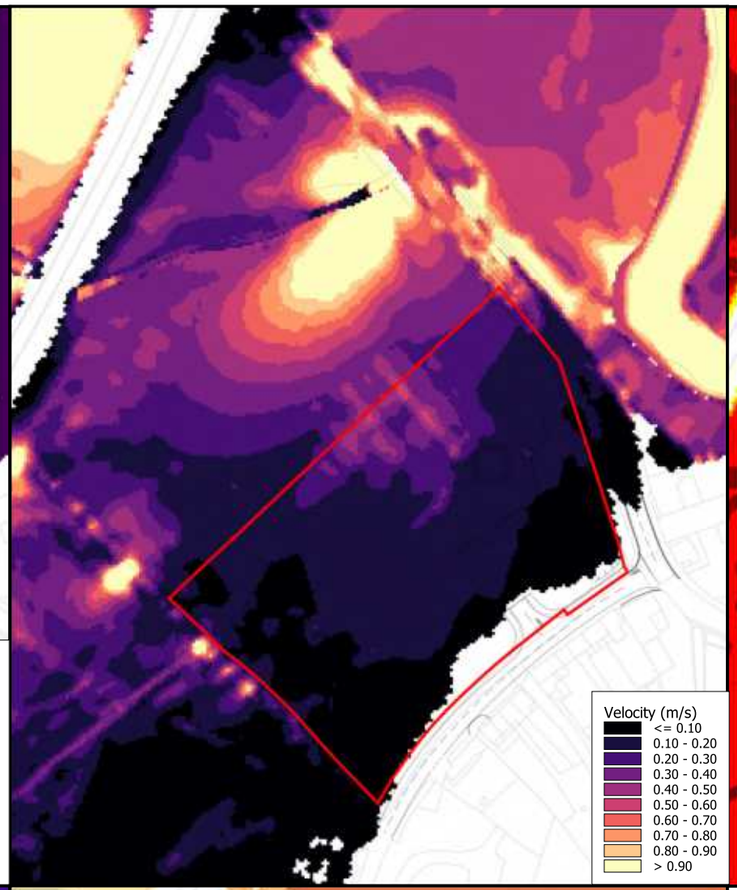

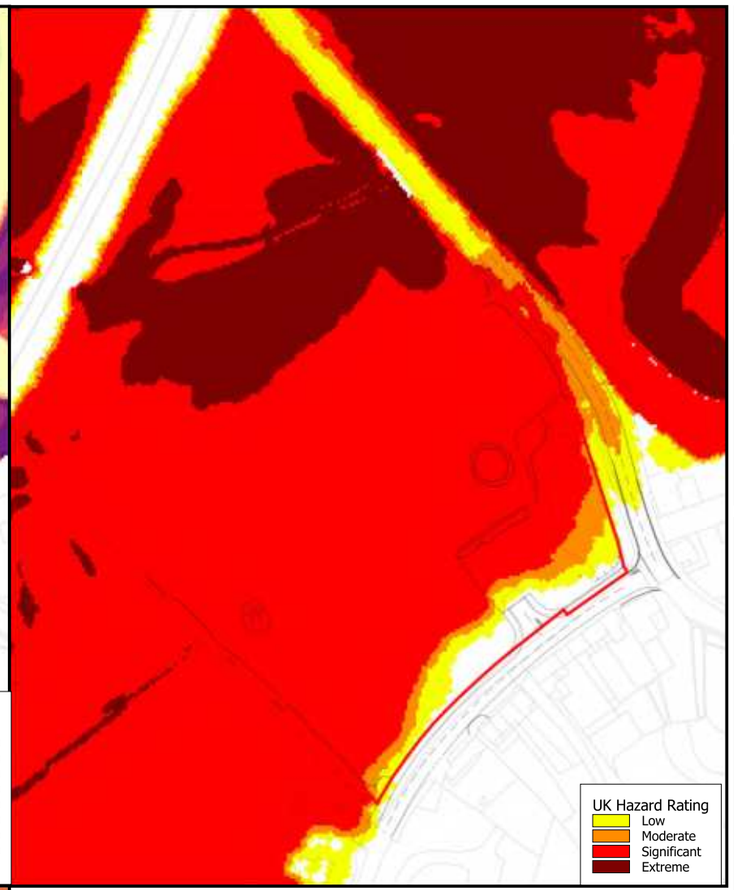

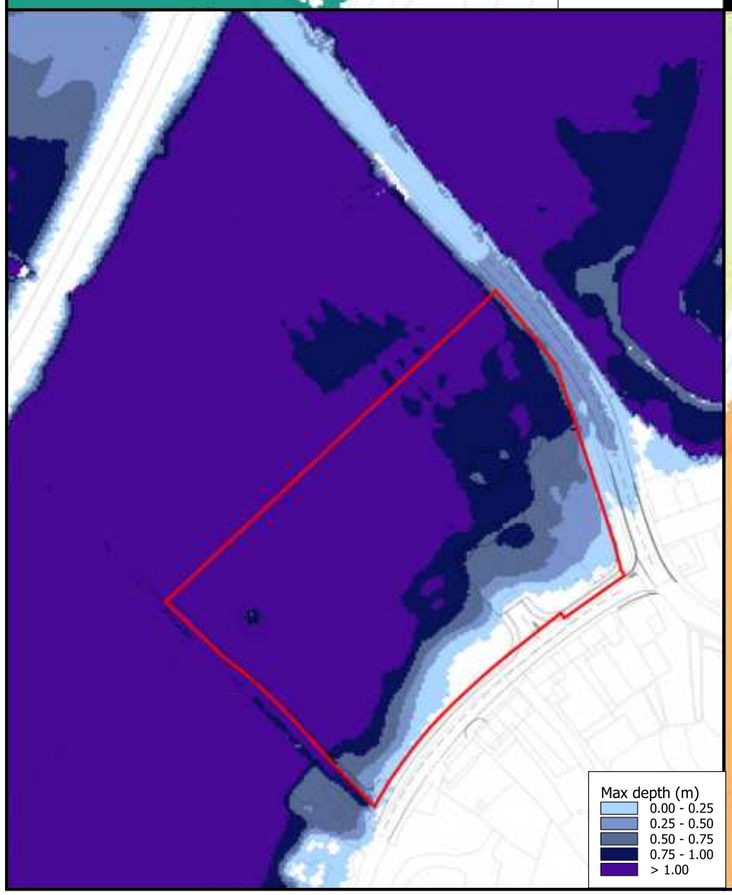

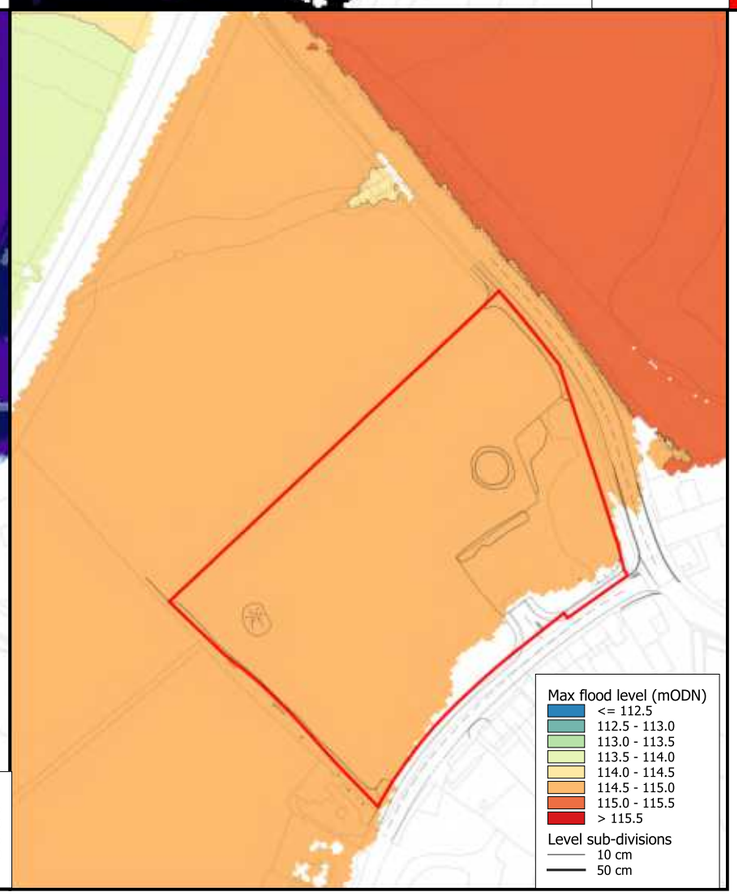

20 0 20 40 60 80 m

N

TITLE

EXISTING CONDITIONS
0.5%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

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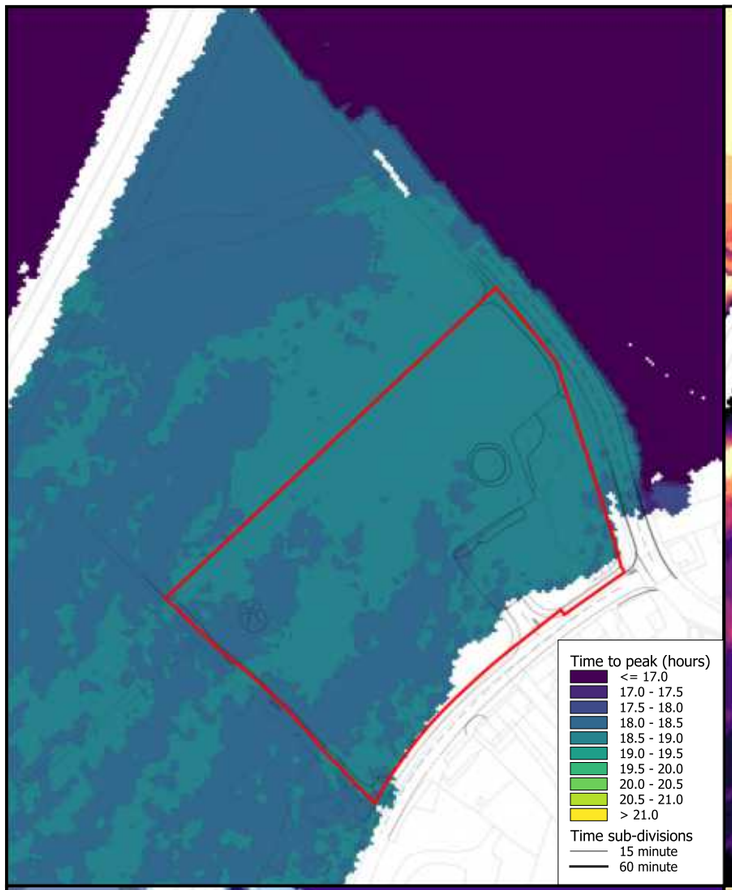
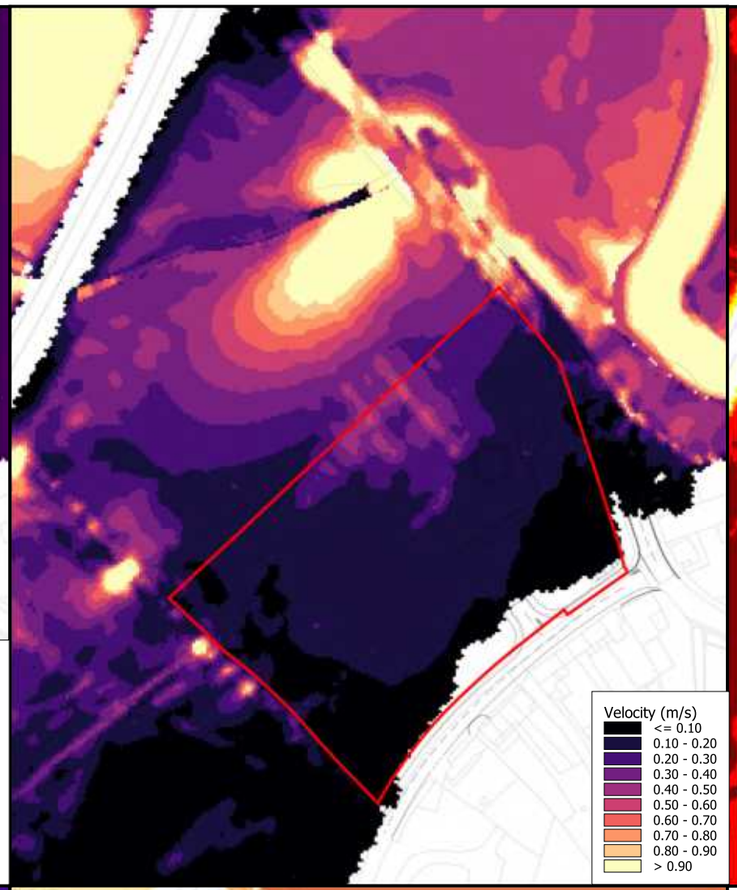
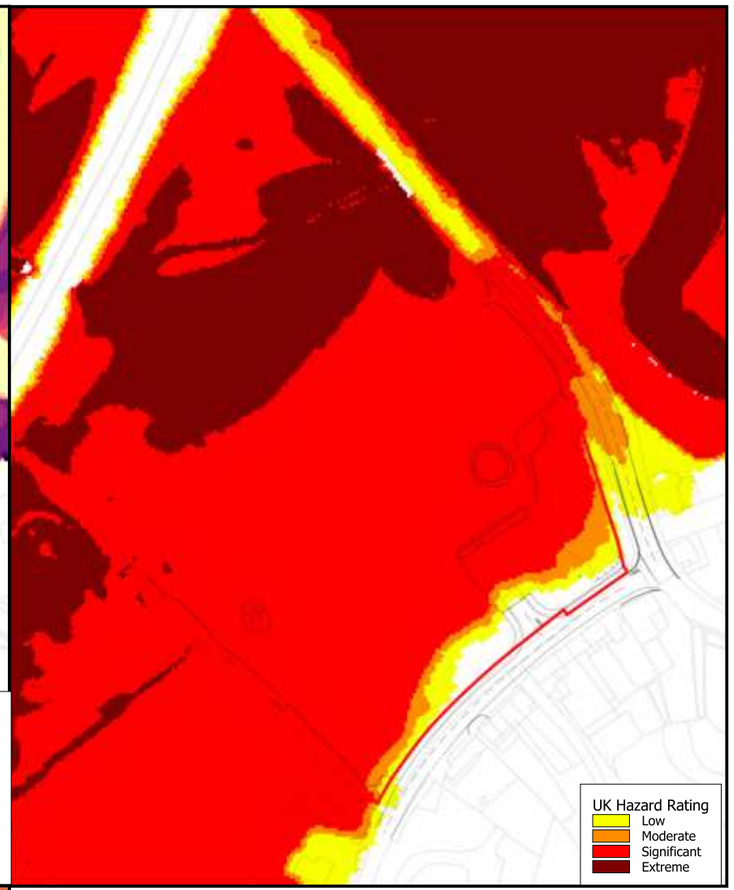
PROJECT
LIDL, LAMPETER

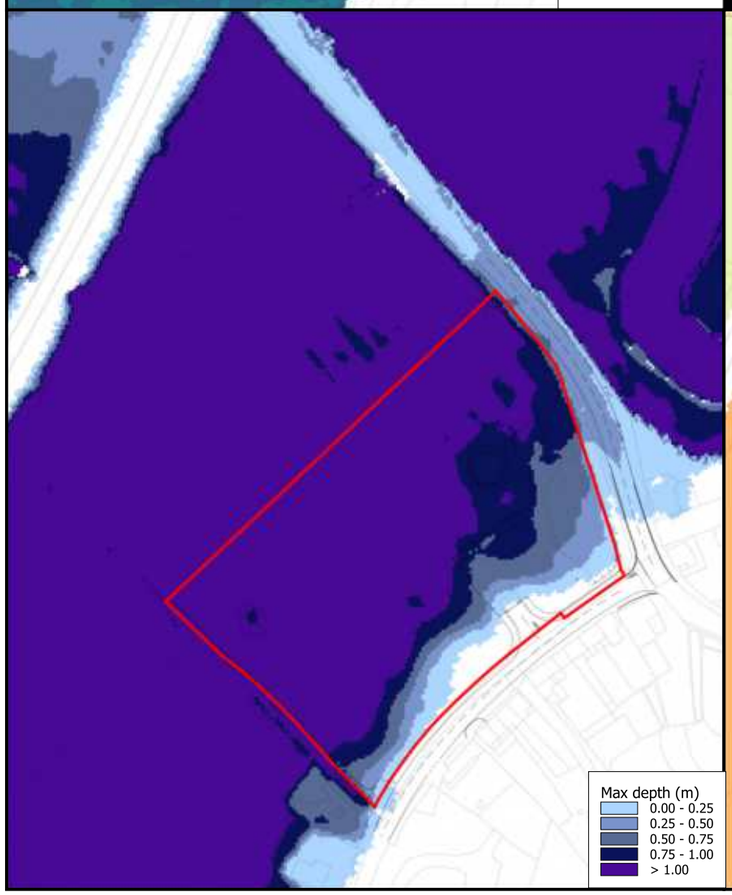
SCALE	PROJECT No.	INITIALS	CHECKED BY
1:2191 @ A3	4112	NW	--

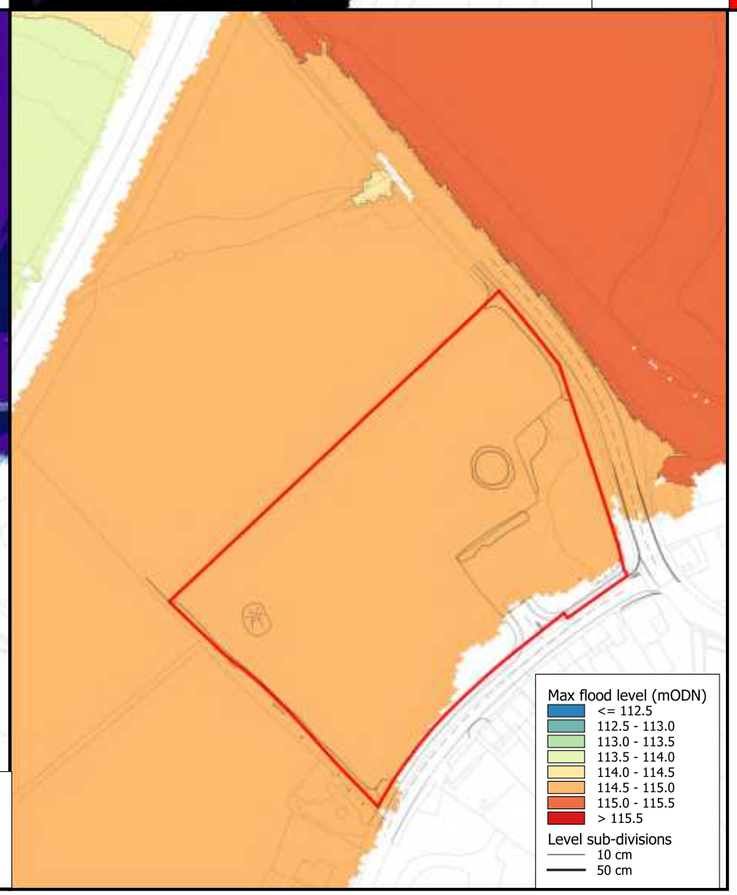
DRAWING No.
A.9











20 0 20 40 60 80 m

N

TITLE

EXISTING CONDITIONS
0.1%AEP EVENT
PRESENT DAY

LEGEND

Site boundary

DETAILS

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6	6th issue	16-12-2025

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PROJECT
LIDL, LAMPETER

SCALE	PROJECT No.	INITIALS	CHECKED BY
1:2191 @ A3	4112	NW	--

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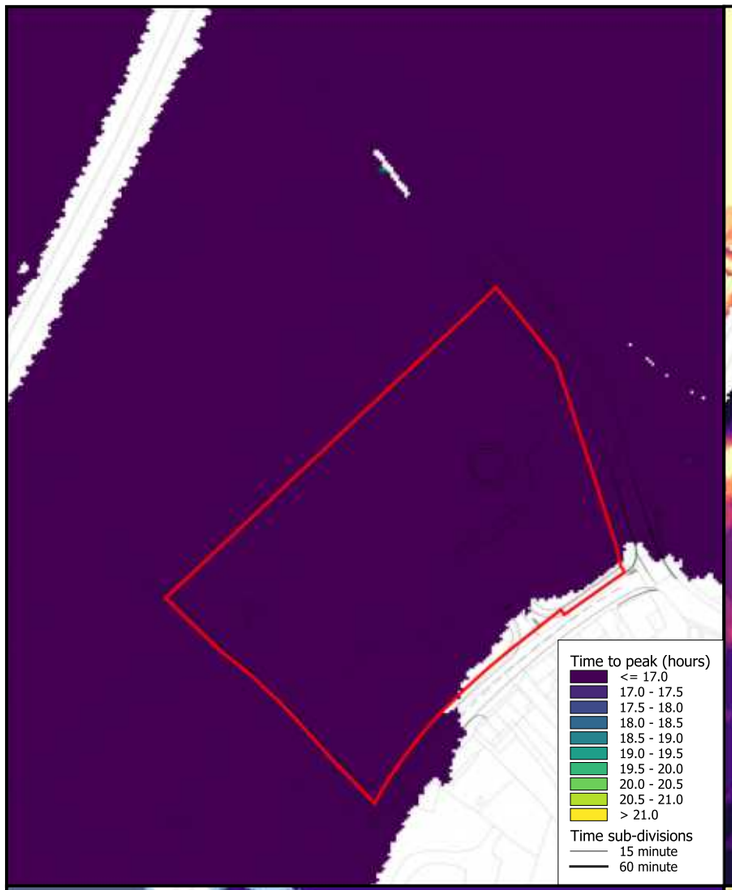

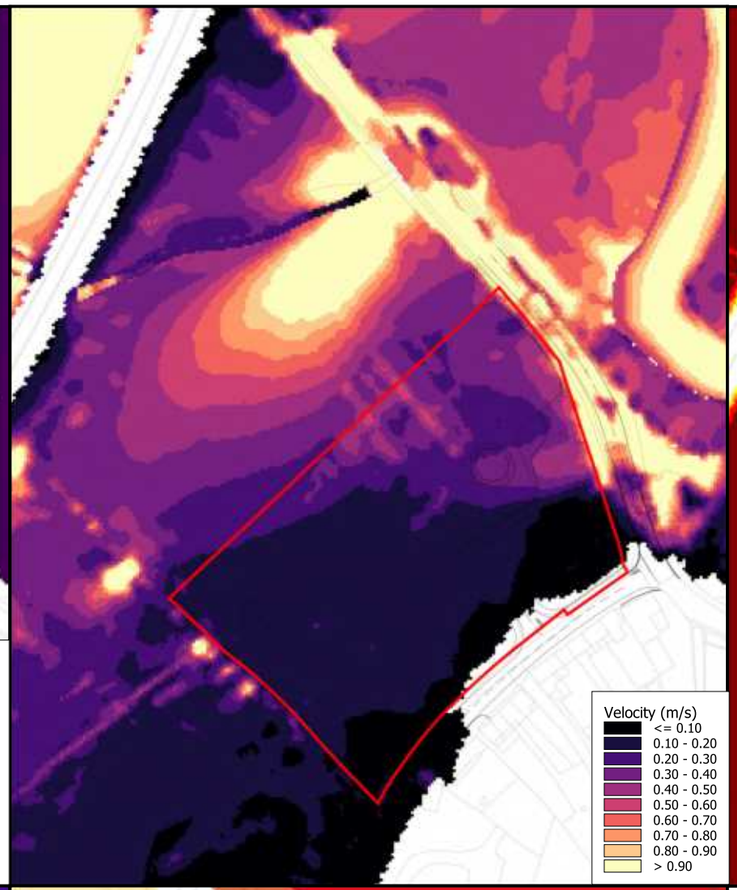

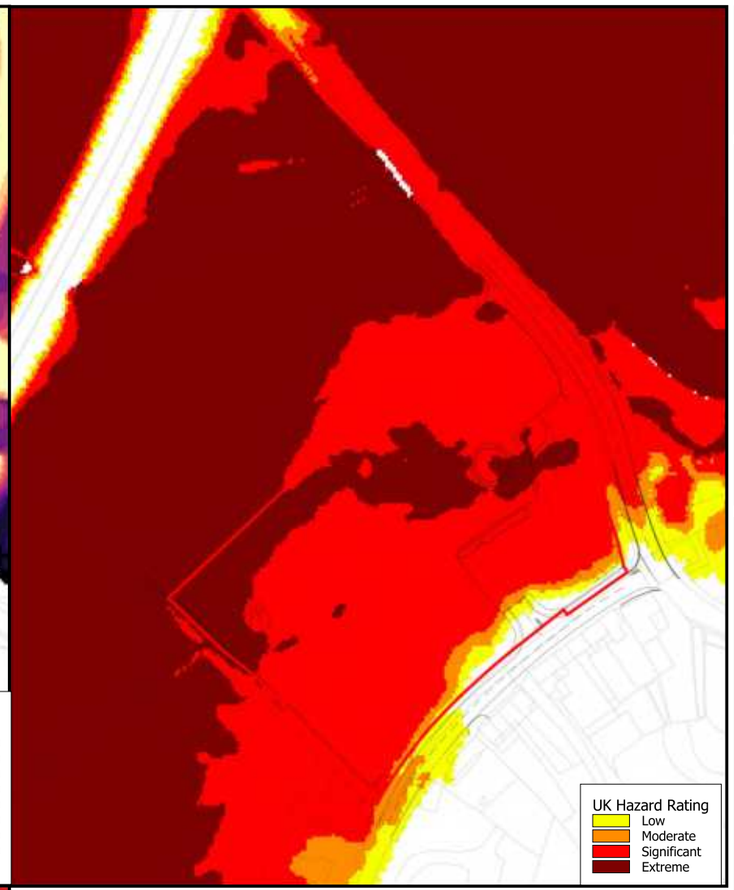

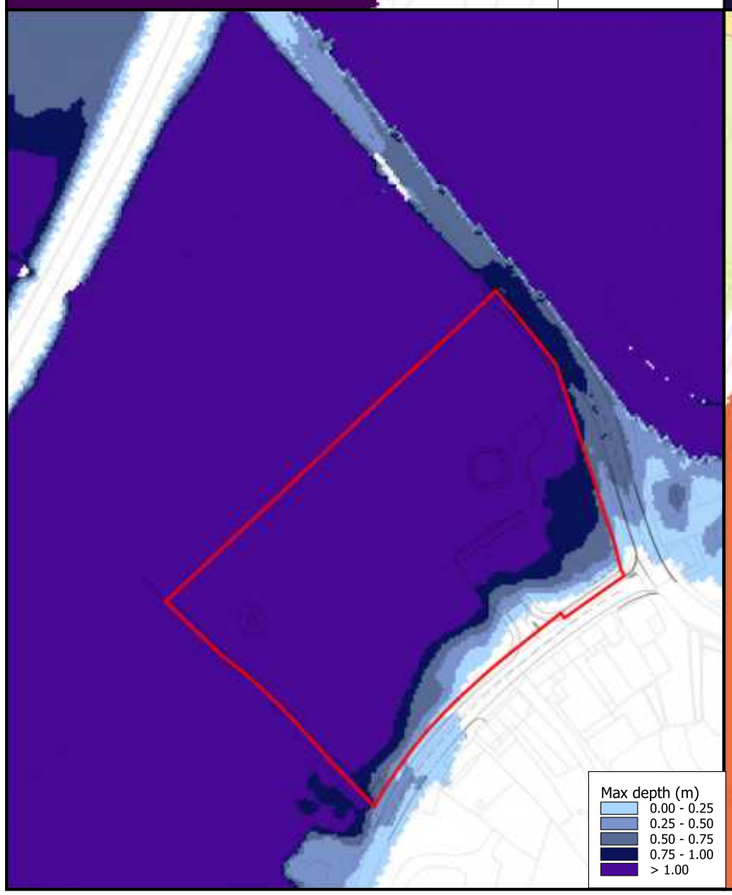

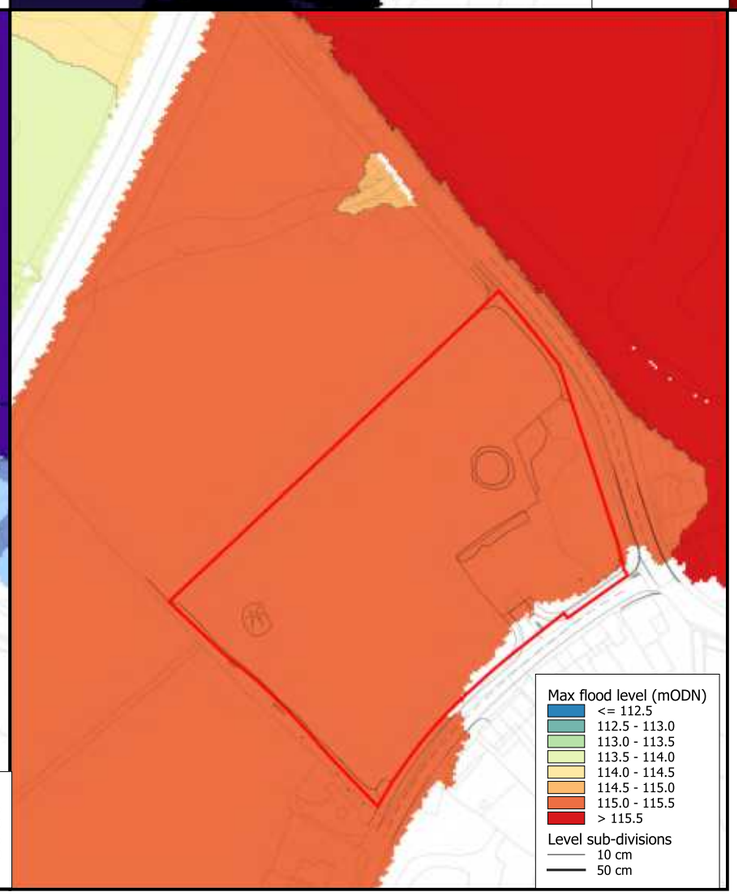

20 0 20 40 60 80 m

N

TITLE

EXISTING CONDITIONS
0.1%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

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PROJECT LIDL, LAMPETER

SCALE	PROJECT No.	INITIALS	CHECKED BY
1:2191 @ A3	4112	NW	--

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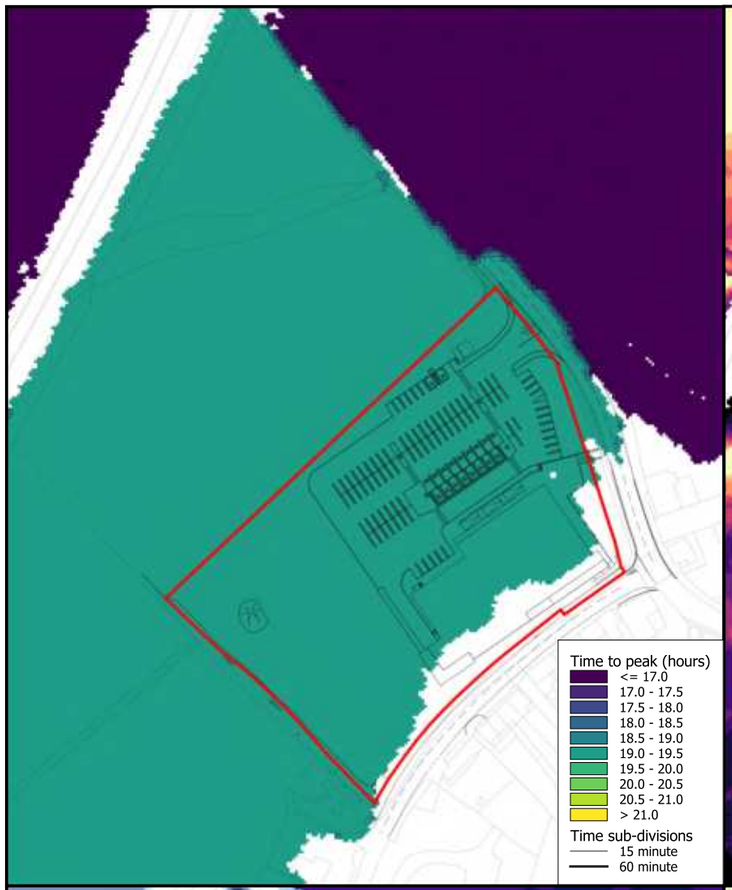

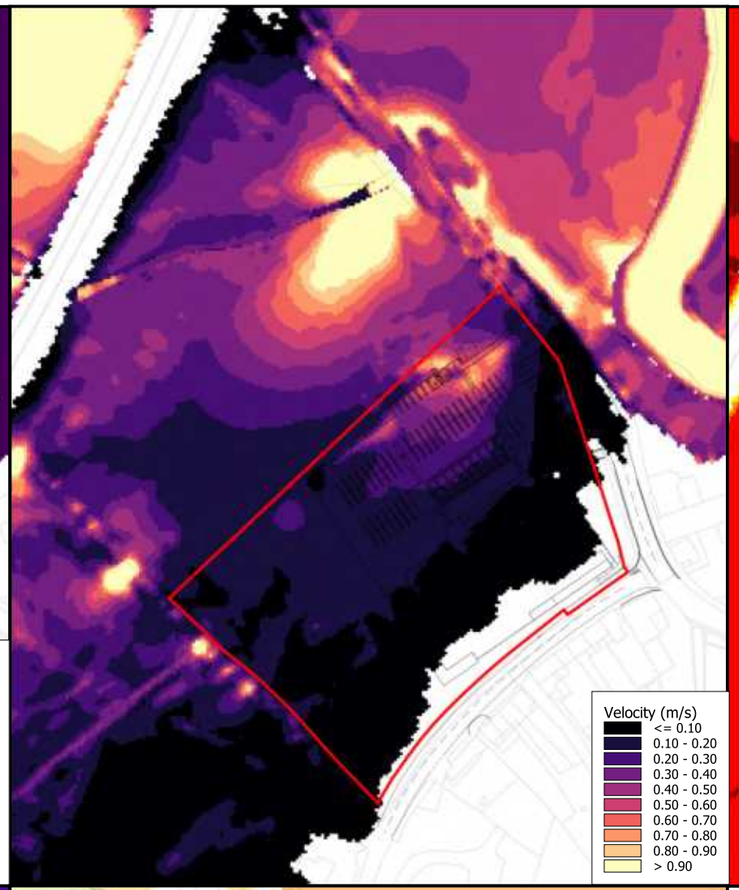

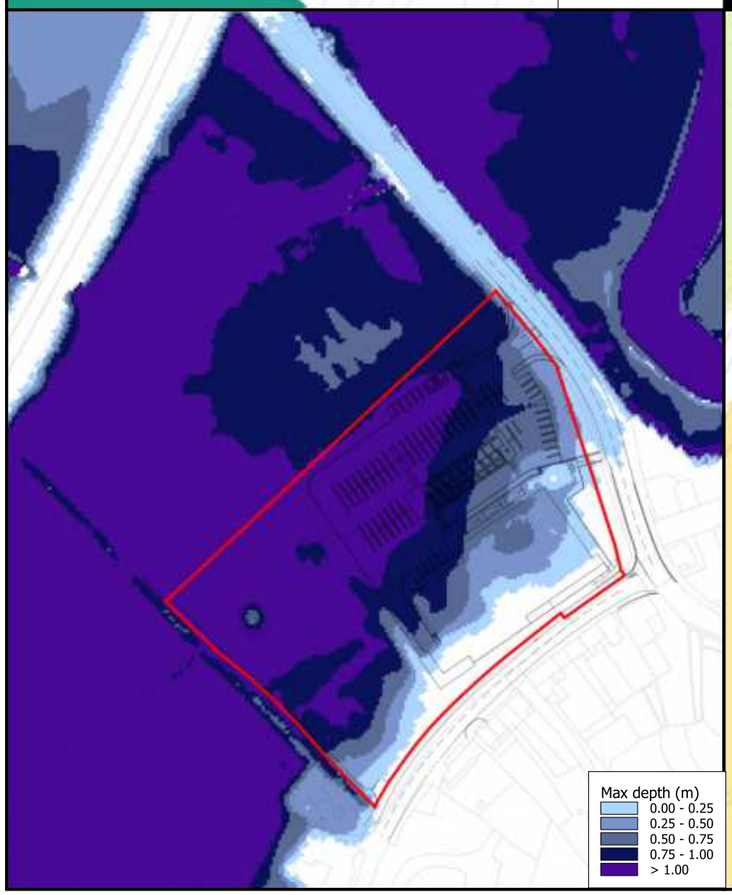

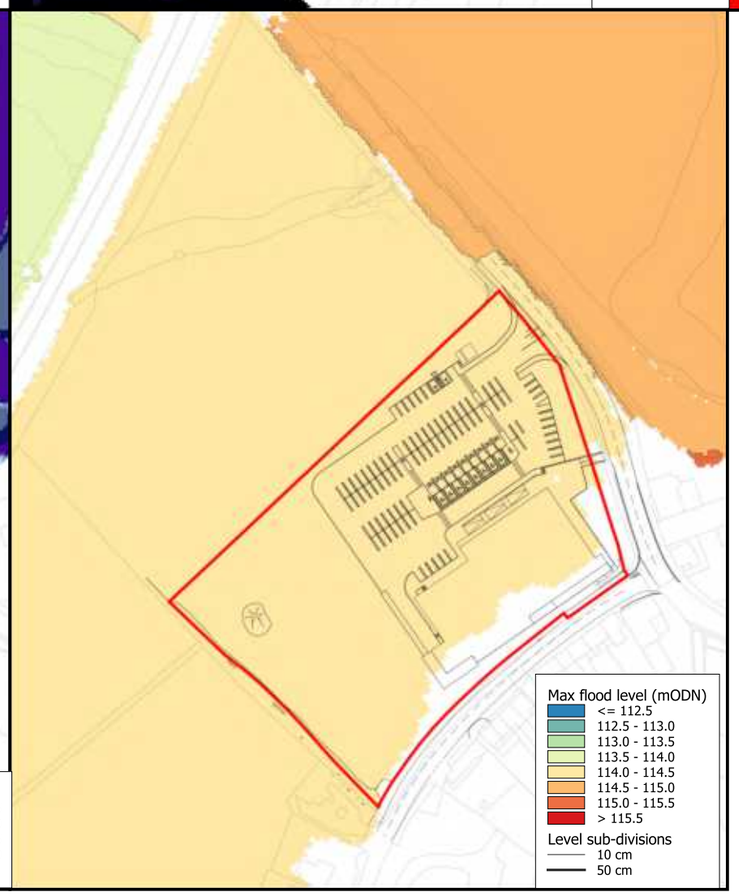

20 0 20 40 60 80 m

N

TITLE

POST DEVELOPMENT
1%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

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LIDL, LAMPETER

SCALE	PROJECT No.	INITIALS	CHECKED BY
1:2191 @ A3	4112	NW	--

DRAWING No.
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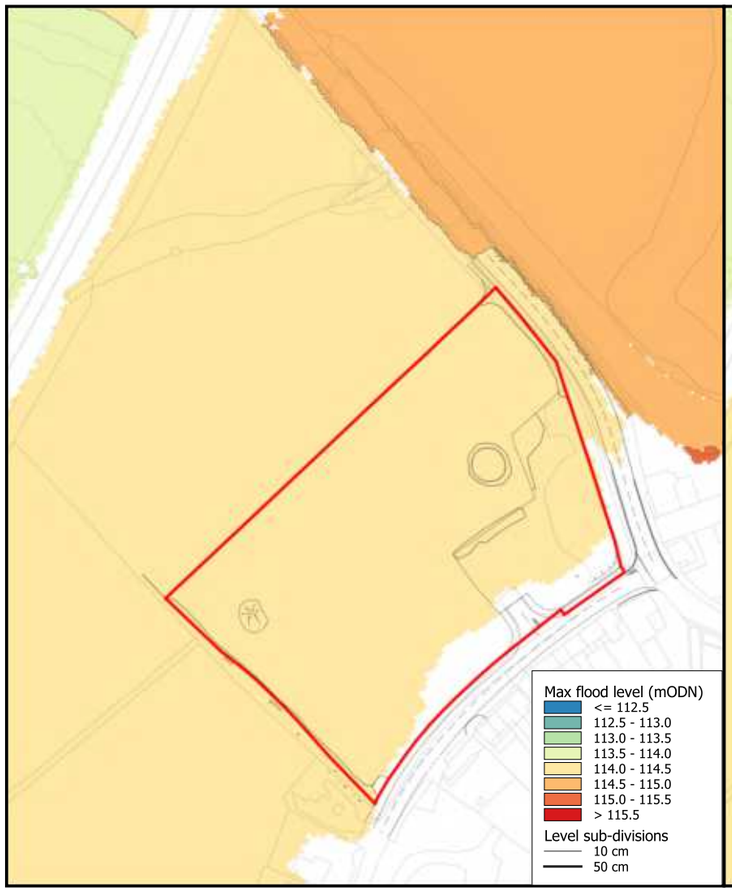

