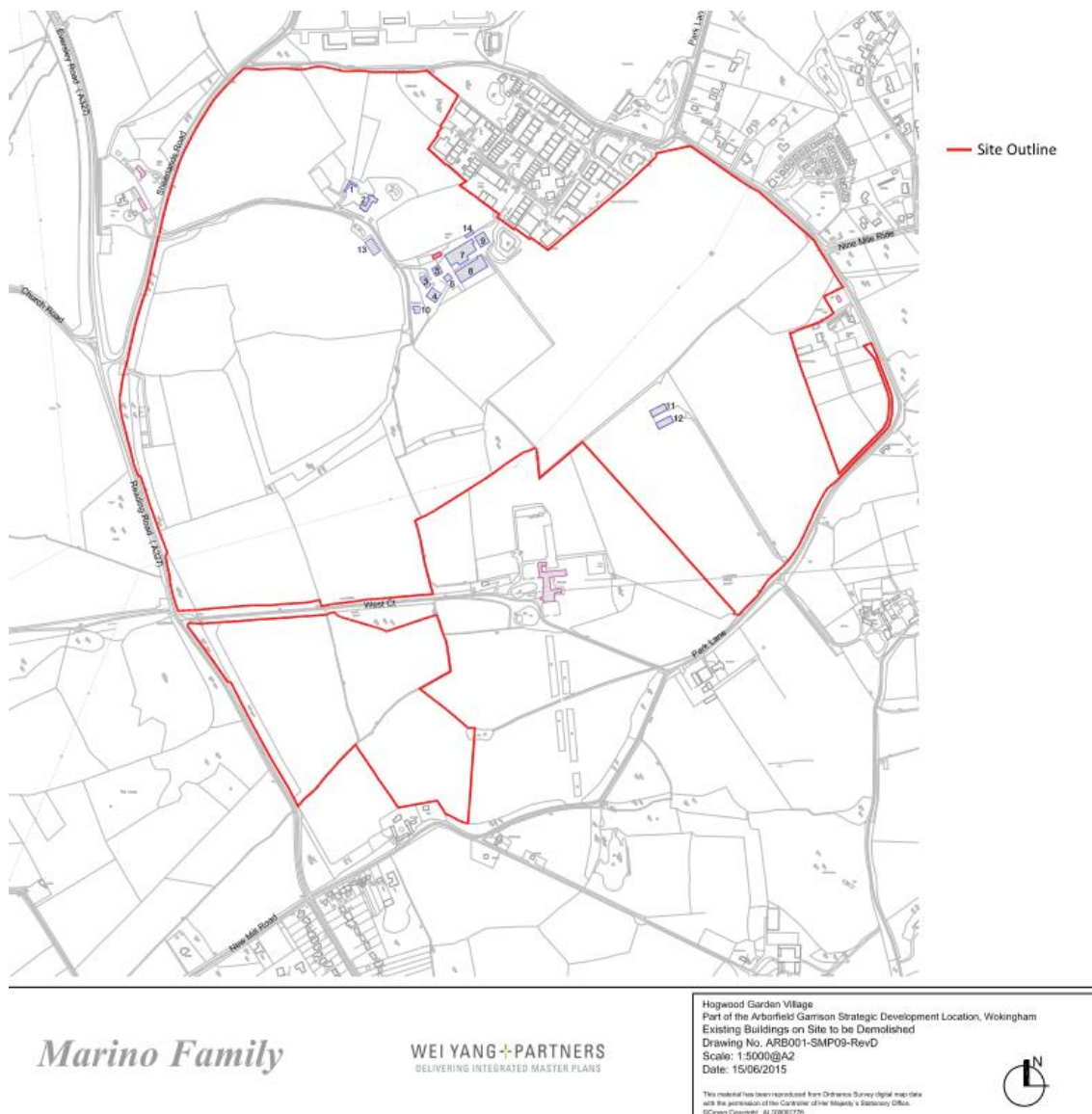


Figure 1: Site Location Plan

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- 2.4 The site is bounded to the north-west/north by Hogwood Lane, which leads into Hogwood Industrial Estate. Hogwood Industrial Estate bounds the rest of the site at the northern boundary.
  - 2.5 The land of the site is comprised mainly of large open fields which are used for agricultural purposes and separated by hedgerows and fences. Sections of mature woodland are also present in the site, including Hogwood Shaw; a Wildlife Heritage Site. Various buildings are present across the site. The majority of these are agricultural (stables etc). There are two houses present as well in the Hogwood House and The Lodge, one is to the north and the other to the south of a small private road that leads directly to Hogwood Farm. The overall site specifically excludes the Hogwood Farmhouse which is a Grade 2 Listed Building, this building is located within the Industrial Estate.

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## 3. Geological/Hydrogeological Setting

- 3.1 British Geological Survey (BGS) have provided 1:50,000 scale geological mapping. This indicates that the site is underlain by London Clay Formation bedrock, with no overlying superficial deposits. BGS has also provided public borehole data in the area of Hogwood Industrial Estate; immediately to the north-east of the site. This shows a layer of topsoil that ranges between 0.15 to 0.3m in thickness, underlain by the London Clay.
- 3.2 A Site Investigation was carried out by Eastwood & Partners Consulting Engineers between 25-27th July 2017 (report reference 41623-002). During the Site Investigation, 45 trial pits were dug across the site, to depths of between 1.2 to 3.2m below ground level (bgl). A plan showing the trial pit locations is provided in Appendix C.
- 3.3 A summary of the findings from the Site Investigation is provided below:
-  Topsoil was the superficial layer of geology found across the site. The topsoil layer was found at thicknesses of between 0.2 to 0.4m. This layer was mainly composed of silty clay and occasional pockets of gravel with flints were also found.
  -  At the eastern side of the site Bagshot Formation was found between the topsoil and London Clay layers. This formation was found between 0.3 to 0.5m bgl. This layer was described as being orange/brown in colour. Medium to fine in grain size and medium in terms of its density. Varying amounts of medium to coarse grained gravel and silt were also found.
  -  The site is underlain by London Clay formation, this layer was first encountered between 0.25 to 0.5m bgl. This layer was described as orange, brown and grey/blue in colour. The clay is commonly described in the logs as stiff with varying amounts of sand and gravel present across the site.
- 3.4 Due to the impermeable clay present across the site, groundwater was rarely encountered during the investigation. Only 13% of the trial pits encountered any groundwater, it was recorded as ingress and described as a slow trickle or seepage at depths between 1.2 and 2.4m bgl.
- 3.5 The Environment Agency's (EA) classification system designates London Clay as an unproductive Strata, meaning that the geology has low permeability and little effect on the areas water supply. However, the eastern end of the site has deposits of Bagshot Formation which the EA classifies as a Secondary A aquifer. This means that the aquifer is only supporting water supplies at a localized scale, meaning it is unlikely to be highly permeable.
- 3.6 The site is not within a groundwater Source Protection Zone as defined by the EA.

## 4. Hydrological Setting

- 4.1 This section should be read in conjunction with the Existing Ditch Network Plan provided in Appendix A.
- 4.2 The closest major watercourse to the site is the Long River which is located approximately 880m away to the south/south-west. The Long River flows into the Blackwater River approximately 3.5km south-west of the site before merging with the River Hart and flowing into the River Loddon which flows away to the north-west and eventually into the River Thames. Figure 2 below shows the Blackwater River catchment, which the site and Long River to the south form a part of.

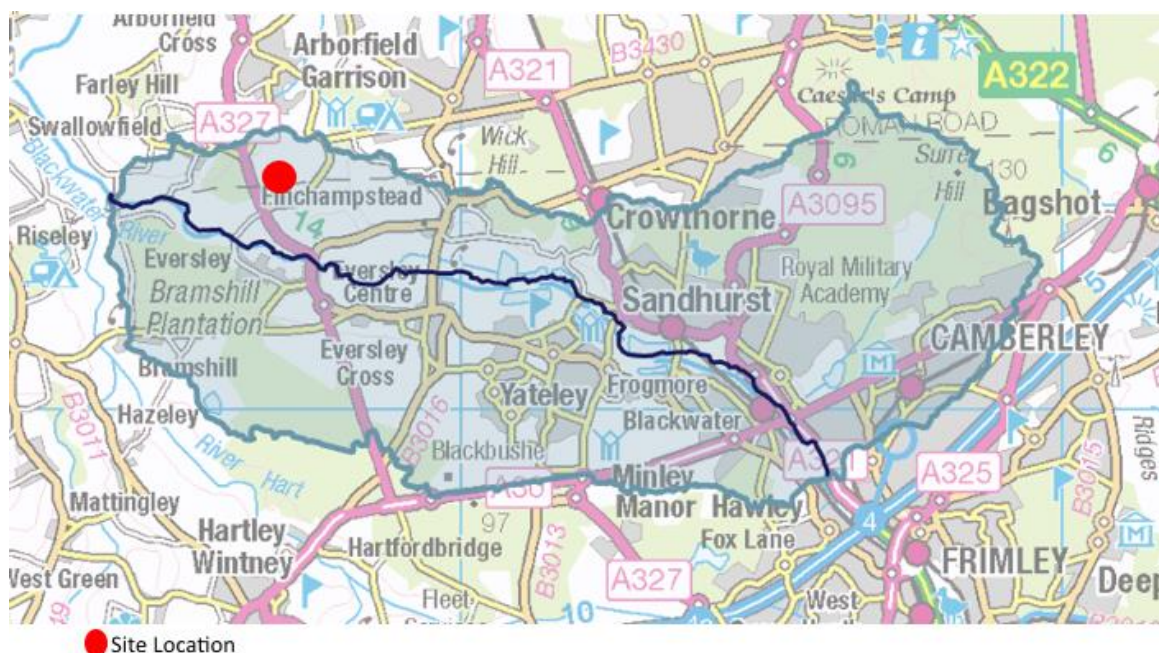


Figure 2: Environment Agency Blackwater River (Hawley to Whitewater confluence at Bramshill) Catchment Area

- 4.3 Multiple ditches have also been identified running throughout the site. These ditches are key to the sites drainage due to the low permeability of the areas geology, which is outlined in Section 3 above. All the ditches and on-site hardstanding areas drain into Hogwood Ditch, which flows from north to south before meandering towards the south-western corner and through a culvert towards Long River.
- 4.4 Approximately 40m away from the sites eastern boundary, Robinson Crusoe Park is located. Within this park there are two lakes which connect into Robinson Crusoe Ditch. Robinson Crusoe Ditch then formally drains a section of Park Lane before entering the site via a culvert beneath the road. On-site, Robinson Crusoe Ditch is also fed by smaller ditches from the surrounding fields and Shepperlands Farm. The ditch flows approximately 1.2km to the west/south-west, where it joins with Hogwood Ditch, which continues to flow south-westwards.
- 4.5 A number of ponds on-site are also present, these are all hydraulically linked by the local ditch network into Hogwood Ditch; including a north-eastern pond which attenuates run-off from the Hogwood Industrial Estate. The on-site industrial area also drains into Hogwood Ditch via a piped network.

## 5. Local Gauging Station Data

- 5.1 Table 1 below gives information on the local gauging stations around the site. Gauging stations are used to gather and monitor hydrological data on terrestrial bodies of water. Local gauging stations and data was identified using the Flood Estimation Handbook (FEH) Web Service and the National River Flow Archive respectively.

*Table 1: Local Gauging Stations Information*

| Gauging Station | Watercourse  | Distance from Site (km) | Operating Start Date | Similarity to Site (%) |
|-----------------|--------------|-------------------------|----------------------|------------------------|
| Swallowfield    | Blackwater   | 3                       | 01/1952              | 40                     |
| Bramshill House | Hart         | 5                       | 01/1972              | 70                     |
| Sheepbridge     | Loddon       | 6                       | 01/1965              | 40                     |
| Binfield        | The Cut      | 11                      | 01/1957              | 60                     |
| Reading         | Thames       | 12                      | 01/1992              | 33                     |
| Twyford         | Loddon       | 13                      | 01/1994              | 33                     |
| Lodge Farm      | Whitewater   | 16                      | 01/1910              | 40                     |
| Farmborough     | Blackwater   | 17                      | Undefined            | 48                     |
| Theale          | Kennet       | 19                      | 01/1961              | 20                     |
| Sulham          | Sulham Brook | 21                      | 01/1991              | 64                     |
| Brimpton        | Enborne      | 22                      | 01/1966              | 20                     |
| Pangbourne      | Pang         | 22                      | 01/1968              | 20                     |
| Famham          | Wey          | 23                      | 01/1978              | 16                     |

- 5.2 The similarity to site (%) represents a total percentage of the catchment descriptors similarity to the site-specific catchment values. Where applicable, data from these gauging stations will be taken as 'donor' values for the final set of data. This is in-line with recommendations within the 1999 Flood Estimation Handbook Volumes 1-5 and the 2015 EA Flood Estimation Guidelines (reference: 197\_08 Version 5).
- 5.3 In the context of this study, local was determined as within a 25km radius of the site.
- 5.4 The gauging stations highlighted red have been discounted from the selection of final values for the Hogwood catchment. These catchments are all over 100km<sup>2</sup>, which is not considered representative of the Hogwood catchment, which is 3.36km<sup>2</sup>. The remaining gauging stations that will be used for comparison is five. The local gauging station information is provided in Appendix D.

## 6. Flood Estimation Handbook Catchment Descriptors

- 6.1 Table 2 below shows the generic catchment descriptors and values derived for the Hogwood Ditch catchment using the FEH Web Service for the site in October 2017. A definition of each catchment descriptor is also given in-line with the 1999 Flood Estimation Handbook Volumes 1-5 and the 2015 EA Flood Estimation Guidelines.

*Table 2: Site Generic Catchment Descriptors*

| Catchment Descriptor | Site Value | Definition of Catchment Descriptor                                                                              |
|----------------------|------------|-----------------------------------------------------------------------------------------------------------------|
| AREA                 | 3.36       | Catchment drainage area (km <sup>2</sup> )                                                                      |
| ALTBAR               | 60         | Mean catchment altitude (m above sea level)                                                                     |
| ASPBAR               | 242        | Index representing the dominant aspect of catchment slopes                                                      |
| ASPVAR               | 0.35       | Index describing the invariability in aspect of catchment slopes                                                |
| BFIHOST              | 0.439      | Base flow index derived using HOST classification                                                               |
| DPLBAR               | 1.49       | Index describing catchment size and drainage path configuration (km)                                            |
| DPSBAR               | 14.2       | Index of catchment steepness (km)                                                                               |
| FARL                 | 0.987      | Index of flood attenuation due to reservoirs and lakes                                                          |
| FPEXT                | 0.1987     | Floodplain extent, the fraction of the catchment inundated by 100-year flood, used for selecting pooling groups |
| FPDBAR               | 0.862      | Mean depth of water on floodplains in a 100-year event                                                          |
| FPLOC                | 0.801      | Floodplain location relative to the catchment outlet                                                            |
| LDP                  | 3.09       | Longest drainage path                                                                                           |
| PROPWET              | 0.29       | Index of proportion of time that soils are wet                                                                  |
| RMED-1H              | 11.7       | Median annual maximum 1-hour rainfall (mm)                                                                      |
| RMED-1D              | 29.2       | Median annual maximum 1-day rainfall (mm)                                                                       |
| RMED-2D              | 37.6       | Median annual maximum 2-day rainfall (mm)                                                                       |
| SAAR                 | 659        | 1961-1990 standard-period average annual rainfall (mm)                                                          |
| SAAR4170             | 651        | 1941-1970 standard-period average annual rainfall (mm)                                                          |
| SPRHOST              | 35.48      | Standard percentage runoff derived using the HOST classification                                                |
| URBCONC1990          | -999999    | 1990 index of concentration of urban and suburban land cover                                                    |
| URBEXT1990           | 0          | 1990 index of fractional urban extent                                                                           |
| URBLOC1990           | -999999    | 1990 index of location of urban and suburban land cover                                                         |
| URBCONC2000          | -999999    | 2000 index of concentration of urban and suburban land cover                                                    |
| URBEXT2000           | 0          | 2000 index of fractional urban extent                                                                           |
| URBLOC2000           | -999999    | 2000 index of location of urban and suburban land cover                                                         |
| C                    | -0.02766   | Rainfall depth-duration-frequency (DDF model parameter)                                                         |
| D1                   | 0.25987    | Rainfall depth-duration-frequency (DDF model parameter)                                                         |
| D2                   | 0.2543     | Rainfall depth-duration-frequency (DDF model parameter)                                                         |
| D3                   | 0.32308    | Rainfall depth-duration-frequency (DDF model parameter)                                                         |
| E                    | 0.30207    | Rainfall depth-duration-frequency (DDF model parameter)                                                         |
| F                    | 2.64776    | Rainfall depth-duration-frequency (DDF model parameter)                                                         |
| C (1 km)             | -0.027     | Point rainfall depth-duration-frequency (DDF model parameter)                                                   |
| D1 (1 km)            | 0.263      | Point rainfall depth-duration-frequency (DDF model parameter)                                                   |
| D2 (1 km)            | 0.25       | Point rainfall depth-duration-frequency (DDF model parameter)                                                   |
| D3 (1 km)            | 0.343      | Point rainfall depth-duration-frequency (DDF model parameter)                                                   |
| E (1 km)             | 0.3        | Point rainfall depth-duration-frequency (DDF model parameter)                                                   |
| F (1 km)             | 2.636      | Point rainfall depth-duration-frequency (DDF model parameter)                                                   |

- 6.2 Whilst the other catchment descriptors give useful information for the catchments characteristics and can be used to identify similar catchments, the ten green highlighted catchment descriptors represent the key descriptors for the purposes of flood estimation.
- 6.3 Each of the 10 key catchment descriptors are reviewed below with their values scrutinised using available topographic, hydrological and geological data in the study area.

## 7. Key Catchment Descriptors Review

### AREA

- 7.1 Confirming the overall catchment area is the first vital part of any hydrological assessment. The FEH Web Service provides a map which displays the Hogwood Ditch catchment area over Ordnance Survey background mapping. This is provided in Figure 3 below.