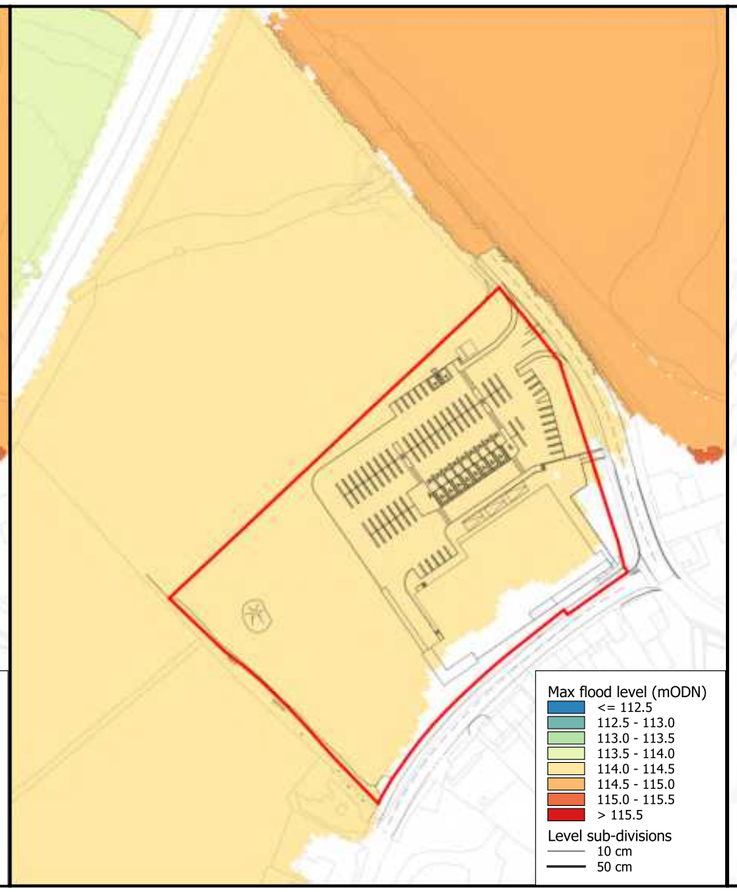

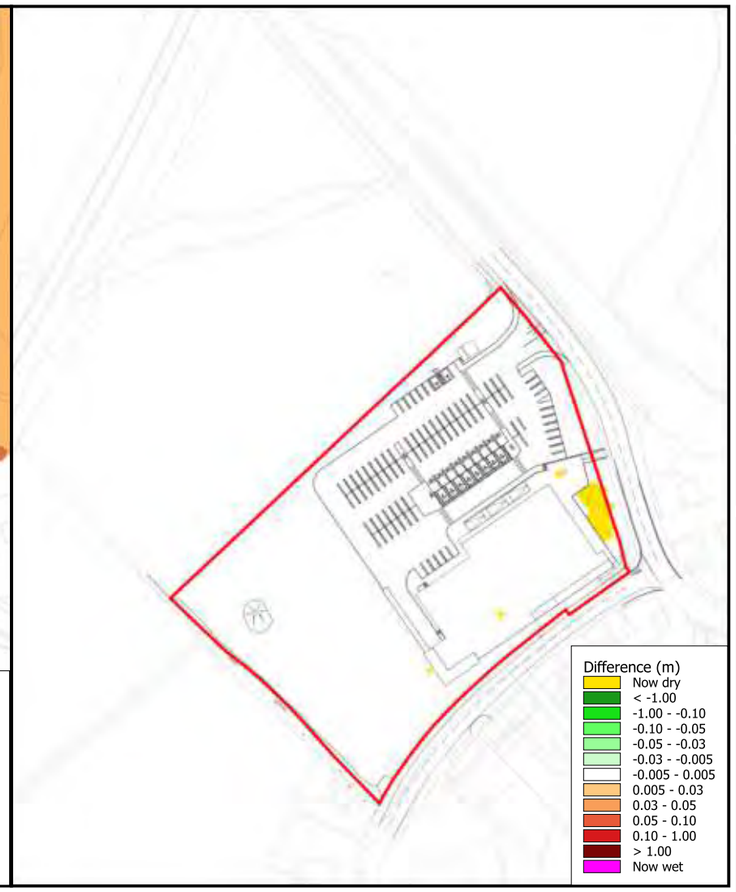

20 0 20 40 60 80 m

N

TITLE

POST DEVELOPMENT IMPACT
1%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

EXISTING | POST DEVELOPMENT | IMPACT

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LIDL, LAMPETER

SCALE	PROJECT No.	INITIALS	CHECKED BY
1: @ A3	4112	NW	--

DRAWING No.
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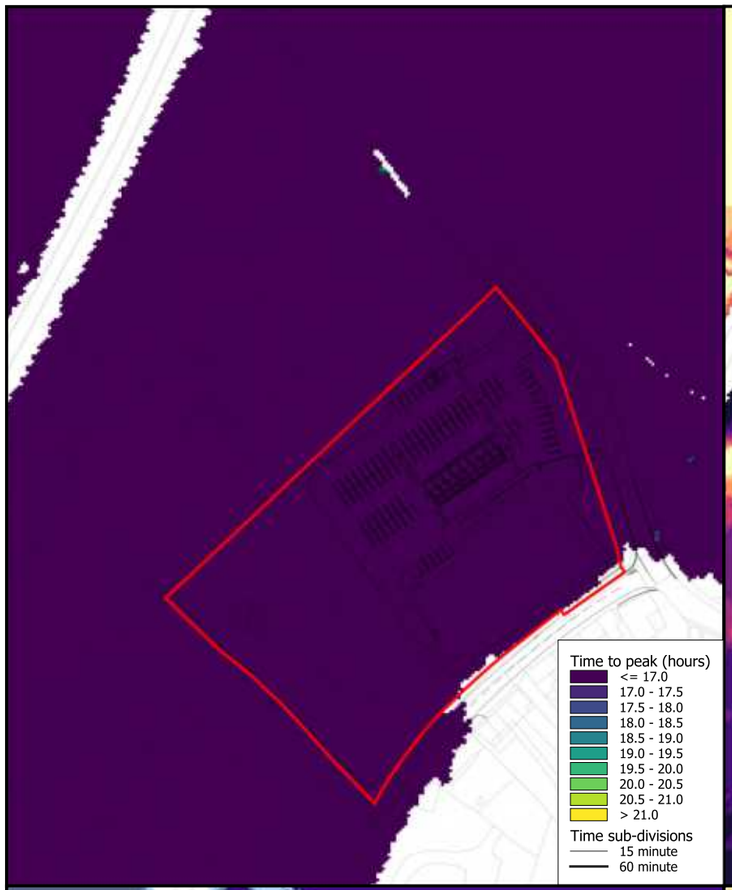

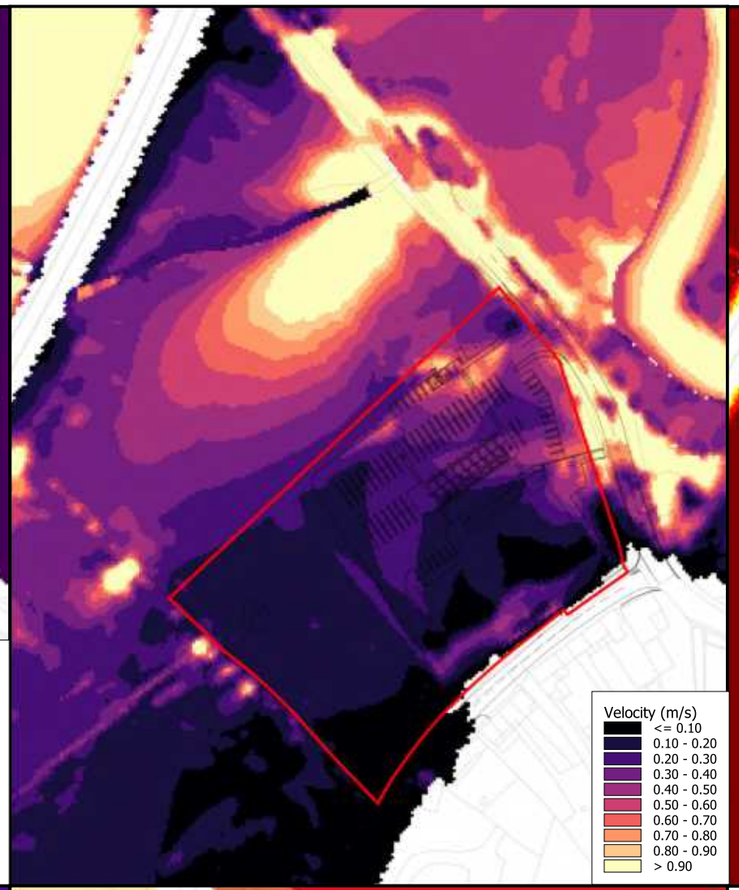

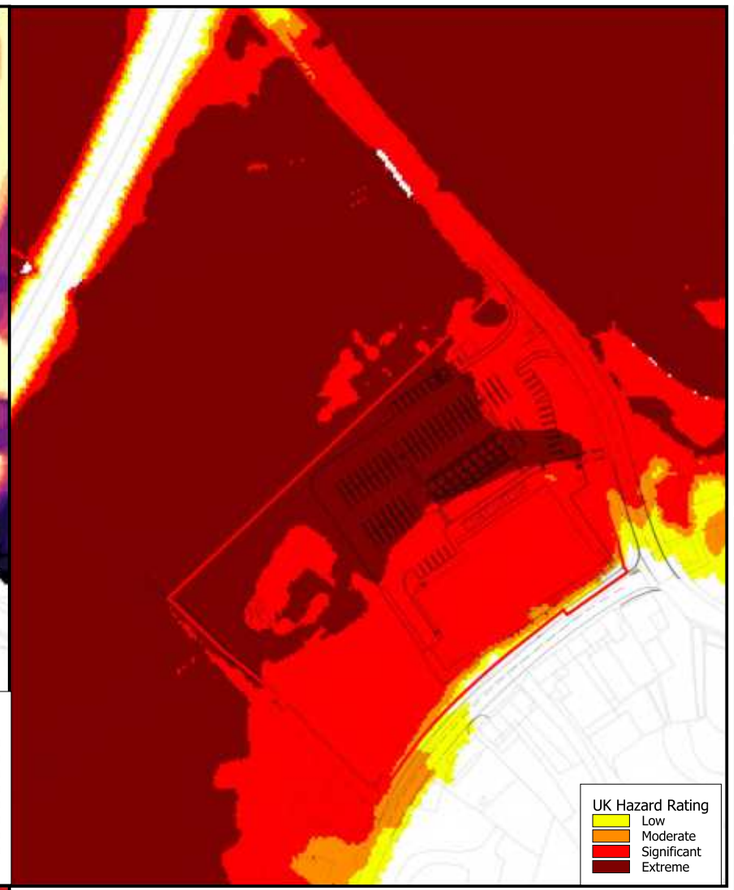

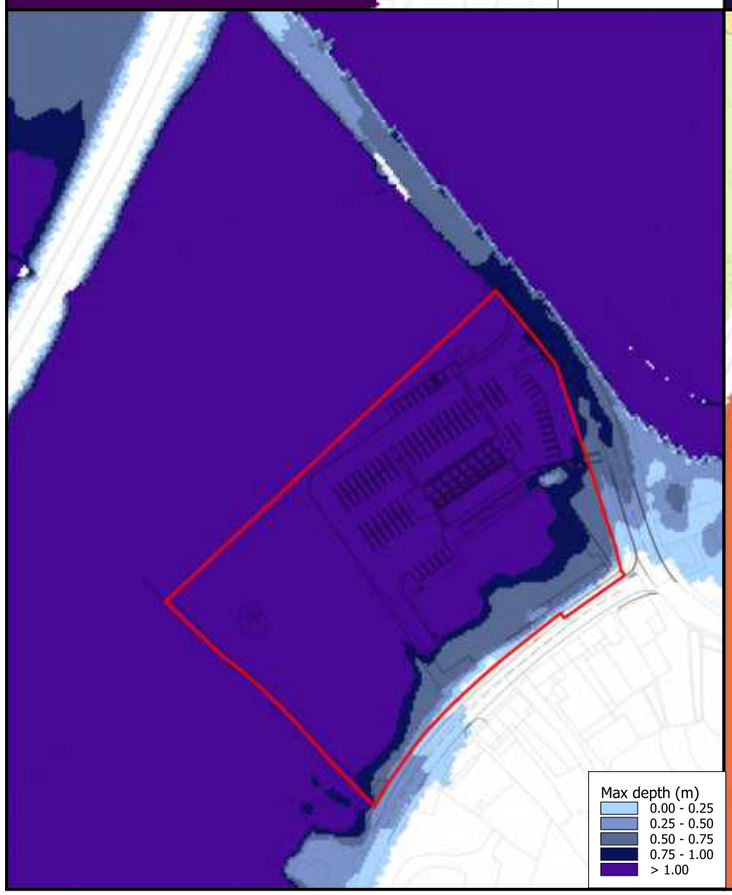

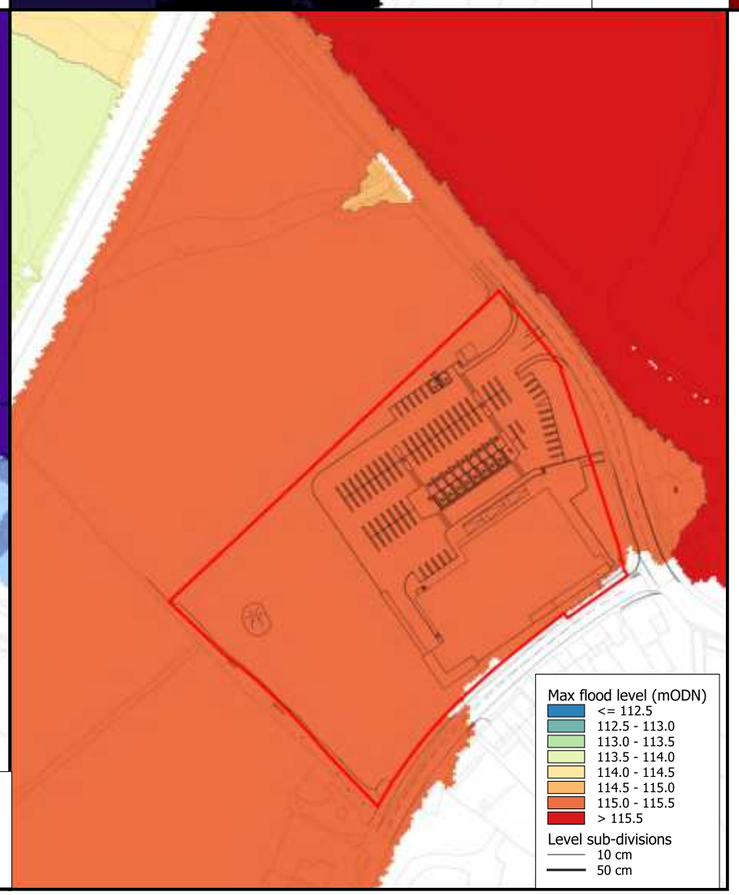

20 0 20 40 60 80 m

N

TITLE

POST DEVELOPMENT
0.1%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

NOTES

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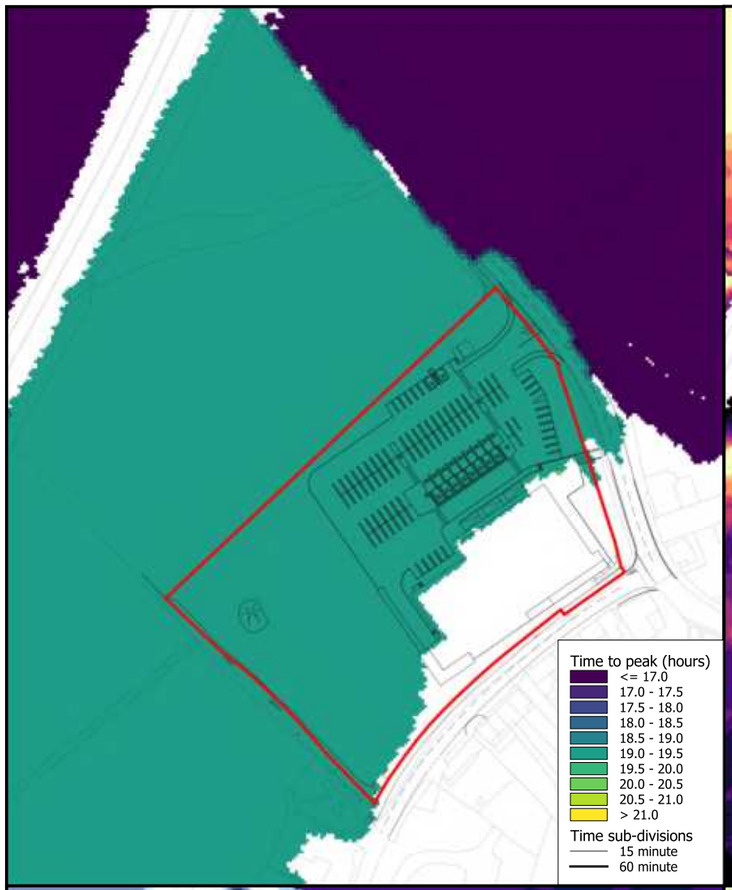
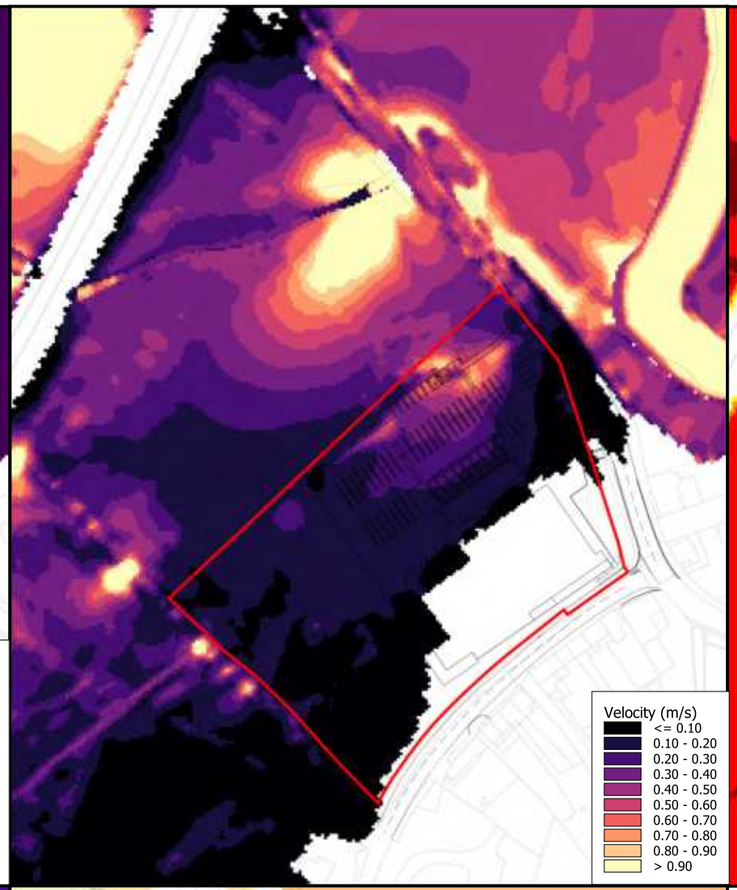
PROJECT
LIDL, LAMPETER

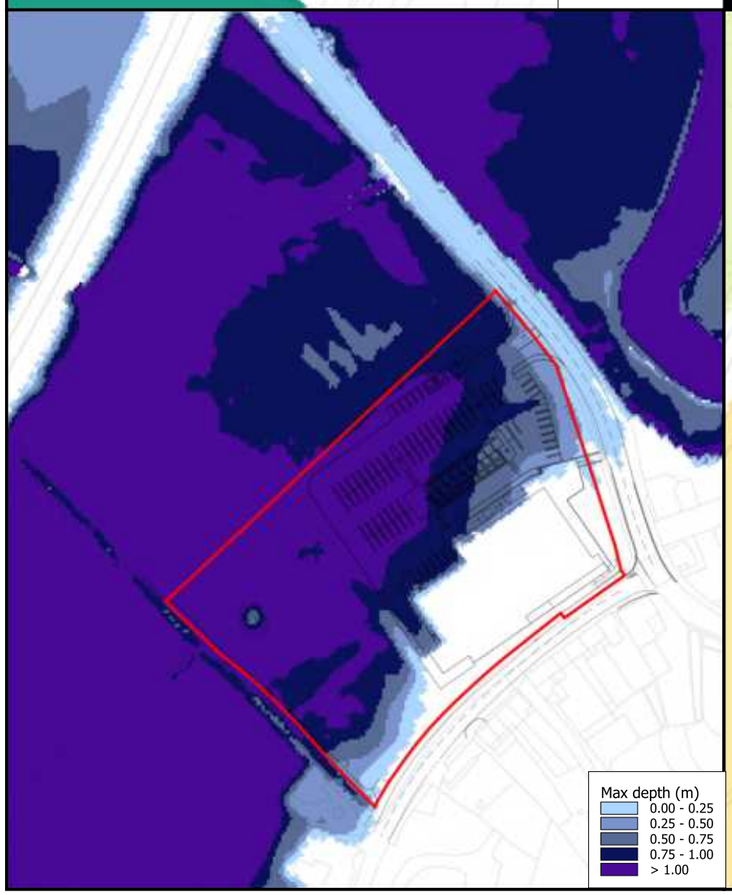
SCALE	PROJECT No.	INITIALS	CHECKED BY
1:2191 @ A3	4112	NW	--

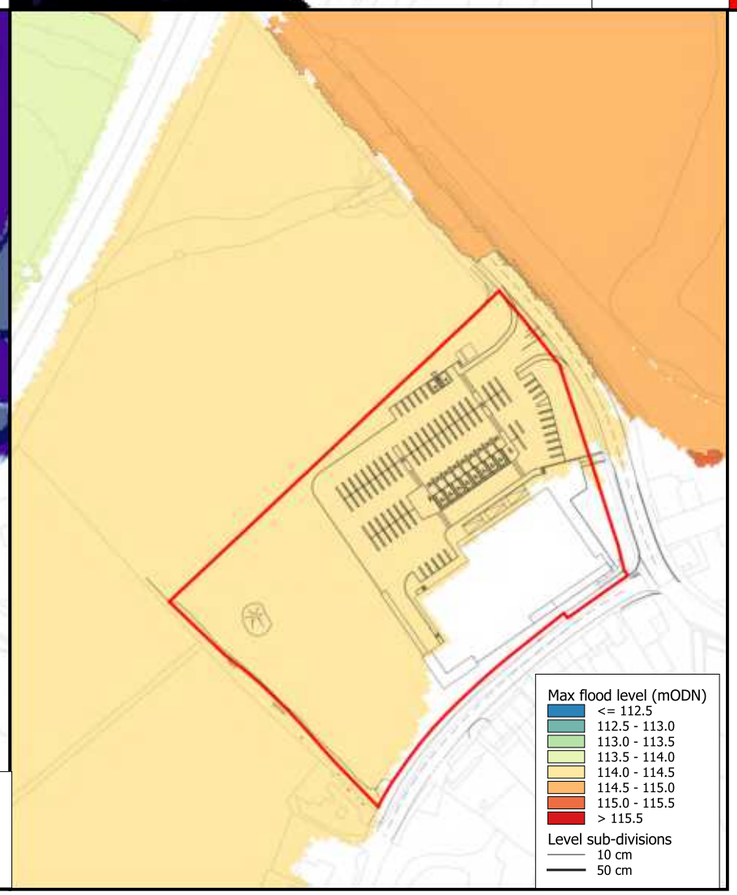
DRAWING No.
B.3

Appendix G – Sensitivity Results









20 0 20 40 60 80 m

N

TITLE

POST DEVELOPMENT
1%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

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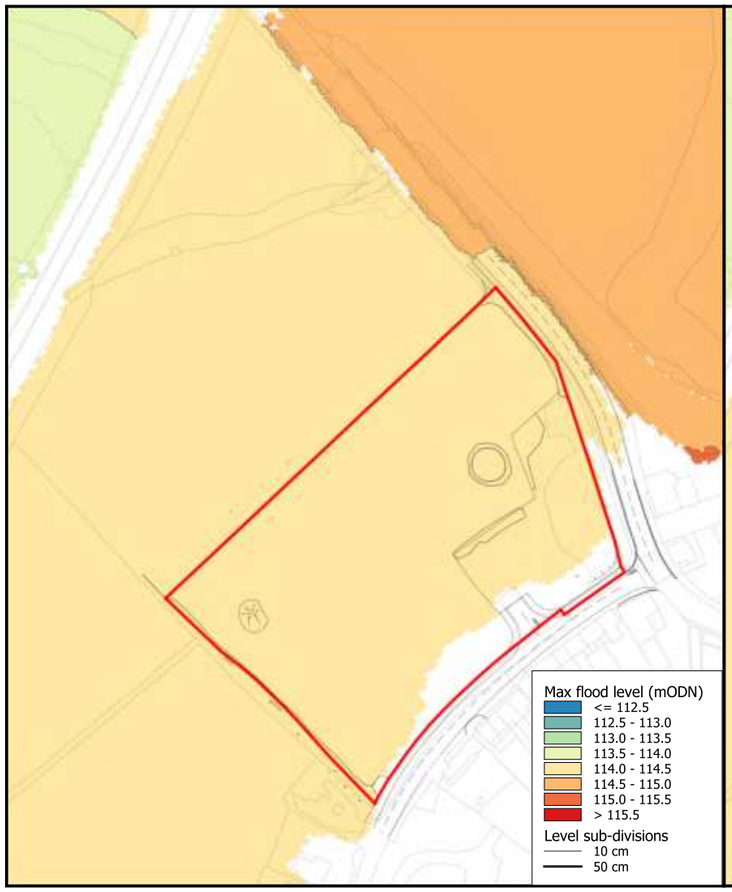
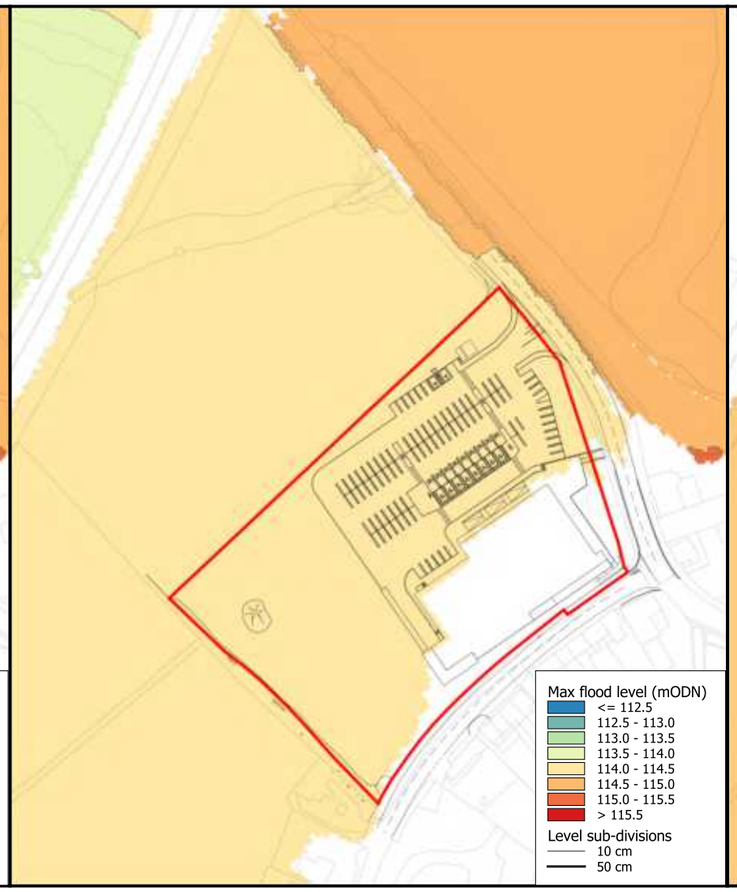
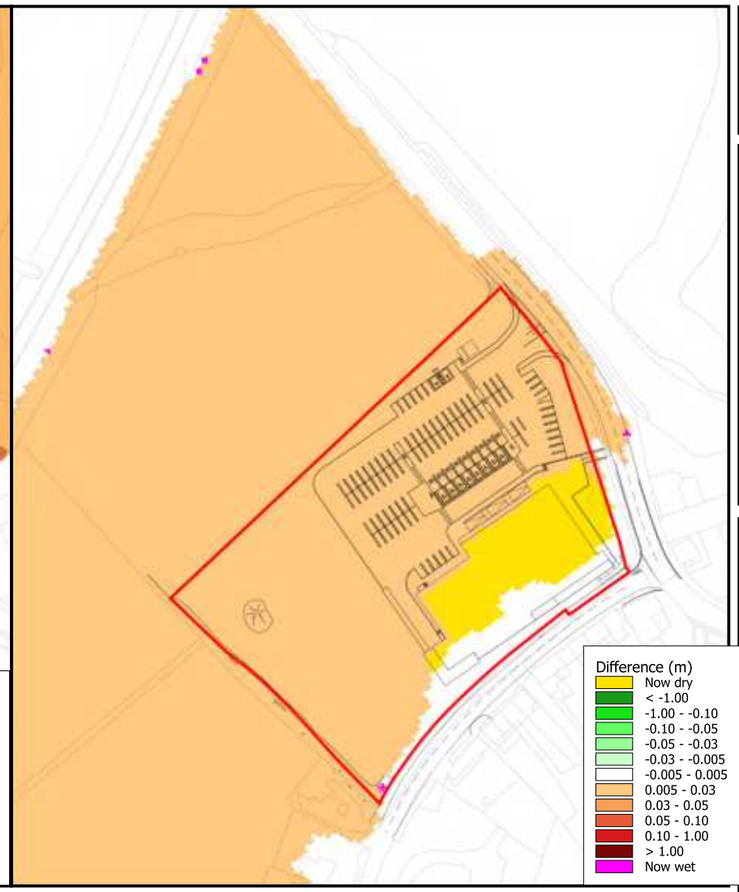
PROJECT
LIDL, LAMPETER

SCALE	PROJECT No.	INITIALS	CHECKED BY
1:2191 @ A3	4112	NW	--

DRAWING No.
C.1







20 0 20 40 60 80 m

N

TITLE

POST DEVELOPMENT IMPACT
1%AEP EVENT
YEAR 2125

LEGEND

Site boundary

DETAILS

EXISTING | POST DEVELOPMENT | IMPACT

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6	6th issue	16-12-2025

CLIENT: LUCION GROUP

PROJECT: LIDL, LAMPETER

SCALE	PROJECT No.	INITIALS	CHECKED BY
1: @ A3	4112	NW	--

DRAWING No.: **C.2**

Appendix H – Hydraulic Modelling Report

Lucion
Protecting people and planet

Technical Note: Updating the NRW Lampeter Fluvial Flood Model for a Proposed Lidl Store

Author(s): N. West BSc MCIWEM

Checked by: S. Maiden-Brooks BSc. (Hons) MSc. C.Eng C.WEM MCIWEM

Project: 4112 – Lidl Lampeter

Date:	18 December 2025
Revision:	5th ISSUE

1. Background Information

1.1. Herrington Consulting (now Environmental Protection Strategies; EPS) has been commissioned to undertake numerical flood modelling for a proposed Lidl Store in Lampeter, Wales. The purpose of the modelling is to support a Flood Risk Assessment (FRA; undertaken by Lucion Group Ltd) and planning application for a new, single, commercial unit. The location of the site is shown in Figure 1.

1.2. This technical note details the adjustments and updates to the existing Lampeter and Llanybydder Fluvial model provided by Natural Resources Wale (NRW) to represent the existing conditions on site, followed by the representation of the development and use of the model to determine the impacts of fluvial flooding.

Figure 1 – Site location (uses OpenStreetMap data)

1.3. A topographic survey of the site has previously been undertaken in late 2024 by EMP Surveys Ltd and has been made available to inform this modelling study. A copy of the topographic survey drawing has been enclosed with this technical note.

2. Numerical Flood Model – Conceptual Overview

2.1. The existing NRW model of Lampeter and Llanybydder was published in 2016 and therefore requires updating. The recommendation to update the model comes from NRW and included the requirement to update the input hydrology. The modernisation of the input hydrology has been documented separately in *"4112_Flood estimation calculation record GN008"*.

3. Numerical Flood Model - Technical Methodology

3.1. Natural Recourses Wales made several recommendations:

- Use the Latest Version of the TUFLOW software
- Update the model grid with the latest available LiDAR
- Review the 1d/2d linkages in the model
- Update bridge unit coefficients
- Determine if OS MasterMap data is required to be updated and update where required
- Consider reduction (shortening) of the model domain
- Review and update the hydrology
- Review whether additional survey data is required for the project
- Check and update climate change allowances

3.2. **Software version**: The TUFLOW version TUFLOW_2025_1_1_w64 has been used in the project. This version only became available after the original model build and before the model was sent for external review. Adoption of this model version was recommended as part of the model review so that recently introduced functionality could be employed. Following TUFLOW recommendations the single precision executable has been used exclusively for the project. The TUFLOW Highly Parallelised Computation (HPC) using Graphical Processing Unit (GPU) approach has been used to ensure the detail is captured and capitalises on improved model run times to allow the large domain to be modelled efficiently and with the latest formulations for roughness and viscosity.

3.3. **LiDAR update**: The model grid has been updated with the latest composite LiDAR from 2022.

3.4. **Model 1D/2D domain linkages**: (**pre-review model setup**) The 2016 model included no widespread implementation of 'bank levels' except for a couple of select locations, relying instead on the LiDAR-derived levels in the 2D model grid to control flow out of the 1D channel domain into the 2D floodplain domain. Typically, bank levels are applied to a 2D model along the connection with the 1D model domain using 2d_zsh lines and points (calling the THICK command) derived from either topographic and survey or watercourse survey profiles. No such

bank levels have been applied in the 2016 model. However, the original 1D channel profile cross section data included easting and northing data, and therefore it has been possible to retrospectively extract the bank levels from the profiles and apply them to the model instead of solely relying on the LiDAR. There has been no discernible impact to the model behaviour due to this alteration as the update to the hydrology dominates.

3.4.1. (**post-review alterations**) The additional bank lines for the new model have been removed on recommendation. A cursory review of bank positions relative to the 2022 composite LiDAR has been undertaken, but considering that the flood water depths on the floodplains are greatly in excess of the bank levels minimal intervention to adjust the bank positions have been made.

3.5. **Bridge coefficients**: The recommendation is for the loss coefficient 0.001 to be applied. This has been implemented throughout for all BB type units. There is no discernible impact to the model due to this alteration as the update to the hydrology dominates.

3.6. **MasterMap materials layer**: A review the latest MasterMap data suggests that there are no significant updates to the land use types near the site that are likely to impact the model. Therefore, the original materials layer has been retained without change.

3.7. **Domain reduction**: The 2016 model includes two 2D domains; one at Lampeter (upstream), and another at Llanybydder (downstream). These two domains are joined by a pure 1D representation of the channel and floodplain, 4.5 km long, that joins them. This arrangement conveniently presents the opportunity to curtail the model near the downstream end of the Lampeter 2D domain. This approach reduces the overall model size significantly, as well as reducing the scope for the update to the hydrology, which has been limited to the inflows connected directly to the Lampeter domain only. This also has a benefit for model run-times and general usability.

3.8. **Review and update hydrology**: The model input hydrology has been updated as detailed fully in *"4112_Flood estimation calculation record GN008"*. Overall, the update to the hydrology increases the flood levels throughout the model.

3.9. **Additional survey data**: The site has been surveyed in late 2024 and the data used to augment the model gird. Further survey has been undertaken of the ordinary watercourses and structures near to the site. This is detailed further in Section 4.5.

3.10. **Climate change allowances**: The climate change allowance applied to represent the 2125 epoch is +30%.

4. Additional model alterations and modernisations

4.1. The 2016 model included a separate simulation that generated the initial conditions for all other simulated extreme events. Preferentially, the initial conditions for the model have now been

incorporated into each event simulation so that the initial conditions simulation does not need to be re-run for alterations to the model.

4.2. This process begins with an initial multi-hour model run to establish a low-flow condition (sub-50%AEP) with a single (non-varying) discharge rate input to the 1D model. This single 'static' rate has been chosen arbitrarily such that no flows leave the 1D channel. The output of this simulation has been poled to extract the water level at each 1D node and then populate a 1d_iwl type file.

4.3. Following the establishment of a non-flooding water level in the channel, all subsequent model simulations begin at time –10 hours (minus ten hours), such that the model has full opportunity (10 hours) to stabilise with a meaningful in-channel flow before reaching the beginning of the true hydrograph at time equals zero. This additional run-time adds a small but minimal overhead to the model duration, although ensures that the model is stable and clear of any model initialisation effects and any impacts that could have.

4.4. Significant effort has been applied to the eradication of negative depths from the model simulation. Measures applied include:

4.4.1. Provision of improved initial conditions and model startup stabilisation period (discussed in Section 4.2 and Section 4.3).

4.4.2. Reintroduction of the channel downstream of bridge DL_0061B before the connection with the main river channel TE_15471U. This provides new S-type open channel unit DL_0061D. Difficulties remain with the initialisation of the model for this connection between the DL_and main channel TE_ such that negative depths still occur, although these are limited to a few timesteps during the startup phase of the model and they do not impact the model results. To minimise the duration and impact of the negate depths here the Manning's n value has been increased to 0.06. However, a review of a popular online mapping data source suggests that this is a realistic value for this section of the watercourse where there is significant vegetative growth in-channel.

4.4.2.1. A WW type unit has been trialled as an alternative option for assisting stability at units DL_0061. However, this was found not to provide the benefits sometimes possible with such an approach. The unit DL_0061D_WW has been left in the model 1d_nwke file, unconnected, for posterity and deactivated with the ignore = T flag (**post-review adjustments now see the removal of such superfluous network units by recommendation**).

4.4.3. The 2016 model applied a WW unit at the immediate downstream side of the TE_15495BM bridge unit. The cross-section data for this WW unit was identified as being identical to the bridge downstream cross section. Such an approach is traditionally applied to assist the stability of bridge units. However, in this instance it appears to no longer be a requirement

for model stability, with any negative depths quashed by the new and improved initial conditions. Therefore, the superfluous TE_15485_BW weir unit has been left disconnected from the network and deactivated with the ignore = T flag but remains present in the model for posterity (**post-review adjustments now see the removal of such superfluous network units by recommendation**).

4.5. The watercourses and structures nearby the site have been updated with new survey data. The structures beneath the nearby disused railway embankment are particularly critical to flows leaving the flood compartment in which the site lies. New survey has only been undertaken where access permissions allow, and thus the extent is confined to the upstream side of the railway embankment. However, this has facilitated the correction of the dimensions of some of the structures beneath the embankment with their actual sizes and levels, as well as the inclusion of the conduit SN 57879 47077 that was not present in the 2016 model.

4.5.1. A total of three conduits for ordinary watercourses beneath the embankment are now present in the model. The ordinary watercourses upstream of the embankment are also included where possible. However, the 'central' set of ditches has been excluded due to the difficulty in stabilising the model where three separate ditches converge at SN 57958 47221. The stability of the model is critical in this area as it represents the flood-compartment in which the site is located, and therefore any model-effect that would impact the model results cannot be tolerated. Therefore, the conduit beneath the embankment has been connected to the 2D domain with an SX-type connection in the absence of a 1D representation of the complex converging ditches.

4.5.2. (**post-review adjustments**) The SX connection to the conduit beneath the A482, FD1_CulvR, has been narrowed to match the width of the culvert inlet, and a short artificial section of open channel inserted between the SX connection and the culvert. The artificial section of open watercourse helps to smooth the flows through the culvert and the ditches downstream.

4.5.3. (**post-review adjustments**) The watercourse 'FD1' exhibited significant oscillations in flows that remained entirely stable once past the wetting during initial conditions. After significant investigation these oscillations were traced to the interaction between the left and right bank HX connections for the ditch. On review, the watercourse was no wider than the model grid resolution which provided insufficient separation between the banks. Therefore, the ditch is no longer excluded from the 2D domain and a single HX connection at the ditch centreline has been used to link the 1D and 2D domains here. In the 2D domain the channel is filled artificially to allow the 1D channel representation to be stamped into the 2D grid. This approach irradicates the oscillations in the flows at this location.

4.6. (**post-review adjustments**) Significant oscillations in flow have been traced to the floodplain conduit, TE_15495BL, that runs parallel to the main river bridge beneath the A482. After

extensive testing, the source of the oscillations have been identified to be a result of feedback between the HX connection of the main river to the floodplain and the SX connections for the conduit. The two main solutions to this are to either shorten the HX connections for the main river so they do not interact with the SX connections, or to insert an artificial bank line to prevent exchange through the HX boundary at this location. The later solution has been employed, with a 15 m upstream and 22 m downstream artificially high river bank added.

4.6.1. (**post-review adjustments**) The model review also suggested that conduit TE_15495BL would be better represented as an irregular culvert instead of as a bridge unit, and therefore, the unit has been switched to an irregular culvert. Additionally, short artificial open channel units have been inserted between the unit's SX connections and its inlet and outlet which help to prevent any interactions between the closely positioned boundary connections at structures at this location.

4.7. The 2d_fsch flow control file applied in the 2016 model is not compatible with the latest TUFLOW model engine and therefore has been translated without alteration into the new format 2d_lfcsh layered flow control file type to continue representing buildings in the same manner. (**post-review adjustment**) The 2d_lfcsh file has been adjusted to include an obvert level to ensure that the first layer has a definitive thickness applied in the model.

4.8. The model applies a spatially varying Manning's n roughness based on the land use types of the Ordinance Survey MasterMap and the values proposed by Chow (1959). The land types and values applied have been taken directly from the 2016 model without alteration. On review, values had already been attributed to facilitate the use of the 'M' flag in the 1D model setup, which is greatly preferable to the practice of using the 'N' flag and specifying the Manning's values directly in the cross-section date.

4.8.1. A similar review of the land use types with the current mapping did not identify any new features or significant alterations that were expected to alter the model results with any significance. Therefore, the materials definition layers from the 2016 model have been reused. The only exception is the exclusion of the patches of increased Manning's n value termed 'stability'. With the modernisation of the model and general corrections made, such an approach has not been required.

4.9. Seven extreme flow events have been simulated within the model as per the recommendations of NRW modelling guidance, including:

- 1 in 2 year return period event (50%AEP, Annual Exceedance Probability), without climate change;
- 1 in 10 year return period event (10%AEP), without climate change;
- 1 in 30 year return period event (3.3%AEP), with and without climate change;
- 1 in 75 year return period event (1.25%AEP), without climate change;
- 1 in 100 year return period event (1%AEP), with and without climate change;

- 1 in 200 year return period event (0.5%AEP), with and without climate change;
- 1 in 1,000 year return period event (0.1%AEP), with and without climate change.

4.10. The full details of the derivation of the flood hydrographs for the above events has been documented in *"4112_Flood estimation calculation record GN008"*. The duration of the events has been tested for 10.5 hour, 15.5 hour, and 20.5 hour. The 20.5 hour duration provided the largest flood extent and depth on site for the 1%AEP event. However, this was only just slightly greater than the 15.5 hour event and therefore the decision was made to not test a longer duration event than the 20.5 hour.

4.11. Table 1 lists the models run for the TUFLOW baseline conditions proposed development design test. All simulations use the TUFLOW control file *4112_Lidl_~s1~_~e1~_~s2~.tcf*. All baseline simulations are designated *B3* while the proposed development condition is designated *C3*.