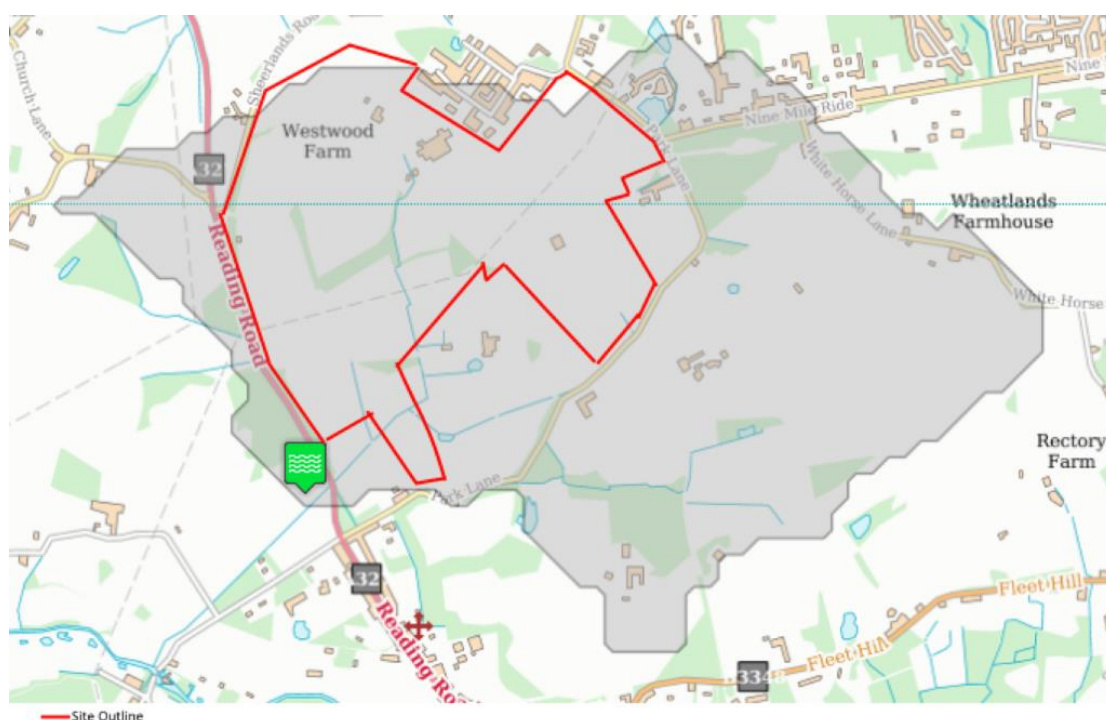


Figure 3: Catchment Area for the Site

- 7.2 From a review of the above map, the catchment area has been confirmed as appropriate as it includes the full extent of the sites hydrological features.
- 7.3 At 3.36km<sup>2</sup>, the Hogwood catchment is small and therefore localised. The other local gauging stations with similar catchment areas can therefore be expected to be similar in nature to the study. It was found that five local gauging stations had similar areas to the sites catchment. As was expected, each of these gauging stations show a reasonable similarity to the site catchment. As mentioned above, the similarity of local gauging stations catchment areas to the area of interest was considered fundamental and therefore, local gauging stations with significantly different catchment areas were not considered appropriate donor stations.
- 7.4 Local gauging stations were deemed similar to the sites area if they were within 100km<sup>2</sup> of the site value.

### BFIHOST

- 7.5 The Hydrology of Soil Types (HOST) system classifies soils by their hydrological properties. The HOST classification system has 29 soils types in total for the UK and Northern Ireland. The HOST classification is also key to flood estimation due to it being used to derive some of the key catchment descriptor values i.e. SPRHOST and BFIHOST.
- 7.6 A HOST classification has been selected for the catchment and used to derive SPRHOST and BFIHOST values

in the generic FEH catchment descriptors.

- 7.7 BFIHOST is a key descriptor because it quantifies the catchment rainfall model baseflow using the areas hydrogeological context (i.e. HOST value). A 0.439 BFIHOST value was given in the generic catchment descriptors obtained for the site from the FEH Web Service. This suggests a permeable soil with a HOST classification of 5. This value is not an accurate representation of the known ground conditions/soil types present at the site.
- 7.8 The soil type on-site and in the wider catchment has been estimated using the 2017 Site Investigation carried out by Eastwood & Partners Consulting Engineers and 1:50000 scale geological mapping available from BGS. All records suggest that the Hogwood Ditch catchment area is underlain by London Clay. The London Clay has a HOST classification of 18 according to the 1995 Hydrology of soil types: a hydrologically-based classification of the soils of the United Kingdom (Report No. 126), HOST soil distribution map. This means the soil is slowly permeable, with an impermeable layer within 100cm of the surface. The soil descriptions from the trial pit logs during the Site Investigation confirms this.
- 7.9 To recalculate the BFIHOST value using a HOST classification of 18, the sites Integrated Air Capacity (IAC) value is needed. This is because IAC is used as a substitute for permeability values in impermeable soils. The IAC value for the site was unknown and therefore a donor BFIHOST value for a local gauging station will be used in the final data set instead of the generic value. The EA Flood Estimation Guidelines outline this as best practice in terms of defining accurate BFIHOST values.
- 7.10 The gauging station that has been selected is Bramshill due to it being the closest gauging station to the site (5km away) with a similar AREA value and impermeable geology. The BFIHOST value for Bramshill is 0.589, this value best represents the study area in a hydrogeological context.

## *DPLBAR*

- 7.11 This descriptor relates to the drainage path configuration for the area in conjunction with catchment size. The DPLBAR value for the site was found to be similar to none of the local gauging stations (although the sample size was small as only three local stations provided DPLBAR values).
- 7.12 The range for a value to be considered similar to the site value was 5 +/- . However, all of the values of DPLBAR given by local gauging stations are larger than the sites AREA. Therefore, the generic value will have to be used in the final data set as the DPLBAR value cannot be larger than the area of the catchment.

## *DPSBAR*

- 7.13 This descriptor gives a value to the catchment areas steepness. The value of DPSBAR for the site was found to be similar to none of the local gauging stations. The generic value for DPSBAR suggests that the site catchment is flat. The site catchment is also known to have hills and valleys present, meaning it is not particularly flat. It would therefore be in-line with the EA Flood Estimation Guidelines best practice if the final value for DPSBAR was selected from a local gauging station. Binfield (DPSBAR value: 24.7) was selected due to its proximity to the site catchment and because this stations value represents the site topography better than the generic descriptor value.
- 7.14 DPSBAR values for the local gauging stations were classed as similar if they were within 5 +/- from the site value.

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## *FARL*

- 7.15 This descriptor was identified as key to flood estimation because it represents flood attenuation offered by reservoirs and lakes in the catchment area. The value of FARL for the site was found to be likened to 100% of the local gauging stations, the values were classed as similar if they were within 0.2+/-.
- 7.16 A higher FARL value is expected for the sites catchment due to there being only a few small lakes located within the catchment area. (Higher FARL values mean lakes and reservoirs are less prevalent in the area). However, as seen in Figure 3, there are indeed a few small bodies of water present in the site which will affect flood attenuation. Therefore, a donor value will be selected to ensure that this attenuation is represented in the final FARL value. In accordance with, the EA Flood Estimation Guidelines of best practice a value from a local gauging station will be selected.
- 7.17 The station selected was Bramshill (FARL value 0.947) due to it being closest to the site (5km away) and its close similarity to the Hogwood Ditch catchment in terms of the attenuation present in the form of lakes and reservoirs.

## *LDP*

- 7.18 This descriptor has been identified as key because it quantifies the maximum distance that water can flow from source to outlet in the catchment area. In terms of the similarity in values between the site and local gauging stations none of the stations gave a similar value to the site catchment (LDP values were only given for 3 of the local stations). However, the FEH states that the majority of catchments fall between 10 to 40 km for LDP and as seen in Table 2 the site-specific value does not fall in this range (3.09 km). This seems reasonable given the small overall catchment area. The generic value for LDP must be used due to all the local gauging stations having values that would exceed the AREA value for the sites catchment.
- 7.19 LDP values from the local gauging stations were classed as similar to the site values if they fell within +/- 5.

## *PROPWET*

- 7.20 PROPWET is an index representing the time that the ground is saturated in the catchment area. The FEH outlines that PROPWET values over 80% are considered as the wettest catchments (the ground is saturated for long periods of time) and values under 20% are the driest. In terms of the generic catchment area value compared to the local gauging stations, 100% of the stations gave values that are similar to the catchment data.
- 7.21 The values from local gauging stations of PROPWET were classed as similar to the sites value if they were within +/- 0.2.
- 7.22 In accordance with EA Flood Estimation Guidelines of best practice a value from a local gauging station will be selected. A donor value of 0.35 from Bramshill was selected as the final value due to it being the closest relevant station to the site at 5km away. Due to this value being from a gauged station it is more accurate than the generic value but still falls within the 0.2+/- acceptance range.

## *SAAR*

- 7.23 This descriptor gives data on the annual average rainfall experienced in the catchment, which is a major input of water into the hydrological calculation. Two sets of data are available SAAR (1961-1990) and SAAR4170 (1941

to 1970), the more modern data set was selected due to it being more relatable to the areas current rainfall. The rainfall data (mm) was provided to the authors of the FEH by the MET Office.

- 7.24 The generic value for the area was compared against local gauging station data. 80% showed similar values.
- 7.25 The final SAAR value selected was taken from a donor site with a similar value in Bramshill (5km away from site). The value given by Bramshill correlates with even more local gauging stations than that of the generic value (100% similarity) and by taking a gauged station value the data is in-line with best practice as noted within the 2015 EA Flood Estimation Guidelines.
- 7.26 SAAR values from the local gauging stations classed as similar to the sites values if they were within 100mm +/-.

## *SPRHOST*

- 7.27 As with the baseflow index, the standard percentage of runoff is also derived using the HOST soil classification. This is a critical factor in deriving runoff and is therefore a key parameter in flood estimation.
- 7.28 As mentioned above, the Hogwood Ditch catchment HOST classification has been identified as 18 (slowly permeable soils with an impermeable layer within 100cm of the surface) using local BGS mapping and the findings of the 2017 Site Investigation.
- 7.29 The generic catchment value of 35.48 suggests that site is partially permeable with a medium surface runoff rate. This value doesn't represent the sites underlying geology well. Because of this, the Bramshill gauging station value will be selected as a donor station (as with the BFIHOST value). This follows the 2015 EA Flood Estimation Guidelines best practice.
- 7.30 The SPRHOST value from this gauging station is 30.00, which still suggests the same hydrological characteristics as the generic value. Although, the gauging station and generic value are similar, it is still recommended to take the gauging station data in the 2015 EA Flood Estimation Guidelines.
- 7.31 SPRHOST values for the local gauging stations were classed as similar if they were within +/- 10 of the sites generic value.

## *URBEXT 2000*

- 7.32 The 2015 EA Flood Estimation Guidelines outline that the URBEXT value is important because the more urbanised the catchment area, the higher the amount of impermeable surfaces present, which increases runoff. A generic value of 0 was given to the sites catchment area, meaning there is no urbanization or development on the sites catchment. This value is not accurate because the sites catchment area does contain some developed areas towards the north, in the form of an industrial estate and some residential and agricultural buildings.
- 7.33 Therefore, a donor value will be selected that accurately represents the site catchment area. The value selected was from the local gauging station of Bramshill (URBEXT2000 0.0366), because it is the closest gauging station to the site and because it is similarly urbanised to the Hogwood Ditch catchment. By taking a gauged station value the data is in-line with best practice as noted within the 2015 EA Flood Estimation Guidelines.
- 7.34 The gauging station values for URBEXT were classed as similar to the sites value if they were within +/- 0.2.

## 8. Final Selected Catchment Descriptor Values

8.1 Table 3 below shows the final selected key catchment descriptor values following the above review.

*Table 3: Final Selected Key Catchment Descriptor Values*

| Catchment Descriptors | Selected Value | Justification                                                                                |
|-----------------------|----------------|----------------------------------------------------------------------------------------------|
| AREA                  | 3.36           | Value was kept due to it being the best representation of the catchment area                 |
| BFIHOST               | 0.589          | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |
| DPLBAR                | 1.49           | Value was kept due to it being the best representation of the catchment area                 |
| DPSBAR                | 24.7           | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |
| FARL                  | 0.947          | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |
| LDP                   | 3.09           | Value was kept due to it being the best representation of the catchment area                 |
| SAAR                  | 707            | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |
| SPRHOST               | 30.00          | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |
| PROPWET               | 0.35           | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |
| URBEXT2000            | 0.0366         | This value was taken from a local station as preferred by the EA Flood Estimation Guidelines |

8.2 The 2015 EA Flood Estimation Guidelines recommends that the DDF model parameters are not altered from the generic catchment descriptor values obtained from FEH, so these values are also retained.

8.3 All other catchment descriptor values not referenced in Table 3 above have retained their generic value as they are not directly relevant to flood estimation calculations.

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## 9. Choice of Flood Estimation Method

9.1 Flood estimation should adhere to the following six maxims set out in the FEH and the 2015 EA Flood Estimation Guidelines:

-  Flood frequency is best estimated from gauged data.
-  While flood data at the subject site are of greater value, data transfers from a nearby site, or a similar catchment, are also useful.
-  Estimation of key variables from catchment descriptors alone should be a method of last resort. Some kind of data transfer is usually feasible and preferable.
-  The most appropriate choice of method is a matter of experience and may be influenced by the requirements of the study and the nature of the catchment. Most importantly, it will be influenced by the available data.
-  In some cases, a hybrid method, combining estimates by statistical and rainfall-runoff approaches, is appropriate.
-  There is always more information. An estimate based on readily available data may be shown to be suspect by a more enquiring analyst.

9.2 In terms of flood estimation there are two principle techniques that are set out by the 2015 EA Flood Estimation Guidelines:

-  The FEH Statistical Method (this method has replaced older methods for the most part)
-  The Revitalised Flood Hydrograph (ReFH 2) method

9.3 The main differences between these two Methods is the statistical method just gives peak flow, whilst the ReFH 2 method produces hydrographs.

9.4 The 2015 EA Flood Estimation Guidelines state that the following factors favour the selection of the FEH Statistical Method:

-  There are more than two/three years of flood peak data on the watercourse or local gauging station that is suitable for high flow measurement
-  The catchment size is  $>1000\text{km}^2$ .

9.5 Neither of the above factors that favour the selection of the FEH statistical method are met for this site.

9.6 The 2015 EA Flood Estimation Guidelines state that the following factors favour the selection of the ReFH 2 Method:

-  There is no continuous flow record, but rainfall and flow data are available for five or more flood events.
-  The problem involves flood storage and/or routing and there is no flood peak data that implicitly accounts for the effect of the storage.
-  The return period is long (over 1000 years).
-  The study involves designing works to counter the effects of a new urban development and/or storm sewer design.
-  The catchment is low-lying, with pumped drainage.

9.7 The site catchment has many of these factors which makes the ReFH 2 method favourable the site.

9.8 In comparison to the FEH Statistical Method, ReFH 2 is more applicable to smaller catchments and is

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potentially deemed more suitable for calculating flow estimates for longer return periods, which means that extreme flood events can be simulated, in-line with planning requirements i.e. the 1 in 1000-year fluvial flood event.

- 9.9 Despite the above favourable site characteristics, there are some restrictions with the ReFH 2 method that do need to be considered. The 2015 EA Flood Estimation Guidelines states that ReFH 2 can overestimate the flow volume of water in highly impermeable areas or heavily urbanised/extremely rural areas.
- 9.10 The issues associated with impermeable catchments in ReFH 2 have been addressed on the ReFH 2 method, released in February 2015 after the latest EA Flood Estimation Guidelines.
- 9.11 The URBEXT2000 descriptor value for the catchment is well below 0.125, which means it is classed as rural in accordance with the 1999 Flood Estimation Handbook. Despite this and the concerns raised in the 2015 EA Flood Estimation Guidelines, ReFH 2 does address this issue by in its adaptable settings. In any case, the results will have to be checked to demonstrate that there are no discrepancies.
- 9.12 Overall, to comply with the EA Flood Estimation Guidelines six maxims the site characteristics lean towards the ReFH 2 method being most favourable for this study. However, a statistical approach can never be discounted fully, mainly due to the low URBEXT2000 value which may led to inaccurate results in the ReFH 2 method.
- 9.13 Therefore, both the ReFH 2 Method and FEH Statistical Method will be used to generate flood estimates with a comparison made of both as part of this study.

## 10. Revitalised Flood Hydrograph (ReFH 2) Flood Estimates

- 10.1 The finalised catchment descriptor values were imported into ReFH 2 software.
- 10.2 The rainfall model selected for this study was FEH2013; the most recently rainfall model. FEH2013 removes the need for an overall alpha correction factor in the calculation, which represents an improvement over its predecessor. Instead FEH2013 implements a correction factor at each step of the calculation.
- 10.3 The storm duration values were kept as the pre-set 'recommended' values, which generates an 'average' storm for a given return period using the catchment descriptor values.
- 10.4 The 2007 FEH Supplementary Report No.1 outlines that URBEXT values over 0.125 are considered urbanised. In the UK more than 50% of observed storms flood urbanised areas in the summer period. Whilst URBEXT2000 values under 0.125 are considered rural in the 2007 FEH Supplementary Report No.1 and for these areas a winter profile needs to be selected. This is because floods in rural areas occur predominantly during the winter. Given the URBEXT2000 value is under 0.125, a winter storm profile was selected for this study.
- 10.5 In February 2016, the EA provided guidance on the predicted impacts of climate change on peak river flow and rainfall intensity over the next 100 years. The site is located in the Thames River Basin District, where peak river flow is predicted to increase by the following potential allowances by 2115:
-  Central Allowance (50% likelihood of actual climate change impact being lower): **25%**
  -  Higher Central Allowance (50% likelihood of actual climate change impact being lower): **35%**
  -  Upper Allowance (90% likelihood of actual climate change impact being lower): **70%**
- 10.6 Each of these allowances have been assessed by adding these percentages to the 1 in 100-year return period peak flow values given for the ReFH 2 Urban Category. The impacts of these ranges are shown in Table 4.
- 10.7 The results of the ReFH 2 method generated a hydrograph and flow data for each return period, two categories of results were produced. The first category is rural, whereby the results represent the catchment as completely rural. As there are clearly urbanised areas in the catchment, these results were discounted and the second category, urban results, were used and analysed for this hydraulic assessment. Table 4 below shows the urban category peak flow for each simulated return period. Full ReFH 2 results reports for each return period are provided in Appendix E.

*Table 4: ReFH 2 Peak Flow Results*

| Return Period (years) | Peak Flow (m <sup>3</sup> /s) |
|-----------------------|-------------------------------|
| 2                     | 0.64                          |
| 5                     | 0.88                          |
| 10                    | 1.04                          |
| 20                    | 1.22                          |
| 30                    | 1.33                          |
| 50                    | 1.48                          |
| 100                   | 1.71                          |
| 200                   | 1.98                          |
| 100+25% CC            | 2.14                          |
| 100+35% CC            | 2.31                          |
| 100+70% CC            | 2.91                          |
| 1000                  | 2.98                          |

- 10.8 The data in Table 4 shows a clear and expected trend with larger return periods and climate change allowances

---

resulting in higher peak flows ( $\text{m}^3/\text{s}$ ) than more frequent flood events.

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## 11. FEH Statistical Method Flood Estimates

- 11.1 The finalized catchment descriptors were imported into WINFAP 4 software. This is the updated version of the recommended software (WINFAP 3) to use when carrying out FEH Statistical method calculations in the 2015 EA Flood Estimation Guidelines.
- 11.2 After the site catchment data was imported into the software, a pooling group had to be defined. The pooling group takes data from selected gauging stations to give a more reliable estimate of the growth curve and the flood frequency curve. The 2015 EA Flood Estimation Guidelines outlines the following advice when selecting stations for the pooling group:
-  The stations should be close to the site
  -  The stations must be classed as suitable for pooling by HiFlows-UK. The EA states that HiFlows-UK gives high quality peak flood data from river gauging stations across the UK.
  -  The stations selected must be rural even if the site catchment is urbanised. This is defined by the URBEXT2000 value for the gauging station, which must be <0.030.
  -  The gauging stations selected should also not be strikingly different from the final site catchment descriptor values. The key catchment descriptors to consider during the evaluation are; AREA, SAAR, FARL and FPEXT (floodplain extent). The recently added catchment descriptor FPEXT had replaced BFIHOST in terms of measuring gauging stations similarity to the site catchment.
- 11.3 As well as individual criteria, the overall pool of selected gauging stations must also satisfy another set of criteria:
-  The pooling group must have at least 500-years of data combined, irrespective of the return periods set.
  -  The pooling group must not be heterogenous. This is done by selecting gauging stations which are similar in terms of their key catchment descriptors and QMED values.
  -  Gauging stations should be similar in terms of their growth curves and L-moments. This is because if the gauged stations are similar in these factors they are
- 11.4 A homogenous pooling group with 532 years of combined data and adhering to the above advice and criteria was selected. The pooling group selected and supporting information extracted from WINFAP 4 is provided in Appendix F.
- 11.5 After the suitable pooling group was selected and reviewed, the urban adjustment of QMED must be set. This allows for more urbanised catchments to be accurately analysed, due to the gauging stations all being rural. As the site catchment is classed as rural, urban adjustment was not needed in this case.
- 11.6 The statistical distribution for the calculations was then selected. In this instance, the default setting of General Logistic was used. This is because the 2015 EA Flood Estimation Guidelines state that this is the recommended distribution for UK flood data sets.

11.7 The results are provided below in Table 5.

*Table 5: WINFAP 4 Peak Flow Results*

| Return Period (years) | Peak Flow (m <sup>3</sup> /s) |
|-----------------------|-------------------------------|
| 2                     | 0.47                          |
| 5                     | 0.61                          |
| 10                    | 0.71                          |
| 20                    | 0.85                          |
| 30                    | 0.86                          |
| 50                    | 0.94                          |
| 100                   | 1.04                          |
| 200                   | 1.16                          |
| 100+25% CC            | 1.31                          |
| 100+35% CC            | 1.4                           |
| 1000                  | 1.46                          |
| 100+70% CC            | 1.77                          |

11.8 The climate change allowances in Table 5 are the same as the ones which were calculated for the ReFH 2 method.

## 12. Review and Confirmation of Appropriate Flood Estimation Results

- 12.1 The two methods show considerably different results for the same catchment area. The highest peak flow ( $\text{m}^3/\text{s}$ ) (excluding climate change allowances) for both methods given is  $2.98\text{m}^3/\text{s}$  for the ReFH 2 method and  $1.45\text{m}^3/\text{s}$  for the FEH Statistical method (this peak value for both events is the 1 in 1000 year). This difference in the results is not just present in the most extreme flood event, as Figure 4 below shows. The ReFH 2 peak flow values are consistently higher than the FEH Statistical values.

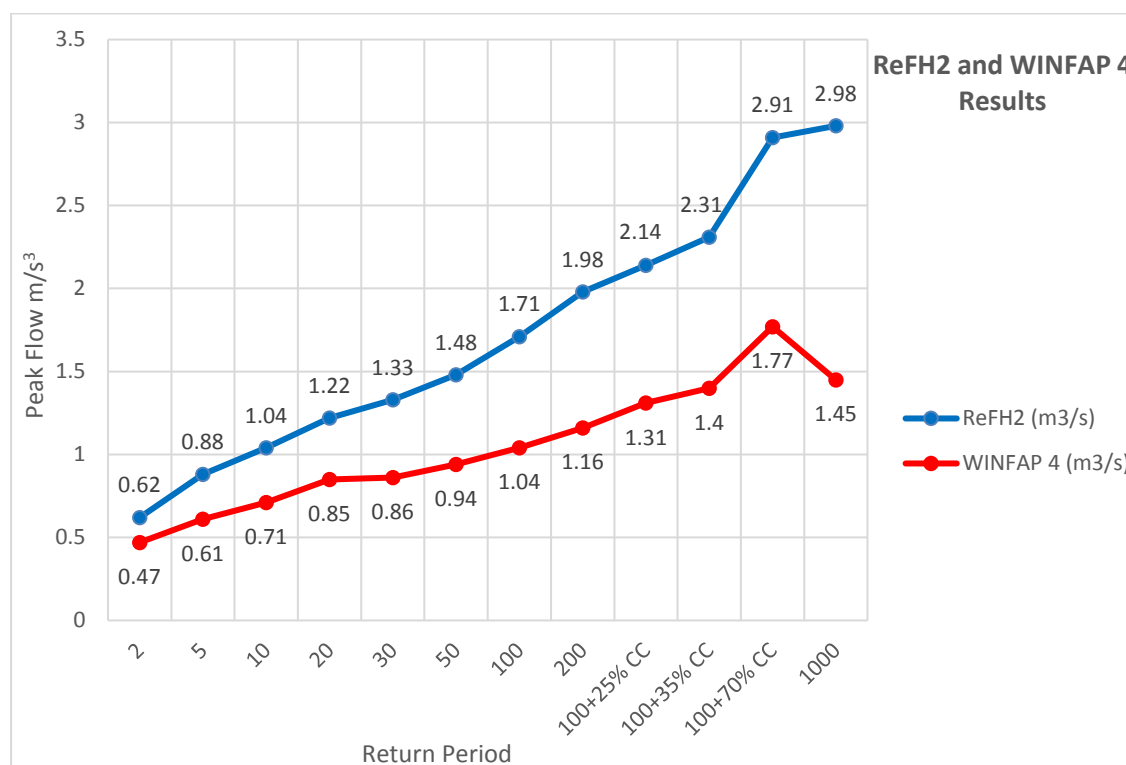


Figure 4: Graph of Results for Both FEH Methods

- 12.2 When climate change is considered, the 1 in 1000 year flood event remains the most extreme peak flow value for the ReFH 2 method. However, for the FEH Statistical method, the 70% climate change allowance pushes the 1 in 100 year peak flow value above the 1 in 1000 year flood event in terms of severity.
- 12.3 From analysing both sets of results and consulting the 2015 EA Flood Estimation Guidelines, the ReFH 2 method results have been selected for use in the hydraulic modelling for this site as opposed to the straight FEH Statistical method or a Hybrid Approach taking data from both methods. This is because the ReFH 2 flow values are more conservative than that of the FEH Statistical method in terms of the peak flow ( $\text{m}^3/\text{s}$ ) (both including and excluding climate change allowances) and further to that, it also meets more of factors favouring its selection when compared to the FEH Statistical approach.

---

## 13. Conclusion

- 13.1 This hydrological assessment has been prepared to generate the inflow data for a range of storm events for a hydraulic flood modelling project of Hogwood Ditch at the site of a proposed major residential development.
- 13.2 The proposed development site is approximately 109.93 hectares in size and is located directly south of the Arborfield Garrison (a British Army Garrison). The land of the site is comprised mainly of large open sections of mature woodland and various buildings.
- 13.3 The topography of the site shows a general fall from north to south/south-west. Local valleys were identified throughout the site, which predominantly fall from the eastern and western boundaries of the site towards the centre of the site.
- 13.4 The ground conditions of the site are defined by the mainly impermeable clay geology, topography and ditch network. The eastern area of the site was found to have more permeable superficial deposits of geology; however, this layer was underlain by the clay.
- 13.5 The hydrology of the site is dominated by the sites topographic features and a network of ditches which flow into Hogwood Ditch and Robinson Crusoe Ditch (a primary tributary).
- 13.6 The catchment descriptors for the site have been reviewed and local gauging station data has been used where applicable. The gauging stations were selected using the Flood Estimation Handbook (FEH) Web Service and the National River Flow Archive. Once all the data had been gathered each catchment descriptor was reviewed and the most appropriate value was selected in accordance with the 2015 EA Flood Estimation Guidelines.
- 13.7 Once the final set of catchment descriptors had been defined the two major flood estimation calculations were carried to find peak flow values for a range of return periods for the sites catchment area. These two methods being ReFH 2 and the FEH Statistical method.
- 13.8 After both methods were carried out the results were compared, and it was found that the ReFH 2 method gave more conservative peak flow ( $\text{m}^3/\text{s}$ ) data (including for forecasted climate change impacts).
- 13.9 Taking the guidance given in the 2015 EA Flood Estimation Guidelines and the results from both methods carried out (ReFH 2 and FEH Statistical). The results of the ReFH 2 method will be taken forward into the hydraulic modelling of the Hogwood site as the most conservative results.

## Document Issue Record

| Technical Note No | Rev | Date | Prepared | Reviewed | Approved |
|-------------------|-----|------|----------|----------|----------|
|                   |     |      |          |          |          |
|                   |     |      |          |          |          |
|                   |     |      |          |          |          |
|                   |     |      |          |          |          |

## List of Appendices

|            |                             |
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| Appendix A | Existing Ditch Network Plan |
| Appendix B | Site Plan                   |
| Appendix C | Trial Pit Location Map      |
| Appendix D | Local Gauging Station Data  |
| Appendix E | ReFH 2 Results Reports      |
| Appendix F | Pooling Station Group Data  |

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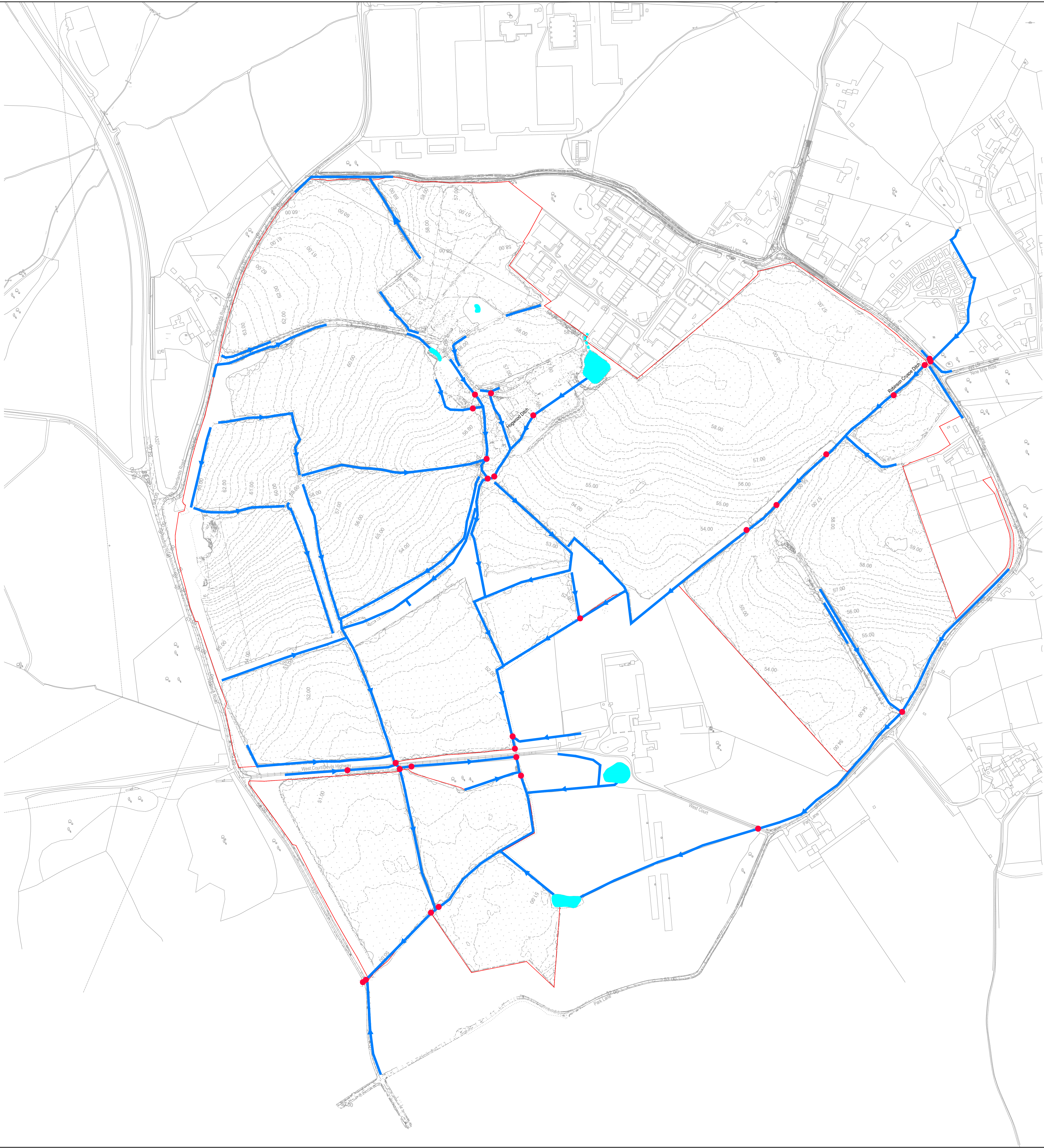
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## Appendix A-Existing Ditch Network Plan





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- Key
- Watercourse
  - Flow Direction
  - Piped Drainage
  - Culvert
  - Pond
  - Site Boundary

- DRAWING REFERENCES:
1. OS Data. © crown copyright and database rights 2016. Ordnance Survey. License Number AL100001776.
  2. Topography based on survey produced by Brunel Surveys Ltd, October 2017 (reference not provided).
- DRAWING NOTES:
1. Watercourses observed during 2nd Site Visit carried out by JNP Group on 09<sup>th</sup> and 15<sup>th</sup> November 2017 respectively.
  2. Hogwood Ditch and Robinson Crook Ditch are names given by JNP Group for ease of reference.
  3. Existing ditches that perform only on-site land drainage function can potentially be removed as they are not needed for post development site hydrology. However, these ditches may need to be retained for ecological and arboreal purposes.
  4. Consent for removal, diversion or culverting of any watercourse will be needed from Wokingham Borough Council in their role as Lead Local Flood Authority.

| Rev.               | Date  | Amendment                               | By | Chk. |
|--------------------|-------|-----------------------------------------|----|------|
| A                  | 04.18 | Updates to ponds and watercourse layout | JC |      |
| Status Preliminary |       |                                         |    |      |



|             |                             |
|-------------|-----------------------------|
| Client      | Legal and General Homes     |
| Job         | Land at Hogwood Farm        |
| Title       | Existing Ditch Network Plan |
| Scale       | 1:2500                      |
| Drawn By    | POF                         |
| Eng. Check  | MAH                         |
| Tech. Check | MAH                         |
| Date        | 16/11/2017                  |
| Drawing No. | C85672-SK-011               |
| Rev.        | A                           |

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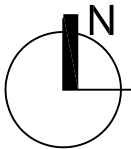
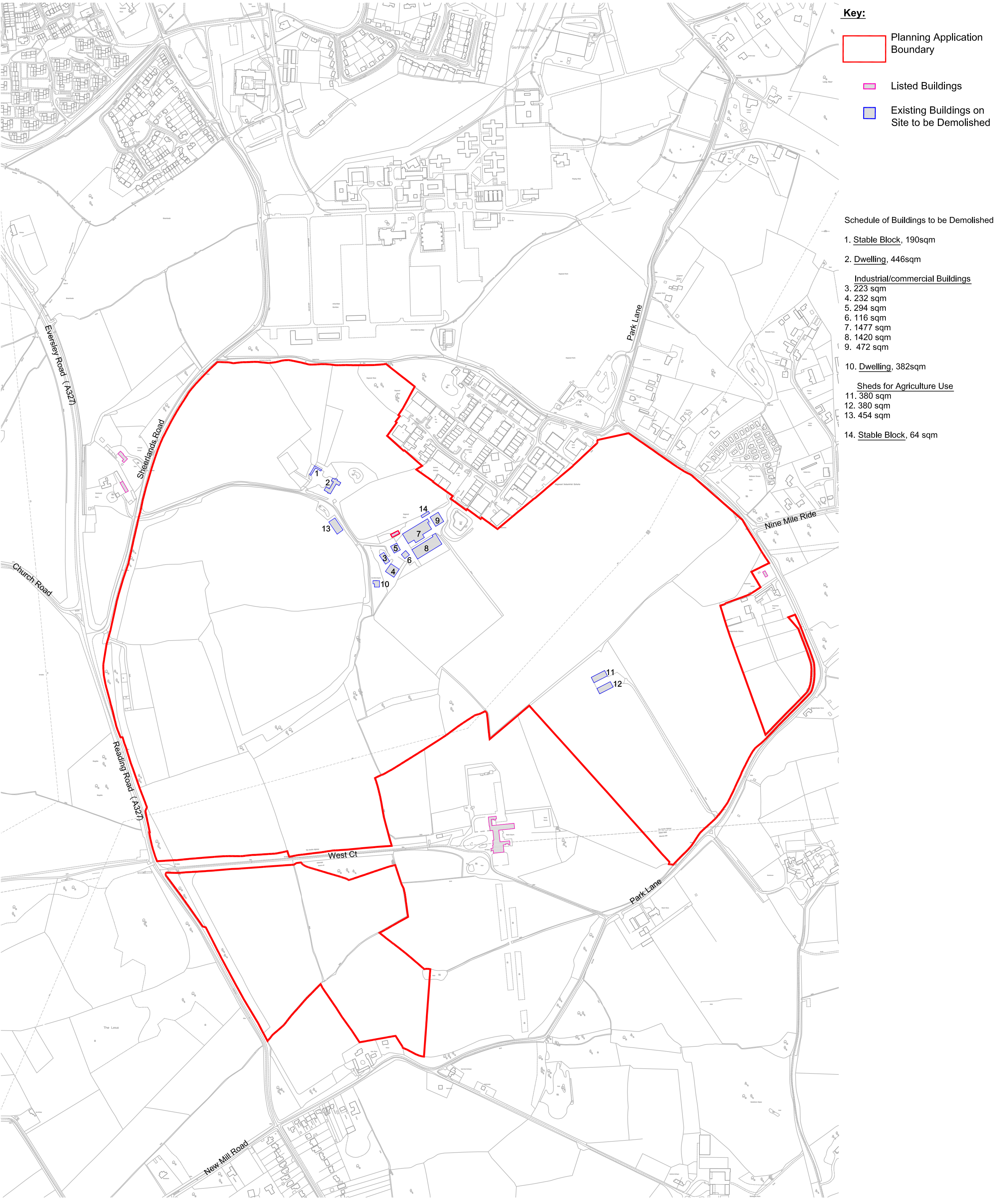
## Appendix B-Site Plan