Scenario	s1	e1	s2	Comment
Existing conditions	B3	Q0002	000	50%AEP
		Q0010		10%AEP
		Q0030		3.3%AEP
		Q0075		1.25%AEP
		Q0100		1%AEP
		Q0200		0.5%AEP
		Q1000		0.1%AEP
		Q0030cc30		3.3%AEP +climate change
		Q0100 cc30		DESIGN CONDITION: 1%AEP +climate change
		Q0200 cc30		0.5%AEP +climate change
		Q1000 cc30		0.1%AEP +climate change
		Q0100 cc30	BL1	RESIDUAL RISK: Closest railway embankment culvert blocked by 50%
Proposed Development	C3	Q0100 cc30		IMPACT SCENARIO
		Q1000 cc30		FEP evaluation scenario

Table 1 – List of model simulations with corresponding events

4.12. Table 2 lists and describes the files used in the TUFLOW model setup, including geometry files, boundary files for both 2D and 1D. The description includes notes on whether the file is original to the 2016 model (only converted to SHP file type from MapInfo type), has undergone modification, or is a new file introduced for this study.

File name	Description
2d_code_4112_Active_Area_C_R	MODIFIED: The original domain has been gelded to represent Lampeter only
0d_rl_4112_lam_A_L	MODIFIED: New check lines added for hydrology checks
1d_bc_4112_QT_HT_lam_B_P 1d_bc_4112_QT_HT_lam_B_R	NO CHANGE: 1D inflows
2d_mat_4112_Materials_lam_B_R 2d_mat_4112_Proposed_surfaces_roughness_A_R	MODIFIED: Gelding of the existing materials layer to the Lampeter domain only NEW FILE: roughness representation of the proposed carpark
1d_bc_4112_sweeteners_A_P	NEW FILE: Sweetener flow added to stabilise minor watercourses
1d_iwl_4112_Wetted_channel_A_P	NEW FILE: New initial conditions file
1d_nwke_4112_DrainStructures_A_L	NEW FILE: Network structures associated with minor watercourses (new survey)
1d_nwke_4112_FieldDrains_B_L	NEW FILE: Minor watercourses (new survey)
1d_nwke_4112_LidlLampeter_A_L	NEW FILE: Modernised and stabilised main river network, incorporates original floodplain conduits and new ditches
1d_WLL_Original_lam_A_L	MODIFIED: 1D output file
1d_xs_4112_Bridges_lam_A_L	NO CHANGE: Cross-sections reference file for bridges from original model
1d_xs_4112_Field_Drains_B_L	NEW FILE: Cross-section deference file for minor floodplain watercourses (new survey)
1d_xs_4112_Original_lam_B_L	NO CHANGE: Cross-sections reference file from original model (main network)
2d_bc_4112_FieldDrains_B1_L	NEW FILE: 1D/2D boundary links for new minor watercourses
2d_bc_4112_HQ_B_L	NEW FILE: Boundary outflow conditions for Lampeter domain
2d_bc_4112_SX_FP_culv_C_L 2d_bc_4112_SX_FP_culv_C_R	NEW FILE: Boundary connections for new minor watercourses

2d_bc_4112_SX_lam_A_L 2d_bc_4112_SX_lam_A_R 2d_bc_4112_HX_lam_B_L	MODIFIED: 1D/2D boundary links for original model, minor corrections applied.
2d_lfcsh_4112_buildings_lam_B_R	MODIFIED: Converted to new file format
2d_loc_4112_Grid_A_L	NO CHANGE: Grid orientation from original model
2d_mat_4112_Materials_lam_B_R	MODIFIED: gelded to Lampeter domain only
2d_zsh_4112_2D_ditches_A_L 2d_zsh_4112_2D_ditches_A_P	NO CHANGE: 2D ditches from original model
2d_zsh_4112_banks_lam_A_L 2d_zsh_4112_banks_lam_A_P	NO CHANGE: Bank levels from original model
2d_zsh_4112_bridge_deck_A_P 2d_zsh_4112_bridge_deck_A_R	NO CHANGE: Bridge decks from original model
2d_zsh_4112_bridge_parapet_A_L 2d_zsh_4112_bridge_parapet_A_P	NO CHANGE: Bridge parapets from original model
2d_zsh_4112_Extracted_XS_banks_B_L 2d_zsh_4112_Extracted_XS_banks_B_P 2d_zsh_4112_2024_bank_adjustments_A_L	NEW FILE: Bank levels along the original watercourse. Originates from original survey data. And adjustments/corrections for LiDAR ‘holes’
2d_zsh_4112_FD1_levels_A_P 2d_zsh_4112_FD1_levels_A_R	NEW FILE: bank levels along the minor watercourses
2d_zsh_4112_FieldDrains_B_L 2d_zsh_4112_FieldDrains_B_P	NEW FILE: Representation of minor watercourses in the 2D domain
2d_zsh_4112_FD1_infill_A_R 2d_zsh_4112_FD1_infill_A_P	NEW FILE: Post-review infill of field drain no.1 to coincide with the switch to a single HX connection line for the ditch
2d_zsh_4112_headwall_A_L	NEW FILE: headwall at the downstream side of the main road
2d_zsh_4112_roads_lam_A_L 2d_zsh_4112_roads_lam_A_P	NO CHANGE: Representation of roads from the original model
2d_zsh_4112_wall_A_L 2d_zsh_4112_wall_A_P	NO CHANGE: Representation of walls from the original model
2d_zsh_4112_boundary_separator_A_L	NEW FILE: artificial bank to separate the HX connection of the main river channel from the SX connection in the

	floodplain (prevents unwanted feedback loop and flow oscillations)
2d_zsh_4112_SubSlab_groundworks_A_R	NEW FILE: alteration of ground levels beneath proposed floor slab
2d_ztin_4112_dem_modified_A_P 2d_ztin_4112_dem_modified_A_R	NO CHANGE: grid edits for specific features
2d_ztin_4112_underpass_approach_A_P 2d_ztin_4112_underpass_approach_A_R	NO CHANGE: representation of the underpasses beneath the main road
4112_Lampeter_2022_merge_A 4112_Topo_minus_LiDAR_A	NEW FILE: Updated LiDAR from the 2022 composite. And the implementation of the site topographic survey levels corrections to the model grid.
2d_zsh_4112_Proposed_Levels_B_R 2d_zsh_4112_Proposed_Levels_B_P 2d_lfcsh_4112_VoidSlab_A_R 2d_lfcsh_4112_VoidSlab_A_L	NEW FILES: Representation of the proposed development.

Table 2 – TUFLOW model files

5. Post Development Scenario

5.1. The post-development condition includes a commercial unit positioned where the highest ground levels are found on-site and a car park positioned in the lower portion of the site, Figure 2. The levels in the car park represent a slightly lowering compared to the existing ground levels. The building is placed on top of a 0.5 m thick slab with a void beneath where ground levels remain largely untouched. The finished flood level atop the slab is at 115.05 mODN. (*post review adjustments*) The ground levels beneath the proposed slab have been curtailed to no higher than the underside of the slab at 114.55 mODN.

Figure 2 – Landscaping of the development car park

5.2. The building slab has a variable height void beneath. The slab has been represented with a layered flow control, 2d_lfcsh type, where the blockage to flow by the slab itself is 100%. The extent of the slab is shown in Figure 3.

5.3. The void beneath the store is open fronted through a series of arched openings, and example of which is shown in Figure 4. An analysis of the openings suggests an overall blockage to flow is 55%. To represent this obstruction a linear layered flow control, 2d_lfcsh type, has been applied along the front of the raised slab. This slows flow into the void beneath the building.

5.4. (**post-review adjustment**) The model of the proposed scheme now includes a 6% blockage to flow beneath the slab to represent the support structures, although these are subject to detailed design and therefore the selection of 6% represents an arbitrarily higher blockage than is likely to remain conservatively high.

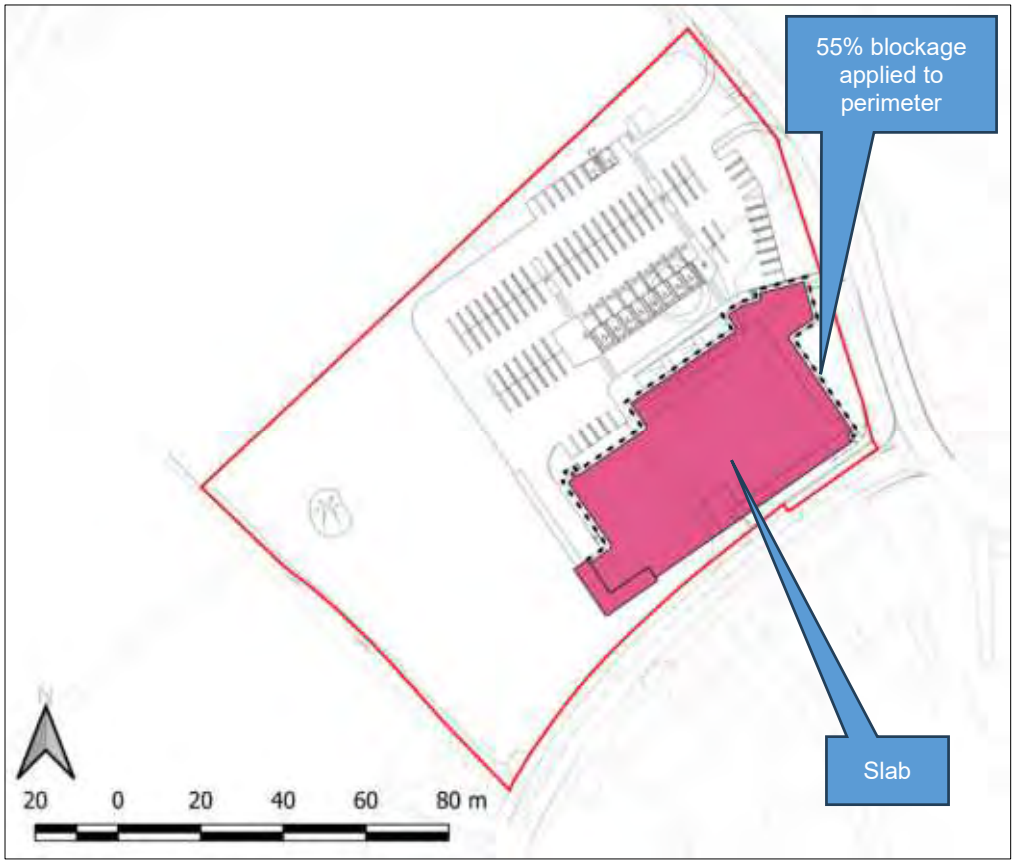


Figure 3 – Building representation

Figure 4 – Example of void openings present on the front and both sides of the building slab

6. Simulation Messages

6.1. The model simulation reports several checks and warnings which have been investigated and found not to have any implications for the model results. These checks and warnings have not been investigated further.

6.1.1. The following message has been attributed to the complex initial conditions near to the confluence of the DL_ watercourse and the main channel. These messages are short-lived and do not impact the model results. Much effort has been applied to the model to ensure the best possible stability which is discussed in Section 4.4.

- WARNING 1991 - -9:59:26: Negative depth at Node DL_0061D.2: y = -0.14 Bed = 111.54 Iter =1

6.1.2. There are several further negative depth warnings during the 10% and 3.3% AEP events nearing, and just after, the peak of the events. These negative depth reports are exclusive to these events only, are located near the downstream model boundary, and occur for a moderate duration. On detailed investigation, the impact of these negative depths on flows and levels are confined to within 300 m of the downstream boundary and do not impact the results at the site or its surroundings.

6.1.2.1. Based on the investigation of these negative depths, no further actions have been taken to quell them as their impacts are non-material with respect to the model results.

7. Results

7.1. The full set of graphical model results are appended to this technical report and are listed in Table 3. Table 3 also includes a summary of the mean and maximum parameter values from the site (minimum values have been excluded as these tend to be zero). The light-blue highlighted rows are the design condition (existing scenario) and impact condition (post development), provided for ease of comparison.

Scenario	Event	Epoch	Mean level (mODN)	Max level (mODN)	Mean depth (m)	Max depth (m)	Mean velocity (m/s)	Max velocity (m/s)	Mean time to peak (hr)	Max time to peak (hr)	Mean hazard (-)	Max hazard (-)
Existing	Q0002	2025	113.52	113.72	0.06	0.33	0.04	0.27	16.93	18.69	0.54	1.17
	Q0010		114.02	114.03	0.43	0.96	0.11	0.57	19.86	20.15	1.14	1.52
	Q0030		114.18	114.18	0.55	1.12	0.12	0.57	20.28	20.45	1.23	1.60
	Q0075		114.28	114.29	0.63	1.22	0.12	0.57	20.59	20.66	1.29	1.66
	Q0100		114.30	114.31	0.65	1.24	0.12	0.57	20.83	20.93	1.31	1.67
	Q0200		114.37	114.38	0.71	1.31	0.12	0.57	20.26	20.29	1.35	1.70
	Q1000		114.75	114.75	1.03	1.69	0.15	0.97	18.50	18.55	1.62	1.99
	Q0030	2125	114.30	114.31	0.65	1.24	0.12	0.57	21.36	21.46	1.31	1.67
	Q0100		114.46	114.47	0.79	1.40	0.12	0.74	19.09	19.16	1.41	1.76
	Q0200		114.69	114.69	0.98	1.63	0.14	0.90	19.03	19.10	1.58	1.94
	Q1000		115.12	115.12	1.37	2.06	0.20	1.25	16.52	16.61	1.81	2.34
Post Development	Q0100		114.46	114.47	0.84	1.57	0.14	0.97	19.08	19.16	1.45	1.90
	Q1000		115.16	115.19	1.44	2.26	0.22	1.08	16.50	16.54	1.87	2.45

Table 3 - List of presented model results and mean and maximum parameter values extracted from site.

7.2. The tabulated results show the minor average lowering of the flood level on site because of the development. This is a combination of the effect of the slight lowering of the car park and the void under the building which has a minimal impact on displacement.

7.2.1. Overall, the mean flood level on site reduces by 0.01 m, while the maximum remains the same in the post-development scenario.

7.2.2. Figure 5 reproduces the impact results from appended figure B.2 and shows that the impacts to flood level are contained on-site (please see additional notes on model sensitivity, Section 9).

7.2.3. The most apparent impact on site is the drying of some areas that would otherwise be wet during the existing conditions.

7.2.4. All predicted flood levels remain lower than the proposed finished floor level of the store, except for future 0.1% event (including climate change) which could exhibit a flood level of 115.19 mODN, or 0.14 m above the finished floor level.

Figure 5 – Post Development impact on flood level (1%AEP in 2125)

7.3. The slight lowering of the car park for the development results in a slight increase in depths on site, and a subsequent increase in the velocity also. These combine to increase the hazard rating on-site for the post-development scenario.

7.3.1. However, a review of the hazard ratings for the existing and post development scenario side-by-side, Figure 6, reveals that there is no materially significant change to the hazard rating with the presence of the development. Notably there is a reduction in the rating beneath the building, but this can be considered non-impactful.

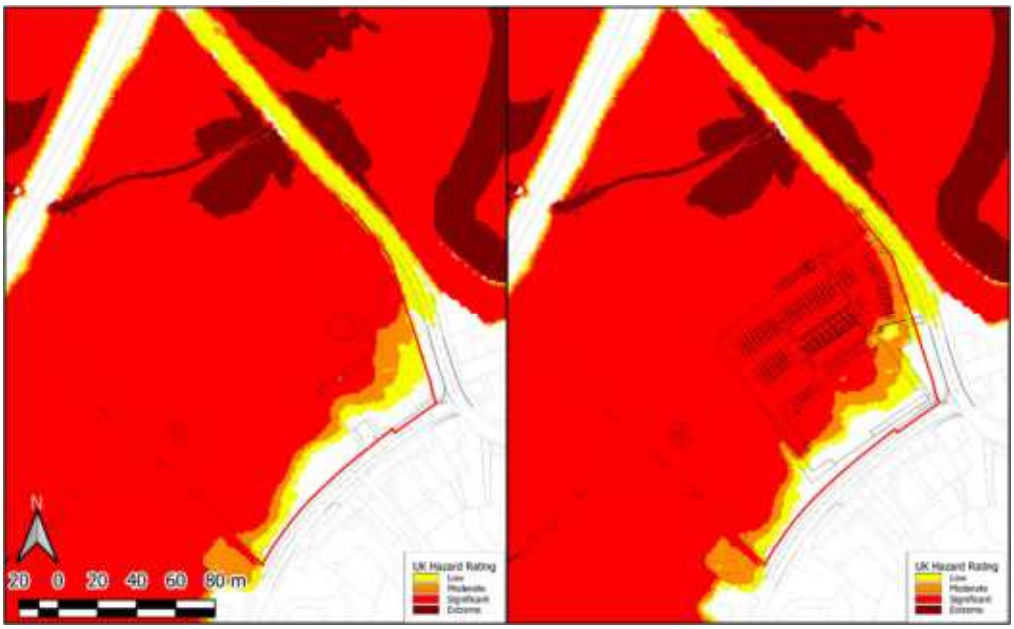


Figure 6 – Existing and post-development hazard rating; left = existing, right = proposed, for the 1%AEP in 2125.

8. Residual risk

8.1. The model has also been run for a scenario that represents a residual risk condition where the nearest culvert beneath the railway embankment (located to the northeast at SN 58088 47468) is blocked by 50%.

8.1.1. The blockage has been represented by a narrowing of the width parameter of the irregular-shaped conduit by 50%. The invert level and soffit level of the structure remains unchanged. This test has been undertaken for existing conditions only.

8.1.2. Where the existing design conditions presents a design flood level on site of 114.47 mODN (mean), the blockage scenario (residual risk) yields an increase of the flood level to 114.79 mODN, an increase of 0.48 m. This flood level remains well below the proposed finished flood level of the store.

9. Sensitivity Testing

9.1. Three sensitivity tests have been undertaken to ensure a full understanding of model behaviour with respect to the Manning's n values. A further sensitivity test has been undertaken to test the impact of blocked voids beneath the building (i.e the building platform is solid). These have included:

- Manning's n roughness value +20%;
- Manning's n roughness value -20%;
- Solid building platform; and
- Control number factor adjustment to 0.8.

9.2. **Manning's n values ±20% –** the surface roughness in the model represents typical conditions with respect to seasonal vegetative growth. However, vegetation can change significantly between summer and winter, and therefore greatly affect the speed at which flood water may transit through an area. Similarly, the accuracy of the estimate of roughness for a given land use type can vary depending on both interpretation and the availability of on-site data.

9.2.1. To represent, primarily, the seasonal variation, the Manning's n value has been varied by ±20% in two separate simulations.

9.2.2. The results show that the variance of Manning's n by +20% and -20% results in flood levels varying on-site by 0.28 m and -0.28 m respectively. On this basis, the seasonal growth and variation in vegetation is considered significant to the model behaviour.

9.2.3. The model's sensitivity to Manning's n roughness is likely attributable to the generally shallow flow conditions in the flood compartment that affects the site and indicates that the flow across the fields near-site is heavily influenced by friction and not just dependent on the outflow through the three conduits beneath the railway embankment.

9.2.4. In the case of the increased roughness nUP scenario, the increased flood level remains well below the proposed finished floor level of the building.

9.2.5. As an additional note, while the nDN and nUP tests remains stable the model log files report an increase in the occurrence of negative depths at the southwestern-most conduit at SN 57879 47077. A review of the model results suggests that there is a localised impact on the model results near to the conduit inlet for the sensitivity tests. These impacts remain localised and do not reach the site and therefore are not expected to influence the results or conclusions from this test. Therefore, no further investigation has been applied to resolving this condition for this test.

9.3. **Solid building platform –** to test a solid building platform the layered flow control file has been replaced with a 2d_zsh file that modifies the ground elevations of the model grid to raise it to the proposed finished floor level of 115.05 mODN.

9.3.1. Figure 7 shows the impacts of the solid raised platform where the materially significant impacts are limited to on-site only. An analysis of the exact differences with the presence of the solid platform reveals an increase in the mean flood level on-site of 0.009 m.

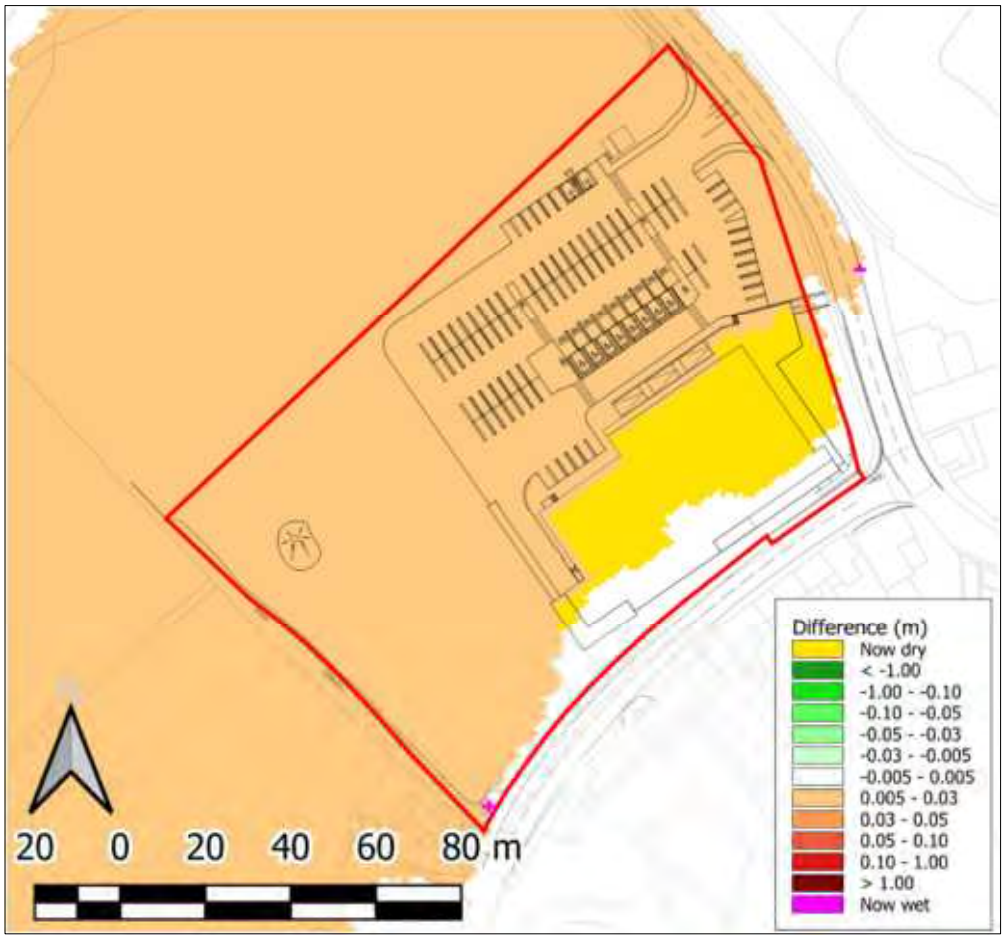


Figure 7 – Impact of solid platform impact on flood level (1%AEP in 2125)

9.4. **Control Number Factor = 0.8 –** (*post-review#1 adjustment*) The model has been tested using a CNF of 0.8 to establish the degree of model sensitivity to HPC automatic timestep selection (all while recognising the model reports no materially significant repeat of any timestep recalculations). The results of the CNF test have been compared to the 'standard' simulation and are shown in Figure 8 where the standard results have been subtracted from the CNF results. The result has been presented with a scale that has a minimum difference colour band of ±5 mm. A detailed review of the results reveals the flood compartment exhibits a lowering of 6 mm compared to the standard results when the CNF is 0.8. At the inlet of the primary conduit

beneath the railway embankment, FD1_Cul_HW, the results show a very localised increase in maximum flood level of 13 mm

9.4.1. (*post-review#2 adjustment*) The additional improvements to the model have seen the sensitivity to CNF reduce further. Figure 8 now shows the post-review#2 model sensitivity result.

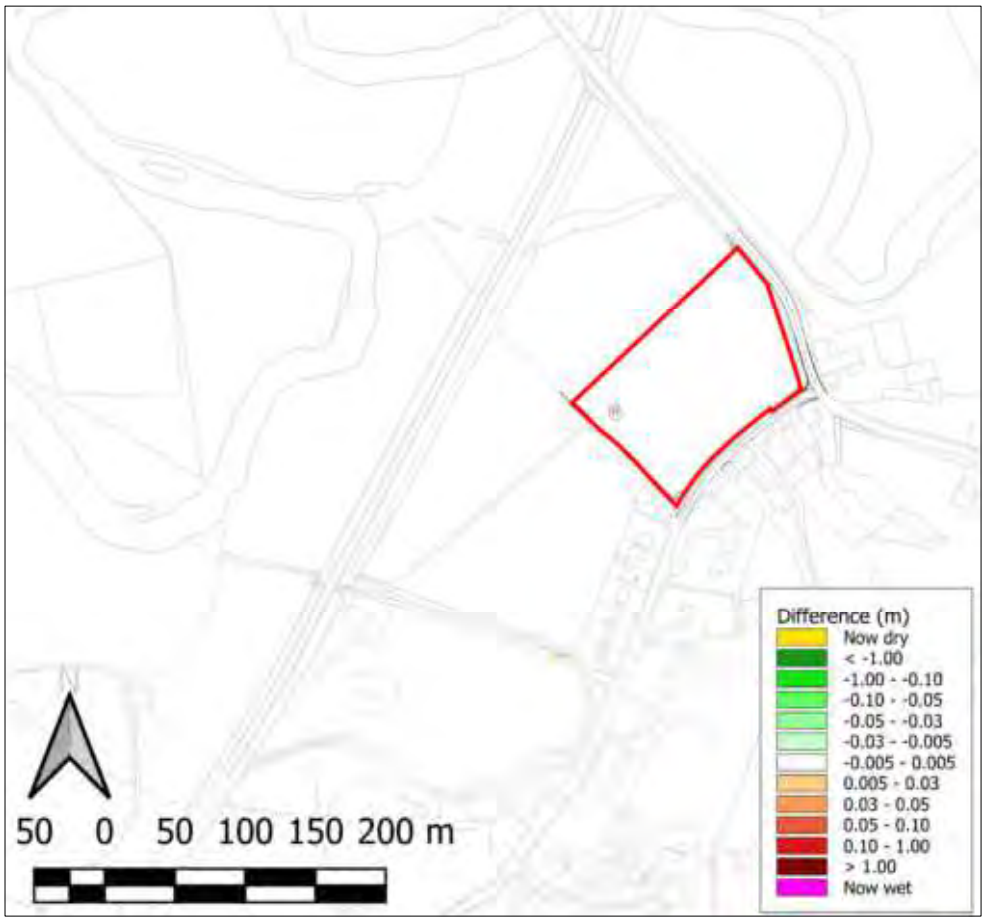


Figure 8 – Sensitivity to CNF (timestep control)

9.5. (*The following statements were made post-review#1, further model improvements have been made post-review#2*) Further investigation suggests that the conduit is rapidly switching flow regimes (critical vs sub-critical flows at the outlet) during the simulation and that these affect the peak flows through the culvert. The same review of the flow and flow regime for the CNF simulation shows similar patterns although with a very difficult to perceive difference near the peak of the flow curve which has been surmised to result in a net increase in discharge through the culvert for the CNF simulation.

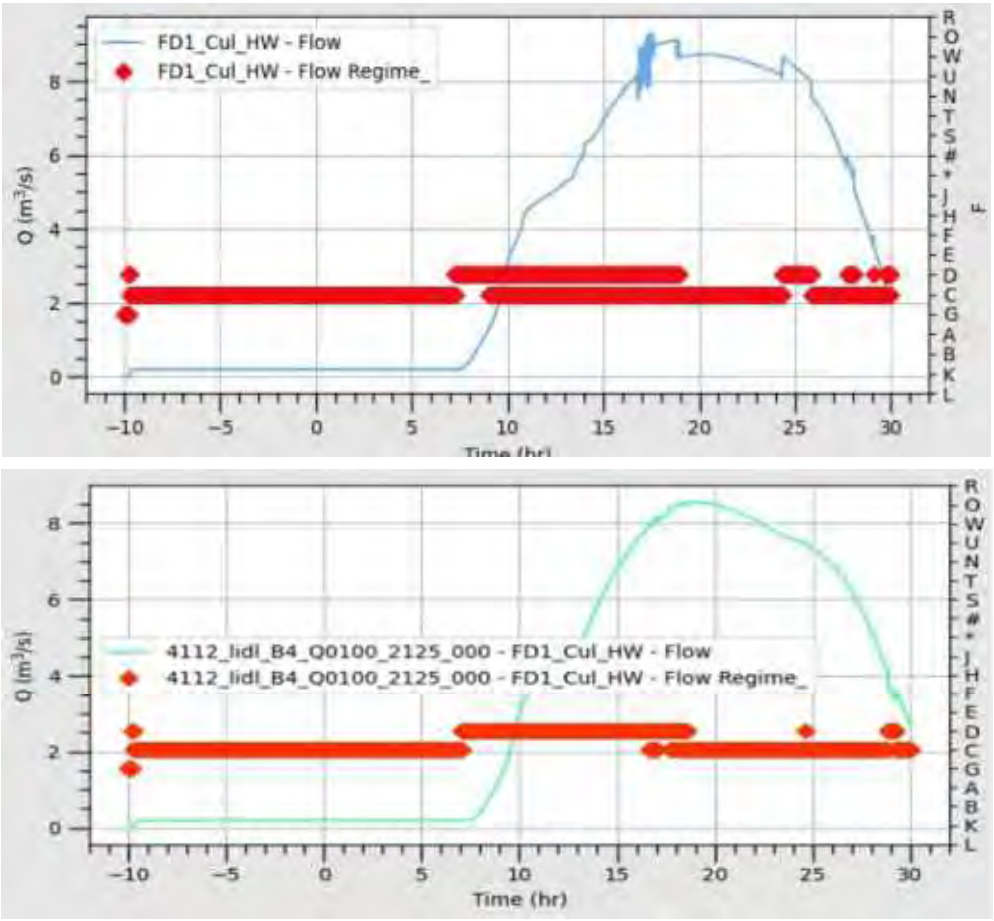


Figure 9 – Flow rates and flow regime at FD1_Cul_HW conduit (top = post-review #1, bottom = post-review#2)

9.5.1. The difference caused by the lowering of the CNF to 0.8 is very clear and apparent in the spatial difference results for flood level of Figure 8. The colour scale for the difference results for the impact scenarios have now also been reduced to ±5 mm and do not show any such similar extensive impact in the flood compartment where the site is located. This clearly demonstrates that the HPC model timestep regime, and therefore the flow regime through FD1_Cul_HW, are consistent enough between design simulations that the gross impact of the switching flow regime in the conduit does not impact the results significantly.

9.5.2. Although very minor spatially-scattered apparent differences do appear in the results, these are typical of an HPC model where the timestep is always altering, and therefore these very isolated differences can be attributed to 'model effects' and not meaningful impacts of the proposed development. These model effects are highlighted in Figure 10 and should be ignored. (*post-review#2 model improvements have seen timestep sensitivity reduce further still* and are now shown in Figure 10)

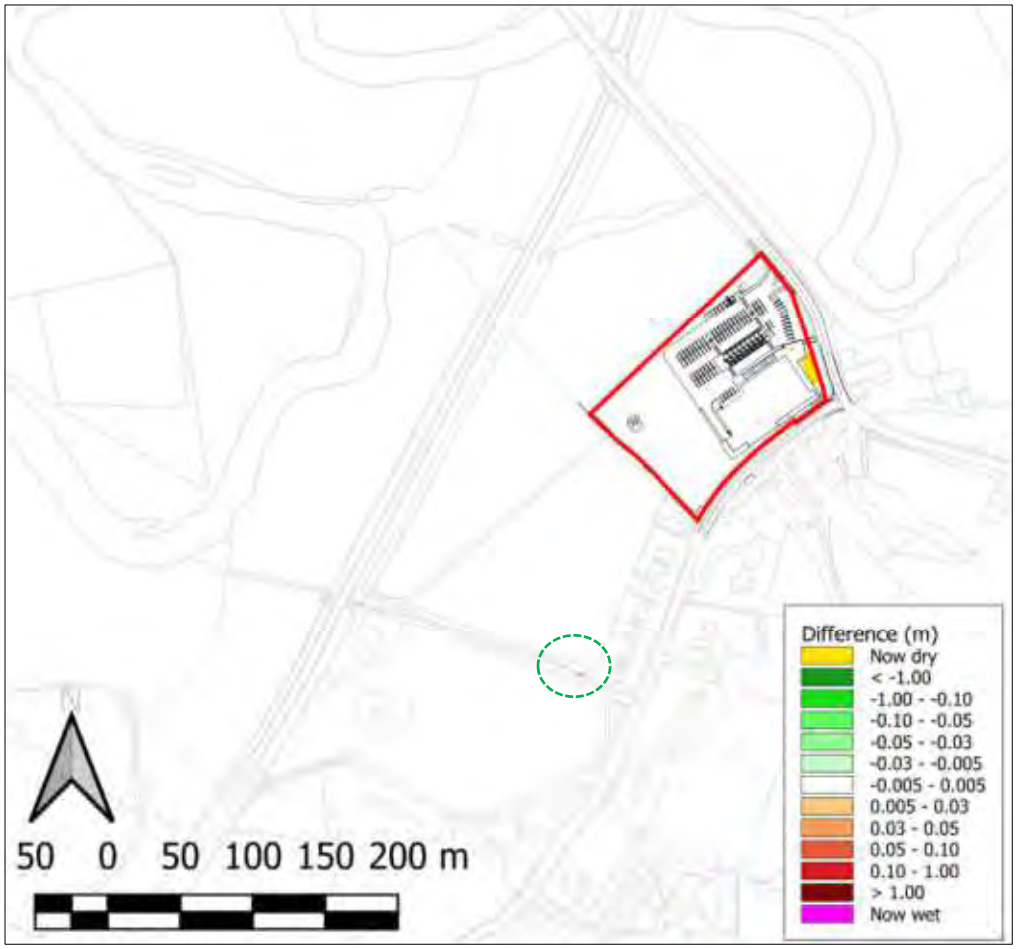


Figure 10 – Examples of model effects (highlighted with dashed green circles).

10. Enclosed Documents

10.1. The following documents have been enclosed with this technical note:

- Topographic surveys;
- EA hydrology reporting; and
- Modelling results.

Flood estimation – calculation record

Site/Project Name: 4112 – Lidl Lampeter

Date: 06/01/2024

Introduction

This document is a supporting document to the Natural Resources Wales (NRW) Flood Estimation Technical Guidance Note V2. It provides a template for recording calculations and decisions made during flood estimation. It will often be complemented by more general hydrological information given in a project report. The information given here should be enough to enable the work to be reproduced in the future.

Note 1: Table, content or page layout can be adapted to best present relevant information. Additional rows should be added to, or removed, from tables as appropriate.

Note 2: Probability of flood occurrence is traditionally expressed within Hydrology as a Return Period, this is the average time between years with at least one larger flood. It can also be expressed as Annual Exceedance Probability (AEP), and this is often more appropriate to use when communicating with the public. Return Period has been retained within this document but can be replaced with AEP is wished.

Contents

Approval

	Name	Qualifications	Date	Competence level
Calculations prepared by:	*Anne Wiltshire*	MSc MCIWEM C.WEM CSci PIEMA	06/01/2024	Level 2
Calculations checked by:				
Calculations approved by:				

Competence levels:

level 1 – hydrologist with minimum approved experience in flood estimation

level 2 – senior hydrologist

level 3 – senior hydrologist with extensive experience of flood estimation

Abbreviations

AEP	Annual Exceedance Probability
AMAX	Annual maximum
AREA	Catchment area (km^2)
BFI	Base flow index
BFIHOST	Base flow index derived using the HOST soil classification
BFIHOST19	Base flow index derived using the revised (2019) HOST soil classification
DPLBAR	Mean drainage path length (km)
DPSBAR	Mean drainage path slope (m/km)
FARL	FEH index of flood attenuation due to reservoirs and lakes

FEH	Flood Estimation Handbook
FPEXT	Floodplain extent
HOST	Hydrology of soil types
NRFA	National River Flow Archive
NRW	Natural Resources Wales
POT	Peaks over a threshold
QMED	Median annual maximum flow (with Annual Exceedance Probability of 50% / return period 2 years)
ReFH	Revitalised flood hydrograph method – used for rainfall runoff method
SAAR	Standard average annual rainfall (mm)
SPR	Standard percentage run-off
SPRHOST	Standard percentage run-off derived using the HOST soil classification
Tp	Time to peak
URBAN	Flood Studies Report index of fractional urban extent
URBEXT2000	Revised index of urban extent
WINFAP	Windows Frequency Analysis Package – used for FEH statistical method

1. Method statement

1.1 Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: • purpose of study • names of river/s • location • number of calculation points (and if peak flows or hydrographs) • previous relevant calculations • availability of flood history	The purpose of the study is to inform a scheme design for a new convenience store at the site of interest. The site is shown to be affected by flooding from the Afon Teifi. Flood modelling has been undertaken previously of the area by JBA Consulting in June 2016. The study covered both the Afon Teifi at Lampeter and also the Llanybydder in Ceredigion. However, as the site of interest is located along the reaches of the Afon Teifi, this hydrological assessment concentrates on this section of the modelling study only. Whilst a hydrological assessment has been undertaken as part of the 2016 modelling study and the methodologies used to estimate flood flows in catchments have not substantially changed since, a review of the previous hydrological assessment has been requested following correspondence with Natural Resource Wales (NRW). Updates have therefore been made where considered necessary. In addition, updates to software used to undertake the flood estimation have been released since 2016 which have been shown to have a minor impact on flood estimation. Any updates that have been undertake are discussed within this report. Where information contained within the previous 2016 modelling study are still considered to be valid, this has been referenced accordingly. In this case, the purpose of the hydrological assessment is to estimate peak flows for the Afon Teifi catchment and obtain hydrographs which will be used in a 1D-2D ESTRY-TUFLOW hydraulic model to appraise the risk of flooding from the Afon Teifi in more detail. The site of interest is situated further upstream along the Afon Teifi and as such, the model extent has been limited to the catchments and tributaries drainaing towards the site only. A map showing the site of interest in relation to the study area covered as part of this report is shown below in Figure

	1.1. The sub-catchments and flow estimation points which have been identified in the 2016 modelling study and are located within the area of interest have been retained. The design events for which hydrographs have been estimated are as follows; • 1 in 2 year flood event • 1 in 10 year flood event • 1 in 30 year flood event • 1 in 75 year flood event • 1 in 100 year flood event • 1 in 100 year flood event, including an allowance for climate change • 1 in 200 year flood event • 1 in 1000 year flood event Hydrographs are required for 3 inflow locations (refer to the Figure 1.1). In addition, there are 3 check point locations. Lateral inflows have been applied for intervening areas. The purpose of this document is to set out the hydrological analysis that has been undertake to derive the inflows for these locations.

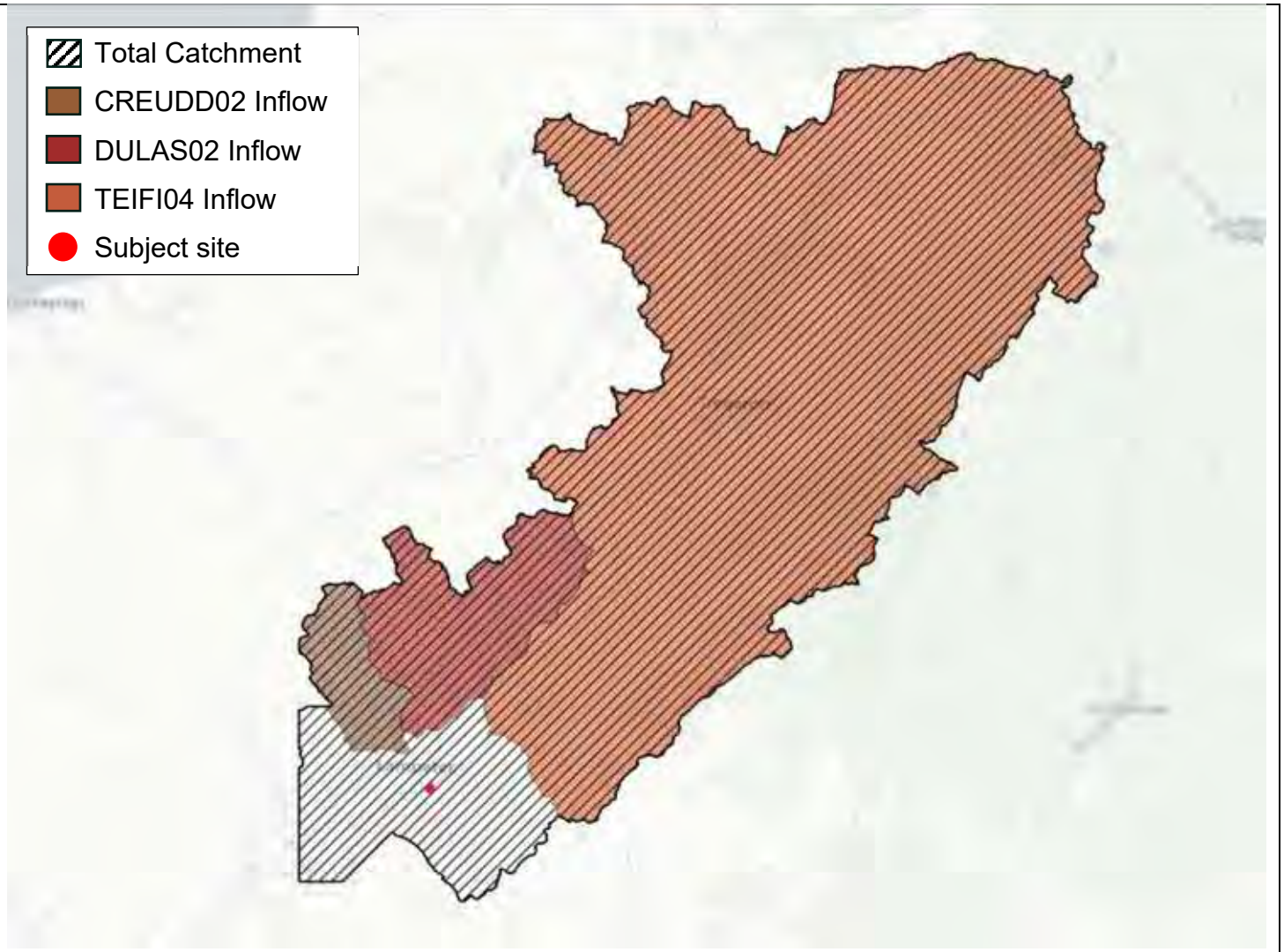


Figure 1.1 - Study area and subject site, alongside inflow locations.