# Hogwood Garden Village

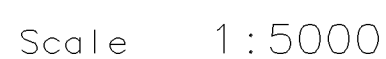
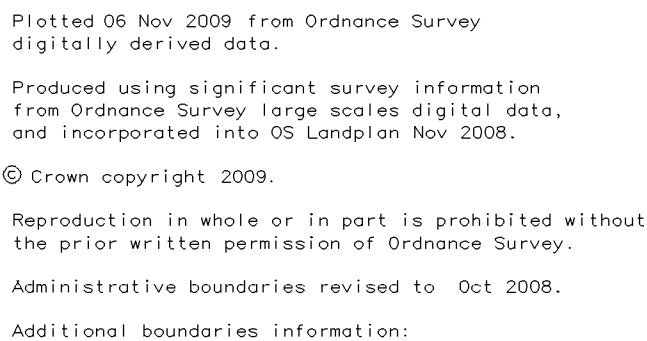
## Part of the Arborfield Garrison Strategic Development Location, Wokingham

### Existing Buildings on Site to be Demolished



## Appendix C-Trial Pit Location Map





Plot centre coordinates: 477000 164000  
Supplied by: Thames Print Room  
Plot serial number: 00145800

## Appendix D-Local Gauging Station Data



|                                                        | Site Specific | Local Ga     |                 |             |          |         |         |
|--------------------------------------------------------|---------------|--------------|-----------------|-------------|----------|---------|---------|
| Catchment Descriptors                                  | Site          | Swallowfield | Bramshill House | Sheepbridge | Binfield | Reading | Twyford |
| Distance From Site (km)                                | -             | 3            | 5               | 6           | 11       | 12      | 13      |
| AREA                                                   | 3.36          | 354.8        | 84              | 164.5       | 50.2     | 4633.7  | 751.8   |
| BFIHOST                                                | 0.439         | 0.63         | 0.589           | 0.594       | 0.355    | 0.643   | 0.585   |
| DPLBAR                                                 | 1.49          | 19.59        | 11.58           | 19.72       | 7.52     | -       | -       |
| DPSBAR                                                 | 14.2          | 32.1         | 32              | 32.8        | 24.7     | 37.9    | 29.4    |
| FARL                                                   | 0.987         | 0.886        | 0.947           | 0.947       | 0.939    | 0.961   | 0.902   |
| LDP                                                    | 3.09          | 35.88        | 20.61           | 31.6        | 13.74    | -       | -       |
| PROPWET                                                | 0.29          | 0.32         | 0.35            | 0.33        | 0.29     | 0.31    | 0.31    |
| SAAR                                                   | 659           | 708          | 707             | 735         | 676      | 680     | 703     |
| SPRHOST                                                | 35.48         | 26.79        | 30              | 26.4        | 41.54    | -       | -       |
| URBEXT2000                                             | 0             | 0.0664       | 0.0366          | 0.0453      | 0.1173   | -       | -       |
| Overall Similarity % (of gauging stations to the site) | -             | 40           | 70              | 40          | 60       | 33      | 33      |

| Key |                     |
|-----|---------------------|
|     | Not similar to site |
|     | Similar to site     |
|     | Not Applicable      |

| Lodging Station |             |        |        |          |            |        | Similarity of each catchment descriptor |
|-----------------|-------------|--------|--------|----------|------------|--------|-----------------------------------------|
| Lodge Farm      | Farmborough | Theale | Sulham | Brimpton | Pangbourne | Famham |                                         |
| 16              | 17          | 19     | 21     | 22       | 22         | 23     | -                                       |
| 44.6            | 35.5        | 1033.4 | 42.7   | 147.6    | 170.9      | 191.1  | -                                       |
| 0.906           | 0.646       | 0.766  | 0.408  | 0.5      | 0.72       | 0.865  | 100%                                    |
| 7.36            | -           | 46.99  | -      | 28.02    | 20.73      | -      | 0%                                      |
| 47.4            | 33.7        | 54.9   | 46     | 53.6     | 52.7       | 55.3   | 0%                                      |
| 0.999           | 0.849       | 0.965  | 1      | 0.978    | 0.996      | 0.984  | 100%                                    |
| 12.52           | -           | 90.53  | -      | 28.02    | 41.14      | -      | 0%                                      |
| 0.35            | 0.35        | 0.31   | 0.29   | 0.32     | 0.31       | 0.35   | 100%                                    |
| 779             | 717         | 758    | 657    | 789      | 694        | 868    | 80%                                     |
| 8.43            | -           | 18.72  | -      | 32.78    | 22.04      | -      | 67%                                     |
| 0.0115          | -           | 0.0138 | -      | 0.0094   | 0.0046     | -      | 67%                                     |
| 40              | 48          | 20     | 64     | 20       | 20         | 16     |                                         |

---

## Appendix E-ReFH 2 Results Reports



# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:19:38 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 1 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 19.89 | Total runoff (ML):             | 9.01  |
| Total Rainfall (mm):      | 12.99 | Total flow (ML):               | 21.21 |
| Peak Rainfall (mm):       | 3.53  | Peak flow (m <sup>3</sup> /s): | 0.56  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m³/s) | Baseflow<br>(m³/s) | Total Flow<br>(m³/s) |
|-----------------|--------------|--------------------|------------------|------------------|--------------------|----------------------|
| 00:00           | 0.371        | 0.000              | 0.072            | 0.000            | 0.075              | 0.075                |
| 00:30           | 0.697        | 0.000              | 0.136            | 0.002            | 0.075              | 0.076                |
| 01:00           | 1.296        | 0.000              | 0.255            | 0.008            | 0.074              | 0.082                |
| 01:30           | 2.367        | 0.000              | 0.475            | 0.024            | 0.073              | 0.097                |
| 02:00           | 3.534        | 0.000              | 0.729            | 0.057            | 0.073              | 0.129                |
| 02:30           | 2.367        | 0.000              | 0.502            | 0.115            | 0.073              | 0.188                |
| 03:00           | 1.296        | 0.000              | 0.279            | 0.197            | 0.074              | 0.271                |
| 03:30           | 0.697        | 0.000              | 0.151            | 0.286            | 0.077              | 0.363                |
| 04:00           | 0.371        | 0.000              | 0.081            | 0.365            | 0.080              | 0.446                |
| 04:30           | 0.000        | 0.000              | 0.000            | 0.426            | 0.086              | 0.512                |
| 05:00           | 0.000        | 0.000              | 0.000            | 0.460            | 0.092              | 0.552                |
| 05:30           | 0.000        | 0.000              | 0.000            | 0.460            | 0.098              | 0.558                |
| 06:00           | 0.000        | 0.000              | 0.000            | 0.430            | 0.105              | 0.535                |
| 06:30           | 0.000        | 0.000              | 0.000            | 0.385            | 0.111              | 0.496                |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.334            | 0.116              | 0.449                |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.282            | 0.120              | 0.402                |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.237            | 0.123              | 0.360                |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.201            | 0.126              | 0.327                |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.171            | 0.128              | 0.299                |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.145            | 0.129              | 0.275                |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.121            | 0.130              | 0.251                |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.098            | 0.131              | 0.229                |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.076            | 0.131              | 0.206                |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.054            | 0.130              | 0.184                |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.035            | 0.129              | 0.164                |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.019            | 0.128              | 0.147                |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.009            | 0.127              | 0.136                |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.004            | 0.125              | 0.129                |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.001            | 0.124              | 0.125                |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.000            | 0.122              | 0.123                |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000            | 0.121              | 0.121                |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000            | 0.119              | 0.119                |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000            | 0.118              | 0.118                |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000            | 0.116              | 0.116                |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000            | 0.115              | 0.115                |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:21:50 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 2 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 22.82 | Total runoff (ML):             | 10.42 |
| Total Rainfall (mm):      | 14.91 | Total flow (ML):               | 24.58 |
| Peak Rainfall (mm):       | 4.05  | Peak flow (m <sup>3</sup> /s): | 0.64  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 0.426        | 0.000              | 0.083            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 0.799        | 0.000              | 0.156            | 0.002                         | 0.075                           | 0.076                             |
| 01:00           | 1.486        | 0.000              | 0.294            | 0.010                         | 0.074                           | 0.083                             |
| 01:30           | 2.715        | 0.000              | 0.547            | 0.028                         | 0.073                           | 0.101                             |
| 02:00           | 4.055        | 0.000              | 0.844            | 0.065                         | 0.073                           | 0.138                             |
| 02:30           | 2.715        | 0.000              | 0.583            | 0.132                         | 0.073                           | 0.205                             |
| 03:00           | 1.486        | 0.000              | 0.325            | 0.227                         | 0.075                           | 0.302                             |
| 03:30           | 0.799        | 0.000              | 0.177            | 0.330                         | 0.078                           | 0.408                             |
| 04:00           | 0.426        | 0.000              | 0.095            | 0.422                         | 0.082                           | 0.504                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 0.492                         | 0.088                           | 0.581                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 0.533                         | 0.096                           | 0.629                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 0.532                         | 0.104                           | 0.636                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 0.498                         | 0.111                           | 0.609                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 0.446                         | 0.118                           | 0.564                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.387                         | 0.124                           | 0.511                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.327                         | 0.129                           | 0.456                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.275                         | 0.133                           | 0.408                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.233                         | 0.136                           | 0.369                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.199                         | 0.138                           | 0.337                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.169                         | 0.140                           | 0.309                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.141                         | 0.141                           | 0.282                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.114                         | 0.142                           | 0.256                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.088                         | 0.142                           | 0.230                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.063                         | 0.142                           | 0.205                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.040                         | 0.141                           | 0.181                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.022                         | 0.140                           | 0.162                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.011                         | 0.138                           | 0.149                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.004                         | 0.137                           | 0.141                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.001                         | 0.135                           | 0.136                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.133                           | 0.134                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.128                           | 0.128                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.121                           | 0.121                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.118                           | 0.118                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.110                           | 0.110                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.102                           | 0.102                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.091                           | 0.091                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:22:07 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 5 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 31.56 | Total runoff (ML):             | 14.79 |
| Total Rainfall (mm):      | 20.62 | Total flow (ML):               | 34.91 |
| Peak Rainfall (mm):       | 5.61  | Peak flow (m <sup>3</sup> /s): | 0.88  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 0.589        | 0.000              | 0.114            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 1.105        | 0.000              | 0.217            | 0.003                         | 0.075                           | 0.077                             |
| 01:00           | 2.055        | 0.000              | 0.409            | 0.013                         | 0.074                           | 0.087                             |
| 01:30           | 3.755        | 0.000              | 0.768            | 0.039                         | 0.073                           | 0.112                             |
| 02:00           | 5.607        | 0.000              | 1.197            | 0.090                         | 0.073                           | 0.164                             |
| 02:30           | 3.755        | 0.000              | 0.836            | 0.184                         | 0.074                           | 0.258                             |
| 03:00           | 2.055        | 0.000              | 0.469            | 0.318                         | 0.077                           | 0.395                             |
| 03:30           | 1.105        | 0.000              | 0.256            | 0.464                         | 0.081                           | 0.545                             |
| 04:00           | 0.589        | 0.000              | 0.137            | 0.595                         | 0.088                           | 0.683                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 0.696                         | 0.097                           | 0.793                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 0.755                         | 0.108                           | 0.863                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 0.756                         | 0.119                           | 0.875                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 0.709                         | 0.130                           | 0.839                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 0.636                         | 0.141                           | 0.776                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.551                         | 0.150                           | 0.701                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.467                         | 0.157                           | 0.624                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.392                         | 0.163                           | 0.555                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.333                         | 0.168                           | 0.500                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.284                         | 0.171                           | 0.455                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.241                         | 0.174                           | 0.415                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.201                         | 0.176                           | 0.377                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.163                         | 0.177                           | 0.340                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.126                         | 0.178                           | 0.304                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.090                         | 0.178                           | 0.268                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.058                         | 0.177                           | 0.235                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.032                         | 0.176                           | 0.208                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.015                         | 0.174                           | 0.189                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.006                         | 0.172                           | 0.178                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.002                         | 0.170                           | 0.172                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.168                           | 0.168                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.166                           | 0.166                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.163                           | 0.163                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.161                           | 0.161                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.159                           | 0.159                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.157                           | 0.157                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.155                           | 0.155                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.153                           | 0.153                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.152                           | 0.152                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.150                           | 0.150                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.148                           | 0.148                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.146                           | 0.146                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.144                           | 0.144                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.142                           | 0.142                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.140                           | 0.140                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.139                           | 0.139                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.137                           | 0.137                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.135                           | 0.135                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.134                           | 0.134                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.129                           | 0.129                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.121                           | 0.121                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.118                           | 0.118                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:22:29 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 10 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 37.43 | Total runoff (ML):             | 17.85 |
| Total Rainfall (mm):      | 24.45 | Total flow (ML):               | 42.22 |
| Peak Rainfall (mm):       | 6.65  | Peak flow (m <sup>3</sup> /s): | 1.04  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 0.699        | 0.000              | 0.136            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 1.311        | 0.000              | 0.257            | 0.003                         | 0.075                           | 0.078                             |
| 01:00           | 2.438        | 0.000              | 0.488            | 0.016                         | 0.074                           | 0.090                             |
| 01:30           | 4.454        | 0.000              | 0.920            | 0.046                         | 0.073                           | 0.119                             |
| 02:00           | 6.651        | 0.000              | 1.445            | 0.108                         | 0.073                           | 0.181                             |
| 02:30           | 4.454        | 0.000              | 1.015            | 0.220                         | 0.075                           | 0.295                             |
| 03:00           | 2.438        | 0.000              | 0.572            | 0.381                         | 0.078                           | 0.459                             |
| 03:30           | 1.311        | 0.000              | 0.312            | 0.556                         | 0.084                           | 0.640                             |
| 04:00           | 0.699        | 0.000              | 0.168            | 0.714                         | 0.092                           | 0.806                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 0.838                         | 0.103                           | 0.941                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 0.910                         | 0.116                           | 1.026                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 0.913                         | 0.130                           | 1.043                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 0.857                         | 0.144                           | 1.001                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 0.769                         | 0.156                           | 0.925                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.667                         | 0.167                           | 0.835                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.565                         | 0.177                           | 0.741                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.475                         | 0.184                           | 0.659                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.403                         | 0.190                           | 0.593                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.343                         | 0.194                           | 0.538                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.291                         | 0.198                           | 0.489                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.243                         | 0.201                           | 0.444                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.197                         | 0.202                           | 0.400                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.153                         | 0.203                           | 0.356                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.110                         | 0.203                           | 0.313                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.071                         | 0.202                           | 0.273                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.039                         | 0.201                           | 0.240                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.019                         | 0.199                           | 0.217                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.008                         | 0.196                           | 0.204                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.002                         | 0.194                           | 0.196                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.192                           | 0.192                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.189                           | 0.189                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.187                           | 0.187                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.184                           | 0.184                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.182                           | 0.182                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.180                           | 0.180                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.178                           | 0.178                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.175                           | 0.175                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.173                           | 0.173                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.171                           | 0.171                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.169                           | 0.169                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.167                           | 0.167                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.165                           | 0.165                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.163                           | 0.163                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.161                           | 0.161                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.159                           | 0.159                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.157                           | 0.157                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.155                           | 0.155                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.153                           | 0.153                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.151                           | 0.151                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.149                           | 0.149                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.147                           | 0.147                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.145                           | 0.145                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.143                           | 0.143                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.142                           | 0.142                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.140                           | 0.140                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.138                           | 0.138                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.136                           | 0.136                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.135                           | 0.135                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.133                           | 0.133                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.131                           | 0.131                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.128                           | 0.128                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.126                           | 0.126                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.123                           | 0.123                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.120                           | 0.120                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.117                           | 0.117                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.114                           | 0.114                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.110                           | 0.110                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.107                           | 0.107                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.102                           | 0.102                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.091                           | 0.091                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.076                           | 0.076                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:22:54 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 20 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 43.54 | Total runoff (ML):             | 21.13 |
| Total Rainfall (mm):      | 28.44 | Total flow (ML):               | 50.00 |
| Peak Rainfall (mm):       | 7.74  | Peak flow (m <sup>3</sup> /s): | 1.22  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 0.813        | 0.000              | 0.158            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 1.525        | 0.000              | 0.300            | 0.004                         | 0.075                           | 0.078                             |
| 01:00           | 2.836        | 0.000              | 0.570            | 0.018                         | 0.074                           | 0.092                             |
| 01:30           | 5.180        | 0.000              | 1.081            | 0.054                         | 0.073                           | 0.127                             |
| 02:00           | 7.736        | 0.000              | 1.710            | 0.126                         | 0.074                           | 0.199                             |
| 02:30           | 5.180        | 0.000              | 1.210            | 0.258                         | 0.075                           | 0.333                             |
| 03:00           | 2.836        | 0.000              | 0.684            | 0.447                         | 0.079                           | 0.526                             |
| 03:30           | 1.525        | 0.000              | 0.374            | 0.655                         | 0.086                           | 0.741                             |
| 04:00           | 0.813        | 0.000              | 0.201            | 0.842                         | 0.096                           | 0.938                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 0.989                         | 0.109                           | 1.098                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 1.076                         | 0.125                           | 1.201                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 1.081                         | 0.142                           | 1.222                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 1.016                         | 0.158                           | 1.174                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 0.912                         | 0.173                           | 1.085                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.792                         | 0.186                           | 0.979                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.671                         | 0.197                           | 0.868                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.564                         | 0.206                           | 0.771                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.478                         | 0.214                           | 0.692                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.408                         | 0.219                           | 0.627                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.346                         | 0.224                           | 0.570                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.289                         | 0.227                           | 0.516                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.235                         | 0.229                           | 0.464                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.182                         | 0.230                           | 0.412                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.131                         | 0.230                           | 0.361                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.085                         | 0.229                           | 0.314                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.047                         | 0.228                           | 0.274                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.022                         | 0.225                           | 0.248                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.009                         | 0.223                           | 0.232                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.003                         | 0.220                           | 0.223                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.217                           | 0.218                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.215                           | 0.215                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.212                           | 0.212                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.209                           | 0.209                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.207                           | 0.207                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.204                           | 0.204                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.202                           | 0.202                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.199                           | 0.199                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.197                           | 0.197                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.194                           | 0.194                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.192                           | 0.192                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.189                           | 0.189                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.187                           | 0.187                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.185                           | 0.185                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.182                           | 0.182                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.180                           | 0.180                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.178                           | 0.178                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.175                           | 0.175                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.173                           | 0.173                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.171                           | 0.171                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.169                           | 0.169                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.167                           | 0.167                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.165                           | 0.165                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.163                           | 0.163                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.161                           | 0.161                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.159                           | 0.159                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.157                           | 0.157                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.155                           | 0.155                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.153                           | 0.153                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.151                           | 0.151                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.149                           | 0.149                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.147                           | 0.147                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.145                           | 0.145                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.143                           | 0.143                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.142                           | 0.142                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.140                           | 0.140                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.138                           | 0.138                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.136                           | 0.136                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.135                           | 0.135                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.133                           | 0.133                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.131                           | 0.131                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.128                           | 0.128                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.126                           | 0.126                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.123                           | 0.123                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.120                           | 0.120                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.117                           | 0.117                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.114                           | 0.114                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.110                           | 0.110                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.107                           | 0.107                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.102                           | 0.102                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.091                           | 0.091                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 51:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 52:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 52:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 53:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 53:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 54:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 54:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 55:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 55:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |
| 56:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.076                           | 0.076                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:23:20 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 30 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 47.20 | Total runoff (ML):             | 23.14 |
| Total Rainfall (mm):      | 30.83 | Total flow (ML):               | 54.83 |
| Peak Rainfall (mm):       | 8.39  | Peak flow (m <sup>3</sup> /s): | 1.33  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 0.881        | 0.000              | 0.171            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 1.653        | 0.000              | 0.326            | 0.004                         | 0.075                           | 0.079                             |
| 01:00           | 3.074        | 0.000              | 0.620            | 0.020                         | 0.074                           | 0.094                             |
| 01:30           | 5.616        | 0.000              | 1.179            | 0.058                         | 0.073                           | 0.132                             |
| 02:00           | 8.386        | 0.000              | 1.873            | 0.137                         | 0.074                           | 0.210                             |
| 02:30           | 5.616        | 0.000              | 1.330            | 0.280                         | 0.076                           | 0.356                             |
| 03:00           | 3.074        | 0.000              | 0.754            | 0.487                         | 0.080                           | 0.567                             |
| 03:30           | 1.653        | 0.000              | 0.413            | 0.714                         | 0.088                           | 0.802                             |
| 04:00           | 0.881        | 0.000              | 0.222            | 0.920                         | 0.099                           | 1.019                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 1.081                         | 0.113                           | 1.195                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 1.178                         | 0.130                           | 1.308                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 1.184                         | 0.149                           | 1.333                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 1.114                         | 0.167                           | 1.280                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 1.001                         | 0.183                           | 1.184                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.869                         | 0.198                           | 1.067                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.736                         | 0.210                           | 0.947                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.619                         | 0.220                           | 0.839                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.525                         | 0.228                           | 0.753                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.447                         | 0.234                           | 0.682                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.380                         | 0.239                           | 0.619                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.318                         | 0.243                           | 0.560                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.258                         | 0.245                           | 0.503                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.200                         | 0.246                           | 0.446                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.144                         | 0.247                           | 0.391                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.093                         | 0.246                           | 0.339                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.052                         | 0.244                           | 0.296                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.025                         | 0.242                           | 0.266                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.010                         | 0.239                           | 0.249                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.003                         | 0.236                           | 0.239                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.233                           | 0.234                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.230                           | 0.230                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.227                           | 0.227                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.225                           | 0.225                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.222                           | 0.222                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.219                           | 0.219                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.216                           | 0.216                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.214                           | 0.214                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.211                           | 0.211                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.208                           | 0.208                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.206                           | 0.206                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.203                           | 0.203                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.200                           | 0.200                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.198                           | 0.198                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.196                           | 0.196                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.193                           | 0.193                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.191                           | 0.191                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.188                           | 0.188                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.186                           | 0.186                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.184                           | 0.184                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.181                           | 0.181                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.179                           | 0.179                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.177                           | 0.177                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.175                           | 0.175                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.172                           | 0.172                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.170                           | 0.170                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.168                           | 0.168                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.166                           | 0.166                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.164                           | 0.164                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.162                           | 0.162                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.160                           | 0.160                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.158                           | 0.158                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.156                           | 0.156                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.154                           | 0.154                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.152                           | 0.152                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.150                           | 0.150                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.148                           | 0.148                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.146                           | 0.146                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.144                           | 0.144                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.143                           | 0.143                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.141                           | 0.141                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.139                           | 0.139                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.137                           | 0.137                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.136                           | 0.136                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.134                           | 0.134                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.131                           | 0.131                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.129                           | 0.129                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.126                           | 0.126                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.123                           | 0.123                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.121                           | 0.121                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.120                           | 0.120                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.118                           | 0.118                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.117                           | 0.117                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.114                           | 0.114                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.107                           | 0.107                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 51:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 52:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.091                           | 0.091                             |
| 52:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 53:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 53:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 54:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 54:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 55:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 55:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 56:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 56:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 57:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 57:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 58:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 58:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |
| 59:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.076                           | 0.076                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:23:45 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 50 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 52.06 | Total runoff (ML):             | 25.88 |
| Total Rainfall (mm):      | 34.01 | Total flow (ML):               | 61.33 |
| Peak Rainfall (mm):       | 9.25  | Peak flow (m <sup>3</sup> /s): | 1.48  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 0.972        | 0.000              | 0.189            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 1.824        | 0.000              | 0.360            | 0.005                         | 0.075                           | 0.079                             |
| 01:00           | 3.391        | 0.000              | 0.686            | 0.022                         | 0.074                           | 0.096                             |
| 01:30           | 6.194        | 0.000              | 1.311            | 0.064                         | 0.073                           | 0.138                             |
| 02:00           | 9.250        | 0.000              | 2.095            | 0.151                         | 0.074                           | 0.225                             |
| 02:30           | 6.194        | 0.000              | 1.495            | 0.311                         | 0.076                           | 0.387                             |
| 03:00           | 3.391        | 0.000              | 0.849            | 0.541                         | 0.081                           | 0.622                             |
| 03:30           | 1.824        | 0.000              | 0.466            | 0.795                         | 0.090                           | 0.885                             |
| 04:00           | 0.972        | 0.000              | 0.251            | 1.025                         | 0.102                           | 1.127                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 1.207                         | 0.119                           | 1.325                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 1.316                         | 0.138                           | 1.454                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 1.324                         | 0.158                           | 1.483                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 1.247                         | 0.179                           | 1.425                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 1.121                         | 0.197                           | 1.318                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 0.974                         | 0.214                           | 1.188                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.825                         | 0.228                           | 1.053                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.694                         | 0.239                           | 0.933                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.588                         | 0.248                           | 0.836                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.502                         | 0.255                           | 0.757                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.426                         | 0.261                           | 0.687                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.356                         | 0.265                           | 0.621                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.289                         | 0.268                           | 0.557                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.224                         | 0.269                           | 0.493                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.162                         | 0.269                           | 0.431                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.105                         | 0.268                           | 0.373                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.058                         | 0.267                           | 0.325                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.028                         | 0.264                           | 0.292                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.011                         | 0.261                           | 0.273                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.004                         | 0.258                           | 0.262                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.001                         | 0.255                           | 0.255                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.252                           | 0.252                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.248                           | 0.248                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.245                           | 0.245                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.242                           | 0.242                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.239                           | 0.239                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.236                           | 0.236                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.233                           | 0.233                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.230                           | 0.230                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.227                           | 0.227                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.225                           | 0.225                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.222                           | 0.222                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.219                           | 0.219                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.216                           | 0.216                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.214                           | 0.214                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.211                           | 0.211                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.208                           | 0.208                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.206                           | 0.206                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.203                           | 0.203                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.201                           | 0.201                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.198                           | 0.198                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.196                           | 0.196                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.193                           | 0.193                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.191                           | 0.191                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.188                           | 0.188                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.186                           | 0.186                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.184                           | 0.184                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.181                           | 0.181                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.179                           | 0.179                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.177                           | 0.177                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.175                           | 0.175                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.172                           | 0.172                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.170                           | 0.170                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.168                           | 0.168                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.166                           | 0.166                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.164                           | 0.164                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.162                           | 0.162                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.160                           | 0.160                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.158                           | 0.158                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.156                           | 0.156                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.154                           | 0.154                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.152                           | 0.152                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.150                           | 0.150                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.148                           | 0.148                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.146                           | 0.146                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.144                           | 0.144                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.143                           | 0.143                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.141                           | 0.141                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.139                           | 0.139                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.137                           | 0.137                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.136                           | 0.136                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.134                           | 0.134                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.131                           | 0.131                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.129                           | 0.129                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.126                           | 0.126                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.123                           | 0.123                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.121                           | 0.121                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.120                           | 0.120                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.118                           | 0.118                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.117                           | 0.117                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.114                           | 0.114                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.107                           | 0.107                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.102                           | 0.102                             |
| 51:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 52:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 52:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 53:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 53:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 54:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 54:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 55:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 55:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.091                           | 0.091                             |
| 56:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 56:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 57:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 57:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 58:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 58:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 59:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 59:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 60:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 60:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 61:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 61:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 62:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |
| 62:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.076                           | 0.076                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:24:14 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 100 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 59.23 | Total runoff (ML):             | 30.02 |
| Total Rainfall (mm):      | 38.69 | Total flow (ML):               | 71.11 |
| Peak Rainfall (mm):       | 10.52 | Peak flow (m <sup>3</sup> /s): | 1.71  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 1.106        | 0.000              | 0.215            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 2.075        | 0.000              | 0.411            | 0.005                         | 0.075                           | 0.080                             |
| 01:00           | 3.858        | 0.000              | 0.785            | 0.025                         | 0.074                           | 0.099                             |
| 01:30           | 7.047        | 0.000              | 1.508            | 0.073                         | 0.074                           | 0.147                             |
| 02:00           | 10.523       | 0.000              | 2.430            | 0.173                         | 0.074                           | 0.247                             |
| 02:30           | 7.047        | 0.000              | 1.746            | 0.356                         | 0.077                           | 0.433                             |
| 03:00           | 3.858        | 0.000              | 0.996            | 0.622                         | 0.083                           | 0.705                             |
| 03:30           | 2.075        | 0.000              | 0.548            | 0.916                         | 0.093                           | 1.009                             |
| 04:00           | 1.106        | 0.000              | 0.295            | 1.184                         | 0.107                           | 1.291                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 1.396                         | 0.126                           | 1.523                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 1.526                         | 0.149                           | 1.674                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 1.537                         | 0.173                           | 1.710                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 1.449                         | 0.197                           | 1.645                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 1.304                         | 0.219                           | 1.522                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 1.134                         | 0.238                           | 1.372                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 0.961                         | 0.254                           | 1.215                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.808                         | 0.267                           | 1.076                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.685                         | 0.278                           | 0.963                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.584                         | 0.286                           | 0.871                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.496                         | 0.293                           | 0.789                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.415                         | 0.298                           | 0.713                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.337                         | 0.301                           | 0.639                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.262                         | 0.303                           | 0.565                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.189                         | 0.304                           | 0.493                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.123                         | 0.303                           | 0.426                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.068                         | 0.301                           | 0.369                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.033                         | 0.298                           | 0.331                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.013                         | 0.295                           | 0.308                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.004                         | 0.291                           | 0.295                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.001                         | 0.288                           | 0.288                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.284                           | 0.284                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.280                           | 0.280                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.277                           | 0.277                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.273                           | 0.273                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.270                           | 0.270                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.267                           | 0.267                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.263                           | 0.263                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.260                           | 0.260                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.257                           | 0.257                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.253                           | 0.253                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.250                           | 0.250                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.247                           | 0.247                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.244                           | 0.244                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.241                           | 0.241                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.238                           | 0.238                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.235                           | 0.235                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.232                           | 0.232                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.229                           | 0.229                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.226                           | 0.226                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.223                           | 0.223                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.221                           | 0.221                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.218                           | 0.218                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.215                           | 0.215                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.212                           | 0.212                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.210                           | 0.210                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.207                           | 0.207                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.205                           | 0.205                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.202                           | 0.202                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.199                           | 0.199                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.197                           | 0.197                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.195                           | 0.195                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.192                           | 0.192                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.190                           | 0.190                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.187                           | 0.187                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.185                           | 0.185                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.183                           | 0.183                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.180                           | 0.180                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.178                           | 0.178                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.176                           | 0.176                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.174                           | 0.174                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.171                           | 0.171                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.169                           | 0.169                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.167                           | 0.167                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.165                           | 0.165                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.163                           | 0.163                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.161                           | 0.161                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.159                           | 0.159                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.157                           | 0.157                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.155                           | 0.155                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.153                           | 0.153                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.151                           | 0.151                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.149                           | 0.149                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.147                           | 0.147                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.146                           | 0.146                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.144                           | 0.144                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.142                           | 0.142                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.140                           | 0.140                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.138                           | 0.138                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.137                           | 0.137                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.135                           | 0.135                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.133                           | 0.133                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.128                           | 0.128                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.120                           | 0.120                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.117                           | 0.117                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 51:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 52:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 52:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.110                           | 0.110                             |
| 53:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 53:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 54:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 54:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 55:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 55:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.102                           | 0.102                             |
| 56:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 56:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 57:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 57:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 58:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 58:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 59:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 59:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 60:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.091                           | 0.091                             |
| 60:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 61:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 61:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 62:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 62:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 63:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 63:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 64:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 64:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 65:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 65:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 66:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 66:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 67:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:24:40 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 200 year

### Summary of results

|                           |       |                                |       |
|---------------------------|-------|--------------------------------|-------|
| Rainfall - FEH 2013 (mm): | 67.56 | Total runoff (ML):             | 35.02 |
| Total Rainfall (mm):      | 44.13 | Total flow (ML):               | 82.98 |
| Peak Rainfall (mm):       | 12.00 | Peak flow (m <sup>3</sup> /s): | 1.98  |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 1.261        | 0.000              | 0.246            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 2.366        | 0.000              | 0.470            | 0.006                         | 0.075                           | 0.080                             |
| 01:00           | 4.400        | 0.000              | 0.902            | 0.029                         | 0.074                           | 0.103                             |
| 01:30           | 8.038        | 0.000              | 1.743            | 0.084                         | 0.074                           | 0.158                             |
| 02:00           | 12.003       | 0.000              | 2.835            | 0.198                         | 0.075                           | 0.273                             |
| 02:30           | 8.038        | 0.000              | 2.053            | 0.410                         | 0.078                           | 0.488                             |
| 03:00           | 4.400        | 0.000              | 1.176            | 0.718                         | 0.085                           | 0.803                             |
| 03:30           | 2.366        | 0.000              | 0.648            | 1.060                         | 0.097                           | 1.157                             |
| 04:00           | 1.261        | 0.000              | 0.350            | 1.374                         | 0.114                           | 1.487                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 1.623                         | 0.136                           | 1.759                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 1.777                         | 0.162                           | 1.939                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 1.794                         | 0.190                           | 1.984                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 1.693                         | 0.218                           | 1.911                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 1.525                         | 0.244                           | 1.769                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 1.327                         | 0.267                           | 1.594                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 1.125                         | 0.286                           | 1.411                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 0.947                         | 0.302                           | 1.248                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 0.802                         | 0.314                           | 1.117                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 0.684                         | 0.324                           | 1.008                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.581                         | 0.332                           | 0.913                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.486                         | 0.338                           | 0.824                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.396                         | 0.342                           | 0.738                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.307                         | 0.344                           | 0.652                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.222                         | 0.345                           | 0.567                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.145                         | 0.344                           | 0.489                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.081                         | 0.342                           | 0.423                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.039                         | 0.339                           | 0.378                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.016                         | 0.335                           | 0.351                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.005                         | 0.331                           | 0.336                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.001                         | 0.327                           | 0.328                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.323                           | 0.323                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.319                           | 0.319                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.315                           | 0.315                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.311                           | 0.311                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.307                           | 0.307                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.303                           | 0.303                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.299                           | 0.299                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.296                           | 0.296                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.292                           | 0.292                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.288                           | 0.288                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.285                           | 0.285                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.281                           | 0.281                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.278                           | 0.278                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.274                           | 0.274                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.271                           | 0.271                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.267                           | 0.267                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.264                           | 0.264                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.261                           | 0.261                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.257                           | 0.257                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.254                           | 0.254                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.251                           | 0.251                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.248                           | 0.248                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.245                           | 0.245                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.242                           | 0.242                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.239                           | 0.239                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.236                           | 0.236                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.233                           | 0.233                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.230                           | 0.230                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.227                           | 0.227                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.224                           | 0.224                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.221                           | 0.221                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.219                           | 0.219                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.216                           | 0.216                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.213                           | 0.213                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.210                           | 0.210                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.208                           | 0.208                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.205                           | 0.205                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.203                           | 0.203                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.200                           | 0.200                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.198                           | 0.198                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.195                           | 0.195                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.193                           | 0.193                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.190                           | 0.190                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.188                           | 0.188                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.185                           | 0.185                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.183                           | 0.183                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.181                           | 0.181                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.179                           | 0.179                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.176                           | 0.176                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.174                           | 0.174                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.172                           | 0.172                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.170                           | 0.170                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.168                           | 0.168                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.166                           | 0.166                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.164                           | 0.164                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.161                           | 0.161                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.159                           | 0.159                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.157                           | 0.157                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.155                           | 0.155                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.154                           | 0.154                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.152                           | 0.152                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.150                           | 0.150                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.148                           | 0.148                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.146                           | 0.146                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.144                           | 0.144                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.142                           | 0.142                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.141                           | 0.141                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.139                           | 0.139                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.137                           | 0.137                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.135                           | 0.135                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.134                           | 0.134                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |
| 51:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.129                           | 0.129                             |
| 52:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 52:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |
| 53:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 53:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 54:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.121                           | 0.121                             |
| 54:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 55:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.118                           | 0.118                             |
| 55:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 56:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 56:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |
| 57:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 57:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 58:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 58:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 59:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.107                           | 0.107                             |
| 59:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 60:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 60:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.103                           | 0.103                             |
| 61:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 61:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 62:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 62:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.098                           | 0.098                             |
| 63:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 63:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 64:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 64:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 65:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 65:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 66:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 66:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 67:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 67:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 68:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 68:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 69:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 69:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 70:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 70:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 71:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 71:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 72:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