1.2 Overview of catchment

Item	Comments
Brief description of catchment, including key features needing consideration or reference to section in accompanying report. Map/s should be presented here or in section 2.1 of this report.	The total catchment of the Afon Teifi is approximately 400km^2 which is of moderate size. As part of this study, however, the reach of the Afon Teifi that has been modelled, has been shortened up to the check point location TEIFI03. This results in a slightlyer smaller catchment considered as the study area of approximately 311km^2. The main contributing catchment is from the Afon Teifi which makes up just over 85% of the total catchment draining towards the subject site. The Nant Creuddyn and Afon Dulas form small tributaries which discharge into the Afon Teifi at the downstream end, towards Lampeter. The Afon Teifi originates to the northeast of the subject site in the Cambrian Mountains and flows in a south-westerly direction towards Lampeter and Llanybydder. The Afon Teifi catchment is characterised by Cors Caron, which is a raised bog land located just upstream of Tregaron and approximately 20km upstream of Lampeter. Approximately 123km^2 of the Afon Teifi catchment (approximately 50% of the upper catchment) drains into Cors Caron. The Cors Caron itself is approximately just under 10km^2 in size, however, provides a large storage function similar to reservoirs within the upper catchment. The Afon Teifi then flow southwest towards Lampeter and continues to flow south of Lampeter. Two watercourses join the Afon Teifi in the Lampeter area, with the Afon Dulas flowing along the eastern part of Lampeter and the Nant Creuddyn joining the Afon Teifi just downstream of Lampeter. The modelling study undertaken as part of this assessment has been shortened and only considered the catchment of the Afon Teifi up to the upstream end of Llyn Pencarreg at the Ty-Llyn Lakeside campsite.

	Review of aerial height data shows that the catchment is generally relatively steep in the upper reaches. In the area of the subject site, the sub-catchments of the Afon Dulas and Nant Creuddyn consist of gentler hill slopes, however, their valleys are still well defined. Lampeter itself is situated on flatter land, partially within the floodplain of the Afon Teifi. The disused railway embankment crosses the floodplain to the north west of the site and has significant implications for flood levels on-site. This is evident from both the existing 2016 modelling study and the updated model as detailed in “Technical Note: Updating the NRW Lampeter Fluvial Flood Model”. Generally, the total catchment is relatively rural with isolated urban areas nearby towns. The land use is agricultural with the exception of the Cors Caron Natural Nature Reserve. Reference to the British Geological Society geology maps identifies that there is a mix of different formations, predominantly consisting of mudstone and sandstone. In the valleys of the Afon Teifi and its tributaries are superficial deposits of Alluvium (gravel, sand silt and clay) and glaciofluvial ice contact deposits (sand and gravel). In addition, the entire catchmenht has sporadic superficial deposits of Devensian Till (diamicton), with the Cors Caron bog predominantly consisting of Peat deposits. Review of the Soilscapes website hosted by LandIs identifies that the drainage of the soils ranges between freely draining, naturally wet and impeded which is reflected by the BFIHOST19 having a value of 0.422 for the total catchment. Based on the information above, the flood mechanism in the area is likely to be attributed to a rapid response from the catchment to rainfall, especially in relation to the tributaries drainaing towards the Afon Teifi. However, the presence of the Cors Caron means that a substantial volume of rainfall within the upper catchment is likely to be stored within the bog and slowly released, resulting in a significantly slower response than the tributaries. Water from the tributaries is therefore likely to have drained away before the peak flow from Afon Teifi is reached.

1.3 Source of flood peak data

Item	Comments
Was the NRFA Peak Flows dataset used? If so, which version?	Yes, Peak Flow Dataset 13.0.3

1.4 Gauging stations (flow or level)

Within, or near to, the study area. Most stations will be included on National River Flow Archive (NRFA), but other station data may also be available.

Watercourse	Station name	NRFA number	Grid reference	Catchment area (km^2)	Location relative to study area (eg, within), note any significant differences in catchments (eg URBEXT)
Teifi	Llanfair	62002	SN433406	510	Significantly downstream of site of interest and subject area, over 60% greater than subject area
Teifi	Pont Llanio	62003	SN652568	175.4	Upstream of site of interest and downstream of Cors Caron, taking impact of Cors Caron into consideration

1.5 Data available at each flow gauging station

Station Name	Start and end date on NRFA	Update for this study?	Suitability (Pooling/ QMED/ Neither)?	Data quality check needed?	Comments on data availability and quality e.g. use for Tp calculation, QMED calculation from daily mean flow, trends in flood peaks, outliers
Llanfair	01/1970 – N/A	No	Qmed	No	Station closed between 1982 and 2002 but re-opened with new rating in 2010. Gauged within 10% of Qmed. Used for Qmed calculations.
Pont Llanio	07/1998 – N/A	No	Qmed	No	Newly added to peak flow dataset in August 2021. Downstream of Cors Caron and therefore, takes impact of bog into account. Flows can spread across floodplain, however, floodplain flows calculated to be approximately 5% at Qmed.

1.6 Rating equations

Station name	Type of rating e.g. theoretical, empirical, degree of extrapolation	Rating review needed?	Reasons e.g. availability of recent flow gaugings, amount of scatter in the rating
Llanfair	Rated	No	Data available up to water year 2023 which is considered sufficient.

Pont Llanio	Rated	No	Data available up to water year 2023 which is considered sufficient.
Include a link or reference to any rating reviews carried out:		N/A	

1.7 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data and licence reference from NRW	Details
Historic flood data – give link to historic review if carried out	Yes	Yes	NRW – Open license	Data Map Wales has been reviewed.
Flow data for events (if carrying out Tp or ReFH analysis)	Yes	Yes	NRFA	Used to derive Qmed. No event analysis undertaken.
Rainfall data for events (if carrying out Tp or ReFH analysis)	N/A	N/A	N/A	No event analysis undertaken.
Results from previous studies	Yes	Yes	NRW - ATI27346b	Numerical flood modelling study for Lampeter and LLanybydder undertaken by JBA in 2016, and released in 2017

Type of data	Data relevant to this study?	Data available?	Source of data and licence reference from NRW	Details
Other data or information e.g. groundwater, tides	N/A	N/A	N/A	N/A

1.8 Initial choice of approach

Item	Comment
Outline the conceptual model. Address questions such as: • Where are the main sites of interest? • What is likely to cause flooding at those locations? (e.g. peak flows, flood volumes, combination of peaks, groundwater, snowmelt, tides) • Might those locations flood from runoff generated on part of the catchment only e.g. downstream of a reservoir?	The main site of interest is located to the south of Lampeter, on the opposite river bank of the Afon Teifi. The site lies within close proximity to the river, i.e. approximately 40m to the northeast, with the river continuing to flow around the site further to the north and west. Flooding of the site is attributed to high flows within the Afon Teifi itself, resulting in out of bank flooding and expansion of water into the wider floodplain. It is recognised that there is a disused railway embankment to the northwest of the site, with the Afon Teifi crossing the disused railway embankment further to the north of the site. This obstruction may exacerbate flooding at the site as flows are restricted, resulting in water to back up. The Afon Dulas joins the Afon Teifi just downstream of the disused railway embankment, potentially further slowing the flows within the river and resulting in elevated river levels.

Item	Comment
	The presence of Cors Caron in the upper catchment is considered to have a significant impact on the flow regime of the Afon Teifi as it provides large attenuation. This may result in a double-peak, with rapid runoff from the immediate surrounding catchment of Lampeter, followed by a slower growing peak which is typically higher due to the significantly greater size of the Afon Teifi catchment. Consequently, a succession of several rainfall events could result in the Cors Caron to be saturated and runoff to occur more rapidly from the upper catchment as well. Surface water runoff is also considered to contribute to flooding at the subject site, due to steep slopes in and around Lampeter, and channelisation within roads. However, this study only appraises the fluvial risk of flooding to the subject site.
Any unusual catchment features to account for? e.g. • highly permeable (BFIHOST> 0.65) – consider permeable catchment adjustment for statistical method if SPRHOST<20% • highly urbanised – consider choice of method carefully; consider method that can account for differing sewer and topographic catchments • small catchment (<40 km^2) – consider use of small catchment pooling method • pumped watercourse – consider lowland catchment version of rainfall-runoff method • major reservoir influence – consider flood routing	The Cors Caron is located within the upper catchment and acts as a natural attenuation feature.

Item	Comment
• extensive floodplain storage – consider choice of method carefully	
Initial choice of method(s) and reasons • Are FEH statistical and/or ReFH appropriate? • If not appropriate, describe why and give details of the other methods to be used. • Will the catchment be split into sub-catchments/intervening areas? If so, how will flows for intervening areas be estimated?	The FEH methods are appropriate. Both FEH statistical and ReFH methods are suitable for peak flow estimation. However, due to the presence of gauging stations within the catchment, the statistical method is preferred to derive peak flows. Hydrographs will be derived from ReFH2.3 and fitted to the peak flows obtained from the statistical method. The flow estimation points will be matched with the flow estimates previously identified within the 2016 modelling study. This only applies to flow estimation points which are situated within the area of interest and study area. The intervening areas between these flow estimation points will be used to generate lateral inflows which will be put into the hydraulic model. If necessary, the inflows will be scaled to ensure that the modelled peak flow estimates at each flow estimation location approximate the lumped catchment estimates.
Software to be used (edit as applicable.)	WINFAP Version: 5.2.9014 ReFH 2.3 version 4.0.8560.23190

2. Locations where flood estimates are required

2.1 Map of study area, including subject site(s) and gauging stations (where applicable).

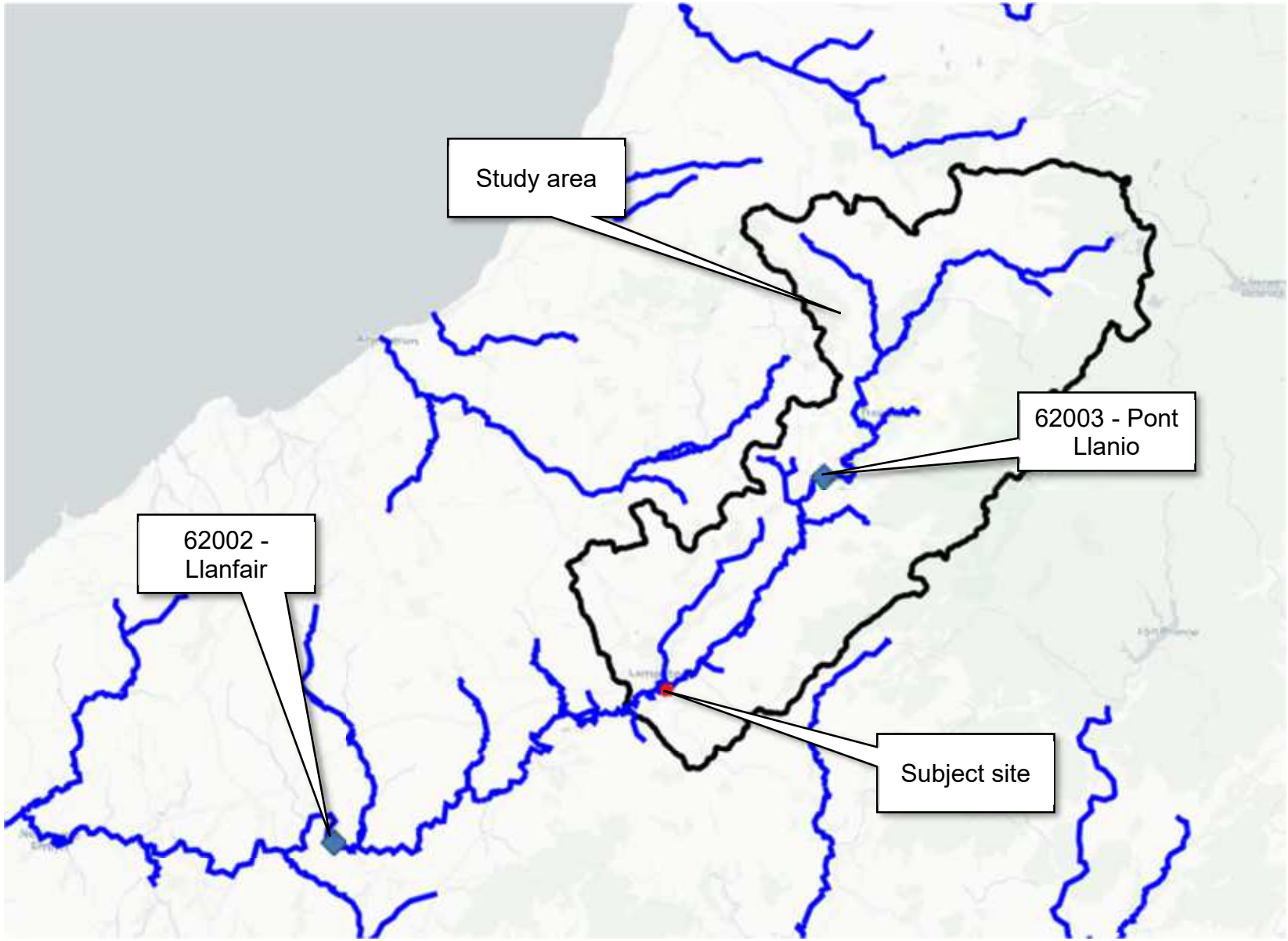


Figure 2.1 - Context of subject site and study area.

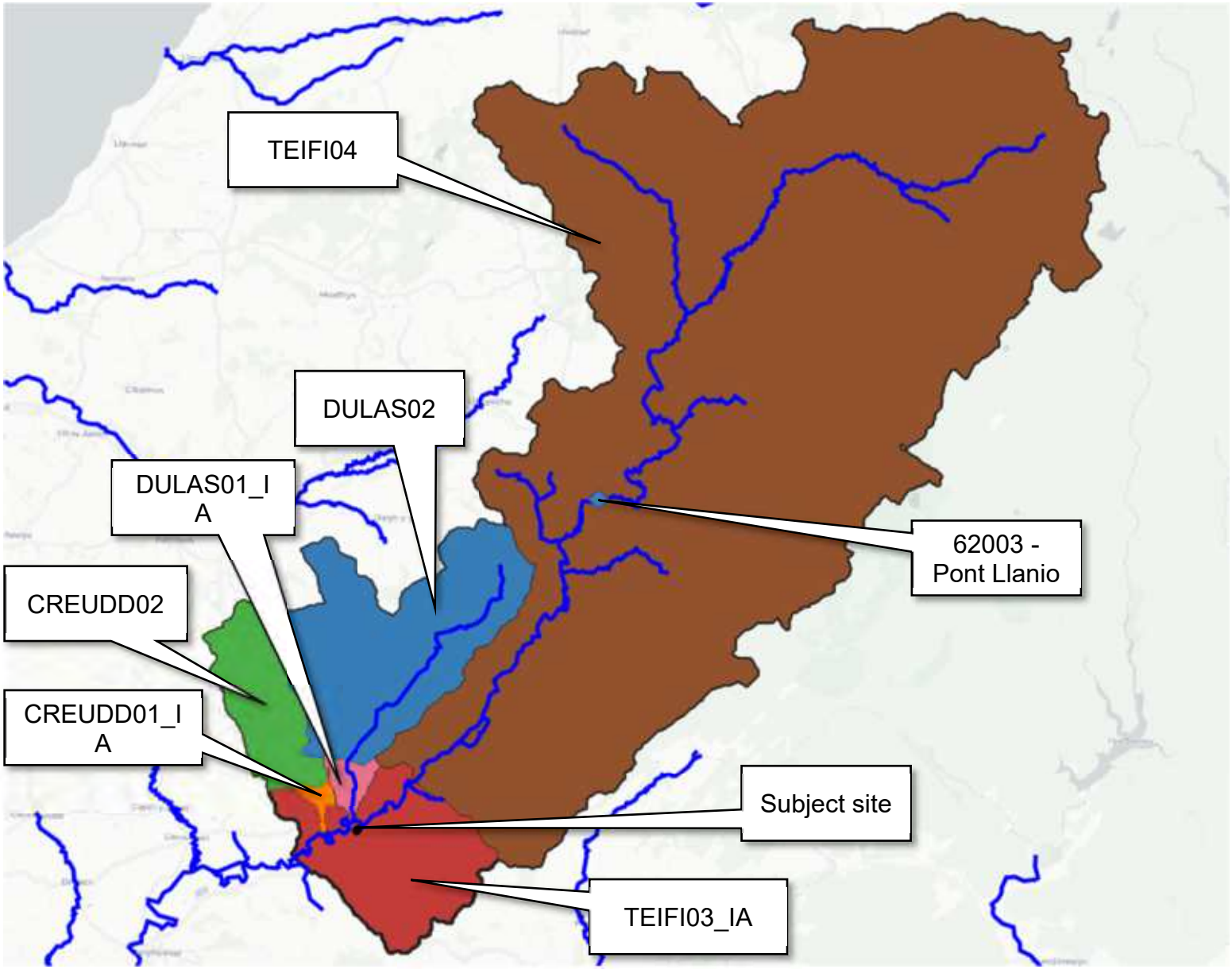


Figure 2.2 - Inflow locations, intervening areas and gauging stations in relation to subject site and study area.

2.2 Summary of subject sites

The table below lists the locations of flow estimation points. Use site codes in all subsequent tables to save space.

Site code	Watercourse	Site Name (description)	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered (km^2)	Peak flow, hydrograph or both required?
CREUDD02	Nant Creuddyn	Upstream Nant Creuddyn catchment	257100	248650	10.1	N/A	Peak flow and hydrograph
CREUDD01	Nant Creuddyn	Downstream Nant Creuddyn catchment at confluence with Afon Teifi	257250	247300	10.8	N/A	Peak flow
DULAS02	Afon Dulas	Upstream Afon Dulas catchment	257900	249400	28.7	N/A	Peak flow and hydrograph
DULAS01	Afon Dulas	Downstream Afon Dulas catchment at confluence with Afon Teifi	258100	247700	30.4	N/A	Peak flow
TEIFI04	Afon Teifi	Upstream Lampeter catchment	259900	248800	250.8	N/A	Peak flow and hydrograph
TEIFI03	Afon Teifi	Downstream Lampeter catchment	256400	246600	310.8	N/A	Peak flow
TEIFI03_IA	Afon Teifi	Intervening area between TEIFI03, TEIFI04, CREUDD01 and DULAS01	N/A	N/A	N/A	18.9	Peak flow and hydrograph
CREUDD01_IA	Nant Creuddyn	Intervening area between CREUDD01 and CREUDD02	N/A	N/A	N/A	0.7	Peak flow and hydrograph

DULAS01_IA	Afon Dulas	Intervening area between DULAS01 and DULAS02	N/A	N/A	N/A	1.7	Peak flow and hydrograph

2.3 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	AREA (km^2)	BFIHOST	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	FARL	FPEXT	PROPWET	SAAR (mm)	URBEXT 2000
CREUDD02	10.1	0.514	0.478	3.86	102.6	1	0.015	0.5	1258	0.0028
CREUDD01	10.8	0.523	0.488	5.12	102	1	0.0279	0.5	1258	0.0097
DULAS02	28.7	0.51	0.478	5.58	97.9	0.995	0.0542	0.53	1262	0.0054
DULAS01	30.4	0.515	0.484	7.2	98	0.996	0.0595	0.52	1263	0.0144
TEIFI04	250.8	0.449	0.405	24.54	111.6	0.988	0.071	0.65	1438	0.0021
TEIFI03	310.8	0.463	0.422	27.19	109	0.99	0.071	0.6	1409	0.0041
TEIFI03_IA	18.9	0.463	0.422	5.00	109	0.99	0.071	0.6	1409	0.0106
CREUDD01_IA	0.7	0.523	0.488	0.82	102	1	0.0279	0.5	1258	0.0097
DULAS01_IA	1.7	0.515	0.484	1.32	98	0.996	0.0595	0.52	1263	0.0144

2.4 Checking catchment descriptors

Item	Comment
Record how catchment boundary was checked • describe any changes • refer to maps if needed	The Strahler Order has been undertaken for the catchments draining towards the inflow locations. Whilst minor discrepancies have been identified, the change for the main contributing catchment of the TEIFI04 is only a decrease of 1%. The largest change was identified for the Nant Creuddyn catchment with an increase of 5%. The overall change for the total catchment of the study area is just over 3% and consequently, given the minor discrepancies, it was not considered necessary to amend the catchment boundary.
Record how other catchment descriptors were checked, especially soils • describe any changes • include a before and after table if necessary	The BFIHOST19 values have been compared with the geology and soil types described in section 1.2. The soils are considered to be moderately impermeable which is reflected by the BFIHOST19. FARL is close to 1.000 which indicates little to no attenuation due to the presence of reservoirs or lakes. It is recognised that the Cors Caron is located within the TEIFI04 sub-catchment which partially acts as an area where water is attenuated. The presence of the bog is not taken into consideration as part of FARL and it is not possible to determine the impact of the bog on peak flows. Nevertheless, it is expected that the Cors Caron will influence the peak flows within the catchment and as such, the gauging station at Pont Llanio will be used to reflect the impact of the bog rather than FARL. URBEXT2000 has been checked by comparing the FEH web service extent with satellite imagery and it was found that URBEXT2000 is representative, i.e. an essentially rural catchment with localised urbanisation. Changes have, however, been made to update URBEXT2000 to the current year (2024). In the 2016 study, catchment descriptors for the intervening areas have been derived using area weighting of the sub-catchments' catchment descriptors.

	However, the report concluded that this could partially have led to unusual final results. As part of this study, the catchment descriptors from the primary catchment have consequently been used and applied to the intervening areas, with the following catchment descriptors having been changed; ***TEIFI03_IA*** – Area and DPLBAR amended. URBEXT2000 calculated from area weighting to account for urban influence of sub-catchments. All other catchment descriptors have been found to be representative from TEIFI03 and have been applied. ***CREUDD01_IA*** - Area and DPLBAR amended. All other catchment descriptors (including URBEXT2000) have been found to be representative from CREUDD01 and have been applied. ***DULAS01_IA*** - Area and DPLBAR amended. All other catchment descriptors (including URBEXT2000) have been found to be representative from DULAS01 and have been applied. This approach is considered appropriate given the close correlation between the intervening areas and catchments. In addition, the intervening areas are relatively small in size when compared to the sub-catchments and therefore, any influence is unlikely to be significant. No other changes to catchment descriptors have been made.
Method for updating URBEXT / URBAN • Refer to WINFAP Urban Adjustment procedures/guidance	URBEXT2000 has been updated to year 2024 for all catchments, based on equation $$UEF = 0.7851 + 0.2124\ \tan^{-1}\{(Year - 1967.5)/20.32\}$$

3. Statistical method

3.1 Search for donor gauging stations for QMED

Note that donor catchments will usually be rural but may be urban provided the data is deurbanised prior to the adjustment process. Include a map if necessary.

Comment on potential donor sites Mention: • distance from subject site (based on catchment centroid) • whether they are on the same, adjacent or nearby watercourse • features which may impact applicability, eg FARL • quality of flood peak data • length of record	One gauging station is located upstream of site of interest, i.e. 62003. This gauging station has been added to the Peak Flow Dataset in August 2021 and contains approximately 30 years of record. In addition, the gauging station is located just downstream of Cors Caron which means that it is likely to take into consideration the impact of the bog. Whilst only a short record is available for the gauging station, it contains valuable information regarding the peak flows in the river and Cors Caron. The quality of data is further considered to be good. There is also a gauging station further downstream of the site of interest and study area, i.e. 62002. This gauging station has a longer record, i.e. since 1970, however, the station was closed for an extended period of time between 1982 and 2002, thus significantly reducing the length of record with quality data. As the site is situated a significant distance downstream of cors Caron, the impact is likely to diminish and other influences from more rapid tributaries and urbna areas may dominate. 62002 is also significantly larger (i.e. over 60%) than the study area. Nevertheless, both gauging stations are considered suitable as donors as they are on the same watercourse. Typically, the default setting in WINFAP5 is 6 donors for larger catchments. However, as there are two gauging stations along the watercourse, with one of them considered to represent the impact of Cors Caron, only these two gauging stations have been considered as donors. Both gauging stations have therefore been used toe stimate Qmed for TEIFI04 due to the size of TEIFI04 and impact of Cors Caron. All other catchments are considered to not be impactd by Cors Caron and are contributing catchments based on size (except for TEIFI03 – intervening area).

	Therefore, 1 donor has been chosen which also provides a more conservative estimate for Qmed when compared to two donors or more.

3.2 Donor stations and QMED adjustment factors

If using WINFAP3 great caution should be taken in urban catchments that are also highly permeable (BFIHOST>0.65). Further details are provided in the EA Flood Estimation Guidelines.

Station Name	**NRFA station number**	**Reasons for choosing or rejecting**	**Record Length**	**QMED from flow data (gauged) (m^3/s)**	**QMED from flow data with urban influence removed (A) (m^3/s)**	**QMEDrural from catchment descriptors (B) (m^3/s)**	**Adjustment ratio (A/B)**
Llanfair	62002	Chosen as on same watercourse	35	138.8	138.261	233.987	0.59
Pont Llanio	62003	Chosen as on same watercourse	25	40.6	40.513	107.335	0.38

3.3 Overview of estimation of QMED at each subject site

Notes for completing this table

- Methods
  - CD: catchment descriptors alone
  - DT: data transfer
  - BCW: catchment descriptors and bankfull channel width
  - FV: flow variability (using flow duration statistics)
- Urban adjustment procedures should be applied regardless of whether the subject site is rural or urban.

- If using WINFAP3, great caution should be taken in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.65).
- The data transfer procedure is from Science Report SC050050. The QMED adjustment factor A/B for each donor site is given in Table 3.2. This is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial estimate from catchment descriptors.
- If more than one donor has been used, use multiple rows for the site and give the weights used in the averaging. Record the weighted average adjustment factor in the table.

				Data transfer						
Site code	**QMEDrural from CDs (m^3/s)**	**Method**	**NRFA numbers for donor site/s used (see 3.2)**	**Distance between centroids d_{ij} (km)**	**Power term a**	**Moderated QMED adjustment factor $(A/B)^a$**	**If more than one donor**		**Final estimate of QMEDrural (m^3/s)**	**Final estimate of QMEDurban (m^3/s)**
							Weight (if WINFAP4 (or later versions) method not used)	**Weighted average QMED adjustment factor**		
CREUDD02	6.633	DT	62002	5.08	0.463	0.784	-	-	5.199	5.215
CREUDD01	6.816	DT	62002	5.08	0.463	0.784	-	-	5.343	5.402
DULAS02	15.947	DT	62002	1.04	0.779	0.664	-	-	10.582	10.646
DULAS01	16.508	DT	62002	1.26	0.744	0.676	-	-	11.162	11.344

TEIFI04	162.161	DT	62003 62002	3.75 11.61	0.516 0.367	0.762 0.700	-	-	83.439	83.612
TEIFI03	143.894	DT	62003	6.51	0.428	0.659	-	-	106.912	107.357
Has the Kjeldsen (2014) urban adjustment method (as used in WINFAP4 or later versions) been applied? If not, why?					Yes, as part of WINFAP 5					
How are the weights derived?					-					
Are the values of QMED and QMED adjustment factors consistent, for example at successive points along the watercourse and at confluences?					Yes, Qmed increases downstream as is expected.					

3.4 Derivation of pooling groups

- Several subject sites may use the same pooling group.
- The composition of pooling groups should be presented in the Annex.
- If Single Site (with or without flood history) was used, add 'N/a' to the last column.

Name of pooling group	**Site code from which pooling group was derived**	**Site codes to which it is applied**	**Method: Single Site / with History, Enhanced Single Site or Pooled / Small Catchment Pooled?** Include reasons for choice of method	**Changes made to default pooling group, with reasons.** Include any sites that were investigated but retained in the group

CREUDD02	CREUDD02	CREUDD02	Pooled	44008 removed due to non-flood years being greater than 15%. Remainder of pooling group retained.
CREUDD01	CREUDD01	CREUDD01	Pooled	44008 removed due to non-flood years being greater than 15%. Remainder of pooling group retained.
DULAS02	DULAS02	DULAS02	Pooled	No changes made.
DULAS01	DULAS01	DULAS01	Pooled	No changes made.
TEIFI04	TEIFI04	TEIFI04	Pooled	71011 removed due to negative L-skew.
TEIFI03	TEIFI03	TEIFI03	Pooled	No changes made.
62003	62003	62003	Enhanced single-site analysis with pooling group	71011 removed due to negative L-skew.
URBEXT2000 threshold used to create pooling group(s). **Have pooling group growth curves been deurbanised?**			A default URBEXT2000 threshold of 0.03 has been used as URBEXT2000 of sub-catchments and subject area is less than 0.03.	

3.5 Derivation of flood growth curves at subject sites

It was found that the growth curve for TEIFI04 may be too steep and not fully consider the impacts of Cors Caron. As such, a combined approach has been taken to derive the flood growth curve which takes the Qmed calculated for TEIFI04 and applies the growth curve derived for 62003. 62003 gauging station is situated just downstream of Cors Caron and therefore, is considered to take account of Cors Caron and its impact on flood flows. The same approach has been applied to the check flow at TEIFI03.

Site code	Pooling group name	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Growth factor for 100-year return period event
CREUDD02	CREUDD02	GEV as provides best fit	Urban adjustment applied as part of WINFAP 5 WHS Non-flood-years-spreadsheet)Beta v.2.2) used to apply permeable adjustement	2.992
CREUDD01	CREUDD01			3.019
DULAS02	DULAS02			2.624
DULAS01	DULAS01			2.803
TEIFI04	62003			2.223
TEIFI03	62003			2.223

3.6 Flood estimates from the statistical method

	Site Code					
Flood peak (m^3/s) for the following return periods (in years)	**CREUDD02**	**CREUDD01**	**DULAS02**	**DULAS01**	**TEIFI04**	**TEIFI03**
2	5.215	5.402	10.646	11.344	83.612	107.357
10	8.646	8.978	16.640	18.309	121.823	156.419
30	11.489	11.965	21.356	23.890	149.582	192.062
75	14.503	15.142	26.200	29.699	176.505	226.631
100	15.603	16.309	27.935	31.797	185.869	238.655
200	18.623	19.512	32.619	37.492	210.535	270.325
1000	28.203	29.716	46.906	55.109	281.354	361.256

4. Revitalised flood hydrograph (ReFH) method for peak flow estimation

This section records calculations for peak flow estimates, if different calculations are subsequently made for hydrographs for modelling, details should be recorded in section 5.

4.1 Parameters for ReFH model for peak flow estimation

If parameters are all estimated from catchment descriptors, they are easily reproducible, so it is not essential to record them here –Just enter 'all' under site code and 'Catchment descriptors' under method. Where values have been calculated from local data, include catchment descriptor values in brackets, or additional columns.

Site code	**Details of method** Catchment descriptors Tp data transfer Optimisation (Calibration Utility)	**Tp (hours)** Time to peak	**C_{max} (mm)** **maximum storage capacity**	**BL (hours)** baseflow lag	**BR** baseflow recharge
All	Catchment descriptors				
Brief description of any flood event analysis carried out Provide further details either here or give reference to location of documentation		None carried out.			

4.2 Design events for ReFH method for peak flow estimation

Refer to Guidance for latest research regarding choice of summer or winter season based on URBEXT2000, BFIHOST and SAAR. Where values have been calculated from local data, include catchment descriptor values in brackets or additional columns.

ReFH2.3 peak flow estimates have only been undertaken for the inflow locations and downstream peak flow checkpoint as peak flows were only obtained for comparison.

Site code	Season of design event (summer or winter)	Recommended Storm duration (hours)	Storm area for ARF (if not catchment area)	Record any adjustment to default parameters
CREUDD02	Winter	9.5hrs	-	The storm duration has been adjusted to reflect the highest peak flow
DULAS02	Winter	10.5hrs	-	The storm duration has been adjusted to reflect the highest peak flow
TEIFI04	Winter	18.5hrs	-	The storm duration has been adjusted to reflect the highest peak flow
TEIFI03	Winter	21.5hrs	-	The storm duration has been adjusted to reflect the highest peak flow
Source of design rainfall statistic **(FEH13 or FEH99).** If FEH99 has been used provide justification:		FEH22		

4.3 Peak flow estimates from the ReFH method

Based on catchment descriptors.

	Site Code			
Flood peak (m^3/s) for the following return periods (in years)	**CREUDD02**	**DULAS02**	**TEIFI04**	**TEIFI03**
2	4.868	12.700	120.613	129.726
10	7.182	18.675	176.012	188.517
30	8.849	22.992	217.021	232.913
75	10.465	27.219	257.553	277.068
100	11.035	28.688	271.736	292.353
200	12.528	32.53	307.955	330.967
1000	16.611	42.918	398.776	427.282

5. Revitalised flood hydrograph (ReFH) method for model inflow hydrographs

5.1 Parameters for ReFH model for model inflow hydrographs

This section records calculations for model inflow hydrographs, parameters may have been calibrated and storm durations changed.

If parameters are all estimated from catchment descriptors, they are easily reproducible, so it is not essential to record them here –Just enter ‘all’ under site code and ‘Catchment descriptors’ under method. Table can be amended as needed.

Site code	**Details of method** Catchment descriptors Tp data transfer Optimisation (Calibration Utility)	**Tp (hours)** Time to peak	**C_{max} (mm)** **maximum storage capacity**	**BL (hours)** baseflow lag	**BR** baseflow recharge
All	Catchment descriptors				
Brief description of any flood event analysis carried out Provide further details either here or give reference to location of documentation					

5.2 Design events for ReFH method for model inflow hydrographs

Refer to Guidance for latest research regarding choice of summer or winter season based on URBEXT2000, BFIHOST and SAAR.

Storm duration (hours)	**ARF**	**Source of Storm Duration and ARF**	**Why Chosen**
20.5hrs	0.89	Storm duration: Sensitivity testing ARF: Taken from TEIFI03	Storm duration testing has been undertaken for 10.5hrs, 15.5hrs and 20.5hrs. These durations were considered to be representative of the varying storm durations of the different sub-catchments to consider potential influences by both smaller catchments and the larger catchment. It was found that the larger contributing catchment of the TEIFI04 is dominating flows and therefore, a storm duration which is within 1% of peak flows estimated for TEIFI04 has been chosen.

			A review of rainfall data for the 62003 gauging station would further indicate that it takes approximately 1 day after an extreme rainfall event to cause peak flows at the gauge. However, this only applies to the winter season. In summary, notable rainfall events are shown to have little impact on peaks and do not result in POT values. Further storm duration sensitivity has been undertaken and described in Section 6.4.
Where hydrographs scaled to alternative peak flow estimates? If so, give details			Yes, scaled back to flows obtained from statistical method.

Provide link/reference to location of hydrographs or provide in appendix	**Appendix A.3**

6. Final Peak Flow and Hydrograph Estimates

6.1 Comparison of peak flow estimates from different methods

This table compares peak flows from the ReFH method, FEH Statistical method and any available previous study at each site for two key return periods. Note and explain any significant difference from previous studies.

	QMED (2-year return period)				**100-year return period**			
Site code	**Statistical**	**ReFH2.3**	**Previous Study**	**Comment**	**Statistical**	**ReFH2.3**	**Previous Study**	**Comment**

CREUDD02	5.215	4.868	6.0	ReFH2.3 align better with higher estimates based on CDs, however, does not take local circumstances into account, i.e. Cors Caron for larger catchment which is the influencing catchment on peak flows.	15.603	11.035	20.6	Difference to previous study could be due to software updates and changes to Peak Flow Dataset.
DULAS02	10.646	12.700	14.8		27.935	28.688	37.5	
TEIFI04	83.612	120.613	82		185.869	271.736	165	
TEIFI03	107.357	129.726	94		238.655	292.353	181	

6.2 Final Peak Flow Estimates

	Site Code					
Flood peak (m^3/s) for the following return periods (in years)	**CREUDD02**	**CREUDD01**	**DULAS02**	**DULAS01**	**TEIFI04**	**TEIFI03**
2	5.215	5.402	10.646	11.344	83.612	107.357

10	8.646	8.978	16.640	18.309	121.823	156.419
30	11.489	11.965	21.356	23.890	149.582	192.062
75	14.503	15.142	26.200	29.699	176.505	226.631
100	15.603	16.309	27.935	31.797	185.869	238.655
200	18.623	19.512	32.619	37.492	210.535	270.325
1000	28.203	29.716	46.906	55.109	281.354	361.256

Choice of method and reasons Include reference to type of study, nature of catchment, and type of data available	The FEH Statistical Method has been chosen for generating peak flow for the study area as the river is gauged and therefore, adjustment to Qmed was possible via donor transfer. This is considered to provide a more accurate representation of the peak flows within the catchment than the ReFH2.3 method which is based on catchment descriptors only. In addition, by applying the growth curve derived for the 62003 gauging station, it is possible to better take the impact of Cors Caron into account which is likely to result in a shallower growth curve. The peak flows obtained for the 1%AEP are significantly greater than the peak flows obtained in the previous study. Consequently, this updated study is considered to provide a more conservative approach.

6.3 Hydrographs for Modelling

How were these calculated, for example by scaling ReFH hydrographs to final flow estimates? include link/reference to hydrographs.	ReFH2.3 hydrographs were scaled to final peak flows estimated from the FEH Statistical Method.

How will flows be applied in the model. If intervening areas are used, will hydrographs be adjusted to better match downstream flows, or will best estimate inflows be used and resulting downstream flows accepted?	Flows will be applied directly to the model through inflow locations. For intervening areas, the same approach as for the inflow locations has been applied, i.e. peak flows have been calculated from the FEH statistical method and hydrograph shapes have been obtained from ReFH2.3. For TEIFI03_IA, the growth curve from 62003 has been applied, as for TEIFI04 and TEIFI03. Review of modelled outputs shows that this results in acceptable and consistent peak flows when compared with the estimated peak flows for the 1%AEP at the following check point locations;

	Estimated peak flow (m^3/s)	Modelled peak flow (m^3/s)	Difference
CREUDD01	16.309	16.768	+ 2.8%
DULAS01	31.797	30.357	- 4.7%
TEIFI03	238.655	241.605	+ 1.2%

	The TEIFI03 defines the downstream end of the study area and whilst it is recognised that modelled flows for DULAS01 are slightly lower than estimated, the model overall seems to perform well, given that the dominating catchment is TEIFI04. Consequently, no intervening areas have been scaled up or down.

6.4 Checks

Are the results consistent, for example at confluences?	Refer to 6.3 above. Model generally performs well and as expected.
What do the results imply regarding the return periods of floods during the period of record?	Local flow data is limited and the study area does not provide outputs at the locations of gauging stations.
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 - 4.0)	The growth factor ranges between 2.2 and 3.1 for the statistical method and is approximately 2.2 for the ReFH2.3 method. The typical range is 2.1 – 4.0 and therefore, the growth factor is considered to be sensible.
If 1000-year flows have been derived, what is the range of ratios for the 1000-year flow over 100-year flow?	For the statistical method, the ratios range between 1.34 for the TEIFI04 and 1.82 for CREUDD01. For ReFH2.3, the ratio varies between 1.46 for TEIFI03 and 1.51 for CREUDD02. The typical range for the ratio is between 1.3 – 1.8. It is recognised that CREUDD01 is slightly above the typical range for the statistical method. However, as this is only a small sub-

<table>
<tr><td></td><td>catchment with limited influence on overall peak flows, this is considered acceptable.

It is recognised that typically the ratio between the 1% and 0.1% is taken from ReFH2.3. However, the ratio for TEIFI03 from the statistical method is slightly greater (i.e. 1.51) than obtained from ReFH2.3. This is likely to be more realistic given that Cors Caron is considered to become saturated during extreme events, resulting in higher peak flow discharge and a more exponential growth curve towards these larger events.</td></tr>
<tr><td>What is the range of specific runoffs (l/s/ha)? Are there any inconsistencies?</td><td>The table below shows the specific runoff for the subject area which is consistent with the outflows recorded at TEIFI03.

<table><tr><th></th><th>TEIFI03</th></tr><tr><td></td><td>l/s/ha</td></tr><tr><td>2</td><td>3.45</td></tr><tr><td>10</td><td>5.03</td></tr><tr><td>30</td><td>6.18</td></tr><tr><td>75</td><td>7.29</td></tr><tr><td>100</td><td>7.68</td></tr><tr><td>200</td><td>8.70</td></tr><tr><td>1000</td><td>11.62</td></tr></table>
The specific discharge for the entire study area is consistent and sensible for a relatively rural catchment.</td></tr>
<tr><td>How did the results compare with those of other studies?

Explain any differences and conclude which results should be preferred</td><td>The results as part of this study show a greater extent than those of previous studies. This could be a result of updated model software and additional information being available. For example, gauging station 62003 was only added to the Peak Flow Dataset</td></tr>
</table>

	in August 2021 and could not be considered as part of the 2016 modelling study.
Are the results compatible with the longer-term flood history?	Although flooding has been recorded significantly further downstream of the study area and site of interest, no local data is available which can be used to compare the results.
Describe any other checks on the results	Whilst the same storm duration is typically applied to the entire catchments, the smaller catchments are considered to drain significantly faster into the Afon Teifi than the upper catchment, represented by TEIFI04. The comparison of storm durations tested also suggests that there is little impact on peak flows for all catchments. Therefore, to sensitivity test the potential impact of faster and slower drainaing times, modelling has been undertaken by applying the hydrograph for the 10.5hr storm duration for the smaller catchments (i.e. Nant Creuddyn and Afon Dulas) and the hydrograph for the 15.5hr storm duration for the upstream end of the Afon Teifi (i.e. TEIFI04). The same principle has then been tested for a 15.5hr storm duration for the smaller catchments and 20.5hr storm duration for the TEIFI04. A delay of 5 hours was chose as these seems to respond well with the difference in critical storm duration between the catchments. Model outputs for the different storm duration testing shows little impact on flood level for 1 in 100 year at site, i.e. in the region of a few centimetres at the site. Consequently, it is concluded that the main risk of flooding to the site is from flows generated within he TEIFI04 catchment, which is the largest contributing factor. No

	delays in applying hydrographs have therefore been applied to the final model outputs.