# UK Design Flood Estimation

Generated on Monday, December 04, 2017 12:25:02 PM by Peter.Oflaherty  
Printed from the ReFH Flood Modelling software package, version 2.1.5792.40861

## Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

### Site details

Checksum: 09F1-5CD2

Site name: Hogwood Garden Villiage

Easting: 476650

Northing: 163350

Country: England, Wales or Northern Ireland

Catchment Area (km<sup>2</sup>): 3.36

Using plotscale calculations: No

Site description:

## Model run: 1000 year

### Summary of results

|                           |       |                                |        |
|---------------------------|-------|--------------------------------|--------|
| Rainfall - FEH 2013 (mm): | 95.46 | Total runoff (ML):             | 53.15  |
| Total Rainfall (mm):      | 62.36 | Total flow (ML):               | 126.24 |
| Peak Rainfall (mm):       | 16.96 | Peak flow (m <sup>3</sup> /s): | 2.98   |

### Parameters

*\* Where the user has overridden a system-generated value, this original value is shown in square brackets after the value used.*

#### Rainfall parameters (Rainfall - FEH 2013 model)

| Name                            | Value  | User-defined? |
|---------------------------------|--------|---------------|
| Duration (hr)                   | 4.5    | No            |
| Timestep (hr)                   | 0.5    | No            |
| SCF(Seasonal correction factor) | 0.68   | No            |
| ARF(Areal reduction factor)     | 0.97   | No            |
| Seasonality                     | Winter | n/a           |

#### Loss model parameters

| Name                        | Value  | User-defined? |
|-----------------------------|--------|---------------|
| Cini (mm)                   | 94.59  | No            |
| Cmax (mm)                   | 511.57 | No            |
| Use alpha correction factor | No     | No            |
| Alpha correction factor     | n/a    | No            |

#### Routing model parameters

| Name    | Value | User-defined? |
|---------|-------|---------------|
| Tp (hr) | 2.88  | No            |
| Up      | 0.65  | No            |
| Uk      | 0.8   | No            |

#### Baseflow model parameters

| Name                    | Value | User-defined? |
|-------------------------|-------|---------------|
| BF0 (m <sup>3</sup> /s) | 0.08  | No            |
| BL (hr)                 | 39.66 | No            |
| BR                      | 1.51  | No            |

#### Urbanisation parameters

| Name                               | Value | User-defined? |
|------------------------------------|-------|---------------|
| Urban area (km <sup>2</sup> )      | 0.19  | No            |
| Urbext 2000                        | 0.04  | No            |
| Urban runoff factor                | 0.7   | No            |
| Imperviousness factor              | 0.3   | No            |
| Tp scaling factor                  | 0.5   | No            |
| Sewered area (km <sup>2</sup> )    | 0.00  | Yes           |
| Sewer capacity (m <sup>3</sup> /s) | 0.00  | Yes           |

# Time series data

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 00:00           | 1.782        | 0.000              | 0.348            | 0.000                         | 0.075                           | 0.075                             |
| 00:30           | 3.344        | 0.000              | 0.670            | 0.008                         | 0.075                           | 0.083                             |
| 01:00           | 6.217        | 0.000              | 1.303            | 0.041                         | 0.074                           | 0.115                             |
| 01:30           | 11.358       | 0.000              | 2.572            | 0.120                         | 0.074                           | 0.194                             |
| 02:00           | 16.961       | 0.000              | 4.302            | 0.285                         | 0.076                           | 0.361                             |
| 02:30           | 11.358       | 0.000              | 3.190            | 0.596                         | 0.081                           | 0.677                             |
| 03:00           | 6.217        | 0.000              | 1.851            | 1.055                         | 0.092                           | 1.147                             |
| 03:30           | 3.344        | 0.000              | 1.026            | 1.572                         | 0.110                           | 1.681                             |
| 04:00           | 1.782        | 0.000              | 0.556            | 2.051                         | 0.136                           | 2.187                             |
| 04:30           | 0.000        | 0.000              | 0.000            | 2.440                         | 0.169                           | 2.609                             |
| 05:00           | 0.000        | 0.000              | 0.000            | 2.688                         | 0.210                           | 2.898                             |
| 05:30           | 0.000        | 0.000              | 0.000            | 2.727                         | 0.253                           | 2.980                             |
| 06:00           | 0.000        | 0.000              | 0.000            | 2.584                         | 0.296                           | 2.881                             |
| 06:30           | 0.000        | 0.000              | 0.000            | 2.335                         | 0.336                           | 2.671                             |
| 07:00           | 0.000        | 0.000              | 0.000            | 2.036                         | 0.372                           | 2.408                             |
| 07:30           | 0.000        | 0.000              | 0.000            | 1.729                         | 0.401                           | 2.130                             |
| 08:00           | 0.000        | 0.000              | 0.000            | 1.455                         | 0.426                           | 1.881                             |
| 08:30           | 0.000        | 0.000              | 0.000            | 1.233                         | 0.446                           | 1.679                             |
| 09:00           | 0.000        | 0.000              | 0.000            | 1.051                         | 0.462                           | 1.513                             |
| 09:30           | 0.000        | 0.000              | 0.000            | 0.893                         | 0.474                           | 1.368                             |
| 10:00           | 0.000        | 0.000              | 0.000            | 0.749                         | 0.484                           | 1.233                             |
| 10:30           | 0.000        | 0.000              | 0.000            | 0.611                         | 0.491                           | 1.101                             |
| 11:00           | 0.000        | 0.000              | 0.000            | 0.475                         | 0.495                           | 0.970                             |
| 11:30           | 0.000        | 0.000              | 0.000            | 0.346                         | 0.496                           | 0.842                             |
| 12:00           | 0.000        | 0.000              | 0.000            | 0.226                         | 0.495                           | 0.722                             |
| 12:30           | 0.000        | 0.000              | 0.000            | 0.127                         | 0.492                           | 0.620                             |
| 13:00           | 0.000        | 0.000              | 0.000            | 0.062                         | 0.488                           | 0.550                             |
| 13:30           | 0.000        | 0.000              | 0.000            | 0.025                         | 0.483                           | 0.508                             |
| 14:00           | 0.000        | 0.000              | 0.000            | 0.008                         | 0.477                           | 0.485                             |
| 14:30           | 0.000        | 0.000              | 0.000            | 0.001                         | 0.471                           | 0.472                             |
| 15:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.465                           | 0.465                             |
| 15:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.459                           | 0.459                             |
| 16:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.454                           | 0.454                             |
| 16:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.448                           | 0.448                             |
| 17:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.442                           | 0.442                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 17:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.437                           | 0.437                             |
| 18:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.431                           | 0.431                             |
| 18:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.426                           | 0.426                             |
| 19:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.421                           | 0.421                             |
| 19:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.415                           | 0.415                             |
| 20:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.410                           | 0.410                             |
| 20:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.405                           | 0.405                             |
| 21:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.400                           | 0.400                             |
| 21:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.395                           | 0.395                             |
| 22:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.390                           | 0.390                             |
| 22:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.385                           | 0.385                             |
| 23:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.380                           | 0.380                             |
| 23:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.376                           | 0.376                             |
| 24:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.371                           | 0.371                             |
| 24:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.366                           | 0.366                             |
| 25:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.362                           | 0.362                             |
| 25:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.357                           | 0.357                             |
| 26:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.353                           | 0.353                             |
| 26:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.348                           | 0.348                             |
| 27:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.344                           | 0.344                             |
| 27:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.340                           | 0.340                             |
| 28:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.335                           | 0.335                             |
| 28:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.331                           | 0.331                             |
| 29:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.327                           | 0.327                             |
| 29:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.323                           | 0.323                             |
| 30:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.319                           | 0.319                             |
| 30:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.315                           | 0.315                             |
| 31:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.311                           | 0.311                             |
| 31:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.307                           | 0.307                             |
| 32:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.303                           | 0.303                             |
| 32:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.299                           | 0.299                             |
| 33:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.296                           | 0.296                             |
| 33:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.292                           | 0.292                             |
| 34:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.288                           | 0.288                             |
| 34:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.285                           | 0.285                             |
| 35:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.281                           | 0.281                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 35:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.277                           | 0.277                             |
| 36:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.274                           | 0.274                             |
| 36:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.271                           | 0.271                             |
| 37:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.267                           | 0.267                             |
| 37:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.264                           | 0.264                             |
| 38:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.261                           | 0.261                             |
| 38:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.257                           | 0.257                             |
| 39:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.254                           | 0.254                             |
| 39:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.251                           | 0.251                             |
| 40:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.248                           | 0.248                             |
| 40:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.245                           | 0.245                             |
| 41:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.242                           | 0.242                             |
| 41:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.239                           | 0.239                             |
| 42:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.236                           | 0.236                             |
| 42:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.233                           | 0.233                             |
| 43:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.230                           | 0.230                             |
| 43:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.227                           | 0.227                             |
| 44:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.224                           | 0.224                             |
| 44:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.221                           | 0.221                             |
| 45:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.218                           | 0.218                             |
| 45:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.216                           | 0.216                             |
| 46:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.213                           | 0.213                             |
| 46:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.210                           | 0.210                             |
| 47:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.208                           | 0.208                             |
| 47:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.205                           | 0.205                             |
| 48:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.202                           | 0.202                             |
| 48:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.200                           | 0.200                             |
| 49:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.197                           | 0.197                             |
| 49:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.195                           | 0.195                             |
| 50:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.193                           | 0.193                             |
| 50:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.190                           | 0.190                             |
| 51:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.188                           | 0.188                             |
| 51:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.185                           | 0.185                             |
| 52:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.183                           | 0.183                             |
| 52:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.181                           | 0.181                             |
| 53:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.178                           | 0.178                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 53:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.176                           | 0.176                             |
| 54:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.174                           | 0.174                             |
| 54:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.172                           | 0.172                             |
| 55:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.170                           | 0.170                             |
| 55:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.168                           | 0.168                             |
| 56:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.165                           | 0.165                             |
| 56:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.163                           | 0.163                             |
| 57:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.161                           | 0.161                             |
| 57:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.159                           | 0.159                             |
| 58:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.157                           | 0.157                             |
| 58:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.155                           | 0.155                             |
| 59:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.153                           | 0.153                             |
| 59:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.152                           | 0.152                             |
| 60:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.150                           | 0.150                             |
| 60:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.148                           | 0.148                             |
| 61:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.146                           | 0.146                             |
| 61:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.144                           | 0.144                             |
| 62:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.142                           | 0.142                             |
| 62:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.140                           | 0.140                             |
| 63:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.139                           | 0.139                             |
| 63:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.137                           | 0.137                             |
| 64:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.135                           | 0.135                             |
| 64:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.134                           | 0.134                             |
| 65:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.132                           | 0.132                             |
| 65:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.130                           | 0.130                             |
| 66:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.129                           | 0.129                             |
| 66:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.127                           | 0.127                             |
| 67:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.125                           | 0.125                             |
| 67:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.124                           | 0.124                             |
| 68:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.122                           | 0.122                             |
| 68:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.121                           | 0.121                             |
| 69:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.119                           | 0.119                             |
| 69:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.118                           | 0.118                             |
| 70:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.116                           | 0.116                             |
| 70:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.115                           | 0.115                             |
| 71:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.113                           | 0.113                             |

| Time<br>(hh:mm) | Rain<br>(mm) | Sewer Loss<br>(mm) | Net Rain<br>(mm) | Runoff<br>(m <sup>3</sup> /s) | Baseflow<br>(m <sup>3</sup> /s) | Total Flow<br>(m <sup>3</sup> /s) |
|-----------------|--------------|--------------------|------------------|-------------------------------|---------------------------------|-----------------------------------|
| 71:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.112                           | 0.112                             |
| 72:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.111                           | 0.111                             |
| 72:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.109                           | 0.109                             |
| 73:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.108                           | 0.108                             |
| 73:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.106                           | 0.106                             |
| 74:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.105                           | 0.105                             |
| 74:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.104                           | 0.104                             |
| 75:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.102                           | 0.102                             |
| 75:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.101                           | 0.101                             |
| 76:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.100                           | 0.100                             |
| 76:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.099                           | 0.099                             |
| 77:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.097                           | 0.097                             |
| 77:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.096                           | 0.096                             |
| 78:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.095                           | 0.095                             |
| 78:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.094                           | 0.094                             |
| 79:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.093                           | 0.093                             |
| 79:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.092                           | 0.092                             |
| 80:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.090                           | 0.090                             |
| 80:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.089                           | 0.089                             |
| 81:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.088                           | 0.088                             |
| 81:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.087                           | 0.087                             |
| 82:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.086                           | 0.086                             |
| 82:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.085                           | 0.085                             |
| 83:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.084                           | 0.084                             |
| 83:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.083                           | 0.083                             |
| 84:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.082                           | 0.082                             |
| 84:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.081                           | 0.081                             |
| 85:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.080                           | 0.080                             |
| 85:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.079                           | 0.079                             |
| 86:00           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.078                           | 0.078                             |
| 86:30           | 0.000        | 0.000              | 0.000            | 0.000                         | 0.077                           | 0.077                             |

## Appendix

### Catchment descriptors

| Name                              | Value | User-defined value used? |
|-----------------------------------|-------|--------------------------|
| Area (km <sup>2</sup> )           | 3.36  | No                       |
| ALTBAR                            | 60    | No                       |
| ASPBAR                            | 242   | No                       |
| ASPVAR                            | 0.35  | No                       |
| BFIHOST                           | 0.59  | No                       |
| DPLBAR (km)                       | 1.49  | No                       |
| DPSBAR (mkm <sup>-1</sup> )       | 24.7  | No                       |
| FARL                              | 0.95  | No                       |
| LDP                               | 3.09  | No                       |
| PROPWET (mm)                      | 0.35  | No                       |
| RMED1H                            | 11.7  | No                       |
| RMED1D                            | 29.2  | No                       |
| RMED2D                            | 37.6  | No                       |
| SAAR (mm)                         | 707   | No                       |
| SAAR4170 (mm)                     | 651   | No                       |
| SPRHOST                           | 30    | No                       |
| Urbext2000                        | 0.04  | No                       |
| Urbext1990                        | 0     | No                       |
| URBCONC                           | 0     | No                       |
| URBLOC                            | 0     | No                       |
| Urban Area (km <sup>2</sup> )     | 0.19  | No                       |
| DDF parameter C                   | -0.03 | No                       |
| DDF parameter D1                  | 0.26  | No                       |
| DDF parameter D2                  | 0.25  | No                       |
| DDF parameter D3                  | 0.32  | No                       |
| DDF parameter E                   | 0.3   | No                       |
| DDF parameter F                   | 2.65  | No                       |
| DDF parameter C (1km grid value)  | -0.03 | No                       |
| DDF parameter D1 (1km grid value) | 0.26  | No                       |
| DDF parameter D2 (1km grid value) | 0.25  | No                       |
| DDF parameter D3 (1km grid value) | 0.34  | No                       |
| DDF parameter E (1km grid value)  | 0.3   | No                       |
| DDF parameter F (1km grid value)  | 2.64  | No                       |

---

## Appendix F-Pooling Station Group Data



|    | Station                           | Years of data | QMED AM | L-CV  | L-SKEW | Discordancy |
|----|-----------------------------------|---------------|---------|-------|--------|-------------|
| 1  | 27073 (Brompton Beck @ Snain)     | 33            | 0.820   | 0.192 | 0.052  | 0.710       |
| 2  | 27051 (Crimple @ Burn Bridge)     | 42            | 4.539   | 0.221 | 0.149  | 0.203       |
| 3  | 20002 (West Peffer Burn @ Luff)   | 41            | 3.299   | 0.292 | 0.015  | 1.928       |
| 4  | 203046 (Rathmore Burn @ Rath)     | 32            | 10.821  | 0.133 | 0.100  | 0.937       |
| 5  | 206006 (Annalong @ Recorder)      | 48            | 15.330  | 0.189 | 0.052  | 0.946       |
| 6  | 91802 (Allt Leachdach @ Intake)   | 34            | 6.350   | 0.153 | 0.257  | 1.410       |
| 7  | 72014 (Conder @ Galgate)          | 47            | 17.703  | 0.196 | 0.049  | 0.458       |
| 8  | 54022 (Severn @ Plynlimon Flun)   | 38            | 14.988  | 0.156 | 0.171  | 1.205       |
| 9  | 41020 (Bevern Stream @ Clappe)    | 45            | 13.660  | 0.210 | 0.189  | 1.192       |
| 10 | 26803 (Water Forlornes @ Driffie) | 15            | 0.437   | 0.288 | 0.146  | 1.711       |
| 11 | 46005 (East Dart @ Bellever)      | 50            | 38.510  | 0.161 | 0.078  | 1.057       |
| 12 | 33054 (Babingley @ Castle Risin)  | 38            | 1.132   | 0.208 | 0.060  | 0.167       |
| 13 | 26003 (Foston Beck @ Foston M)    | 54            | 1.739   | 0.248 | 0.002  | 0.798       |
| 14 | 24007 (Browney @ Lanchester)      | 15            | 10.981  | 0.222 | 0.212  | 1.278       |
| 15 |                                   |               |         |       |        |             |
| 16 | Total                             | 532           |         |       |        |             |
| 17 | Weighted means                    |               |         | 0.204 | 0.105  |             |

Key

- Short Records
- Discordant
- No Pooling
- No Pooling, No QMED

Use of at-site data

URBEXT 2000: 0.0366      Suitable for pooling: No  
(Pool limit: 0.0300)      Suitable for QMED: No

There is no AMAX or POT data available for this catchment.

Urbanisation

Method: Default Parameters

UAF: 1.052

☐ Show urbanised Flood Frequency results

Edit Urbanisation Method

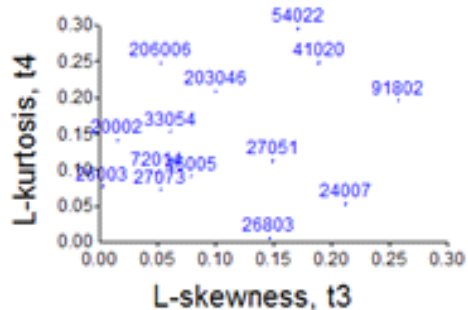
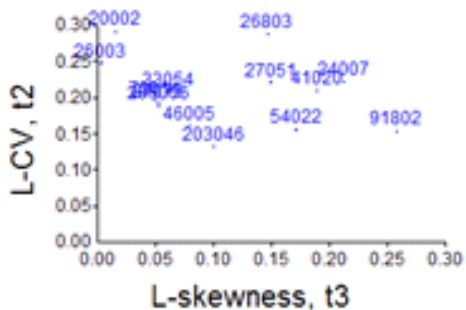
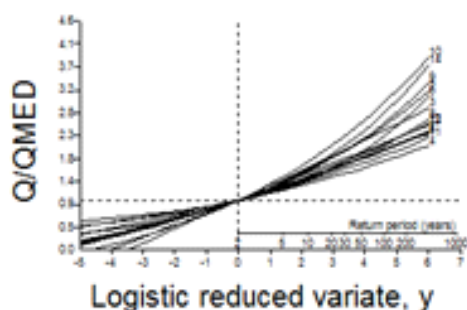
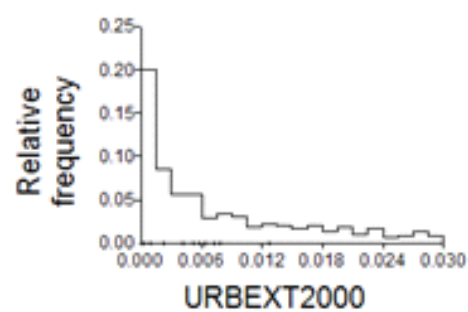
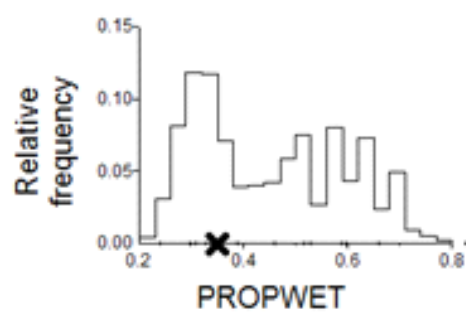
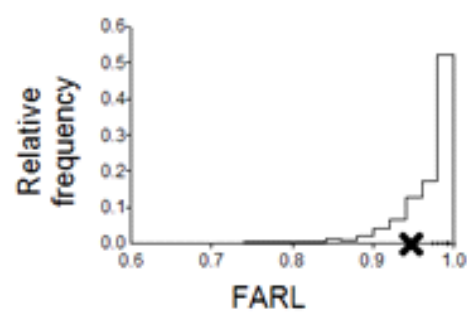
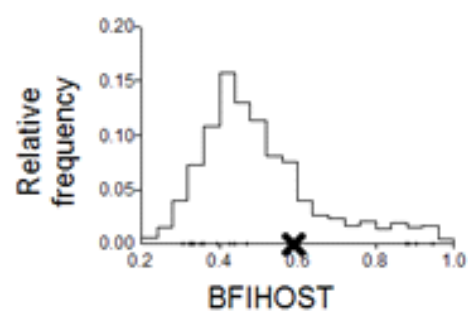
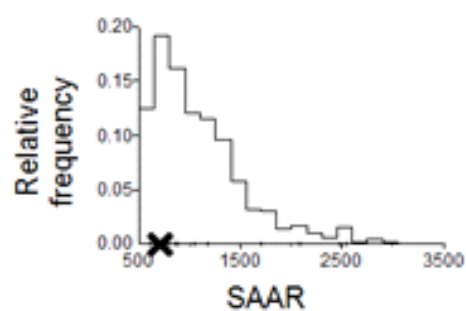
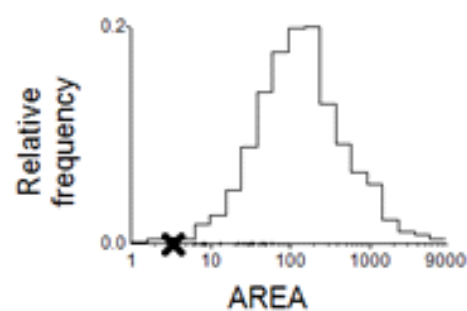
QMED

Method: Catchment Descriptors

QMED: 0.469    m<sup>3</sup>/s

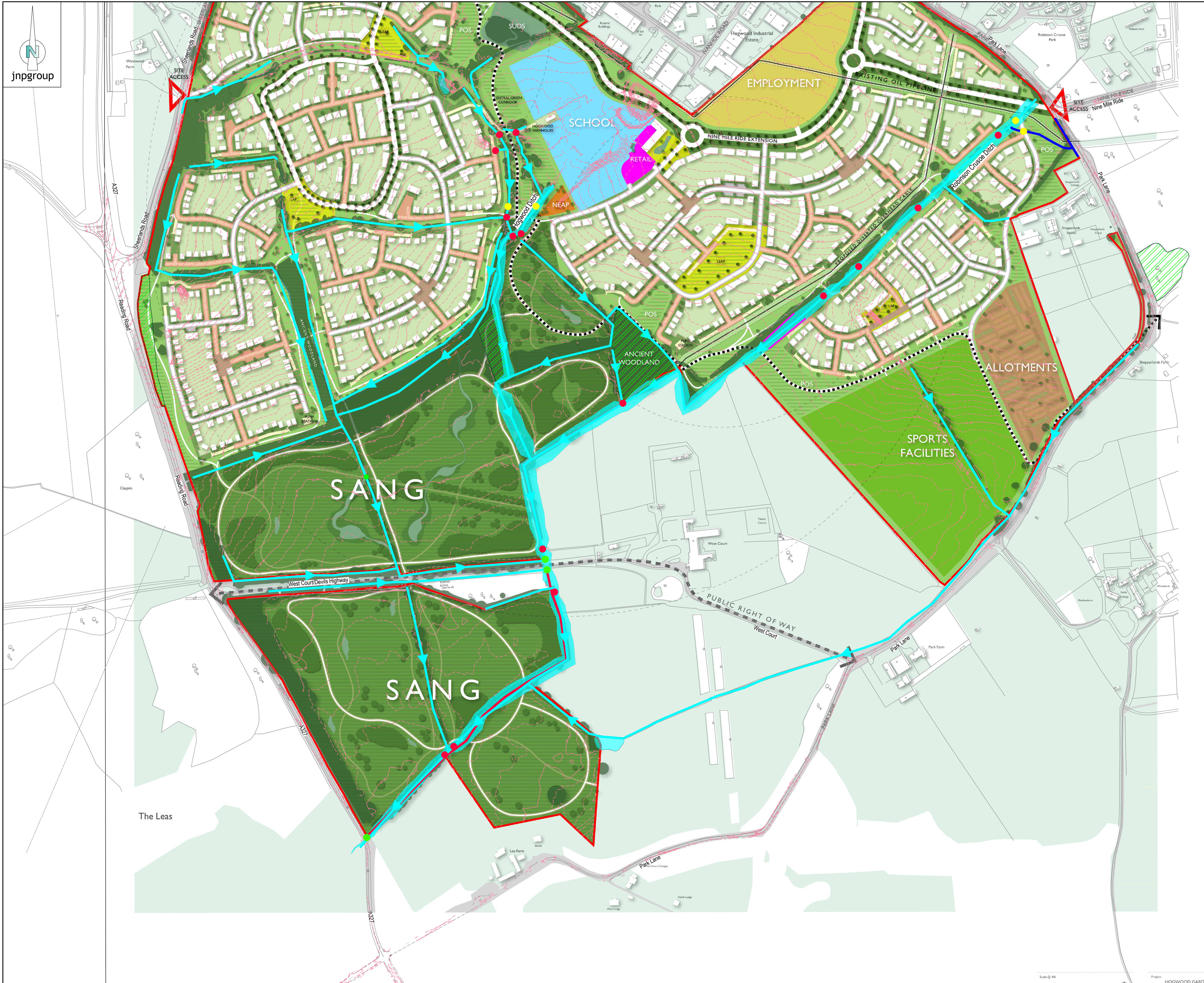
Rural

Edit QMED Method



## Appendix D: Proposed Watercourses Alteration Plan





- Notes:-
- Where this drawing has been issued in electronic .dwg format it has been done so in good faith. jnp group do not take any responsibility for any inaccuracies in the electronic data, which should be checked against the paper (or .pdf) drawing issue. Any apparent discrepancies should be immediately reported to jnp group. The electronic .dwg file should not be assumed to be to scale and should not be used for 'overlying', setting out or checking of any third party information. All dimensions should be taken from the paper (or .pdf) version of the drawing. Electronic drawings may contain third party information, jnp group take no responsibility for this information, which should be checked against the originators paper drawing(s).
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  - Do not scale.
  - Any discrepancies between drawings of different scales, and between drawings and specification where appropriate to be notified to The Engineer for decision.
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  - This drawing should only be used for construction if the drawing status is "Construction". jnp group take no responsibility for construction works undertaken to drawings which are not marked with this status.

Health and Safety Note:  
The details on this drawing have been prepared on the assumption that a competent contractor will be carrying out the works. If the contractor(s) considers that there is insufficient Health and Safety information on this drawing, this should immediately be brought to the attention of the designer.

- Key
- 1D Modelled Channel Extents
  - Proposed Ditch Network
  - Park Lane Ditch Re-Alignment
  - Removed Culverts
  - Retained Culverts
  - New Culverts
  - Areas of Bank Leveling

- General Notes
- Proposed Land Parcels Plan by Cooper Baillie Ltd. Reference: CB\_12\_103\_A100\_Rev\_E. Date: April 2018.
  - OS Data: © Crown Copyright and Database Rights. Ordnance Survey Licence Number: AL100001776.

| Rev.   | Date | Amendment | By | Chk. |
|--------|------|-----------|----|------|
| Status |      |           |    |      |

Preliminary



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Tel: 01494 771221 E-mail: [chesham@jnpgroup.co.uk](mailto:chesham@jnpgroup.co.uk)

|        |                                     |
|--------|-------------------------------------|
| Client | Legal & General Homes               |
| Job    | Hogwood Farm<br>Finchampstead       |
| Title  | Proposed Watercourse<br>Alterations |

|              |            |                 |
|--------------|------------|-----------------|
| Scale 1:2500 | @ A1       | Date April 2018 |
| Drawn by JC  | Checked by | Approved by     |



|             |      |
|-------------|------|
| Drawing No. | Rev. |
| C85672-SK   | -    |

QA Ref: Q010 Rev D

## Appendix E: Model Log



### 1. Conversion of Survey Data to Flood Modeller Pro Sections

**Date: 05/12/2017**

- A review of the updated topographic survey provided by Brunel Surveys Ltd on XX date (references). The watercourse cross sections were provided in 3 batches in .geo format by Brunel Surveyors.
- Opened HEC-RAS and went to Edit/Enter Geometric Data. Using file > import geometry data > GIS.
- Made sure SI (Metric) selected.
- Saved HEC-RAS Project and then geometry data.
- Repeated for each batch of cross sections.

### 2. Conversion of Survey Data to Flood Modeller Pro Sections

**Date: 05/12/2017**

- Created new Flood Modeller Project and Created new 1D river network.
- Right clicked General SI in the network panel > file > import > from HecRAS.
- All cross sections imported (one batch at a time) using this method.
- Network saved as Full Ditch Network.

### 3. Review of 1D River Network

**Date: 05/12/2017**

- A site boundary was added in Flood Modeller Pro as a GIS layers to check if the river sections were correctly georeferenced and to see what nodes are relevant to the modelling.
- A 1m resolution EA LiDAR DTM was also added in Flood Modeller Pro as a GIS layer.
- A new 1D network was then set up. All other river sections not relating to the main onsite watercourses were removed.
- Cross sections were deleted if they were within a short distance (<20m), of a similar cross section.

### 4. Review of River Sections and Adding in Manning's n values, panel markers, relative path lengths and bank marker.

**Date: 06/12/2017 to 12/12/2017**

- Chow's Book 'Open Channel Hydraulics' 1959 contains generic Manning's n values. These were obtained from the HEC-RAS Hydraulic Reference Manual.

| Manning's Value | Value Description                          |
|-----------------|--------------------------------------------|
| 0.07            | Medium to dense brush in the winter        |
| 0.05            | Scattered brush and heavy weeds            |
| 0.035           | Medium/Dense weeds within channel          |
| 0.05            | Light brush with small trees in the winter |
| 0.03            | Little to no weeds in channel              |

|       |                                    |
|-------|------------------------------------|
| 0.100 | Hardstanding or fallen large trees |
|-------|------------------------------------|

- Breaks between 1D chainage network were also fixed at this stage by renaming and re-ordering each cross-section. The furthest upstream node was placed at the top of the list and the downstream node at the bottom. The network was then refreshed and all of nodes were checked to make sure the 1D network was correctly linked.

## 5. Creation of boundary conditions for 1D model

**Date: 12/12/2017**

- The upstream boundary condition selected was ReFH. The upstream boundary was given to the same name as the first river section, in order to link the upstream boundary to the 1D network.
- Each return periods was saved down as a separate 1D network (.dat file).
- The catchment descriptors used in the Flood Modeller ReFH boundary were the same as the catchment descriptors used in the site Hydraulic Assessment.
- The downstream boundary selected for the model was a 'normal depth' boundary condition. The slope was set to an estimated 0.001, this was based on upstream general slope.
- The inflow from the two upstream boundaries was split. 2/3 of the flow was assigned to the Hogwood Ditch and 1/3 to the Robinson Crusoe Ditch.

## 6. Set up and run of steady and unsteady 1D model

**Date: 12/12/2017**

- A 1D simulation file (.ief file) was created to carry out the 1D steady state simulation.
- This steady state simulation checks the model for initial errors and instability.
- In order to improve the model stability, automated preissmann slots were added to river sections and the dflood value was increased to 10.
- One error was encountered during this simulation and that was a node existing in the initial conditions that did not exist in the 1D network. This issue was fixed by importing the nodes into a new 1D network.
- The steady state simulation was re-run and was successful with no errors.
- A 1D simulation file for the unsteady state was then created.
- The unsteady simulation was set up to use a 1s timestep (half of the proposed 2D timestep), a save interval of 300s (a reasonable balance between regular saves and increased CPU pressure).
- The simulation started at 0 hours and was set to run for 20 hours. This is considered a suitable duration to allow in-channel levels to return to pre-flood conditions.
- The simulation results showed no errors and the convergence within the model is within an acceptable tolerance range.
- The initial conditions were then imported into the 1D network.

## 7. Adding in structures to the 1D unsteady model

**Date: 13/12/2017 to 15/12/2017**

- Conduit nodes were added to the 1D model where a structure was found in the latest site topographic survey.
- 4 nodes were added for each structure; an upstream and downstream conduit node that defined the characteristics of the structure (i.e. Manning's and Invert Level (IL)). An input culvert loss node, which defined the entrance to the culvert which water would flow into and an outflow culvert loss node, which defined the orifice that water exits the culvert at. The loss nodes also link the structures to the watercourse chainage.
- Each time a structure was added to the model the steady and unsteady state simulations were re-ran. This was to check that the structure did not cause any errors or divergence in the modelled watercourses.
- Manning's values used for the structures present are displayed in the table below. These values are taken from Chow's Book 'Open Channel Hydraulics' 1959 and are based on photos taken on site of the structures.

| Manning's Value | Description                |
|-----------------|----------------------------|
| 0.011           | Concrete structure         |
| 0.019           | Corrugated metal structure |

## 8. 2D model creation

**Date: 18/12/2017**

- The 2D element of the model was created using 'Flood Modeller Pro 2D'.
- Firstly, a Computational Area was set up. This defines the area in which the calculations are carried out in the model.
- Secondly an Active Area was created. This further defines the area in which the 2D calculations are carried out by outlining which section(s) of the Computational Area are active.
- The Active Area polygon was drawn to encompass any area which may experience flooding from the watercourse. By doing this the total number of cells which need to be calculated during the simulation is reduced and therefore the computational time is reduced.

## 9. Creation of 2D elevation data and linking the 1D and 2D model.

**Date: 19/12/2017 and 20/12/2017**

- The elevation data for the model is a combination of 1m DTM LiDAR data, from the EA and elevation data from the latest topographic survey of the site. The two ascii grid files were combined in Flood Modeller Pro by using the superimpose grid tool.
- The 1D 2D Link Line was checked for anomalies and inconsistencies, any found were altered to ensure that there were no breaks in the link throughout the network. Also, the node labels of the links were checked to ensure that they were connected to the correct nodes. 2 Link Lines were created to represent both banks of the watercourse.

## 10. 2D Simulation Set Up

**Date: 20/12/2017**

- The first 2D simulation was set up for the Q1000 event.
- A roughness grid had to be created for the modelled area. This was done by creating a shape file (.shp) of polygons. Each polygon covers an area with a different defining manning's roughness value.
- A new column was created in the.shp files attribute table. This column was populated by the manning's value for each area, determined by using Chow's Book 'Open Channel Hydraulics' in conjunction with satellite imagery of the area.
- This column had to be named 'value' so the software could extract the relevant data during the simulation run.
- The simulation file was then set up, firstly the run time of the simulation was set up, this was kept the same as the 1D simulation (20hours).
- Then the 'use 1D 2D linked model' option was selected and the 1D element of the model was defined.
- The link line for the 2D element to the 1D element then was declared.
- The domain of the model was then defined. To run the 1D 2D linked model the only data needed was the:
  - Durations of simulation in hours
  - Topographic/elevation data
  - Active Area
  - Manning's roughness grid (note: for the first run of the Q1000 event the manning's roughness was kept at the global pre-set value of 0.1).

## 11. Errors and Bugs Encountered/Fixed

**Date: 20/12/2017**

- ERROR Message- Model failed due to an error in the 1D network.
- The 1D network known to work from unsteady state simulations. Therefore, the error must be in the linking of the 1D and 2D:
  - Possible issue with the 1D 2D link lines showing an unrealistic channel set up. FIXED- re-alignment of link lines so they do not cross each other and changes to link lines to make the modelled watercourse 'realistic'.
- Null data found in 1D network, the un-steady state simulation was re-ran and these values were corrected.

## 12. Simulation Fail and Model Changes

**Date: 22/12/2017**

- The Q1000 1D 2D simulation failed due to an error in the 1D model, this was the same error as before. There were also, multiple messages regarding a warning stating the lateral inflow was sent to some sections with no downstream unit. The sections were the ones connected to structures. This resulted in the simulation sending water back upstream causing instability.

- Going forward it was decided to create two iterations of the model. One as is and the other with multiple Active Areas which don't cover the ditch network itself and open ended 1D 2D link lines. The files were saved in separate folders within the 2D GIS folder as XX\_XX\_Option1/2.
- The reasoning behind the change in the layout of the Active Area(s) and 1D 2D Link Lines is this is the way it appears to be set up in examples from the software company. However, these examples only show one side of the modelled watercourse or a specific area.