6.5 Assumptions, limitations, and uncertainty

List the main assumptions made specific to the study	The catchment descriptors are representative of the catchment. The donors selected to adjust Qmed for statistical method are representative of the catchment, accounting better for the impact of Cors Caron when compared to Qmed derived from catchment descriptors only. Applying the growth curve derived from an enhanced single-site analysis for the 62003 gaufging station to TEIFI04, TEIFI03 and intervening area TEIFI03_IA is considered appropriate as this takes the impact of Cors Caron into account resulting in a less steep growth curve for return periods of interest. The growth ratio is between 1% and 0.1% AEP for TEIFI03 from statistical method which is greater than expected given the likely saturation of Cors Caron under extreme events. This supports this assumption. The impact of the sub-catchments on flows within the subject area are minor and therefore, applying a uniform storm duration with no time delay is appropriate.
Discuss any particular limitations For example, applying methods outside the range of catchment types for which they were developed	The statistical method has been applied outside this range to obtain flows for the 0.1%AEP. However, for the reasons outlined above, this is still considered to be the best approach in this instance, given the lack of long records of flow gauging data and the fact that ReFH2.3 does not consider the impacts of Cors Caron accurately.

Give what information you can on uncertainty in the results

For example, using the methods detailed in ‘Making better use of local and historic data, and estimating uncertainty in FEH design flood estimation (FEH Local) SC130009

Unable to comment on uncertainty in relation to ReFH2.3 outputs.

For the statistical method, a UK average measure to calculate uncertainty has been provided by Kjieldsen (2014). For the 95% confidence level based on one donor adjustment for Qmed, the confidence levels are as follows;

RP	95%
2	0.50-2.02
5	0.49-2.04
10	0.49-2.05
20	0.48-2.07
50	0.48-2.10
100	0.47-2.12
200	0.47-2.15
500	0.46-2.19
1000	0.45-2.23

The table shows that the uncertainties provide a wide range of flows.

The main uncertainty is likely to be linked to the saturation of Cors Caron as a result of increased rainfall intensity and duration. This

	could subsequently increase runoff from the largest contributing catchment, causing more wide-spread flooding downstream. However, the model testing that has been undertaken as part of this assessment indicates that flood levels at the subject site are not sensitive.
Comment on the suitability of the results for future studies For example, at nearby locations or for different purposes	The peak flows and hydrographs were designed for the purpose of this study to inform development at the subject site. Whilst the work undertaken can be used to feed into future updates for sites furth downstream of the subject area, review of the suitability of the study for other purposes should be undertaken.
Give any other comments on the study For example, suggestions for additional work	The model outputs from this study are shown to be greater than the model outputs from the 2016 modelling study, although it was concluded that the 2016 modelling study is likely to overestimate the flood extent. The modelled flows correspond well with the estimated peak flows from the statistical method. As such, there is the potential that the statistical method still overestimates the peak flows, especially from TEIFI04 due to the uncertainty with Cors Caron. Record length at the the 62003 gauging station is relatively short and therefore, does not include an extensive period of flood events which could assist in providing more accurate estimates. It is possible that the storage capacity of Cors Caron is significantly greater than estimated based on pooling group analysis and the use of a single-site rating curve derived from available data for 62003 could be considered.

Annex – supporting information

Appendix 1 - Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix 2 – Permeable Adjustment Worksheet

Appendix 3 – ReFH2.3 outputs

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:11:58
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	1756239264
Site name:	FEH_Catchment_Descriptors_257250_247300_v5_0_1
Site location:	SN 57250 47300
Easting:	257250
Northing:	247300
Catchment area:	10.80 km²
SAAR:	1258 mm
BFIHOST19:	0.488
FPEXT:	0.028
FARL:	1.000
URBEXT2000:	0.0097

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.16 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.01105

Growth curve settings

Distance Measure Method:	Small catchment
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
28033 (Dove @ Hollinsclough)	0.313	48	4.138	0.235	**0.235**	0.367	**0.367**
47022 (Tory Brook @ Newnham Park)	0.357	28	6.134	0.243	**0.245**	0.163	**0.160**
45816 (Haddeo @ Upton)	0.382	30	3.352	0.288	**0.289**	0.408	**0.407**
25011 (Langdon Beck @ Langdon)	0.453	37	15.647	0.225	**0.225**	0.321	**0.321**
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	0.620	13	4.072	0.274	**0.275**	0.295	**0.294**
27032 (Hebden Beck @ Hebden)	0.683	55	4.052	0.203	**0.203**	0.190	**0.190**
18014 (Bannock Burn @ Bannockburn)	0.696	31	15.727	0.226	**0.227**	0.171	**0.169**
48007 (Kennal @ Ponsanooth)	0.726	55	4.180	0.192	**0.193**	0.217	**0.215**
48004 (Warleggan @ Trengoffe)	0.781	54	9.865	0.254	**0.254**	0.266	**0.265**
48009 (St Neot @ Craigshill Wood)	0.795	12	8.465	0.245	**0.245**	0.373	**0.372**
72014 (Conder @ Galgate)	0.801	56	16.971	0.228	**0.229**	0.133	**0.132**
27010 (Hodge Beck @ Bransdale Weir)	0.822	41	9.420	0.224	**0.224**	0.293	**0.293**
73015 (Keer @ High Keer Weir)	0.844	33	12.421	0.204	**0.205**	0.189	**0.189**
72007 (Brock @ upstream of A6)	0.877	45	28.972	0.191	**0.191**	0.223	**0.223**
Total		**538**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			1.004	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			1.049	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.830	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			0.814	
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	Yes	Yes	13	0	0.00			2.886	
27032 (Hebden Beck @ Hebden)	Yes	Yes	55	2	3.64	0.53	None	0.583	
18014 (Bannock Burn @ Bannockburn)	Yes	Yes	31	1	3.23	-0.88	None	0.456	
48007 (Kennal @ Ponsanooth)	Yes	Yes	55	1	1.82	0.54	None	0.818	
48004 (Warleggan @ Trengoffe)	Yes	Yes	54	4	7.41	0.65	None	1.042	
48009 (St Neot @ Craigshill Wood)	Yes	Yes	12	0	0.00			0.660	
72014 (Conder @ Galgate)	Yes	Yes	56	3	5.36	1.39	None	1.044	
27010 (Hodge Beck @ Bransdale Weir)	Yes	Yes	41	1	2.44	-2.10	5	0.259	
73015 (Keer @ High Keer Weir)	Yes	Yes	33	1	3.03	3.30	5	0.434	
72007 (Brock @ upstream of A6)	Yes	Yes	45	0	0.00	-0.42	None	1.121	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	16.080	1044	0.023	0.991	0.006	0.562
27032 (Hebden Beck @ Hebden)	22.245	1433	0.021	0.997	0.000	0.272
18014 (Bannock Burn @ Bannockburn)	25.372	1333	0.054	0.893	0.011	0.407
48007 (Kennal @ Ponsanooth)	26.892	1294	0.026	0.867	0.011	0.700
48004 (Warleggan @ Trengoffe)	25.260	1445	0.035	0.978	0.003	0.432
48009 (St Neot @ Craigshill Wood)	22.973	1511	0.023	0.982	0.002	0.388
72014 (Conder @ Galgate)	28.992	1183	0.082	0.975	0.006	0.427
27010 (Hodge Beck @ Bransdale Weir)	18.820	987	0.009	1.000	0.001	0.303
73015 (Keer @ High Keer Weir)	30.043	1158	0.074	0.976	0.003	0.455
72007 (Brock @ upstream of A6)	31.510	1361	0.053	1.000	0.000	0.318

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments
44008 (South Winterbourne @ Winterbourne Steepleton)	0.796	32	0.572	0.405	0.406	0.254	0.254	Removed due to non-flood years greater than 15%.

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.232	Urban L-CV:	0.230
Rural L-Skewness:	0.255	Urban L-Skewness:	0.256

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.229	-0.255		0.099
GEV	0.878	0.326	-0.128		-1.676
KAP3	0.938	0.272	-0.198	-0.400	-0.438

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.228	-0.256		0.112
GEV	0.879	0.323	-0.130		-1.603
KAP3	0.938	0.270	-0.200	-0.400	-0.412

Goodness of fit

GL:	1.3030 *
GEV:	-0.2834 *
P3:	-2.2705
GP:	-4.1804
KAP3:	0.7656 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: -0.0506

The pooling group is acceptably homogeneous and a review of the pooling group is not required.

Standardised growth curves

Rural

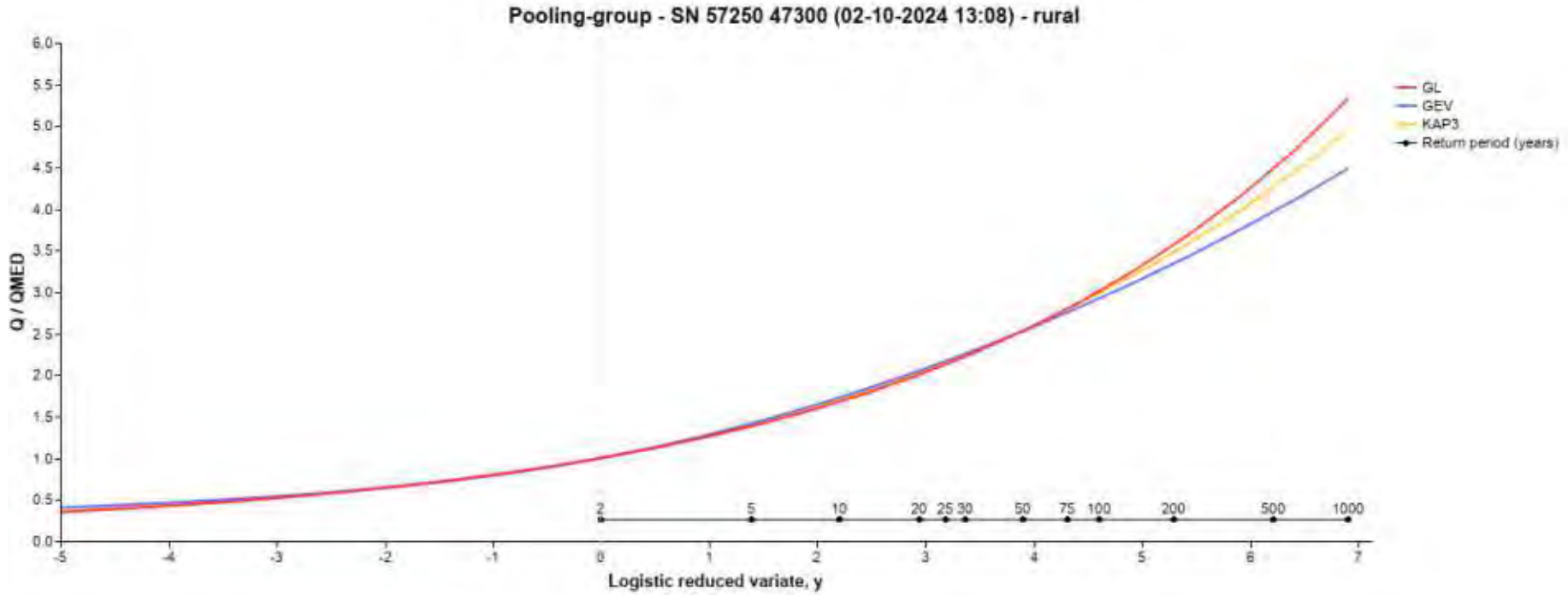
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.381	1.416	1.396
10	1.675	1.727	1.699
20	2.006	2.054	2.031
25	2.122	2.165	2.146
30	2.222	2.257	2.243
50	2.526	2.525	2.534
75	2.794	2.750	2.785
100	3.001	2.916	2.975
200	3.566	3.343	3.479
500	4.480	3.966	4.258
1000	5.327	4.488	4.948

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.379	1.414	1.393
10	1.672	1.723	1.695
20	2.001	2.050	2.027
25	2.118	2.160	2.141
30	2.218	2.252	2.239
50	2.521	2.521	2.529
75	2.789	2.746	2.780
100	2.997	2.913	2.971
200	3.562	3.341	3.476
500	4.479	3.968	4.259
1000	5.329	4.494	4.953

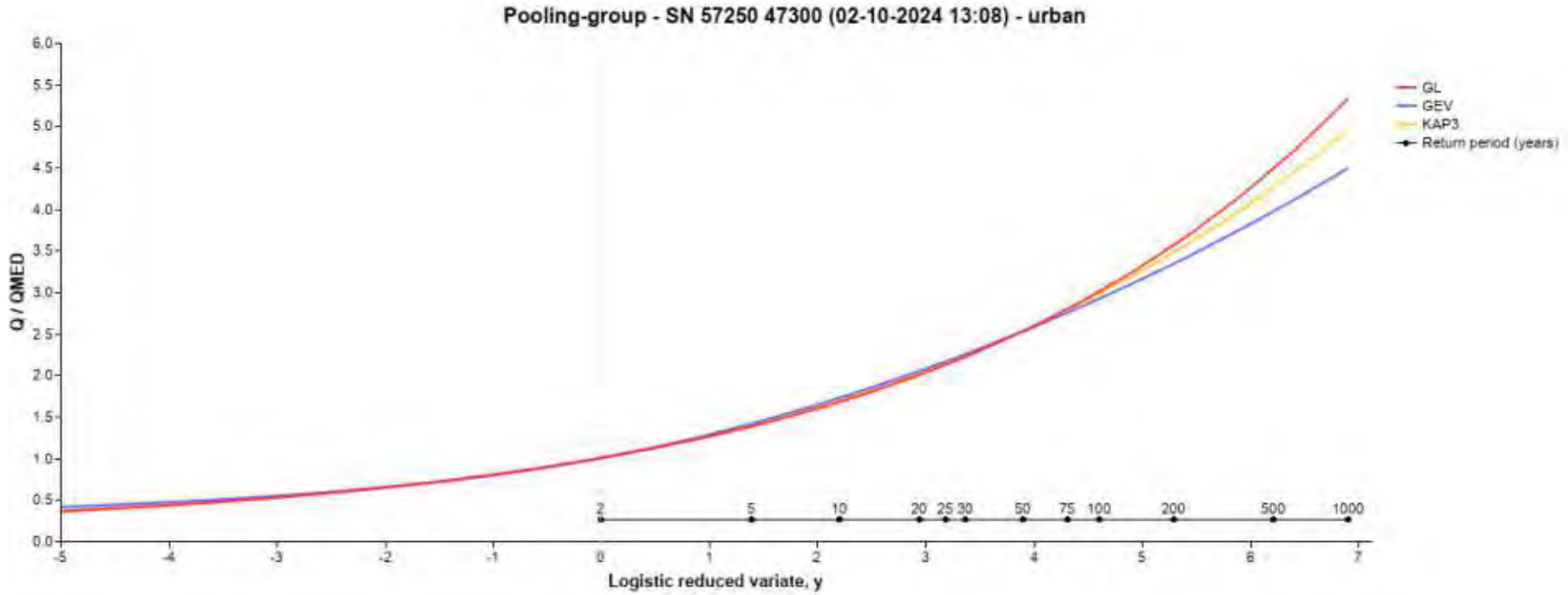
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.374
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62002 (Teifi @ Llanfair)	5.08	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_257250_247300_v5_0_1 @ SN 57250 47300)	10.797	255625	250994	1258	0.028	1.000	0.010	0.488
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
62001 (Teifi @ Glanteifi)	7.22	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes
60012 (Twrch @ Ddol Las)	11.24	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
60013 (Cothi @ Pont Ynys Brechfa)	12.92	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
60002 (Cothi @ Felin Mynachdy)	13.99	0.001	Yes	179.150	**178.999**	171.073	171.073	260063	237727	298.730	1551	0.444	0.997	62	Yes	Yes
63003 (Wyre @ Llanrhystud)	18.80	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
62003 (Teifi @ Pont Llanio)	20.12	0.002	Yes	40.600	**40.513**	107.335	107.335	271146	263799	175.385	1448	0.397	0.983	25	Yes	No
60001 (Tywi @ Ty Castell)	20.37	0.002	Yes	399.100	**398.361**	502.115	502.115	269002	235627	1090.835	1535	0.432	0.984	51	Yes	Yes
60007 (Tywi @ Dolau Hirion)	21.10	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
60016 (Tywi @ Manorafon)	24.35	0.002	Yes	257.918	**257.504**	300.566	300.566	276653	238720	580.870	1564	0.417	0.973	26	Yes	No

QMED

Rural:	5.343 m³/s
Urban:	5.402 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

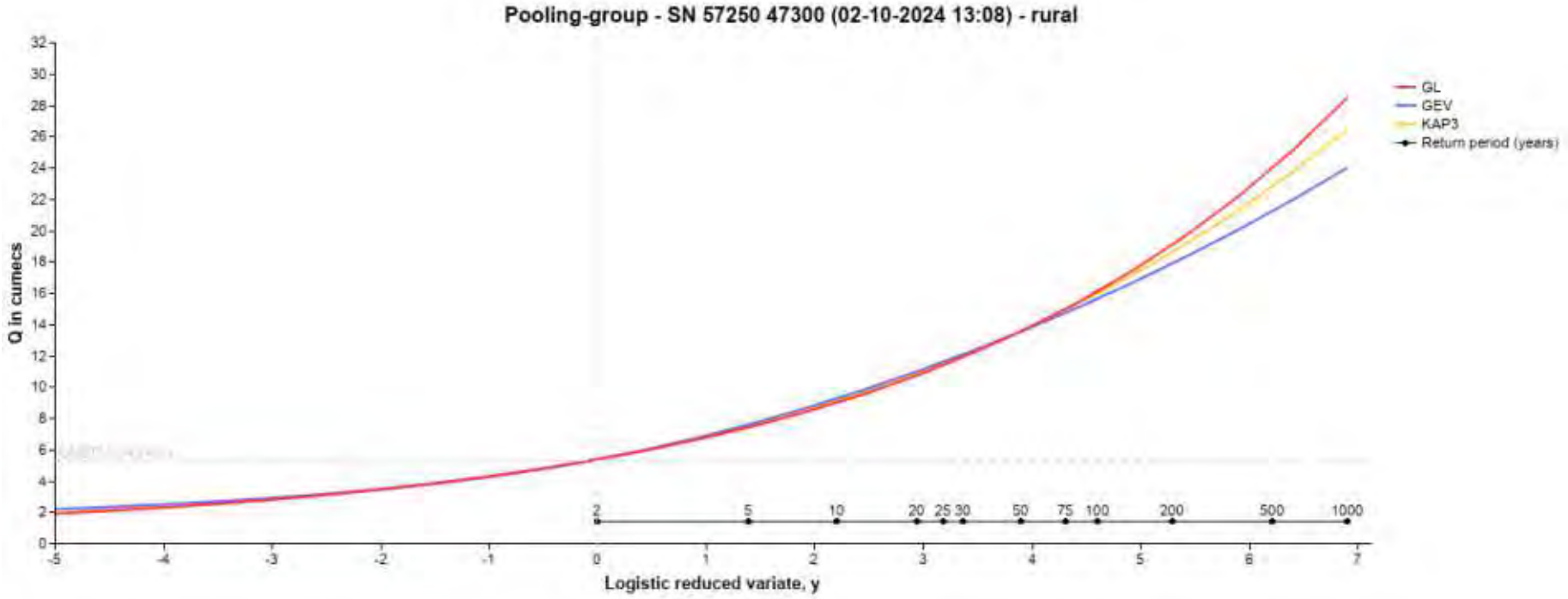
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	5.343	5.343	5.343
5	7.381	7.568	7.458
10	8.952	9.228	9.078
20	10.717	10.977	10.852
25	11.341	11.566	11.467
30	11.875	12.058	11.987
50	13.496	13.493	13.539
75	14.930	14.695	14.880
100	16.038	15.584	15.896
200	19.055	17.861	18.588
500	23.940	21.193	22.753
1000	28.465	23.982	26.441

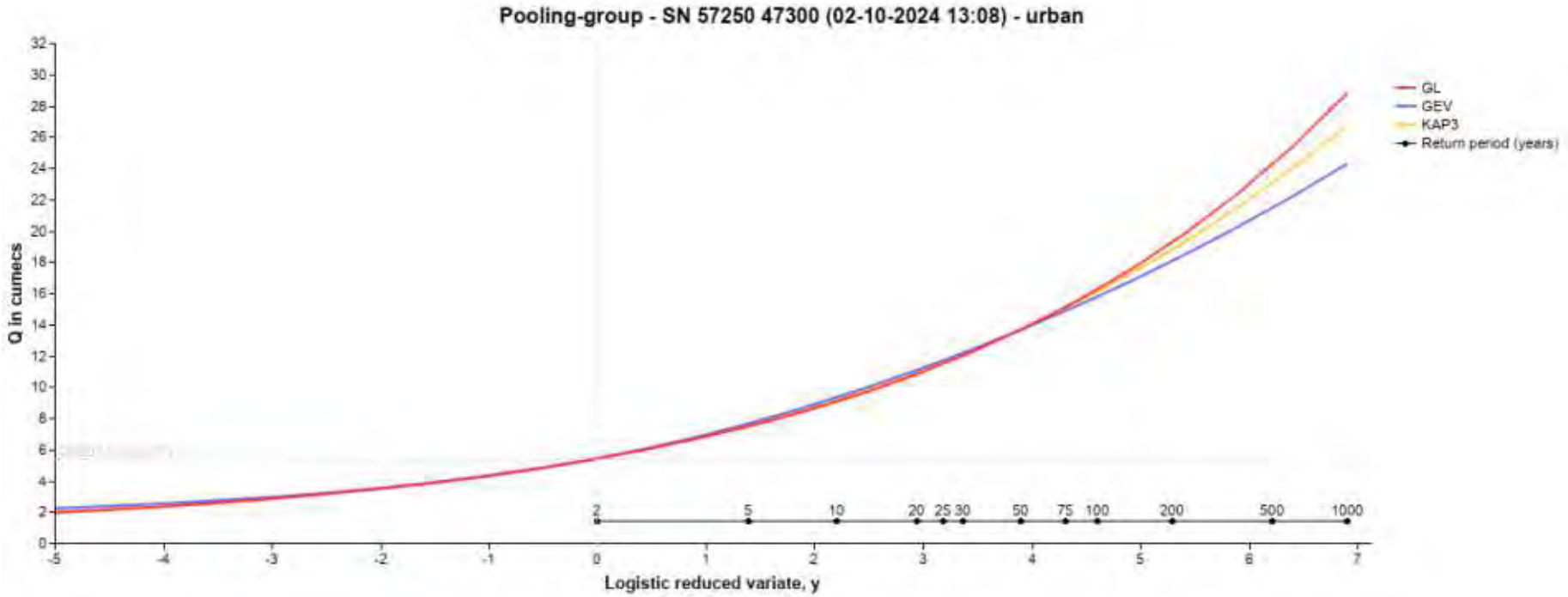
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	5.402	5.402	5.402
5	7.450	7.638	7.528
10	9.032	9.309	9.159
20	10.812	11.074	10.948
25	11.442	11.669	11.569
30	11.981	12.167	12.094
50	13.618	13.618	13.663
75	15.069	14.836	15.020
100	16.189	15.737	16.049
200	19.244	18.049	18.777
500	24.198	21.437	23.007
1000	28.793	24.281	26.758



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

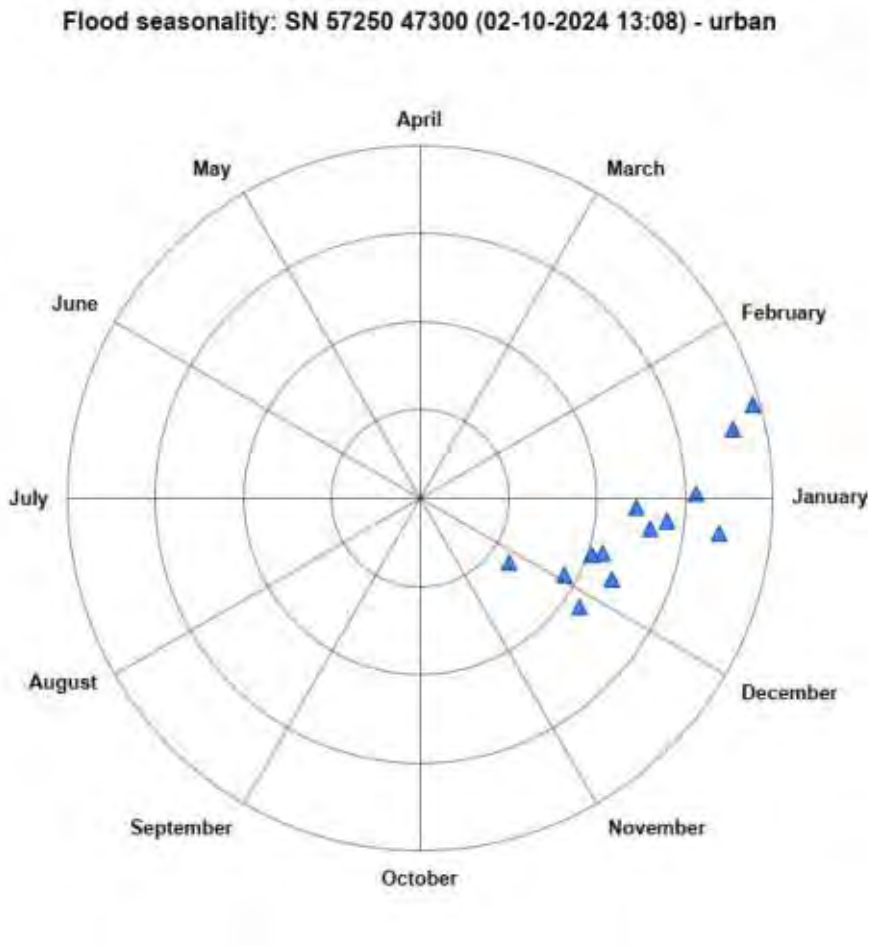


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

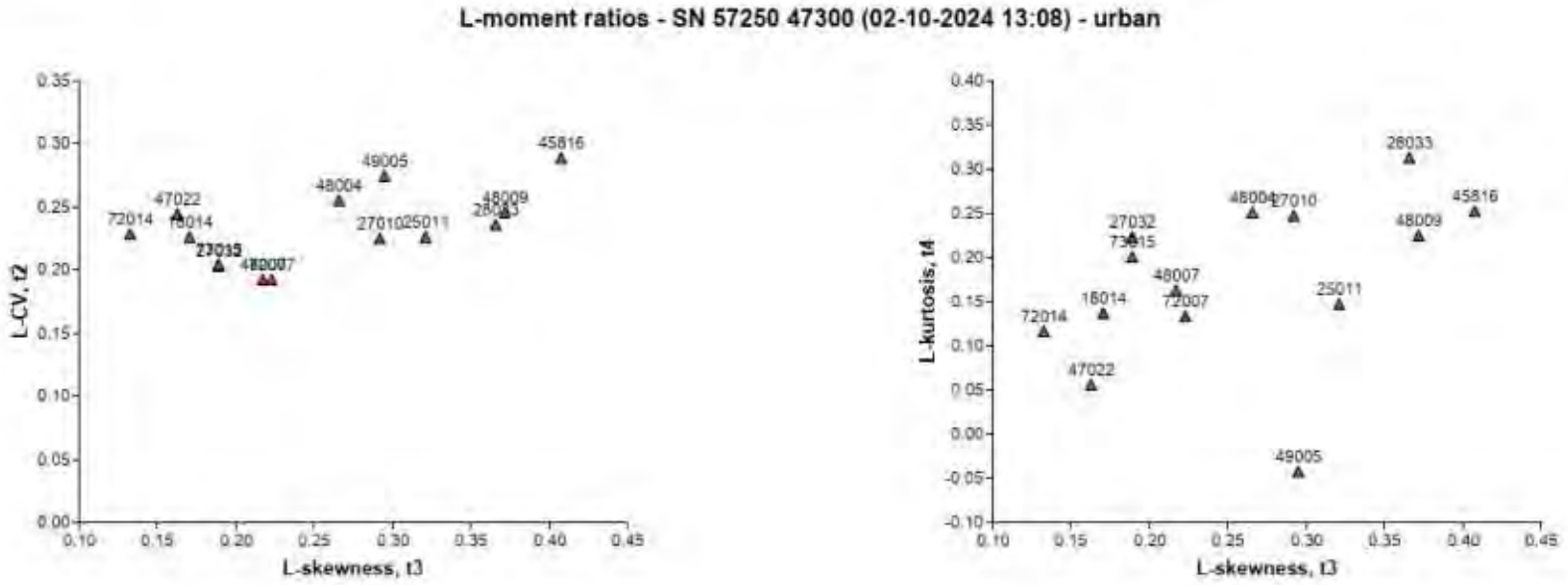


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

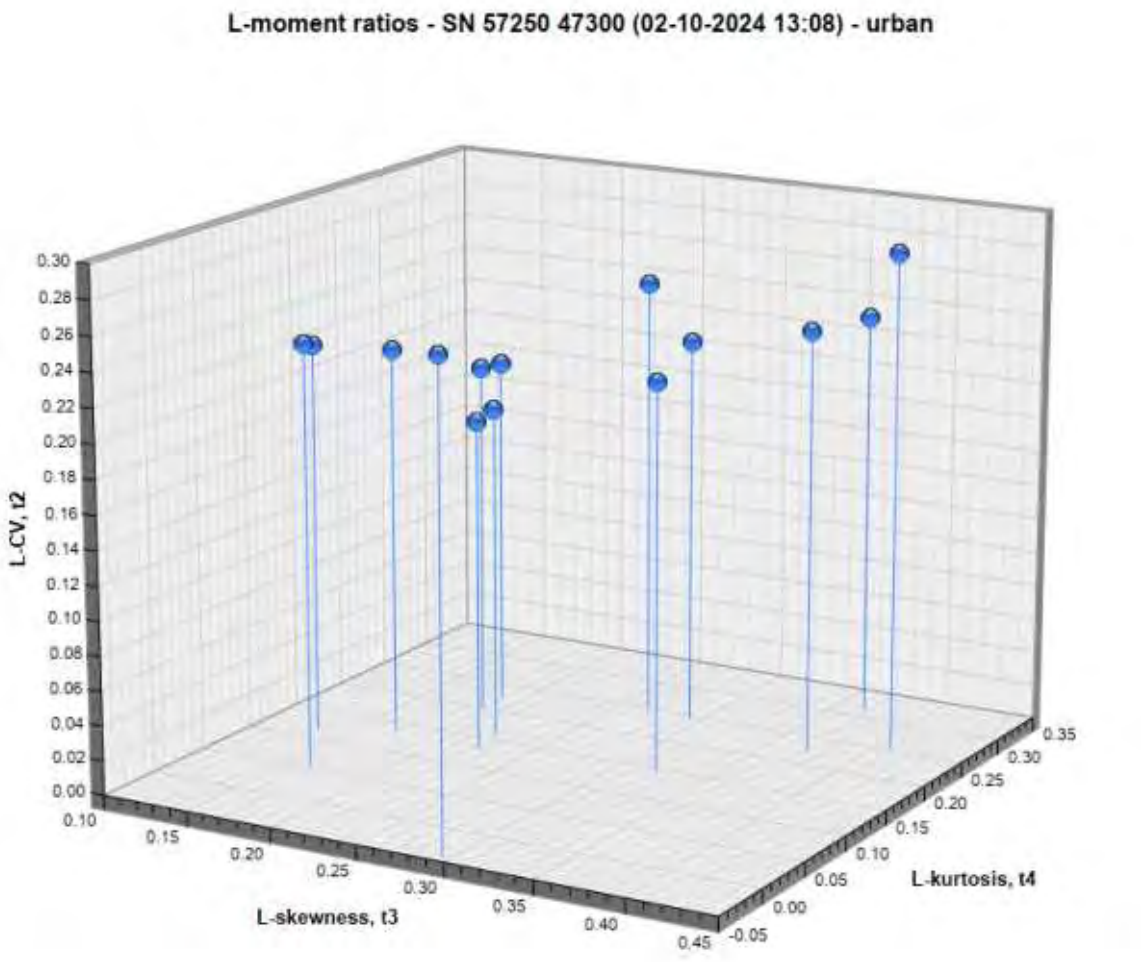
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

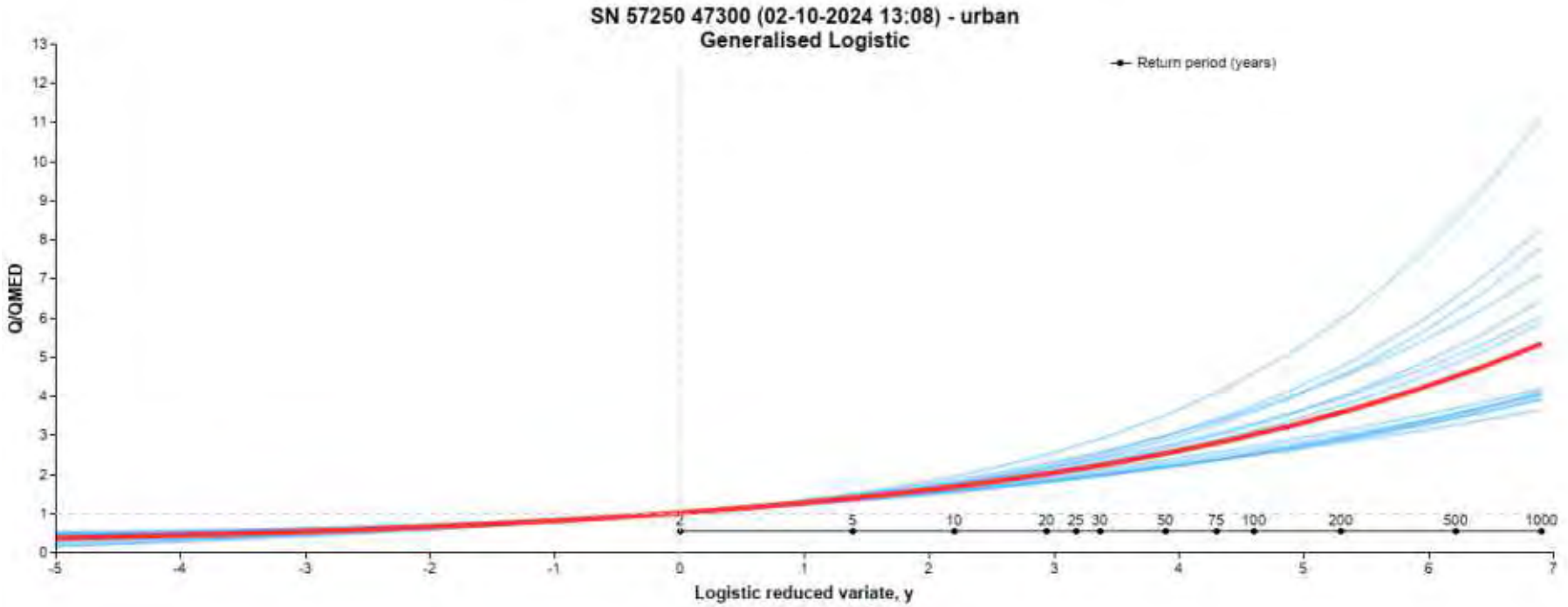
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

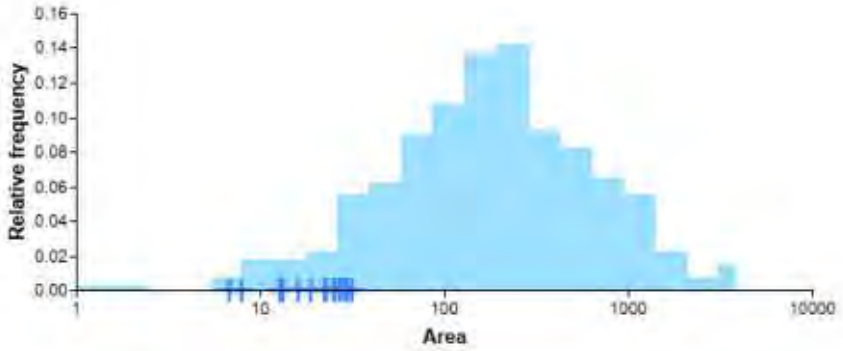
Pooling group growth curves

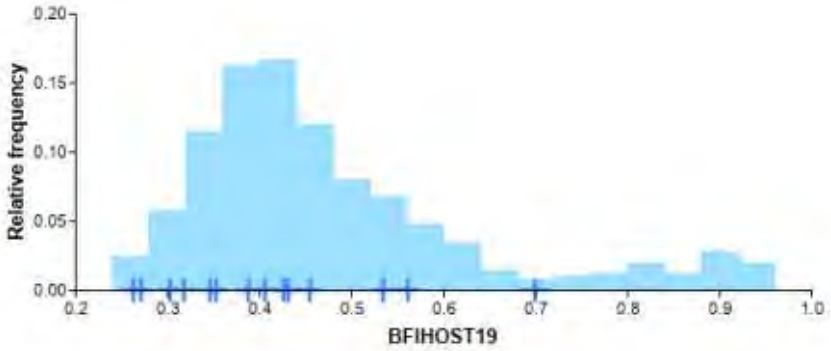


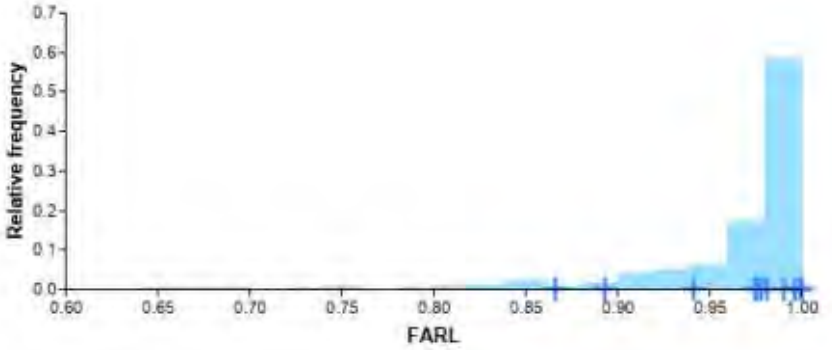
UK Design Flood Estimation

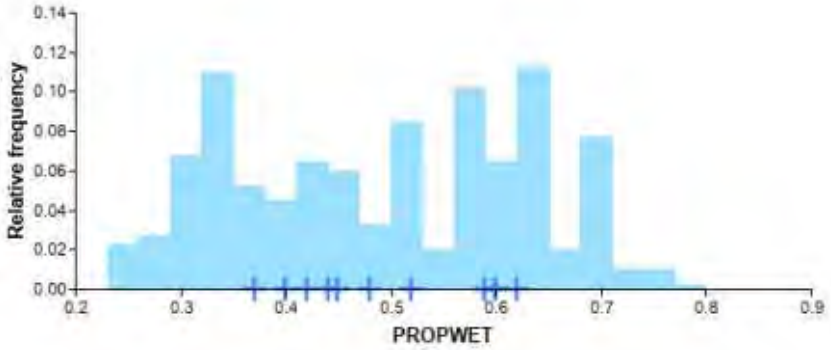
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



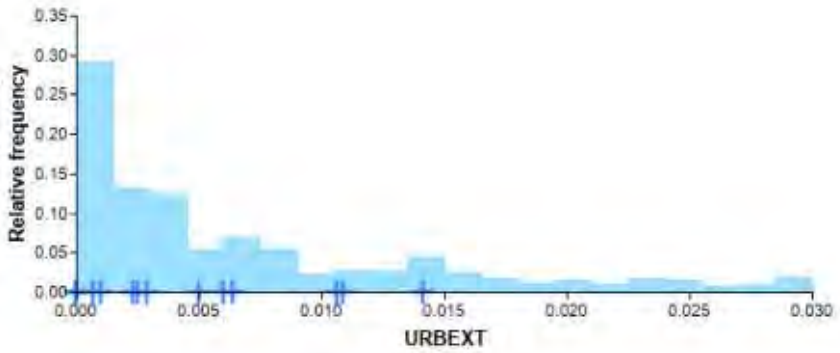


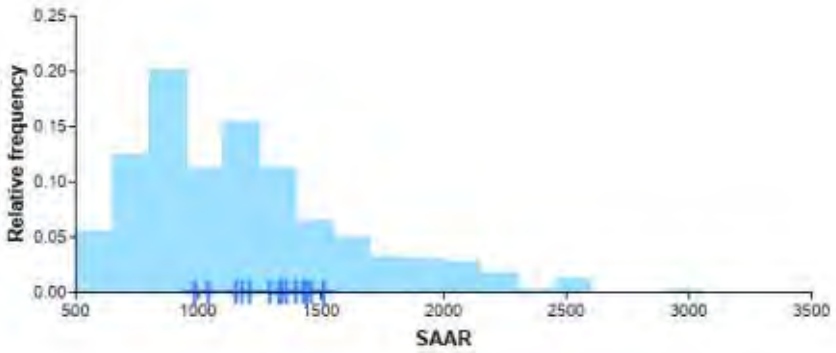


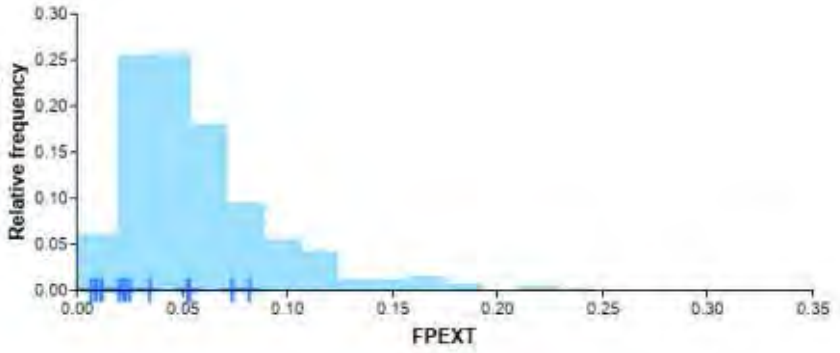


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:17:09
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	1756239264
Site name:	FEH_Catchment_Descriptors_257250_247300_v5_0_1
Site location:	SN 57250 47300
Easting:	257250
Northing:	247300
Catchment area:	0.70 km²
SAAR:	1258 mm
BFIHOST19:	0.488
FPEXT:	0.028
FARL:	1.000
URBEXT2000:	0.0097

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.01 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.01105

Growth curve settings

Distance Measure Method:	Small catchment
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	0.777	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	1.803	30	3.352	0.288	**0.289**	0.408	**0.407**
28033 (Dove @ Hollinsclough)	1.929	48	4.138	0.235	**0.235**	0.367	**0.367**
27051 (Crimple @ Burn Bridge)	2.237	51	4.564	0.217	**0.217**	0.142	**0.141**
25011 (Langdon Beck @ Langdon)	2.339	37	15.647	0.225	**0.225**	0.321	**0.321**
47022 (Tory Brook @ Newnham Park)	2.358	28	6.134	0.243	**0.245**	0.163	**0.160**
71003 (Croasdale Beck @ Croasdale Flume)	2.447	37	10.900	0.212	**0.212**	0.323	**0.323**
27073 (Brompton Beck @ Snainton Ings)	2.506	43	0.812	0.212	**0.213**	0.033	**0.032**
25003 (Trout Beck @ Moor House)	2.507	50	15.182	0.170	**0.170**	0.299	**0.299**
106002 (Laxdale @ Laxdale)	2.525	16	17.449	0.102	**0.102**	0.154	**0.154**
206006 (Annalong @ Recorder)	2.547	48	15.330	0.189	**0.189**	0.052	**0.052**
91802 (Allt Leachdach @ Intake)	2.691	34	6.350	0.153	**0.153**	0.257	**0.257**
27010 (Hodge Beck @ Bransdale Weir)	2.695	41	9.420	0.224	**0.224**	0.293	**0.293**
Total		**509**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
76011 (Coal Burn @ Coalburn)	Yes	Yes	46	0	0.00			0.459	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.480	
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			0.867	
27051 (Crimple @ Burn Bridge)	Yes	Yes	51	3	5.88	1.34	None	0.556	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			0.827	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			1.168	
71003 (Croasdale Beck @ Croasdale Flume)	Yes	Yes	37	1	2.70			0.267	
27073 (Brompton Beck @ Snainton Ings)	Yes	Yes	43	2	4.65	0.92	None	1.454	
25003 (Trout Beck @ Moor House)	Yes	Yes	50	1	2.00			0.444	
106002 (Laxdale @ Laxdale)	Yes	Yes	16	0	0.00			1.732	
206006 (Annalong @ Recorder)	Yes	Yes	48	4	8.33	2.25	None	2.880	
91802 (Allt Leachdach @ Intake)	Yes	Yes	34	0	0.00	-0.42	None	0.655	
27010 (Hodge Beck @ Bransdale Weir)	Yes	Yes	41	1	2.44	-2.10	5	0.210	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
76011 (Coal Burn @ Coalburn)	1.630	1096	0.074	1.000	0.000	0.274
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
27051 (Crimple @ Burn Bridge)	8.172	855	0.013	1.000	0.006	0.329
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
71003 (Croasdale Beck @ Croasdale Flume)	10.710	1882	0.016	1.000	0.000	0.283
27073 (Brompton Beck @ Snainton Ings)	8.060	721	0.237	1.000	0.008	0.811
25003 (Trout Beck @ Moor House)	11.395	1905	0.041	1.000	0.000	0.255
106002 (Laxdale @ Laxdale)	10.640	1993	0.024	0.888	0.000	0.299
206006 (Annalong @ Recorder)	14.438	1704	0.023	0.981	0.000	0.267
91802 (Allt Leachdach @ Intake)	6.522	2555	0.003	0.992	0.000	0.277
27010 (Hodge Beck @ Bransdale Weir)	18.820	987	0.009	1.000	0.001	0.303

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	2.537	13	4.072	0.274	0.275	0.295	0.294	Removed due to only 13 years of record.

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.204	Urban L-CV:	0.203
Rural L-Skewness:	0.240	Urban L-Skewness:	0.241

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.201	-0.240		0.161
GEV	0.892	0.289	-0.105		-1.846
KAP3	0.945	0.240	-0.179	-0.400	-0.392

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.200	-0.241		0.173
GEV	0.893	0.286	-0.108		-1.758
KAP3	0.945	0.238	-0.181	-0.400	-0.366

Goodness of fit

GL:	0.3455 *
GEV:	-1.1501 *
P3:	-2.8635
GP:	-4.7744
KAP3:	-0.1667 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 1.8857

The pooling group is possibly heterogeneous and a review of the pooling group is optional.

Standardised growth curves

Rural

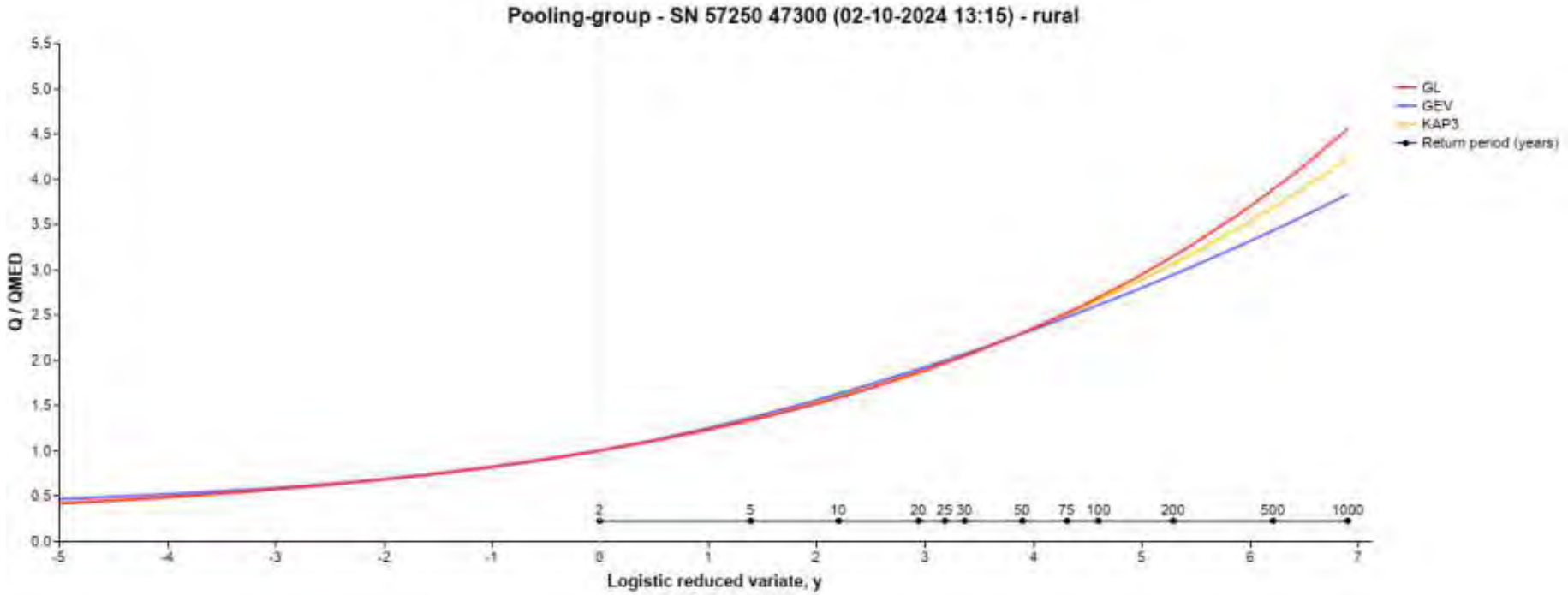
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.330	1.361	1.343
10	1.581	1.625	1.602
20	1.860	1.899	1.881
25	1.957	1.991	1.977
30	2.041	2.066	2.057
50	2.292	2.286	2.297
75	2.514	2.468	2.502
100	2.683	2.602	2.656
200	3.143	2.940	3.062
500	3.877	3.427	3.680
1000	4.549	3.827	4.219

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.329	1.359	1.341
10	1.578	1.622	1.599
20	1.856	1.896	1.877
25	1.954	1.987	1.973
30	2.037	2.063	2.053
50	2.288	2.282	2.293
75	2.510	2.465	2.498
100	2.679	2.599	2.653
200	3.139	2.939	3.059
500	3.876	3.428	3.680
1000	4.551	3.832	4.222

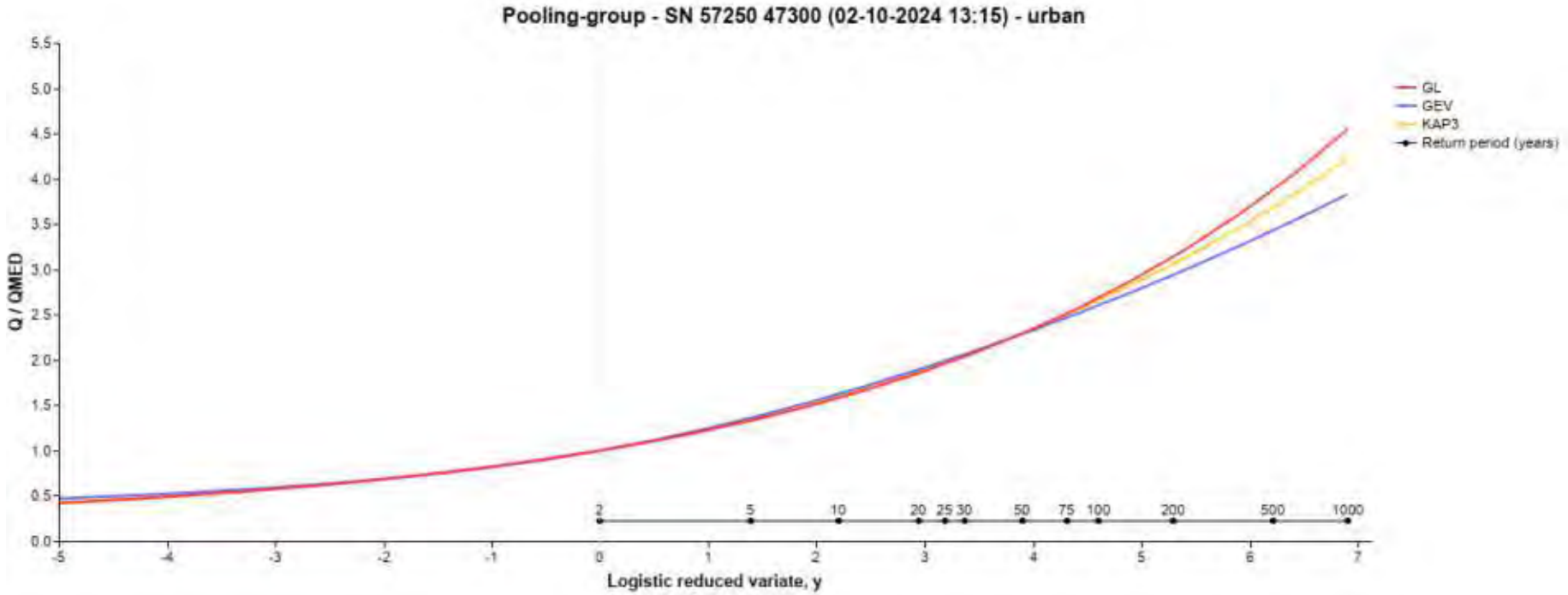
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.374
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62002 (Teifi @ Llanfair)	5.08	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_257250_247300_v5_0_1 @ SN 57250 47300)	0.700	255625	250994	1258	0.028	1.000	0.010	0.488
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
62001 (Teifi @ Glanteifi)	7.22	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes
60012 (Twrch @ Ddol Las)	11.24	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
60013 (Cothi @ Pont Ynys Brechfa)	12.92	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
60002 (Cothi @ Felin Mynachdy)	13.99	0.001	Yes	179.150	**178.999**	171.073	171.073	260063	237727	298.730	1551	0.444	0.997	62	Yes	Yes
63003 (Wyre @ Llanrhystud)	18.80	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
62003 (Teifi @ Pont Llanio)	20.12	0.002	Yes	40.600	**40.513**	107.335	107.335	271146	263799	175.385	1448	0.397	0.983	25	Yes	No
60001 (Tywi @ Ty Castell)	20.37	0.002	Yes	399.100	**398.361**	502.115	502.115	269002	235627	1090.835	1535	0.432	0.984	51	Yes	Yes
60007 (Tywi @ Dolau Hirion)	21.10	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
60016 (Tywi @ Manorafon)	24.35	0.002	Yes	257.918	**257.504**	300.566	300.566	276653	238720	580.870	1564	0.417	0.973	26	Yes	No

QMED

Rural:	0.521 m³/s
Urban:	0.527 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

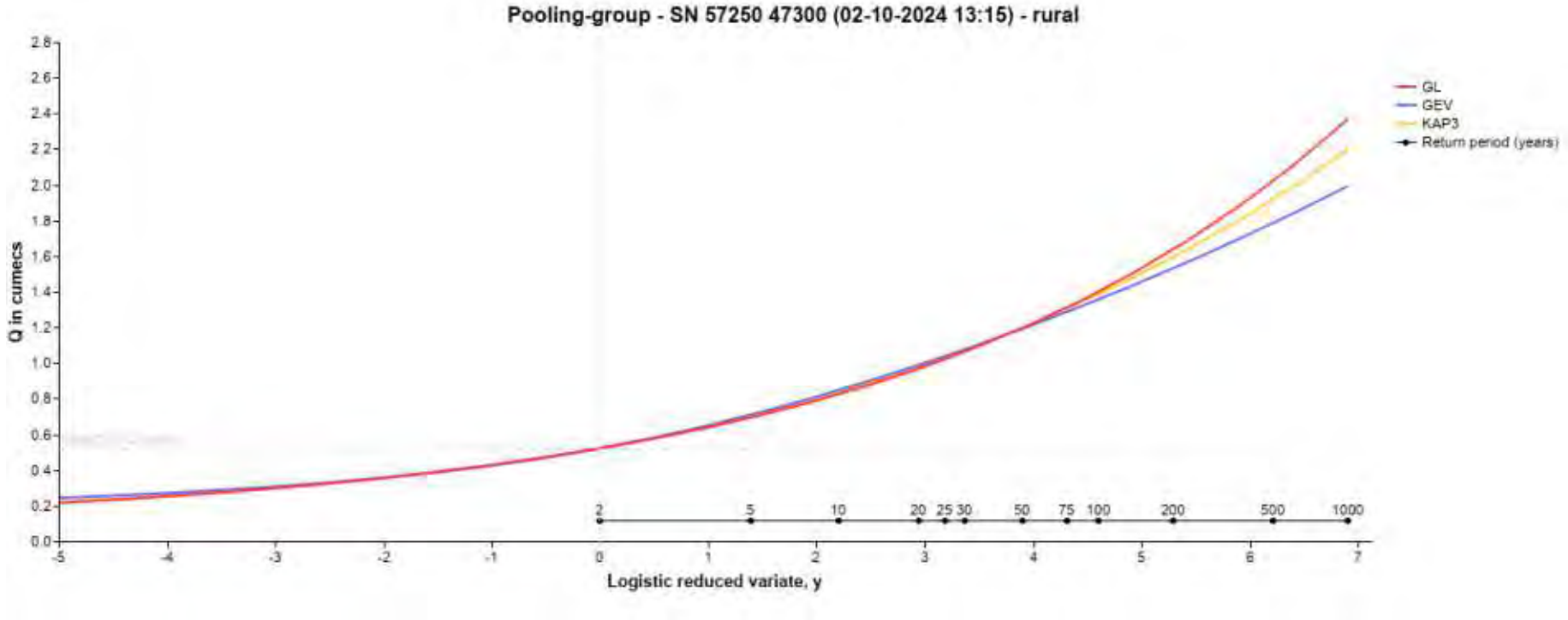
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.521	0.521	0.521
5	0.693	0.709	0.700
10	0.823	0.847	0.834
20	0.968	0.989	0.979
25	1.019	1.037	1.029
30	1.063	1.076	1.071
50	1.194	1.190	1.196
75	1.309	1.285	1.303
100	1.397	1.355	1.383
200	1.637	1.531	1.594
500	2.019	1.784	1.916
1000	2.369	1.993	2.197

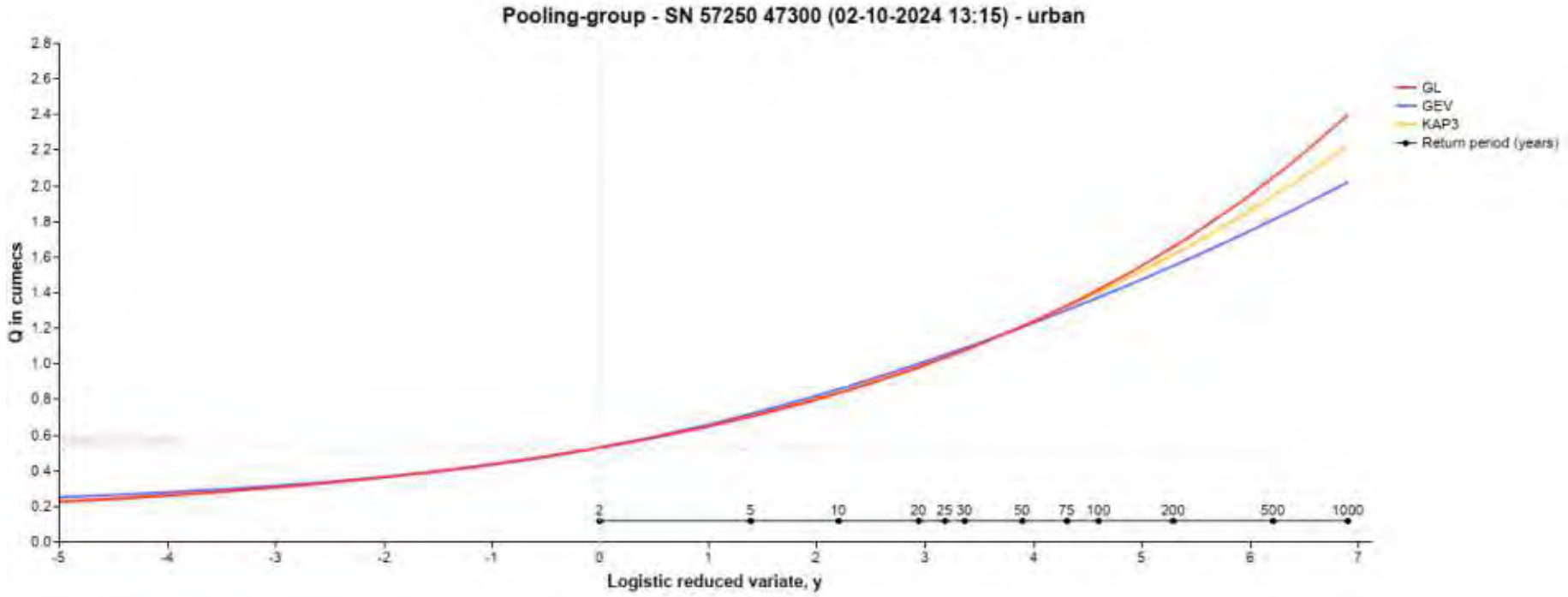
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.527	0.527	0.527
5	0.700	0.716	0.706
10	0.831	0.854	0.842
20	0.977	0.998	0.988
25	1.029	1.046	1.039
30	1.072	1.086	1.081
50	1.205	1.202	1.207
75	1.321	1.298	1.315
100	1.411	1.368	1.397
200	1.653	1.547	1.611
500	2.041	1.805	1.938
1000	2.396	2.017	2.223



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

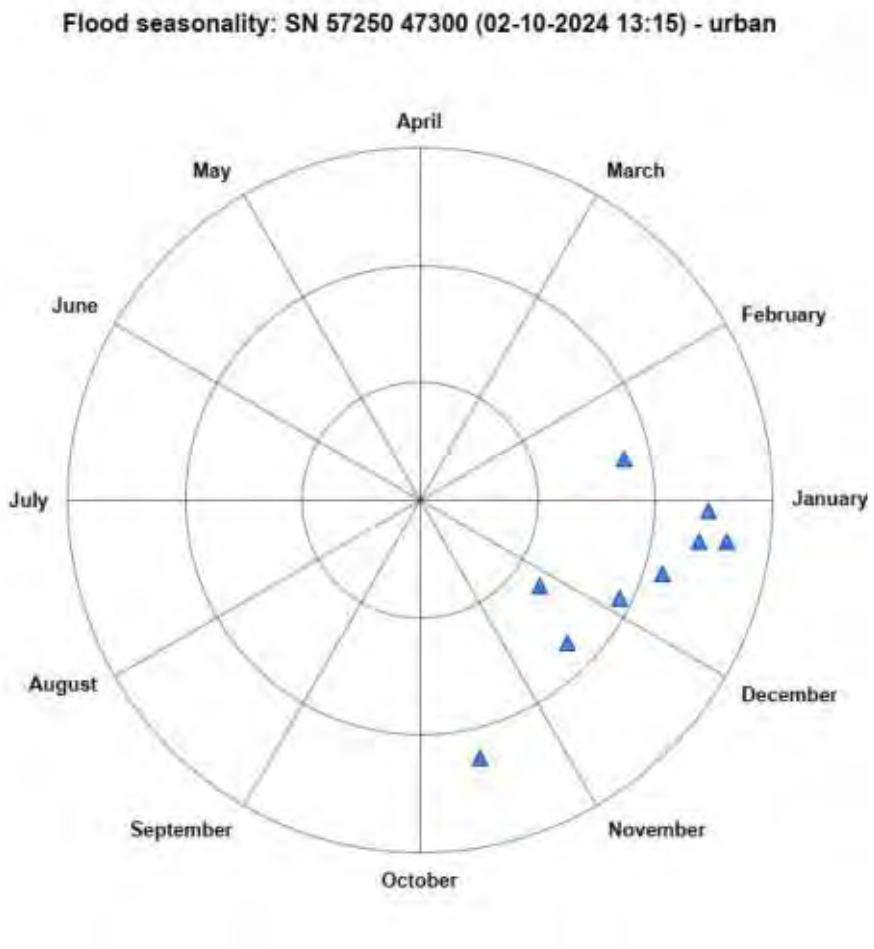


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

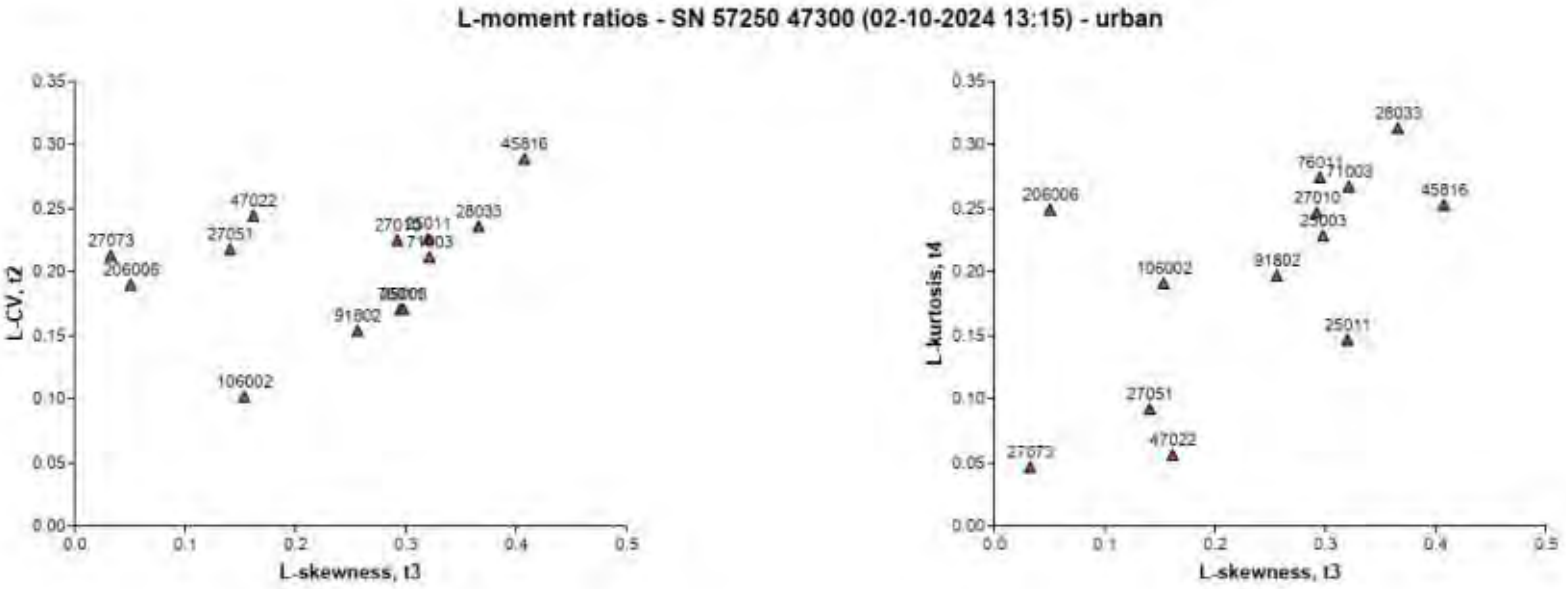


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

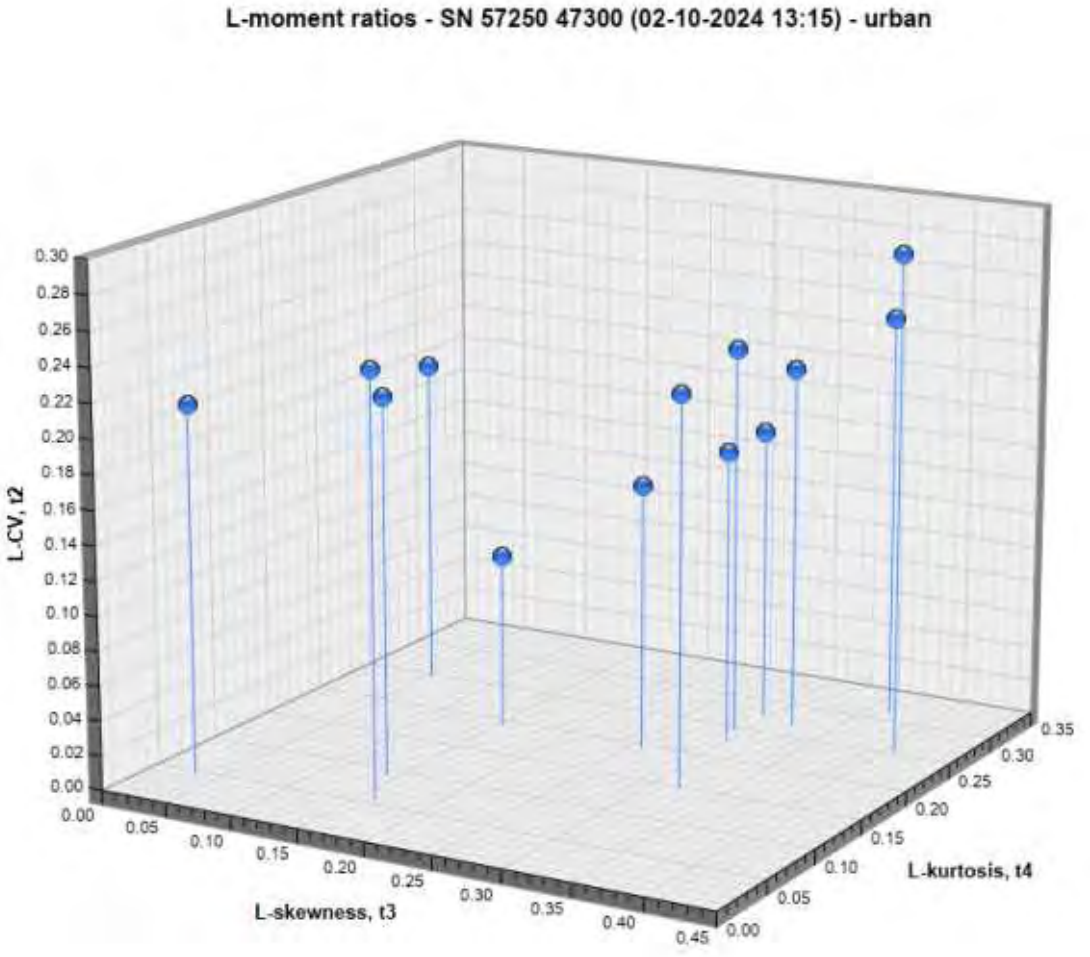
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

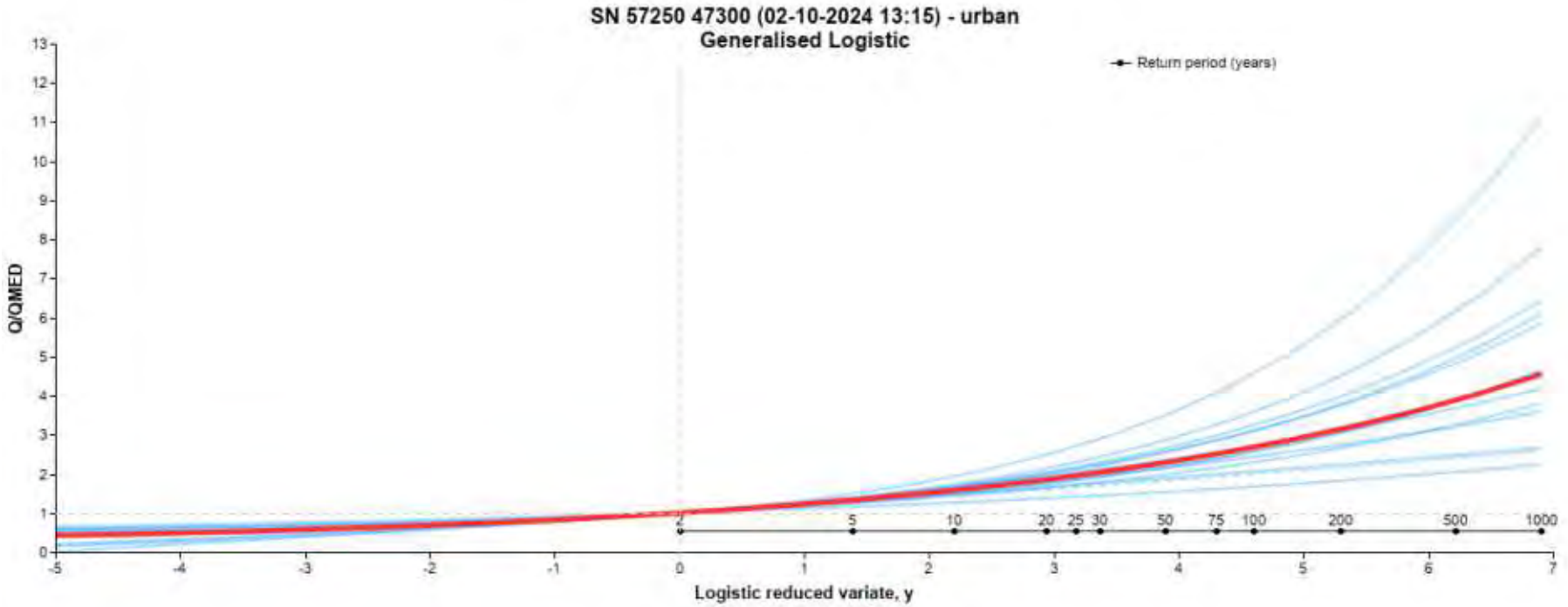
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

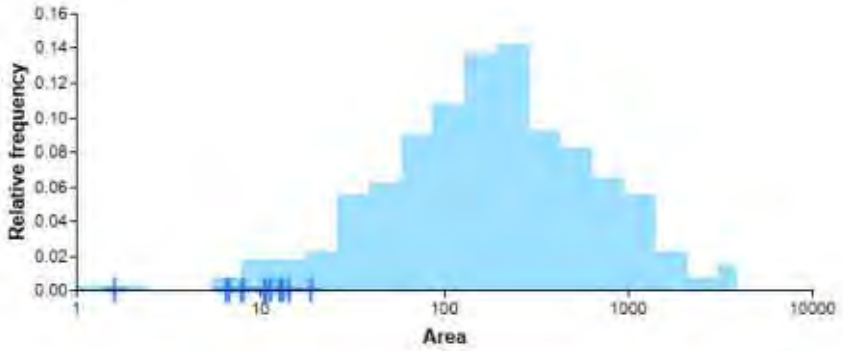
Pooling group growth curves

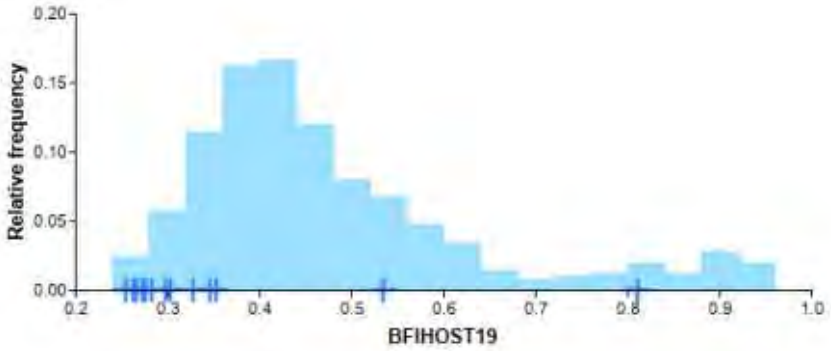


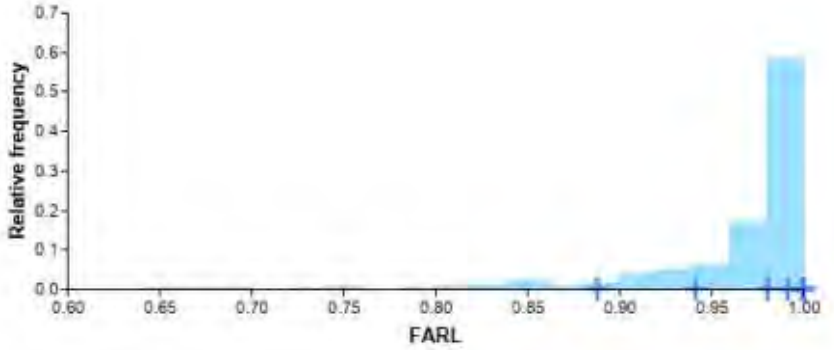
UK Design Flood Estimation

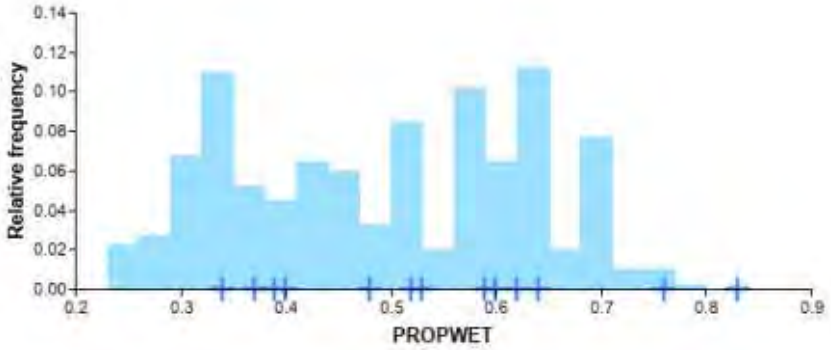
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



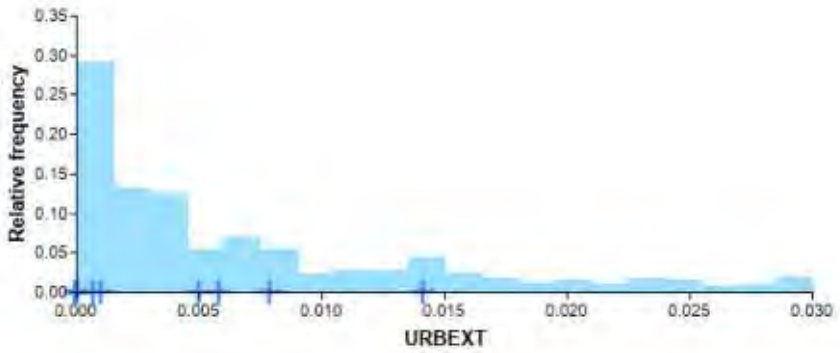


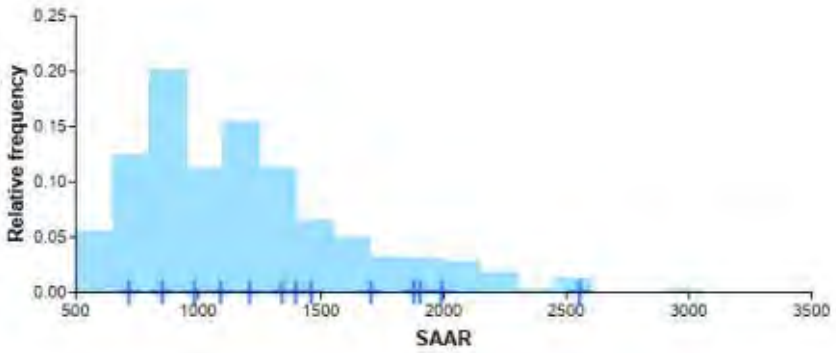


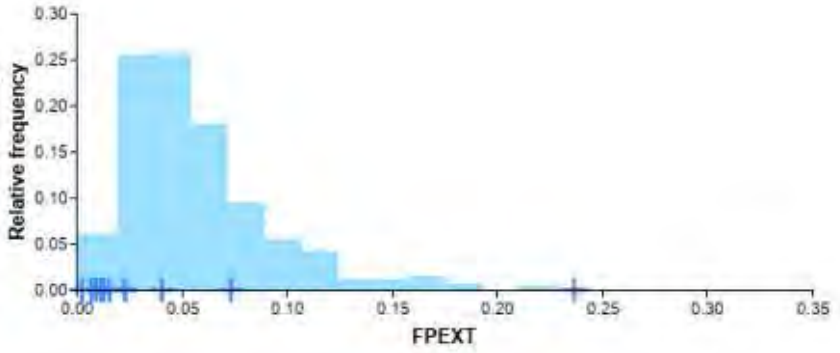


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:22:14
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	1332436392
Site name:	FEH_Catchment_Descriptors_257100_248650_v5_0_1
Site location:	SN 57100 48650
Easting:	257100
Northing:	248650
Catchment area:	10.10 km²
SAAR:	1258 mm
BFIHOST19:	0.478
FPEXT:	0.015
FARL:	1.000
URBEXT2000:	0.0028

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.04 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.00313

Growth curve settings

Distance Measure Method:	Small catchment
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
28033 (Dove @ Hollinsclough)	0.273	48	4.138	0.235	**0.235**	0.367	**0.367**
45816 (Haddeo @ Upton)	0.331	30	3.352	0.288	**0.289**	0.408	**0.407**
47022 (Tory Brook @ Newnham Park)	0.386	28	6.134	0.243	**0.245**	0.163	**0.160**
25011 (Langdon Beck @ Langdon)	0.471	37	15.647	0.225	**0.225**	0.321	**0.321**
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	0.649	13	4.072	0.274	**0.275**	0.295	**0.294**
27032 (Hebden Beck @ Hebden)	0.728	55	4.052	0.203	**0.203**	0.190	**0.190**
18014 (Bannock Burn @ Bannockburn)	0.748	31	15.727	0.226	**0.227**	0.171	**0.169**
48007 (Kennal @ Ponsanooth)	0.779	55	4.180	0.192	**0.193**	0.217	**0.215**
48004 (Warleggan @ Trengoffe)	0.827	54	9.865	0.254	**0.254**	0.266	**0.265**
48009 (St Neot @ Craigshill Wood)	0.836	12	8.465	0.245	**0.245**	0.373	**0.372**
27010 (Hodge Beck @ Bransdale Weir)	0.852	41	9.420	0.224	**0.224**	0.293	**0.293**
72014 (Conder @ Galgate)	0.853	56	16.971	0.228	**0.229**	0.133	**0.132**
73015 (Keer @ High Keer Weir)	0.895	33	12.421	0.204	**0.205**	0.189	**0.189**
206006 (Annalong @ Recorder)	0.914	48	15.330	0.189	**0.189**	0.052	**0.052**
Total		**541**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			1.013	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.996	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			0.955	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			0.976	
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	Yes	Yes	13	0	0.00			2.484	
27032 (Hebden Beck @ Hebden)	Yes	Yes	55	2	3.64	0.53	None	0.361	
18014 (Bannock Burn @ Bannockburn)	Yes	Yes	31	1	3.23	-0.88	None	0.254	
48007 (Kennal @ Ponsanooth)	Yes	Yes	55	1	1.82	0.54	None	1.300	
48004 (Warleggan @ Trengoffe)	Yes	Yes	54	4	7.41	0.65	None	0.971	
48009 (St Neot @ Craigshill Wood)	Yes	Yes	12	0	0.00			0.608	
27010 (Hodge Beck @ Bransdale Weir)	Yes	Yes	41	1	2.44	-2.10	5	0.283	
72014 (Conder @ Galgate)	Yes	Yes	56	3	5.36	1.39	None	0.665	
73015 (Keer @ High Keer Weir)	Yes	Yes	33	1	3.03	3.30	5	0.297	
206006 (Annalong @ Recorder)	Yes	Yes	48	4	8.33	2.25	None	1.839	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	16.080	1044	0.023	0.991	0.006	0.562
27032 (Hebden Beck @ Hebden)	22.245	1433	0.021	0.997	0.000	0.272
18014 (Bannock Burn @ Bannockburn)	25.372	1333	0.054	0.893	0.011	0.407
48007 (Kennal @ Ponsanooth)	26.892	1294	0.026	0.867	0.011	0.700
48004 (Warleggan @ Trengoffe)	25.260	1445	0.035	0.978	0.003	0.432
48009 (St Neot @ Craigshill Wood)	22.973	1511	0.023	0.982	0.002	0.388
27010 (Hodge Beck @ Bransdale Weir)	18.820	987	0.009	1.000	0.001	0.303
72014 (Conder @ Galgate)	28.992	1183	0.082	0.975	0.006	0.427
73015 (Keer @ High Keer Weir)	30.043	1158	0.074	0.976	0.003	0.455
206006 (Annalong @ Recorder)	14.438	1704	0.023	0.981	0.000	0.267

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments
44008 (South Winterbourne @ Winterbourne Steepleton)	0.830	32	0.572	0.405	0.406	0.254	0.254	

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.232	Urban L-CV:	0.232
Rural L-Skewness:	0.243	Urban L-Skewness:	0.244

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.231	-0.243		0.050
GEV	0.876	0.331	-0.111		-2.115
KAP3	0.937	0.275	-0.184	-0.400	-0.561

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.230	-0.244		0.054
GEV	0.876	0.330	-0.111		-2.087
KAP3	0.937	0.274	-0.184	-0.400	-0.552

Goodness of fit

GL:	0.5075 *
GEV:	-1.0630 *
P3:	-2.7164
GP:	-4.8232
KAP3:	-0.0355 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 0.5559

The pooling group is acceptably homogeneous and a review of the pooling group is not required.