### **13. Update to 2D Model and Q1000 Simulation**

**Date: 02/01/2018**

- Model has been setup using the Option2 settings and a new run for the Q1000 event has been initialised.
- Due to the movement of the model files to a different Drive, each element of the 1D and 2D model had to be reloaded in to ensure that the model would have the correct pathway for each file.
- For this run of the model a few assumptions have been made:
  - The 1D model hydrology uses ReFH inflow boundary conditions rather than ReFH2.
  - The Manning's Roughness of the models Flood Plain was kept at the global average setting. Manning's Roughness polygons should be used due to the variations within the floodplains roughness.
- These assumptions are to be addressed once a successfully 1D 2D linked simulation has been successfully completed with displayable results. The reason for this is if the model can be ran without error in its current the areas of possible error once these assumptions have been changed can be narrowed down. Thus, fixing errors that may occur much more efficient.

### **14. Update to 2D Model and Q1000 Simulation Part 2**

**Date: 03/01/2018**

- The 1D 2D Linked model simulation failed again displaying the same error as before (Error with the 1D network).
- After contacting the software company, they have given us a couple of fixes.
- The first fix carried out was removing the 1D 2D Link Lines between the river sections which are offsite. According to the correspondence with the software support this should not impact the model. But this area is one of major instability. Link Lines were also removed from between structures as water cannot flow out of the channel whilst in the culvert.

### **15. Update to 2D Model and Q1000 Simulation Part 3**

**Date: 04/01/2018**

- All previous versions of the 1D steady and unsteady state simulations were moved to the SS folder (superseded folder) and keeping only the latest 1D simulation files Q1000\_Unsteady\_State\_v4 and the 1D network itself Q1000\_EX.dat.

- The same process was carried out for the 1D 2D linked model simulation files, all previous runs were moved into the SS folders including the simulation logs. A new 1D 2D simulation was set up named Q1000\_EX\_5.0.
- New topographic data for the downstream end of the culvert which leads off the site was received and the model was updated.
- The new 1D 2D linked simulation for the Q1000 event used the Manning's Global Roughness value of 0.05 which represents the high end of pasture with long grass.
- The DEM data around Section81 was checked for discrepancies. It was found that the elevation data increases downstream towards Section82 as expected. However, there are some slight fluctuation in the bed level on the DEM. This may be another possible source on instability in the model as the downstream sections of the model are the most frequently appearing in warning messages.
- After checking the latest 1D. zzd file the following points were identified:
  - Poor model convergence at start of simulation (0.00hrs). Location- Structure7\_U and Structure7\_D
  - Backflow encountered at Section8 (at 0.0014hs). No supercritical depth was also found at Section8
  - Backflow encountered at Section82 (at 0.0017hrs).
  - Poor convergence throughout the simulation at Structure7 and nearby nodes.
  - No supercritical depth found at Section82 (Throughout simulation)
  - It would appear that the majority of warnings in the 1D model are coming from the downstream section of the watercourse (Section81+).
- In order to remove the lateral inflow warning the 1D 2D link lines between the culverts needs to be removed. This change to the models link lines was save as 1D\_2D\_LinkLines\_Option2\_V2.
- The 1D network was re-set up under Q1000\_Ex\_v2. This is because after contacting CH2M they suggested that the number of changes that have occurred since the initial conditions were set up may be a cause of instability.
- Model run has been started- new warning encountered stating that water has been encountered at the domain boundary. However, the lateral inflow warning has not re-appeared.

## **16. Model Successfully Ran Q1000 Simulation**

**Date: 05/01/2018**

- Fixes made in section 15 above mad stabilized the model and a run of the model has now been completed (Main issue found to be the 1D network and initial conditions were outdated/corrupted due to the large number of changes to the model since the 1D simulations were carried out).
- Post processing of the model results can now occur. The model can also now be refined, and more frequent events/climate change can now be modelled.

## **17. Post-Processing of Results**

**Date: 05/01/2018**

- The maximum depth result was created using Flood Modeller Pro as an .ascii file using the calculate max values tool.
- Using Layer convert tool in Flood Modeler Pro the .ascii file could be converted into a .shp file.
- The save as outline option was selected (due to its compatibility with CAD)
- The file was then imported into CAD using the mapimport function and selecting the exported .shp file.
- The file was imported as closed polylines This meant that the flood extents could be hatched.
- The exported flood extents did not include the modelled watercourse, which would of course be wet. Therefore, the boundary condition line (which was a trace of the modelled watercourse) was exported as a .shp file and imported into CAD using the same process. This gives the complete Q1000 fluvial flood extent for the watercourse onsite.
- The previously created Q1000 estimated fluvial flood extent was then placed over the modelled extent and the two were compared.
- It was found that the modelled flood extent is a betterment over the estimated. With areas of development area which were previously predicted to flood not flooding in the model.

## **18. Model Refinements**

**Date: 08/01/2018**

- The first refinement made changing the upstream boundary unit from the old ReFH to the new ReFH2 (ReFH2 is also the method used to calculate the watercourses hydrology).
- A new 1D network was created and saved as Ex\_Q1000. The new 1D network had the old boundaries removed and the new ones placed in. The old network was saved and superseded.
- To refine the division of flow from the upstream boundaries in the model the catchment areas of each ditch was acquired from the FEH website. Hogwood ditch- 2.06km<sup>2</sup> and Robinson Crusoe ditch- 0.93km<sup>2</sup>. The ditches individual catchments were converted into a percentage of the total site catchment (Hogwood= 62% and Robinson Crusoe= 38%). The amount of flow set at each ditch was then set by these percentages.
- 1D network has been set up for event that needs to be modelled (excluding climate change).

## **19. Model Refinements Continued**

**Date: 09/01/2018**

- Manning's roughness polygons for the active area have been updated. The polygons cannot cross the 1D 2D Link Lines, it is also recommended that the polygons do not overlap.

- Error encountered whilst running the ReFH2 head time boundary- 'Error5020- Argument missing or invalid- Mode argument FOO unknown, return period 2000 is above the maximum of 1000.'
- Error was fixed- The issue was not with flood modeller but with the secondary ReFH2 software by WHS. The issue was solved by downloading an update to the software. From there the ReFH2 boundaries successfully generated results.
- The 1D model then set up and ran as Ex\_Q1000\_1D. Both the steady and unsteady state simulations ran without error.
- The initial conditions from the unsteady state 1D model were imported into the 1D network and the linked 1D 2D model was set up.
- The grid size of the 1D 2D linked model was set to 2m in the domains tab this is because it is recommended that the grid size be twice the timestep value (timestep value=1 in this instance).
- The Manning's roughness polygons were also implemented into this model, which is preferred over using just one global Manning's value.
- Q100+70% CC file set up flow divided between ditches same as before.

## **20. Setup of Return Periods- Updated Hydrology and 1D Network**

**Date: 10/01/2018**

- 4 simulations can be running at once. The licensing prohibits more than 4 1D 2D simulations. However, 1D simulations can still be run, meaning that other events can set up.
- Before running each 1D 2D simulation to make sure that the correct 1D network is the active network i.e. if you are running the Ex\_Q10\_1D2D model then the Ex\_Q10\_1D network must be the one active (displayed) on the model). The model will still run but this reduces the chance of any errors occurring.
- All 1D 2D linked models (excluding sensitivity testing) have been set up and the remaining 4 just need to be run when possible.

## **21. Setup of Return Periods- Updated Hydrology and 1D Network**

**Date: 12/01/2018**

- POF Reviewed FEH Catchment Areas and determined that Hogwood Ditch incorrectly sized in hydrological calculations. This meant that proportionally, Robinson Crusoe Ditch takes less flows than as modelled. This was updated and flows recalculated. Flow values updated in REFH2 Boundaries within each 1D network. Noted Q100 Hogwood Ditch set up as Q1000 and updated to Q100.

**22. Model Runs- Using Corrected Hydrology****Date: 15/01/2018 – 16/01/2018**

- The allocated flows for both ditches is shown in the table below.

| Watercourse           |            | Total Catchment Size | Proportion of Overall Flows |
|-----------------------|------------|----------------------|-----------------------------|
| Hogwood Ditch         |            | 2.43                 | 0.72                        |
| Robinson Crusoe Ditch |            | 0.93                 | 0.28                        |
| Return Period         | Flow Value | Hogwood Flow Value   | Robinson Crusoe Flow Value  |
| 2                     | 0.64       | 0.46                 | 0.18                        |
| 5                     | 0.88       | 0.64                 | 0.24                        |
| 10                    | 1.04       | 0.75                 | 0.29                        |
| 20                    | 1.22       | 0.88                 | 0.34                        |
| 30                    | 1.33       | 0.96                 | 0.37                        |
| 50                    | 1.48       | 1.07                 | 0.41                        |
| 100                   | 1.71       | 1.24                 | 0.47                        |
| 200                   | 1.98       | 1.43                 | 0.55                        |
| 100+25% CC            | 2.14       | 1.55                 | 0.59                        |
| 100+35% CC            | 2.31       | 1.67                 | 0.64                        |
| 100+70% CC            | 2.91       | 2.10                 | 0.81                        |
| 1000                  | 2.98       | 2.16                 | 0.82                        |

**23. Sensitivity Testing****Date 16/01/2018 – 23/01/2018**

- Manning's Roughness Sensitivity Tests-** 2 new 1D networks were setup for the existing watercourse model. Two models were set up 1 which increased the Manning's values by 20% and another which decreased them 20%. The event used was the Ex\_Q100 event, both the 1D and linked 1D 2D Manning's values were changed. 1D mannings changed using the global edit > roughness tool in Flood Modeller Pro
- Downstream Boundary Test-** 2 new 1D networks were setup, 1 with the downstream boundary (Section84) lowered by 0.2m and 1 with it raised by 0.2m.
- Culvert Blockage Test-** The only culverts that were used during this test were culverts that are being kept post development. All other culverts are going to be removed and the channel daylighted. The dflood level had to be raised to 20 in the 1D simulation in order to successfully run. The culvert blockage was set to 90% for Structure 6 in line BS8533 and 70% for Structure 7 which is slightly less than recommended by BS8533. However, Structure7 is only 0.1mm all from falling into the 50% blockage so it was decided that a middle ground would be used. Model convergence shown on this test is poorer than the other models.
- The culvert blockage test runs successfully in 1D but the linked 1D2D model fails. The reason for the model fail is due to the instability the high percentages of blockage cause within the model. CH2M support was contacted again and they gave some suggestions on how this issue could be fixed.

**24. Change to Model Hydrology- Division of RC Ditch Inflow and Q1000 Model Setup****Date 24/01/2018**

- RC Ditch flow has been divided into 2 inflows using the FEH catchments areas and site topographic survey. The upstream boundary is in the same location, but the catchment area and flow percentage assigned has been reduced (see table below).

| Peak Flow Value (m3/s-1) |       |               |            |              |
|--------------------------|-------|---------------|------------|--------------|
| Return Period            | Total | Hogwood Ditch | RCD Onsite | RCD Upstream |
| 2                        | 0.64  | 0.49          | 0.04       | 0.10         |
| 5                        | 0.88  | 0.68          | 0.06       | 0.14         |
| 10                       | 1.04  | 0.80          | 0.07       | 0.17         |
| 20                       | 1.22  | 0.94          | 0.08       | 0.20         |
| 30                       | 1.33  | 1.02          | 0.09       | 0.22         |
| 50                       | 1.48  | 1.14          | 0.10       | 0.24         |
| 100                      | 1.71  | 1.31          | 0.12       | 0.28         |
| 200                      | 1.98  | 1.52          | 0.14       | 0.32         |
| 100+25% CC               | 2.14  | 1.64          | 0.15       | 0.35         |
| 100+35% CC               | 2.31  | 1.77          | 0.16       | 0.38         |
| 100+70% CC               | 2.91  | 2.23          | 0.20       | 0.48         |
| 1000                     | 2.98  | 2.29          | 0.20       | 0.49         |

- The new inflow boundary has been inserted mid-way down RC Ditch. This is so there is enough distance between the two inflows that dividing the flows will make a hydrological difference.
- The previous model has been SS and a new flood modeller project and 1D network have been set up for the Q1000.
- There is an issue with connecting the new inflow boundary into the model mid-way down RC Ditch.

**25. Model Fixed- Division of RC Ditch Inflow and Q1000 Model Run****Date 26/01/2018**

- POF, successfully connected the new inflow boundary to the watercourse. The steps taken up to and including running the new model Q1000 event are:
  - Renamed RC\_Section20 to RCSection20u and changed distance to 0
  - Added Junction Unit
  - Created new ReFH Boundary
  - Created Copy of RCSection20u and called it RCSection20d with 0.2m distance and then a second copy with 0 distance (RCSection20d2)

- Linked the three sections using the junction unit.
- Linked new ReFH boundary with RCSection20d.
- Ran 1D steady then unsteady model.
- Set up 2D simulation and updated locations of various files (links were dead due to moving things in the project folder). Amended Active Area Option 2 to Active Area.
- Moved log and outputs to 2D results and runs folder respectively.
- Updated link lines to reflect new RCSection20u name.
- Model simulation run.
- Culvert Blockage Test model to be fixed and run once Q1000 event of the new model has been completed.

**26. Model Fixed- Running all Existing Model Simulations, sensitivity testing & proposed Q1000**  
**Date 29/01/2018 – 02/02/2018**

- Updated all 1D existing networks to revised network with 2 Robinson Crusoe Ditch inflows
- Ran 1D unsteady state simulations and then set up new xmls (copied and pasted old ones and updated the links.
- Ran 1D-2D simulations for all.
- Updated Q100.dat downstream cross section + and – 200mm manually for sensitivity testing and ran above steps.
- Used global edit tool and roughness \* 0.8 for all sections including bridges. Selected all nodes upstream and downstream of structures (culverts) and at the head of each ditch. \*1.25 for these sections to reduce instabilities (brought back to normal mannings for these isolated sections). Ran above steps.
- Carried out same roughness edit but \*1.2 for each section and then \*0.835 to bring the culvert and head sections back to normal roughness. Ran model.
- Culvert Blockage Test model to be fixed and run once Q1000 event of the new model has been completed.

**27. Model Fixed- Updated Pr\_Q1000.DAT and DTM**  
**Date 05/02/2018 – 06/02/2018**

- Imported Max Water Level ASC for existing Q1000. Separated out the bits within development areas (used clip surface to polyline) in CAD.
- Banded the depths in 0.25m intervals.
- Took each depth band plan area and reapplied it adjacent to the lost floodplain.
- Exported to dxf.
- Removed culverts from 1D network (apart from the culverts to remain at Section 45 and Section 82).
- Removed RC\_Section1 and 2 and renamed RC\_Section3 as RC\_Section1. This accounts for the new inflow boundary which is approximately where existing RC\_Section3 exists.
- Dropped bank levels on high side of RCD (where development area flooding) to match on both sides along channel where water coming out of existing bank.
- Stamped dxf modified shapefile onto existing surface and tried to run proposed model but not able to solve.

- Tried running with existing surface and all 1D changes remaining. Model running.

## **28. Culvert Blockage Test Re-Run and Proposed Q1000 Run**

**Date 07/02/2018**

- Following guidance from CH2M and the online Flood Modeller Guide the Culvert Blockage Test model tweaked and the re-run.
- Results of the changed Culvert Blockage Test are no different from the previous model or the existing Q100 model.
- This is being investigated further as to why the simulated blockages are having no effect on the model.

## **29. Post Processing and Checking of Results**

**Date 08/02/2018 –12/02/2018**

- The last existing model run to be successfully completed is the Culvert Blockage Test model.
- All the results files for the existing models were checked to ensure that they all have full sets of correct data for the correct event.
- Once the data checks were completed all of the existing models were exported from Flood Modeller Pro and plotted onto a plan.
- The max fluvial flood extent of each model was exported as an ascii grid (.ascii) and outline shapefile (.shp).
- Various data was also extracted from the Q100 model and completed sensitivity testing models for use in the hydraulic modelling report. The main data that was extracted was Max Stages (water level m AOD) and Peak Flows (m/s).
- The proposed Q1000 (Pr\_Q1000) model was also successfully completed and the fluvial flood extents for this model were also exported and plotted onto a plan against the existing Q1000 fluvial flood extents to check if the changes made to the model have led to the desired changes in the floodplain.
- Max Stage (water level m AOD) and Peak Flow (m/s) data at the downstream boundary of the model was compared for the proposed and existing Q1000 events. It was found that the proposed Q1000 event does show a betterment over the existing situation with a reduction in flow and water level at the downstream boundary. Meaning that the changes made to the floodplain have not lead to increased flooding further downstream.

## **30. Finalised Modelling**

**Date 13/02/2018 –**

- Amended Mannings roughness shapefile for proposed to reduce roughness to 0.025 instead of 0.035 along the channel near the south-western corner. The aim is to enable this area to flood more frequently and thus reduce peak flow and stage to existing levels or better.
- Ran Q5. Noticed mass balance output is writing to Q1000\_pr.
- Updated culvert blockage by renaming culvert inlet to unique name i.e. Section\_84\_In and the setting the blockage to that new section name.
- Ran both culvert blockage scenarios.

### **31. Proposed Modelling**

**Date 19/02/2018 –21/02/2018**

- Removed culverts from 1D network (apart from the culverts to remain at Section 45 and Section 82).
- Removed RC\_Section1 and 2 and renamed RC\_Section3 as RC\_Section1. This accounts for the new inflow boundary which is approximately where existing RC\_Section3 exists.
- Dropped bank levels on high side of RCD (where development area flooding) to match on both sides along channel where water coming out of existing bank.
- Modified ditch inflows to account for decreased runoff rates from development areas. Based on C85672-SK-017 (WIP) issued on 19/01/2018 and the latest Drainage Calculations\_CC40 DS spreadsheet, Parcel RE2-RE10, RE17, PRS1, and NMRE area (28.45ha) removed from Hogwood Ditch catchment area. Peak flow for these parcels amounts to 31.4l/s which is added as a new inflow boundary into Hogwood Ditch watercourse (created a ReFH2 boundary hydrograph fitted to the 31.4l/s peak). Repeated the exercise by removing the remaining area from RCD ReFH2 inflow boundary onsite (17.13ha) and adding a new ReFH2 boundary for 20l/s.
- Added junctions at Section3 and RC\_Section25 to enable the new REFH2 boundaries to be added.
- Dropped the minimum flow in the RCSection20d, RC\_Sect25U2, and Section3U2 ReFH2 boundaries to 0.001 as otherwise this minimum flow is higher than the actual peak flow in the more frequent storm events, which would skew the results.
- All model simulations run without issue and results show expected decline in peak flows and stages.
- Added culvert blockages from existing model to proposed Q100 through import model nodes command. Saved each blockage as Q100\_CB45 and \_CB82 respectively. Ran a new .ief for each. Set up a new 1D/2D xml for each and ran to assess implications of culvert blockage on proposed model.

## Appendix F: Existing Fluvial Flood Extents Plan