Standardised growth curves

Rural

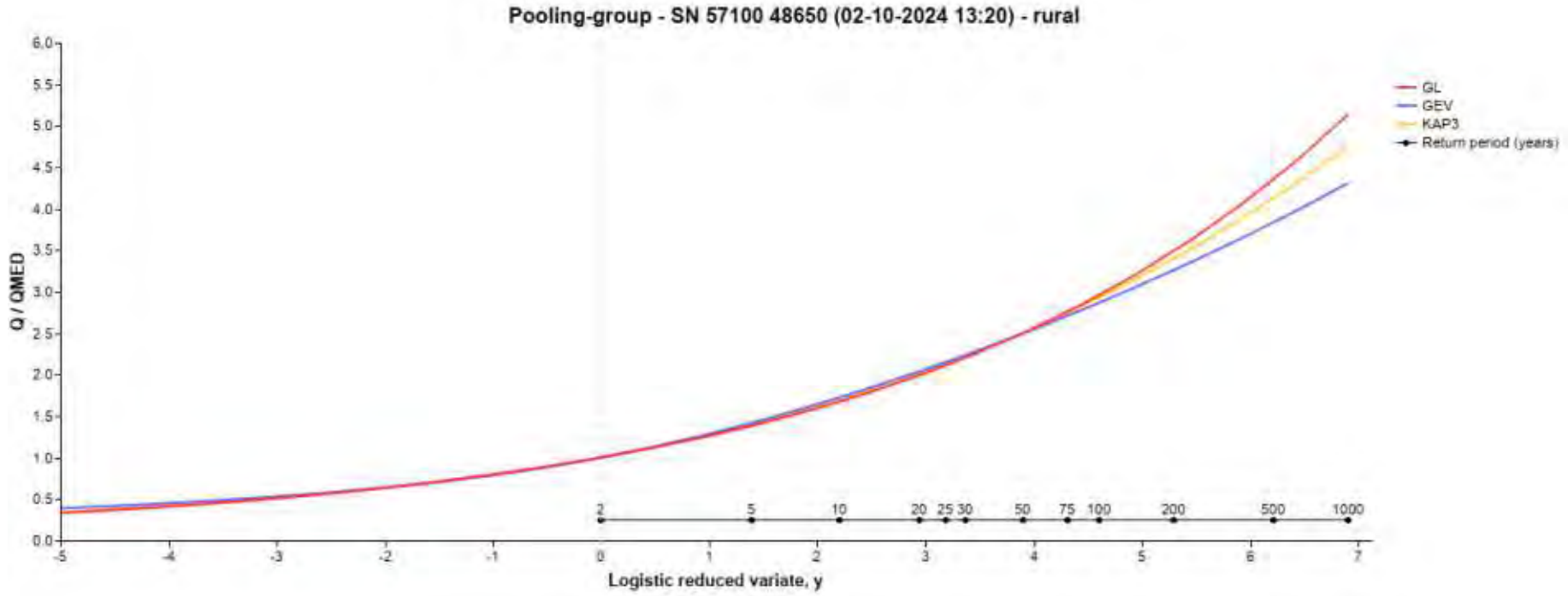
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.380	1.416	1.395
10	1.670	1.722	1.694
20	1.993	2.040	2.018
25	2.106	2.146	2.129
30	2.203	2.235	2.223
50	2.496	2.491	2.502
75	2.753	2.704	2.742
100	2.952	2.861	2.922
200	3.488	3.259	3.397
500	4.349	3.834	4.124
1000	5.139	4.308	4.760

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.380	1.415	1.395
10	1.669	1.721	1.693
20	1.992	2.039	2.016
25	2.105	2.145	2.128
30	2.202	2.233	2.222
50	2.494	2.490	2.501
75	2.752	2.703	2.740
100	2.950	2.860	2.921
200	3.487	3.259	3.396
500	4.348	3.834	4.124
1000	5.139	4.310	4.761

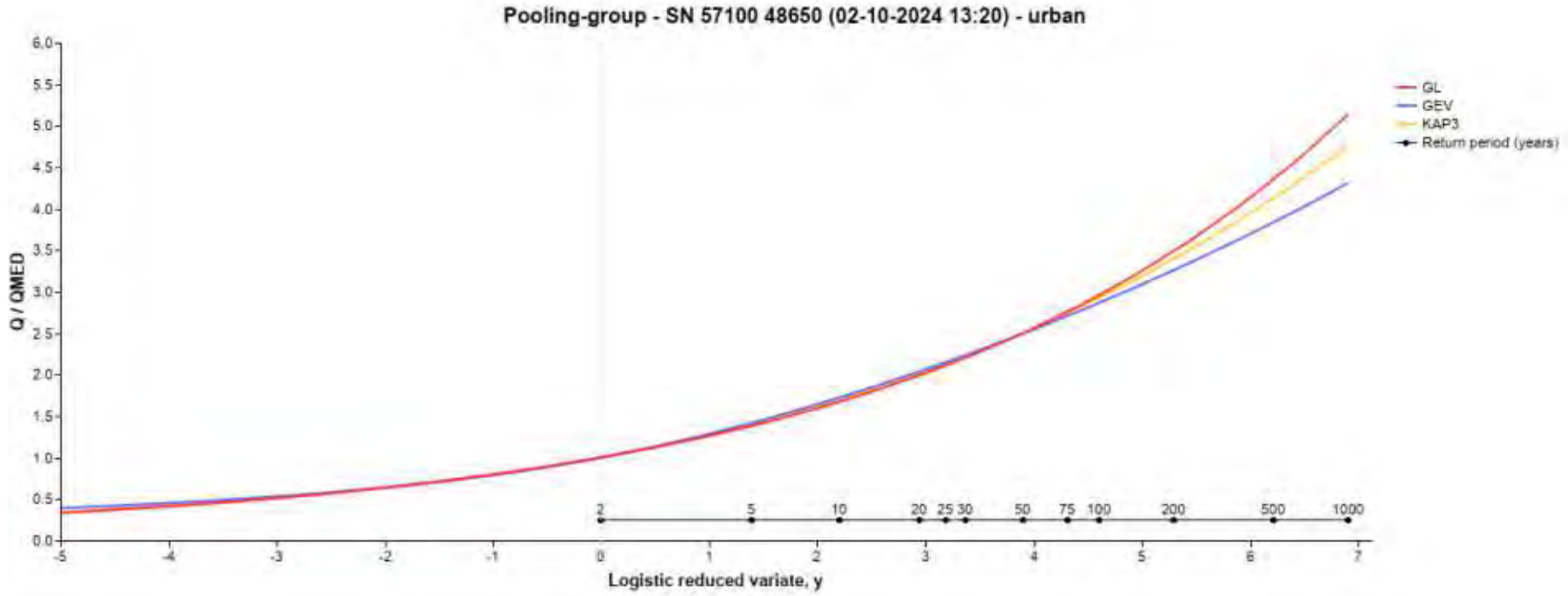
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.374
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62002 (Teifi @ Llanfair)	5.08	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_257100_248650_v5_0_1 @ SN 57100 48650)	10.098	255522	251182	1258	0.015	1.000	0.003	0.478
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
62001 (Teifi @ Glanteifi)	7.21	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes
60012 (Twrch @ Ddol Las)	11.39	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
60013 (Cothi @ Pont Ynys Brechfa)	13.13	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
60002 (Cothi @ Felin Mynachdy)	14.20	0.001	Yes	179.150	**178.999**	171.073	171.073	260063	237727	298.730	1551	0.444	0.997	62	Yes	Yes
63003 (Wyre @ Llanrhystud)	18.64	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
62003 (Teifi @ Pont Llanio)	20.08	0.002	Yes	40.600	**40.513**	107.335	107.335	271146	263799	175.385	1448	0.397	0.983	25	Yes	No
60001 (Tywi @ Ty Castell)	20.58	0.002	Yes	399.100	**398.361**	502.115	502.115	269002	235627	1090.835	1535	0.432	0.984	51	Yes	Yes
60007 (Tywi @ Dolau Hirion)	21.21	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
60016 (Tywi @ Manorafon)	24.53	0.002	Yes	257.918	**257.504**	300.566	300.566	276653	238720	580.870	1564	0.417	0.973	26	Yes	No

QMED

Rural:	5.199 m³/s
Urban:	5.215 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

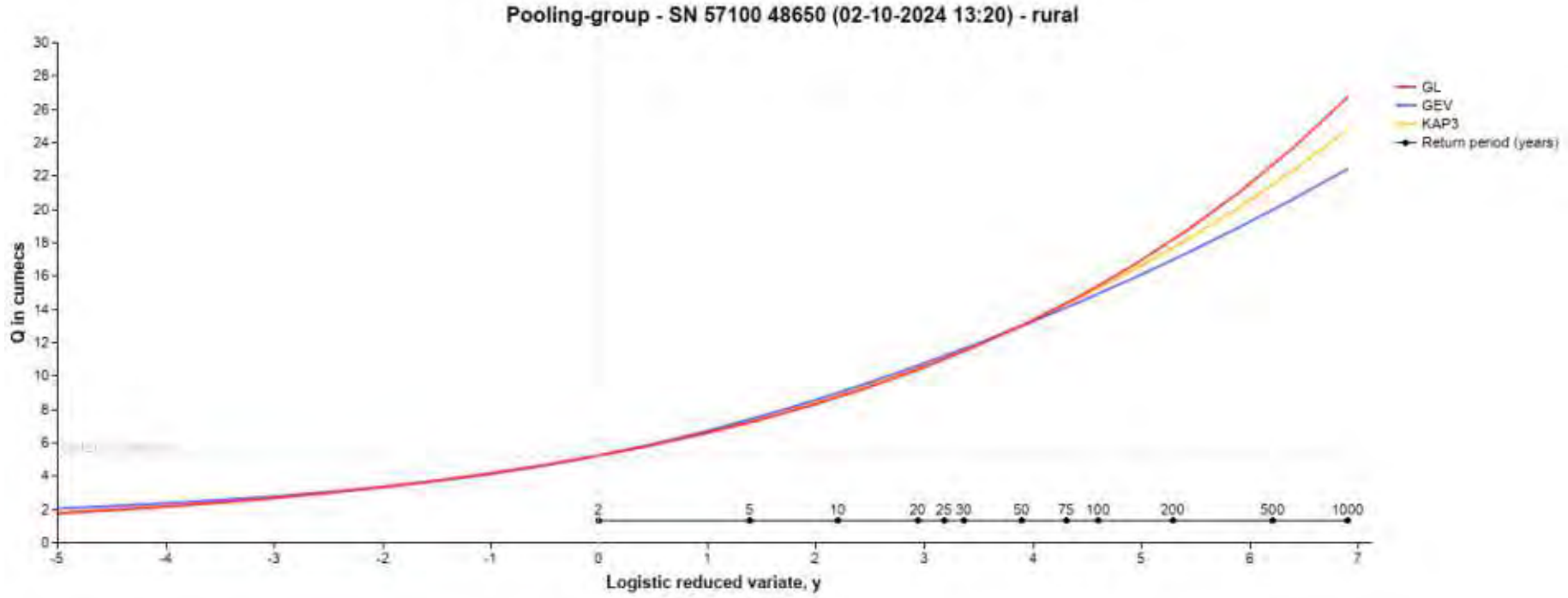
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	5.199	5.199	5.199
5	7.177	7.363	7.255
10	8.683	8.952	8.807
20	10.360	10.606	10.490
25	10.950	11.158	11.069
30	11.453	11.618	11.558
50	12.975	12.951	13.008
75	14.315	14.059	14.253
100	15.345	14.874	15.192
200	18.134	16.944	17.662
500	22.609	19.931	21.440
1000	26.716	22.398	24.748

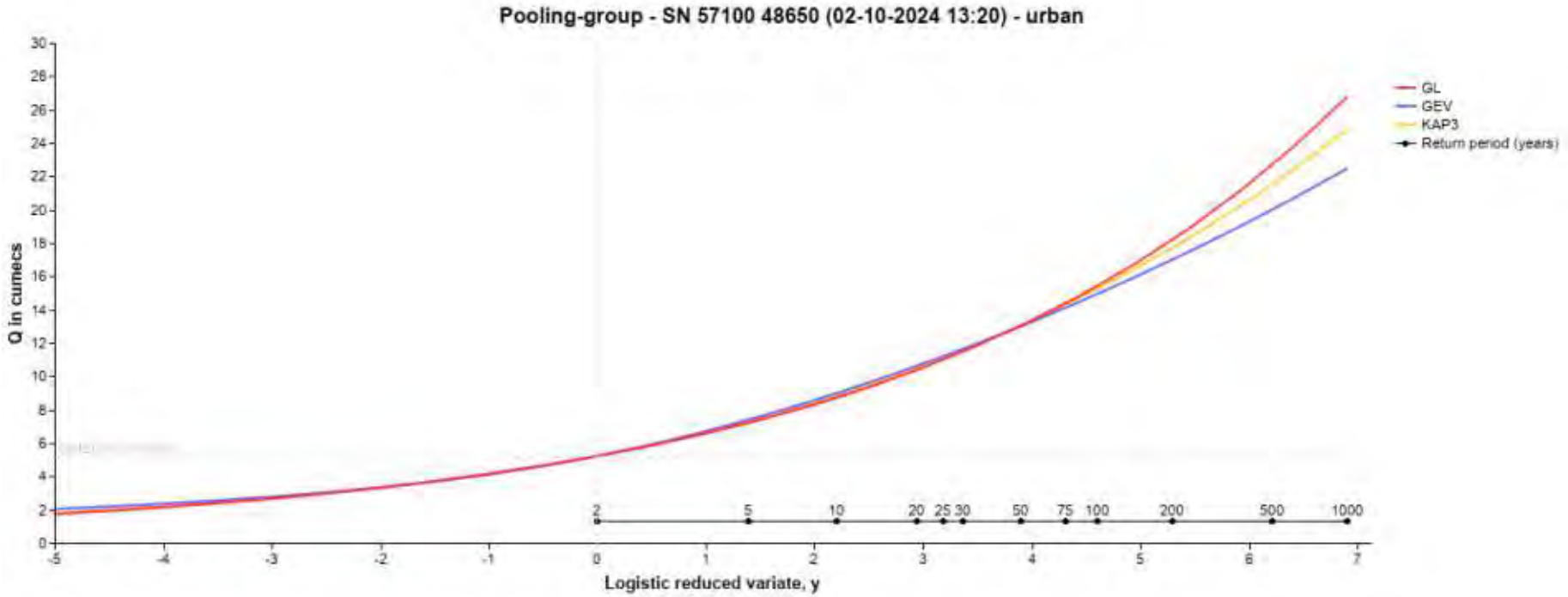
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	5.215	5.215	5.215
5	7.196	7.382	7.274
10	8.705	8.974	8.830
20	10.387	10.632	10.516
25	10.978	11.187	11.097
30	11.482	11.648	11.587
50	13.009	12.985	13.042
75	14.353	14.098	14.291
100	15.386	14.916	15.234
200	18.185	16.995	17.713
500	22.678	19.996	21.508
1000	26.802	22.476	24.832



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

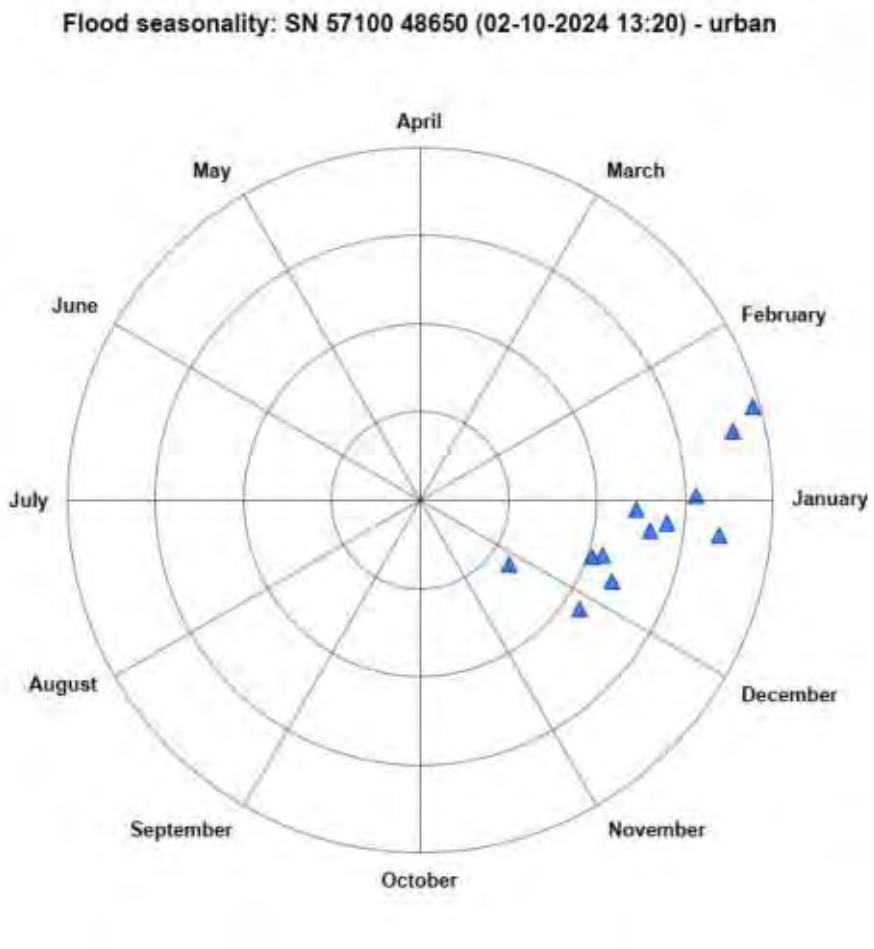


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

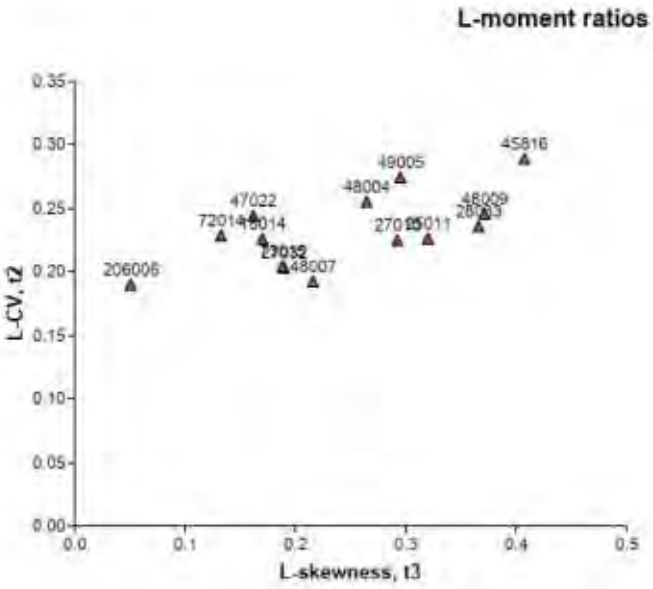


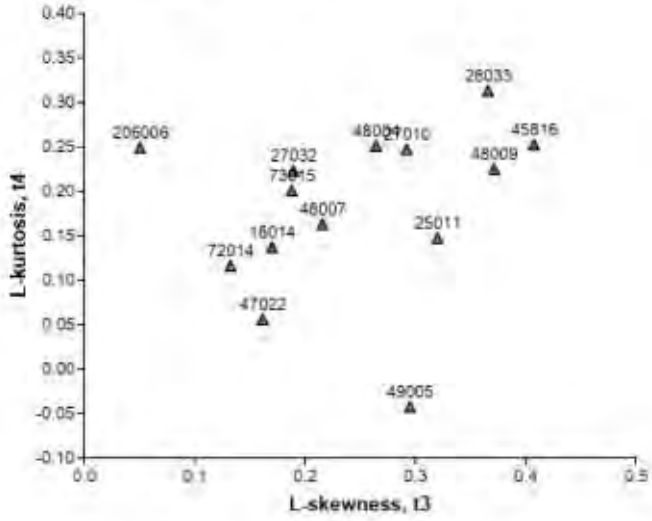
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

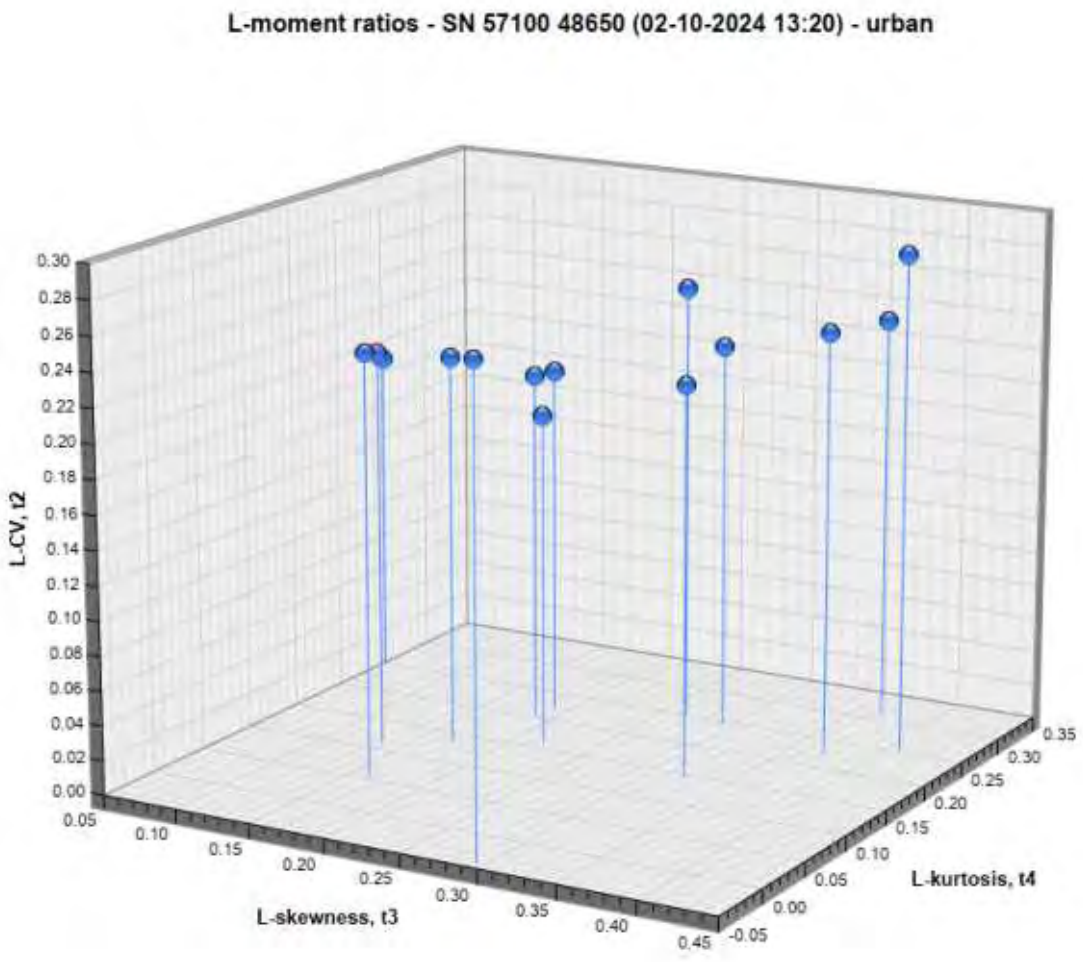
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method





UK Design Flood Estimation

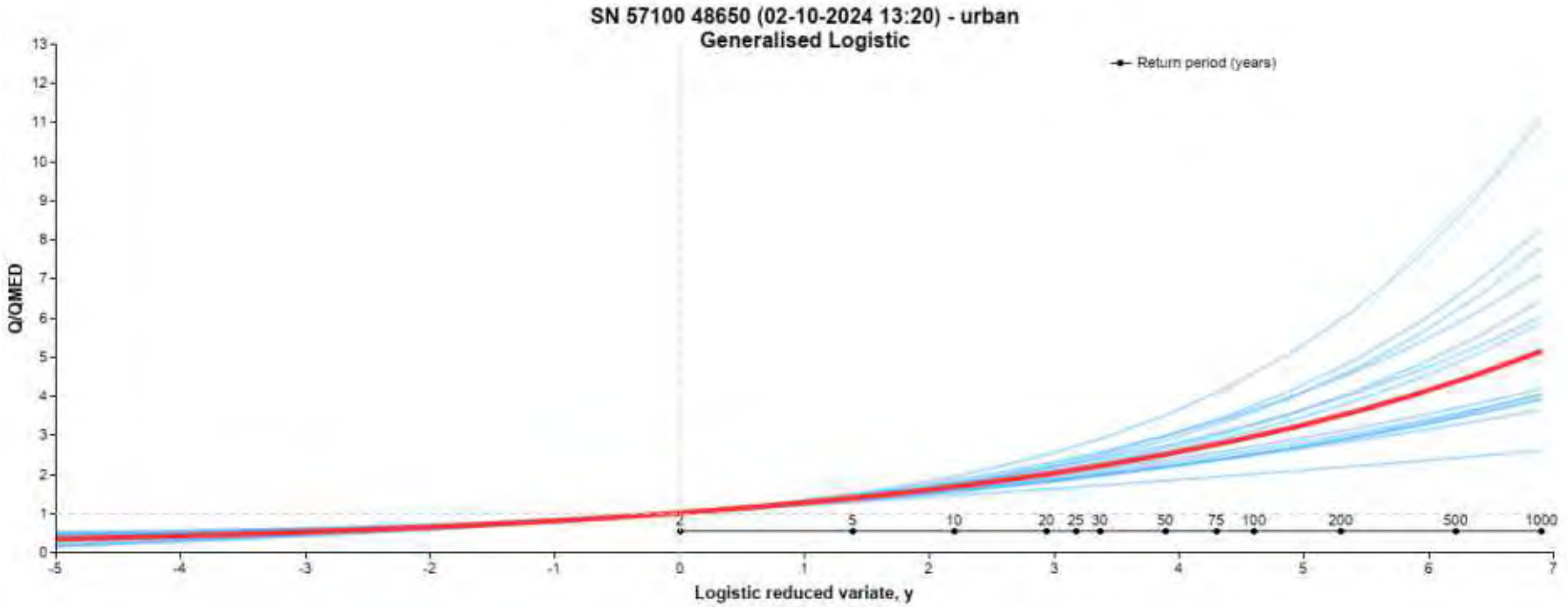
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

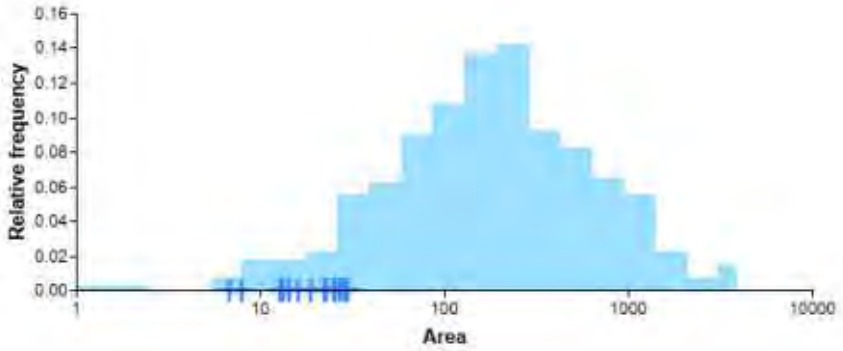
Pooling group growth curves

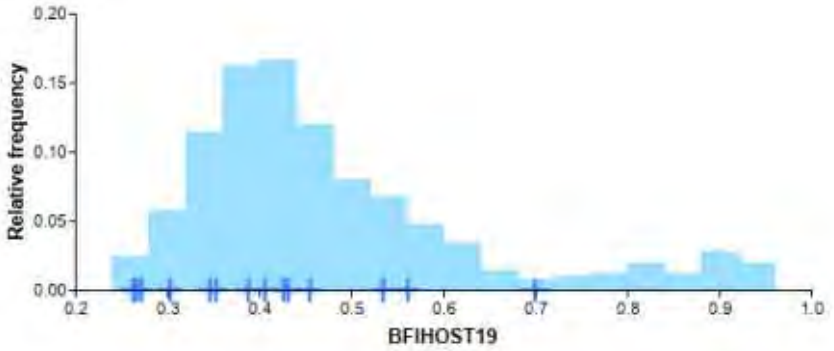


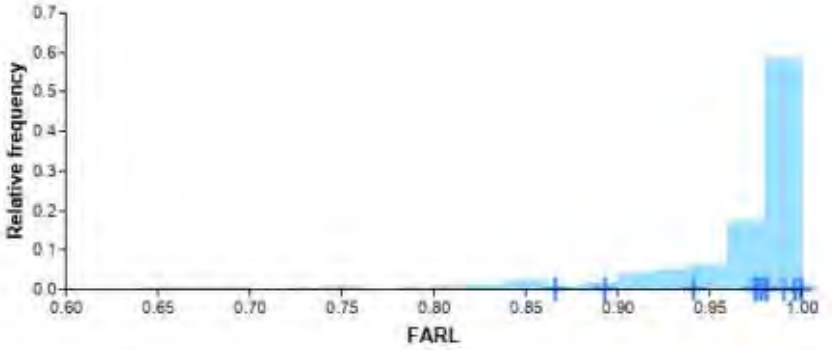
UK Design Flood Estimation

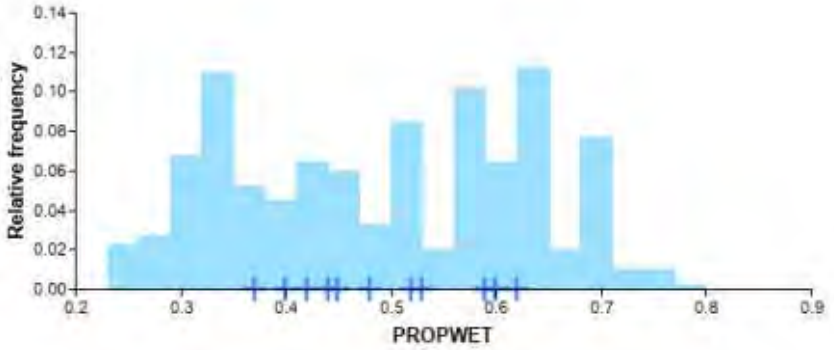
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



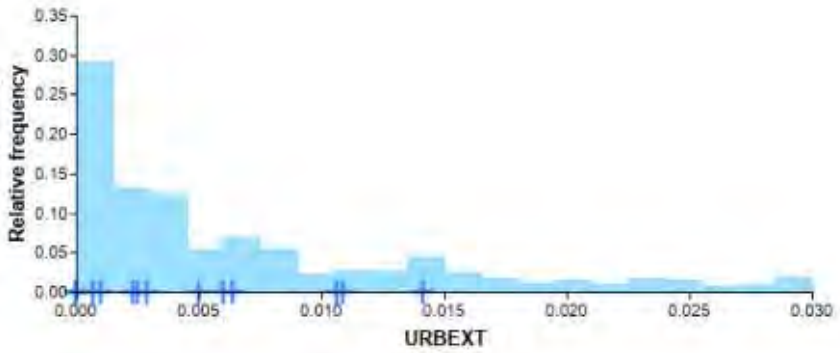


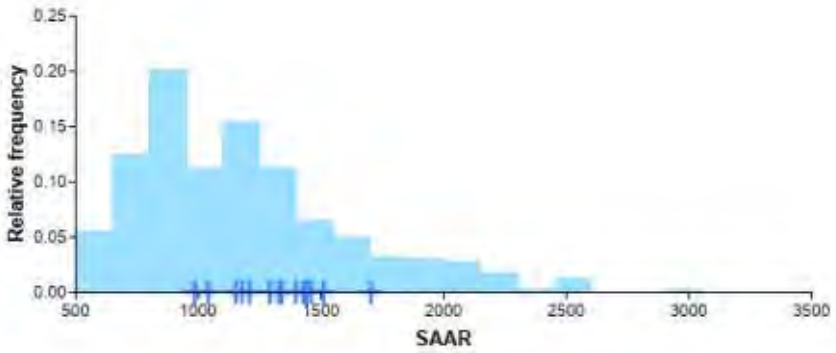


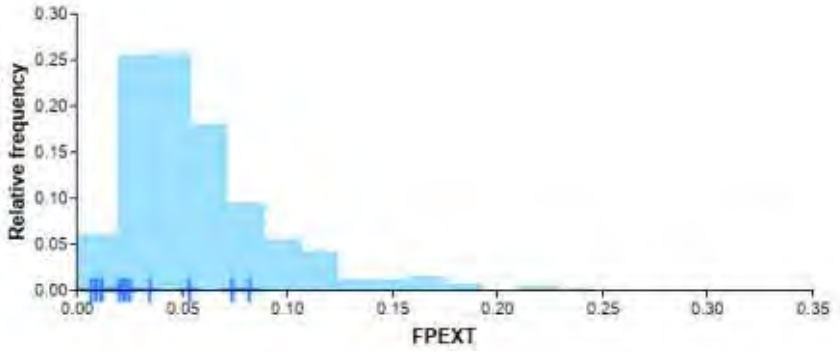


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 15:37:44
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	2886303186
Site name:	FEH_Catchment_Descriptors_258100_247700_v5_0_1
Site location:	SN 58100 47700
Easting:	258100
Northing:	247700
Catchment area:	30.39 km²
SAAR:	1263 mm
BFIHOST19:	0.484
FPEXT:	0.059
FARL:	0.996
URBEXT2000:	0.0144

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.69 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.01631

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
72007 (Brock @ upstream of A6)	0.170	45	28.972	0.191	**0.191**	0.223	**0.223**
73015 (Keer @ High Keer Weir)	0.267	33	12.421	0.204	**0.205**	0.189	**0.189**
76023 (Dacre Beck @ Dacre Bridge)	0.316	23	35.266	0.184	**0.184**	0.238	**0.238**
72014 (Conder @ Galgate)	0.319	56	16.971	0.228	**0.229**	0.133	**0.132**
47021 (Kensey @ Launceston Newport)	0.466	21	13.800	0.197	**0.199**	0.265	**0.262**
48004 (Warleggan @ Trengoffe)	0.470	54	9.865	0.254	**0.254**	0.266	**0.265**
47009 (Tiddy @ Tideford)	0.495	54	6.890	0.198	**0.199**	0.208	**0.206**
28041 (Hamps @ Waterhouses)	0.501	38	26.313	0.213	**0.214**	0.284	**0.283**
24006 (Rookhope Burn @ Eastgate)	0.578	20	24.620	0.152	**0.152**	0.117	**0.117**
27032 (Hebden Beck @ Hebden)	0.661	55	4.052	0.203	**0.203**	0.190	**0.190**
49004 (Gannel @ Gwills)	0.668	54	13.795	0.259	**0.260**	0.133	**0.132**
48009 (St Neot @ Craigshill Wood)	0.669	12	8.465	0.245	**0.245**	0.373	**0.372**
7012 (Lossie @ Ballachraggan)	0.670	9	7.262	0.488	**0.488**	0.670	**0.670**
25012 (Harwood Beck @ Harwood)	0.672	54	33.426	0.181	**0.181**	0.219	**0.219**
Total		**528**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
72007 (Brock @ upstream of A6)	Yes	Yes	45	0	0.00	-0.42	None	0.770	
73015 (Keer @ High Keer Weir)	Yes	Yes	33	1	3.03	3.30	5	0.221	
76023 (Dacre Beck @ Dacre Bridge)	Yes	Yes	23	1	4.35			0.696	
72014 (Conder @ Galgate)	Yes	Yes	56	3	5.36	1.39	None	1.008	
47021 (Kensey @ Launceston Newport)	Yes	Yes	21	0	0.00			0.454	
48004 (Warleggan @ Trengoffe)	Yes	Yes	54	4	7.41	0.65	None	0.343	
47009 (Tiddy @ Tideford)	Yes	Yes	54	1	1.85	1.44	None	0.206	
28041 (Hamps @ Waterhouses)	Yes	Yes	38	2	5.26			1.095	
24006 (Rookhope Burn @ Eastgate)	Yes	Yes	20	0	0.00			0.397	
27032 (Hebden Beck @ Hebden)	Yes	Yes	55	2	3.64	0.53	None	0.431	
49004 (Gannel @ Gwills)	Yes	Yes	54	5	9.26	-0.73	None	2.232	
48009 (St Neot @ Craigshill Wood)	Yes	Yes	12	0	0.00			1.472	
7012 (Lossie @ Ballachraggan)	Yes	Yes	9	0	0.00			3.830	
25012 (Harwood Beck @ Harwood)	Yes	Yes	54	0	0.00	0.83	None	0.844	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
72007 (Brock @ upstream of A6)	31.510	1361	0.053	1.000	0.000	0.318
73015 (Keer @ High Keer Weir)	30.043	1158	0.074	0.976	0.003	0.455
76023 (Dacre Beck @ Dacre Bridge)	33.913	1429	0.072	0.999	0.000	0.411
72014 (Conder @ Galgate)	28.992	1183	0.082	0.975	0.006	0.427
47021 (Kensey @ Launceston Newport)	34.830	1298	0.022	0.998	0.017	0.514
48004 (Warleggan @ Trengoffe)	25.260	1445	0.035	0.978	0.003	0.432
47009 (Tiddy @ Tideford)	37.398	1276	0.024	1.000	0.011	0.536
28041 (Hamps @ Waterhouses)	37.040	1085	0.033	1.000	0.004	0.311
24006 (Rookhope Burn @ Eastgate)	36.597	1126	0.018	0.994	0.000	0.297
27032 (Hebden Beck @ Hebden)	22.245	1433	0.021	0.997	0.000	0.272
49004 (Gannel @ Gwills)	40.830	1046	0.025	0.999	0.007	0.551
48009 (St Neot @ Craigshill Wood)	22.973	1511	0.023	0.982	0.002	0.388
7012 (Lossie @ Ballachraggan)	31.598	941	0.033	0.964	0.000	0.378
25012 (Harwood Beck @ Harwood)	24.582	1577	0.021	1.000	0.000	0.283

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.221	Urban L-CV:	0.219
Rural L-Skewness:	0.227	Urban L-Skewness:	0.229

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.221	-0.227		0.026
GEV	0.881	0.321	-0.086		-2.831
KAP3	0.939	0.265	-0.163	-0.400	-0.680

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.218	-0.229		0.047
GEV	0.882	0.317	-0.090		-2.630
KAP3	0.940	0.262	-0.167	-0.400	-0.631

Goodness of fit

GL:	0.9501 *
GEV:	-0.8140 *
P3:	-2.3434
GP:	-4.9316
KAP3:	0.3279 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: -0.8156

The pooling group is acceptably homogeneous and a review of the pooling group is not required.

Standardised growth curves

Rural

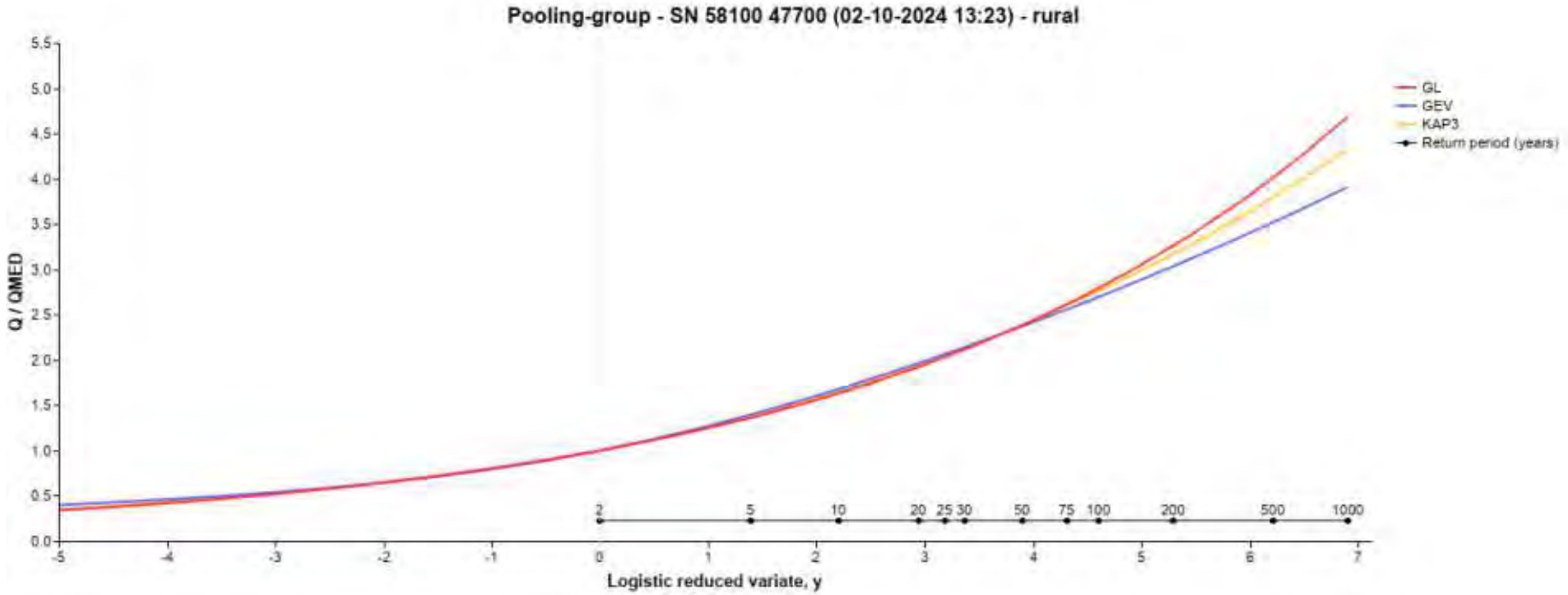
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.360	1.394	1.374
10	1.629	1.677	1.651
20	1.924	1.966	1.947
25	2.027	2.062	2.048
30	2.115	2.141	2.133
50	2.379	2.368	2.382
75	2.609	2.555	2.595
100	2.785	2.692	2.753
200	3.259	3.034	3.168
500	4.007	3.518	3.791
1000	4.686	3.910	4.328

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.356	1.391	1.371
10	1.624	1.672	1.646
20	1.919	1.961	1.941
25	2.022	2.056	2.042
30	2.109	2.135	2.126
50	2.373	2.363	2.376
75	2.603	2.550	2.589
100	2.779	2.687	2.748
200	3.254	3.032	3.164
500	4.006	3.520	3.791
1000	4.688	3.917	4.333

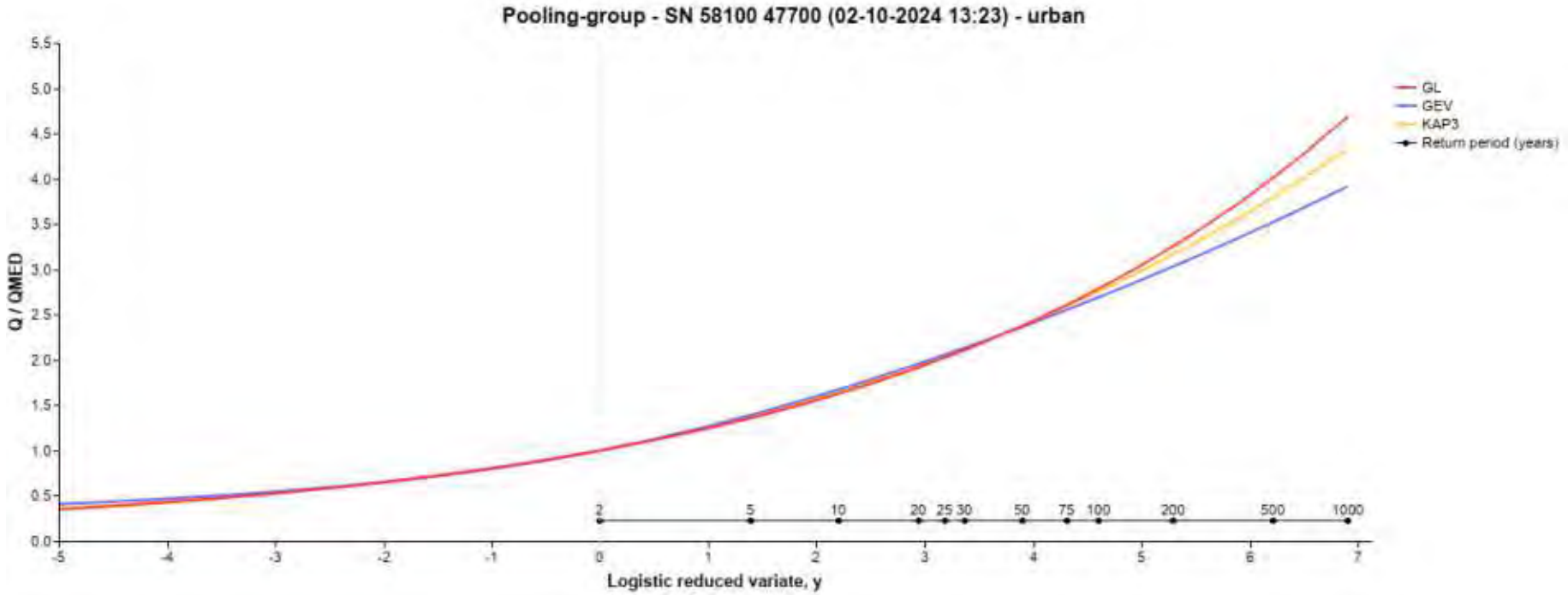
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.271
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62002 (Teifi @ Llanfair)	1.26	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_258100_247700_v5_0_1 @ SN 58100 47700)	30.385	259255	252634	1263	0.059	0.996	0.014	0.484
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
60012 (Twrch @ Ddol Las)	8.60	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
62001 (Teifi @ Glanteifi)	11.21	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes
60013 (Cothi @ Pont Ynys Brechfa)	13.15	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
60002 (Cothi @ Felin Mynachdy)	14.93	0.001	Yes	179.150	**178.999**	171.073	171.073	260063	237727	298.730	1551	0.444	0.997	62	Yes	Yes
62003 (Teifi @ Pont Llanio)	16.31	0.002	Yes	40.600	**40.513**	107.335	107.335	271146	263799	175.385	1448	0.397	0.983	25	Yes	No
63003 (Wyre @ Llanrhystud)	16.67	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
60007 (Tywi @ Dolau Hirion)	17.62	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
60001 (Tywi @ Ty Castell)	19.60	0.002	Yes	399.100	**398.361**	502.115	502.115	269002	235627	1090.835	1535	0.432	0.984	51	Yes	Yes
60016 (Tywi @ Manorafon)	22.28	0.002	Yes	257.918	**257.504**	300.566	300.566	276653	238720	580.870	1564	0.417	0.973	26	Yes	No

QMED

Rural:	11.162 m³/s
Urban:	11.344 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

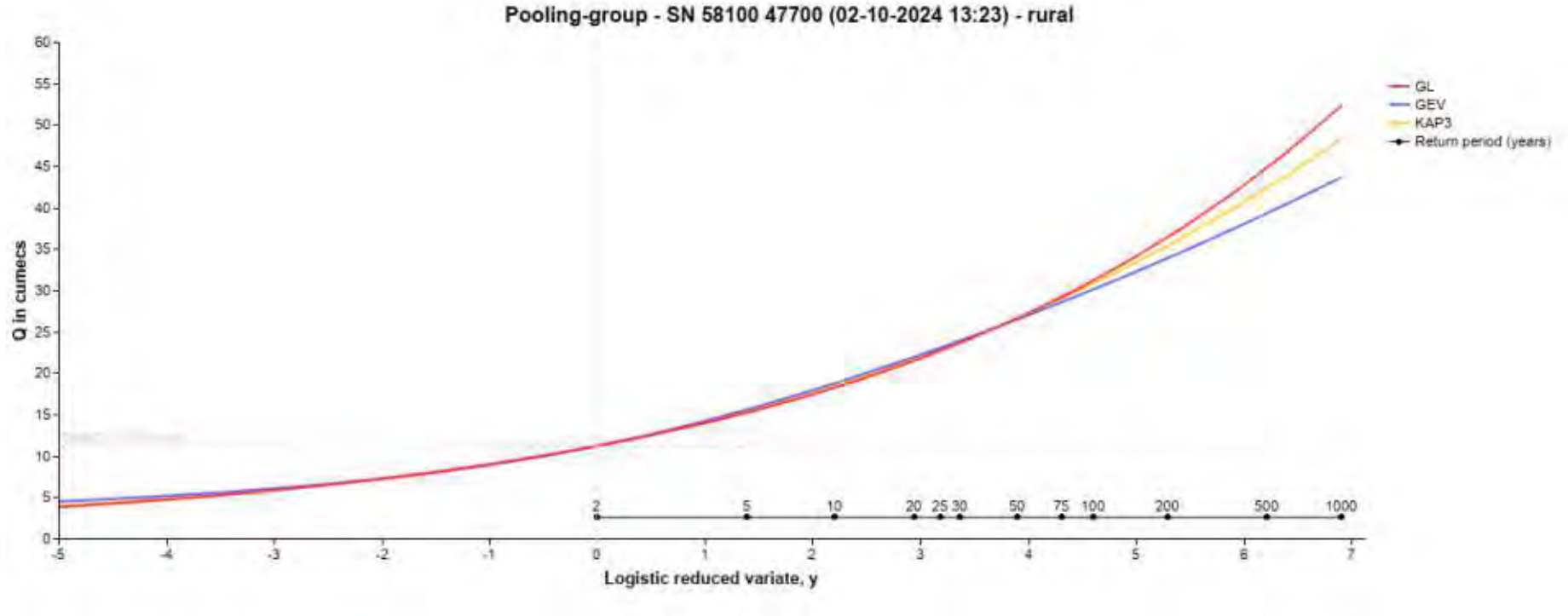
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	11.162	11.162	11.162
5	15.174	15.560	15.338
10	18.177	18.719	18.431
20	21.477	21.947	21.731
25	22.629	23.014	22.857
30	23.608	23.898	23.802
50	26.552	26.436	26.589
75	29.124	28.522	28.959
100	31.090	30.044	30.733
200	36.370	33.863	35.355
500	44.729	39.264	42.310
1000	52.300	43.641	48.302

Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	11.344	11.344	11.344
5	15.387	15.775	15.551
10	18.422	18.968	18.677
20	21.764	22.240	22.020
25	22.932	23.324	23.162
30	23.925	24.222	24.122
50	26.913	26.805	26.954
75	29.527	28.932	29.366
100	31.528	30.485	31.174
200	36.907	34.390	35.890
500	45.438	39.932	43.005
1000	53.183	44.435	49.151



UK Design Flood Estimation

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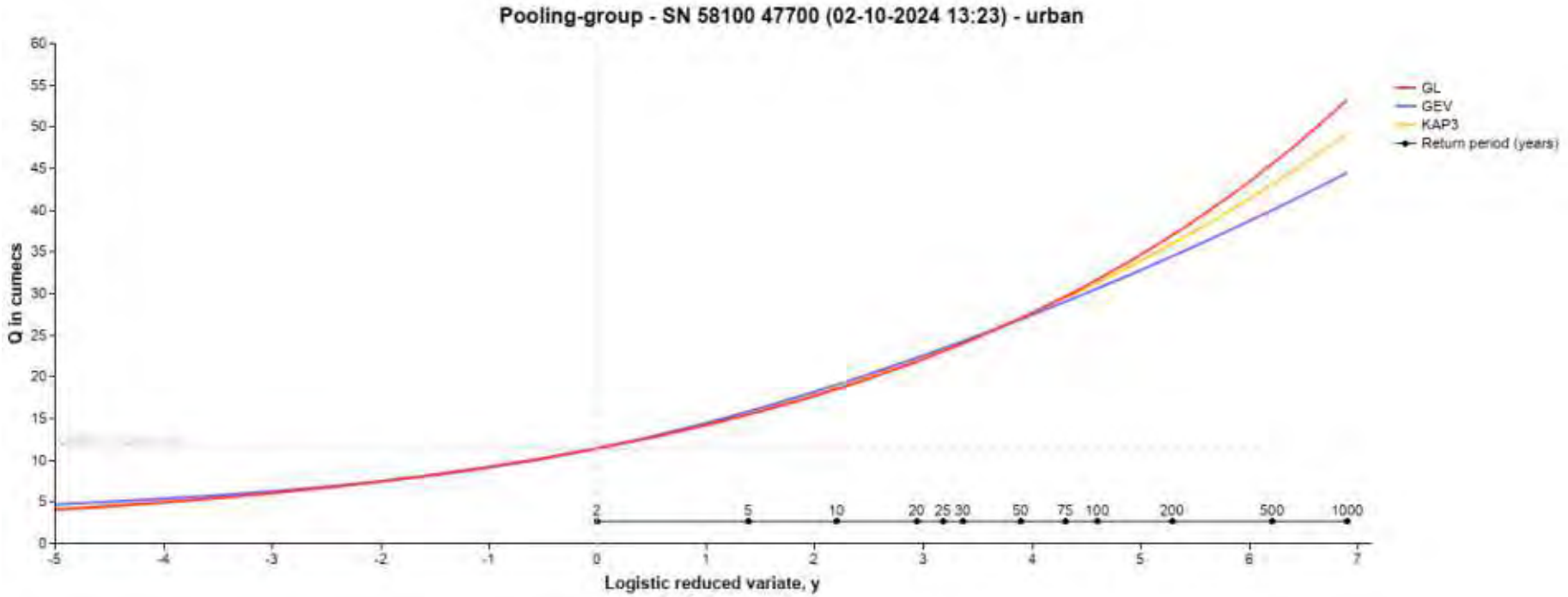
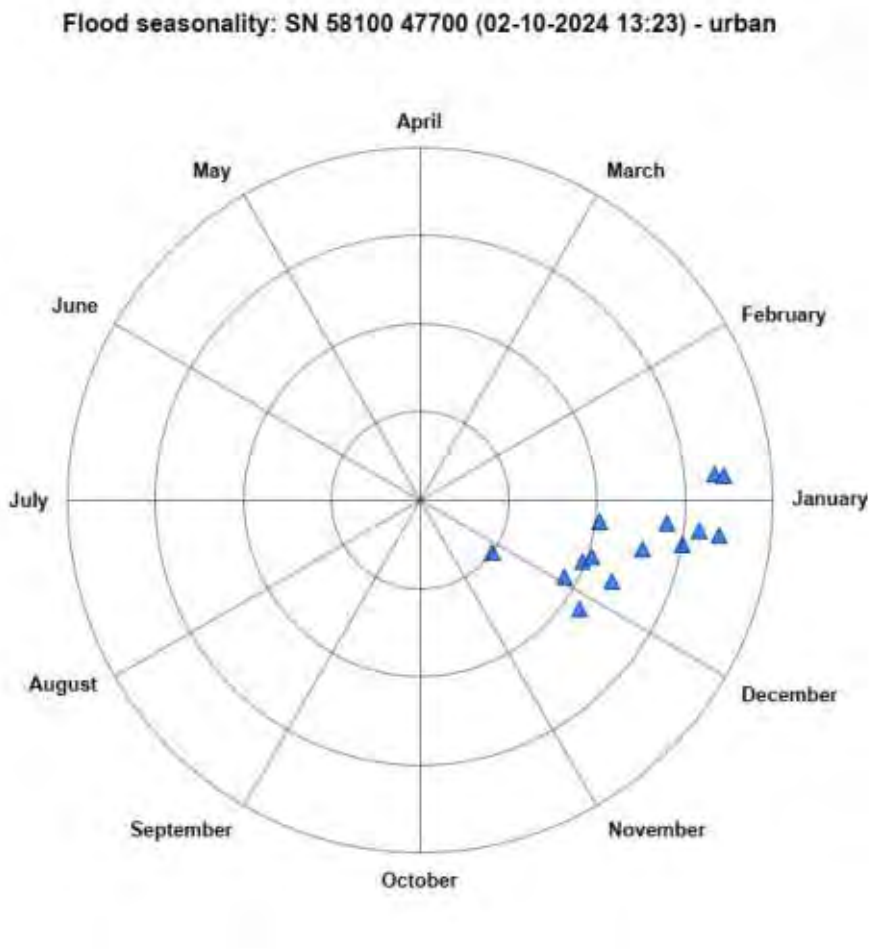


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

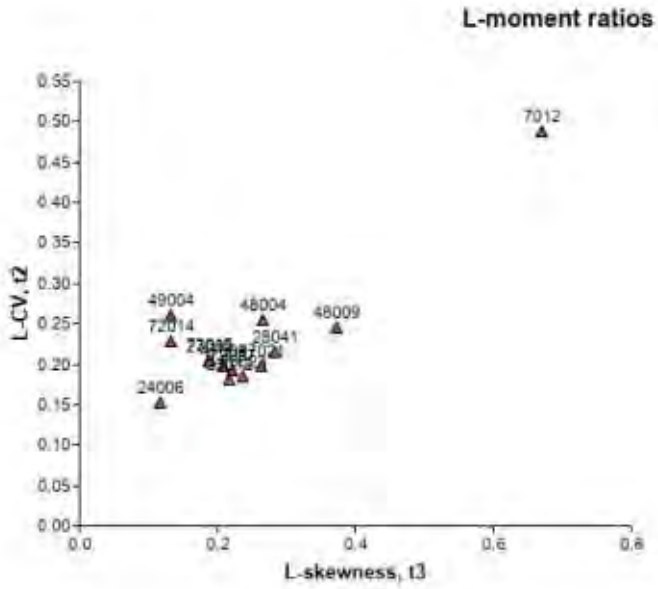


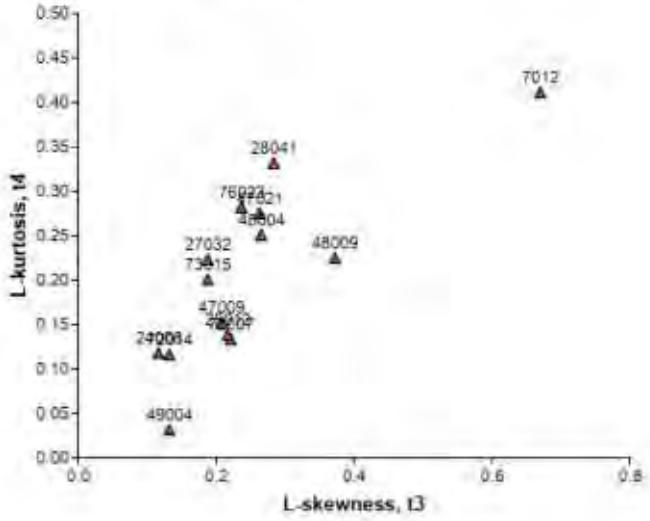
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method





UK Design Flood Estimation

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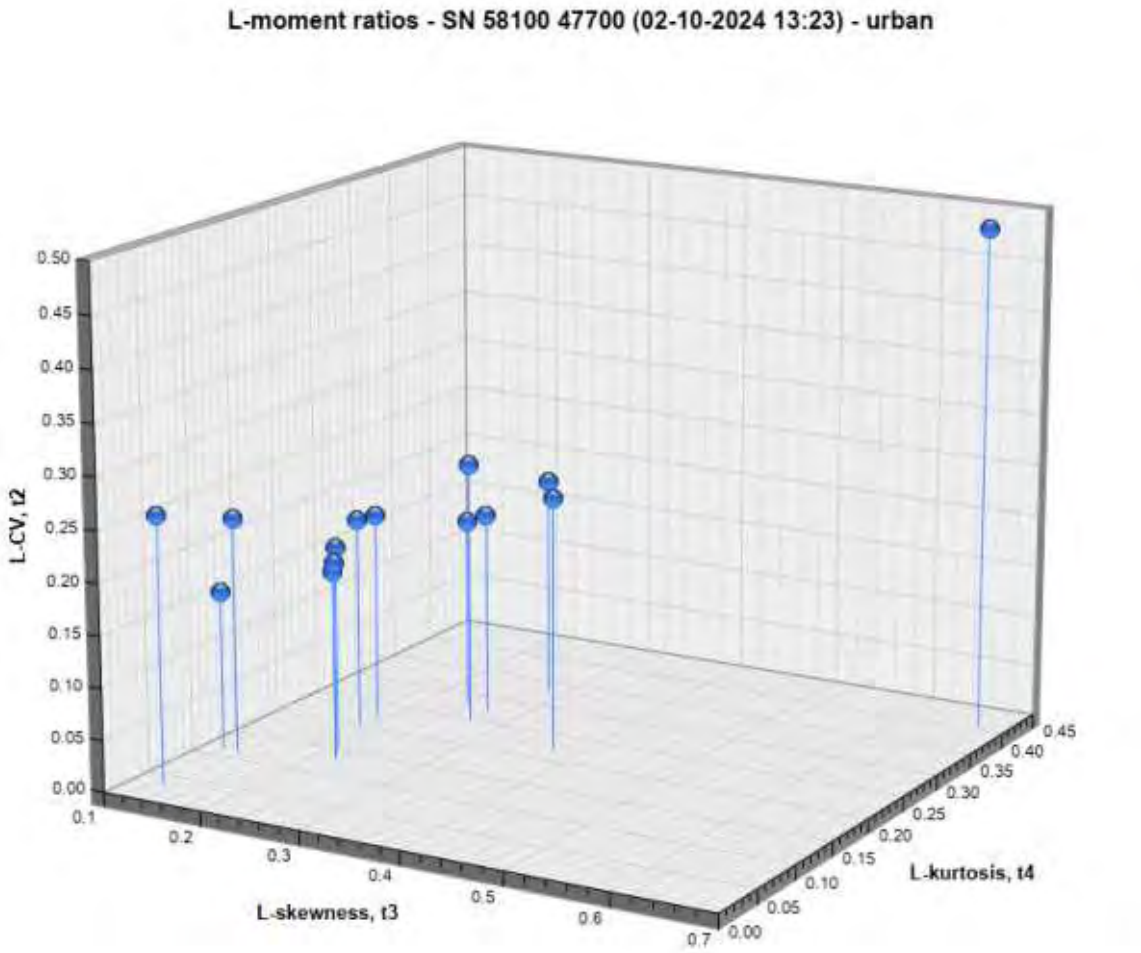
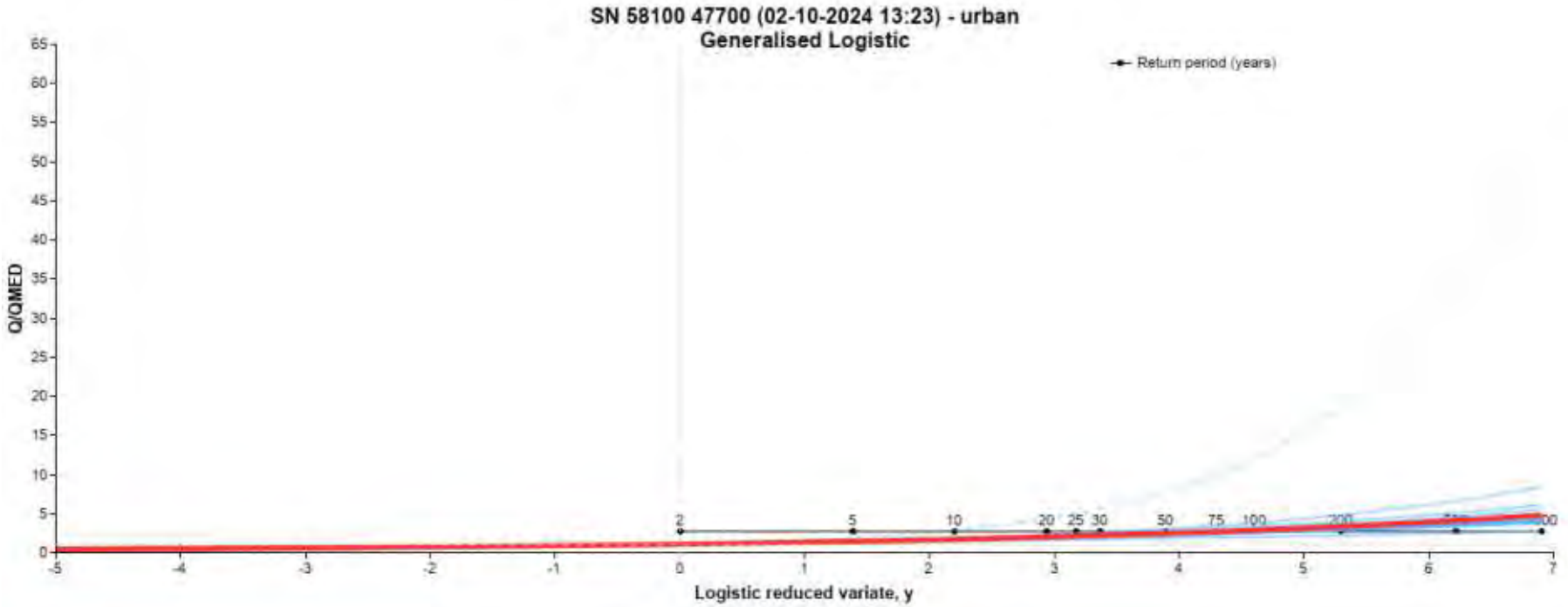


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

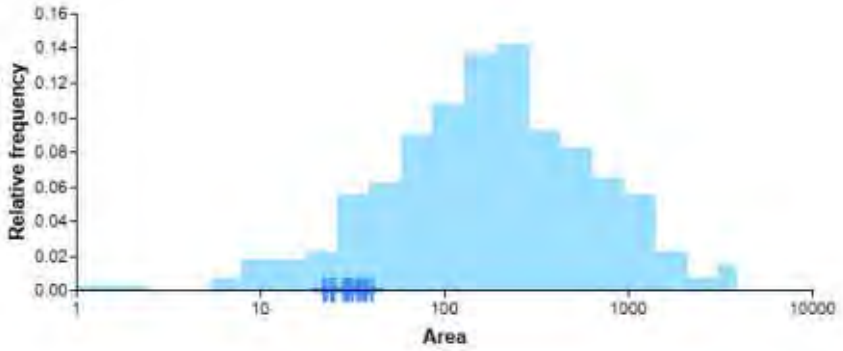
Pooling group growth curves

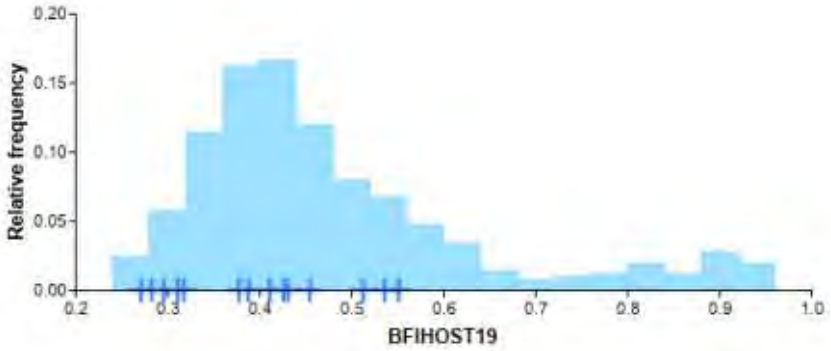


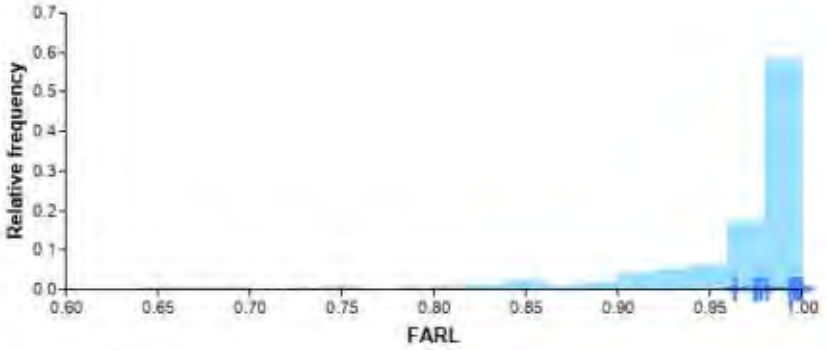
UK Design Flood Estimation

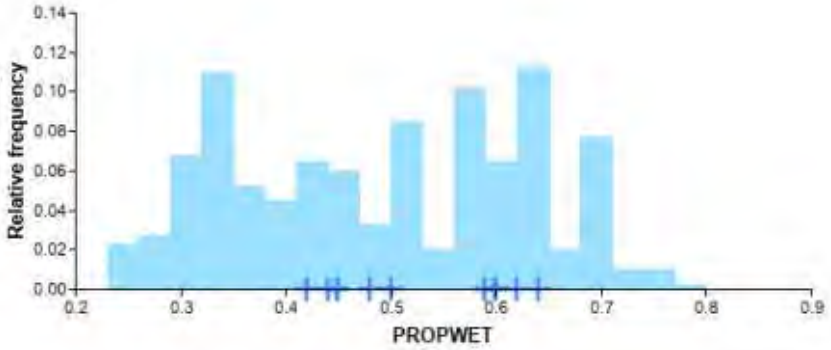
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



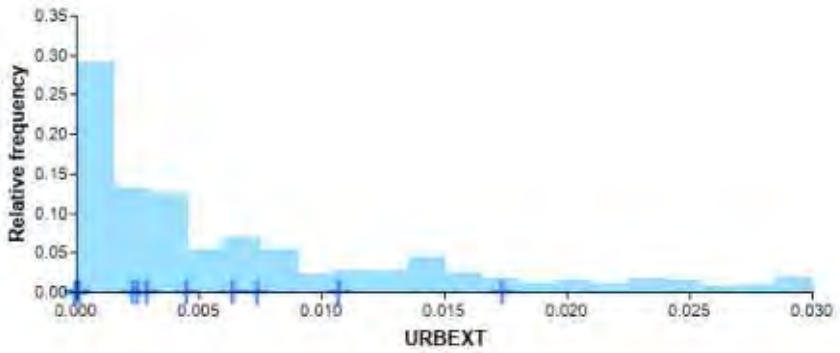


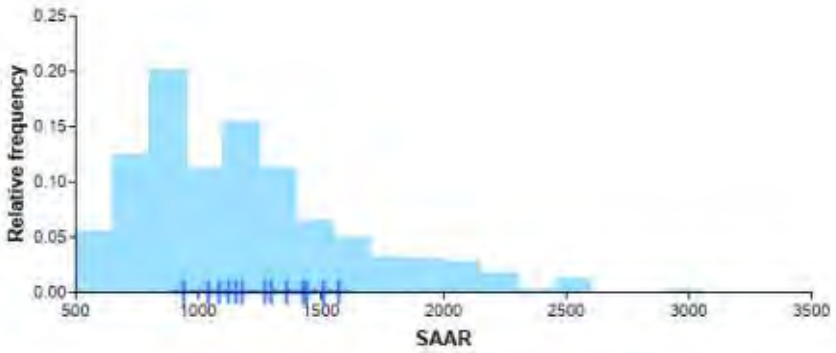


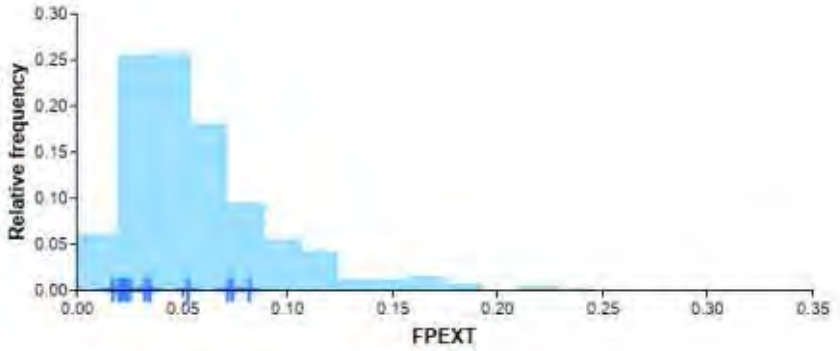


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:28:10
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	2886303186
Site name:	FEH_Catchment_Descriptors_258100_247700_v5_0_1
Site location:	SN 58100 47700
Easting:	258100
Northing:	247700
Catchment area:	1.66 km²
SAAR:	1263 mm
BFIHOST19:	0.484
FPEXT:	0.059
FARL:	0.996
URBEXT2000:	0.0144

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.04 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.01631

Growth curve settings

Distance Measure Method:	Small catchment
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
76011 (Coal Burn @ Coalburn)	0.407	46	1.826	0.170	**0.170**	0.296	**0.296**
45816 (Haddeo @ Upton)	1.124	30	3.352	0.288	**0.289**	0.408	**0.407**
28033 (Dove @ Hollinsclough)	1.250	48	4.138	0.235	**0.235**	0.367	**0.367**
25011 (Langdon Beck @ Langdon)	1.670	37	15.647	0.225	**0.225**	0.321	**0.321**
47022 (Tory Brook @ Newnham Park)	1.683	28	6.134	0.243	**0.245**	0.163	**0.160**
27051 (Crimple @ Burn Bridge)	1.686	51	4.564	0.217	**0.217**	0.142	**0.141**
71003 (Croasdale Beck @ Croasdale Flume)	1.867	37	10.900	0.212	**0.212**	0.323	**0.323**
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	1.879	13	4.072	0.274	**0.275**	0.295	**0.294**
206006 (Annalong @ Recorder)	1.915	48	15.330	0.189	**0.189**	0.052	**0.052**
25003 (Trout Beck @ Moor House)	1.927	50	15.182	0.170	**0.170**	0.299	**0.299**
106002 (Laxdale @ Laxdale)	1.968	16	17.449	0.102	**0.102**	0.154	**0.154**
27073 (Brompton Beck @ Snainton Ings)	2.036	43	0.812	0.212	**0.213**	0.033	**0.032**
27010 (Hodge Beck @ Bransdale Weir)	2.048	41	9.420	0.224	**0.224**	0.293	**0.293**
27032 (Hebden Beck @ Hebden)	2.086	55	4.052	0.203	**0.203**	0.190	**0.190**
Total		**543**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
76011 (Coal Burn @ Coalburn)	Yes	Yes	46	0	0.00			0.602	
45816 (Haddeo @ Upton)	Yes	Yes	30	1	3.33	-0.45	None	1.520	
28033 (Dove @ Hollinsclough)	Yes	Yes	48	1	2.08			0.862	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			0.407	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			0.641	
27051 (Crimple @ Burn Bridge)	Yes	Yes	51	3	5.88	1.34	None	0.377	
71003 (Croasdale Beck @ Croasdale Flume)	Yes	Yes	37	1	2.70			0.308	
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	Yes	Yes	13	0	0.00			2.383	
206006 (Annalong @ Recorder)	Yes	Yes	48	4	8.33	2.25	None	2.019	
25003 (Trout Beck @ Moor House)	Yes	Yes	50	1	2.00			0.695	
106002 (Laxdale @ Laxdale)	Yes	Yes	16	0	0.00			2.364	
27073 (Brompton Beck @ Snainton Ings)	Yes	Yes	43	2	4.65	0.92	None	1.372	
27010 (Hodge Beck @ Bransdale Weir)	Yes	Yes	41	1	2.44	-2.10	5	0.213	
27032 (Hebden Beck @ Hebden)	Yes	Yes	55	2	3.64	0.53	None	0.236	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
76011 (Coal Burn @ Coalburn)	1.630	1096	0.074	1.000	0.000	0.274
45816 (Haddeo @ Upton)	6.808	1210	0.011	1.000	0.005	0.535
28033 (Dove @ Hollinsclough)	7.915	1346	0.007	1.000	0.000	0.347
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
27051 (Crimple @ Burn Bridge)	8.172	855	0.013	1.000	0.006	0.329
71003 (Croasdale Beck @ Croasdale Flume)	10.710	1882	0.016	1.000	0.000	0.283
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	16.080	1044	0.023	0.991	0.006	0.562
206006 (Annalong @ Recorder)	14.438	1704	0.023	0.981	0.000	0.267
25003 (Trout Beck @ Moor House)	11.395	1905	0.041	1.000	0.000	0.255
106002 (Laxdale @ Laxdale)	10.640	1993	0.024	0.888	0.000	0.299
27073 (Brompton Beck @ Snainton Ings)	8.060	721	0.237	1.000	0.008	0.811
27010 (Hodge Beck @ Bransdale Weir)	18.820	987	0.009	1.000	0.001	0.303
27032 (Hebden Beck @ Hebden)	22.245	1433	0.021	0.997	0.000	0.272

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments
44008 (South Winterbourne @ Winterbourne Steepleton)	2.077	32	0.572	0.405	0.406	0.254	0.254	

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.212	Urban L-CV:	0.210
Rural L-Skewness:	0.237	Urban L-Skewness:	0.240

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.209	-0.237		0.119
GEV	0.888	0.301	-0.102		-2.053
KAP3	0.943	0.250	-0.177	-0.400	-0.471

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.207	-0.240		0.137
GEV	0.889	0.297	-0.106		-1.912
KAP3	0.943	0.247	-0.180	-0.400	-0.429

Goodness of fit

GL:	0.4106 *
GEV:	-1.0997 *
P3:	-2.7382
GP:	-4.7309
KAP3:	-0.1099 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 1.9161

The pooling group is possibly heterogeneous and a review of the pooling group is optional.

Standardised growth curves

Rural

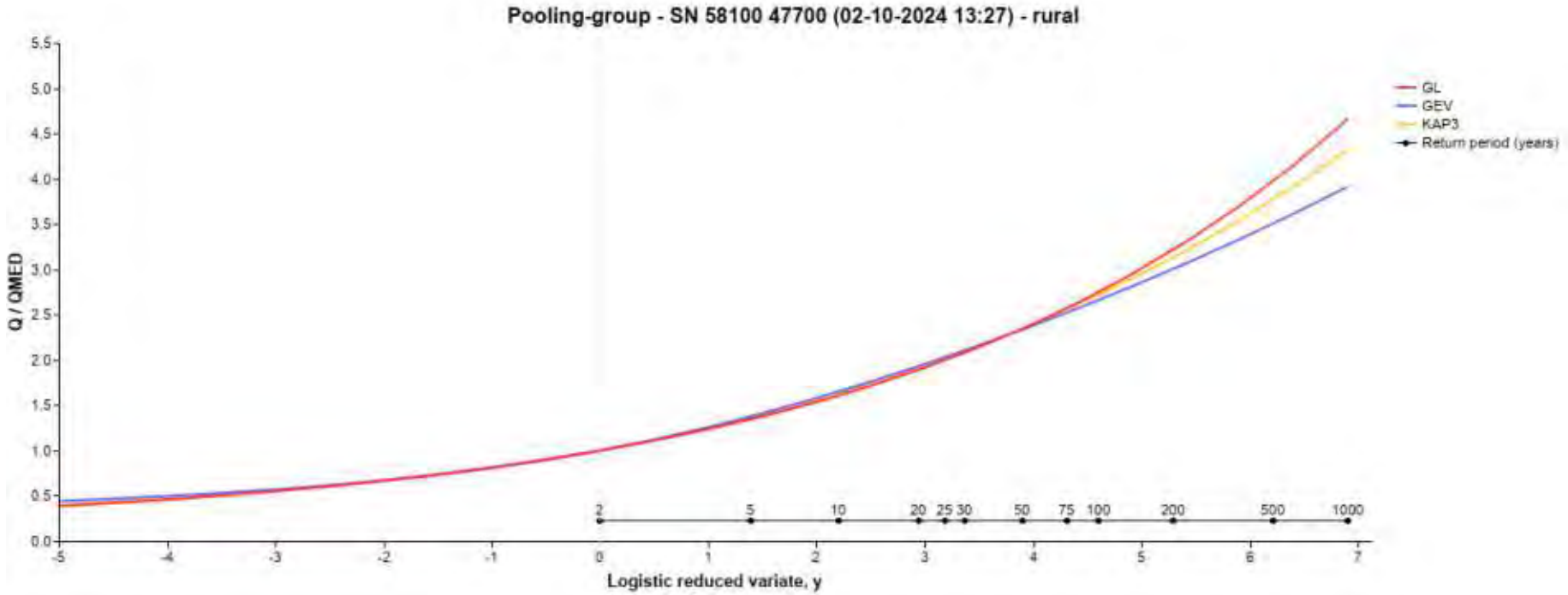
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.344	1.376	1.357
10	1.604	1.650	1.625
20	1.892	1.933	1.914
25	1.993	2.028	2.013
30	2.079	2.106	2.097
50	2.339	2.332	2.344
75	2.568	2.520	2.555
100	2.743	2.657	2.714
200	3.216	3.005	3.132
500	3.972	3.504	3.766
1000	4.662	3.913	4.319

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.341	1.372	1.354
10	1.599	1.645	1.620
20	1.886	1.928	1.908
25	1.987	2.022	2.007
30	2.073	2.100	2.091
50	2.333	2.327	2.338
75	2.561	2.515	2.550
100	2.737	2.653	2.709
200	3.211	3.003	3.128
500	3.970	3.506	3.767
1000	4.665	3.921	4.325

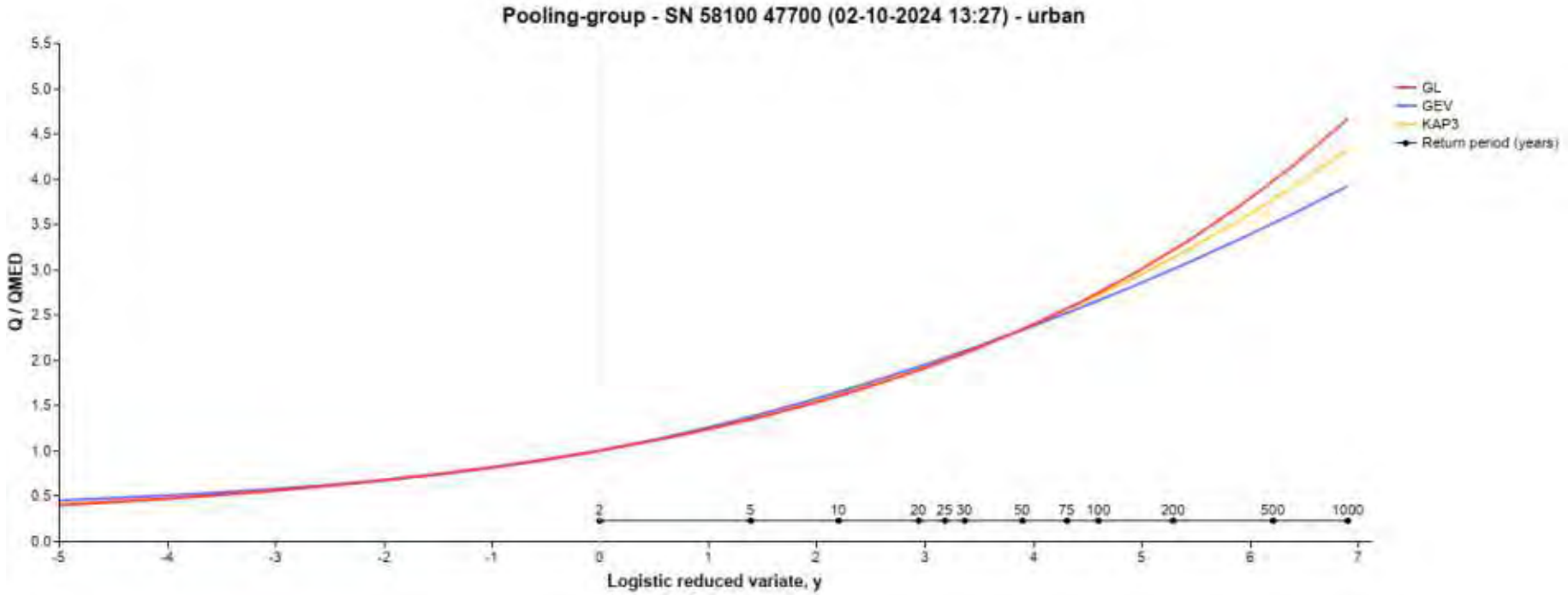
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.271
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62002 (Teifi @ Llanfair)	1.26	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_258100_247700_v5_0_1 @ SN 58100 47700)	1.657	259255	252634	1263	0.059	0.996	0.014	0.484
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
60012 (Twrch @ Ddol Las)	8.60	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
62001 (Teifi @ Glanteifi)	11.21	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes
60013 (Cothi @ Pont Ynys Brechfa)	13.15	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
60002 (Cothi @ Felin Mynachdy)	14.93	0.001	Yes	179.150	**178.999**	171.073	171.073	260063	237727	298.730	1551	0.444	0.997	62	Yes	Yes
62003 (Teifi @ Pont Llanio)	16.31	0.002	Yes	40.600	**40.513**	107.335	107.335	271146	263799	175.385	1448	0.397	0.983	25	Yes	No
63003 (Wyre @ Llanrhystud)	16.67	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
60007 (Tywi @ Dolau Hirion)	17.62	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
60001 (Tywi @ Ty Castell)	19.60	0.002	Yes	399.100	**398.361**	502.115	502.115	269002	235627	1090.835	1535	0.432	0.984	51	Yes	Yes
60016 (Tywi @ Manorafon)	22.28	0.002	Yes	257.918	**257.504**	300.566	300.566	276653	238720	580.870	1564	0.417	0.973	26	Yes	No

QMED

Rural:	0.939 m³/s
Urban:	0.954 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

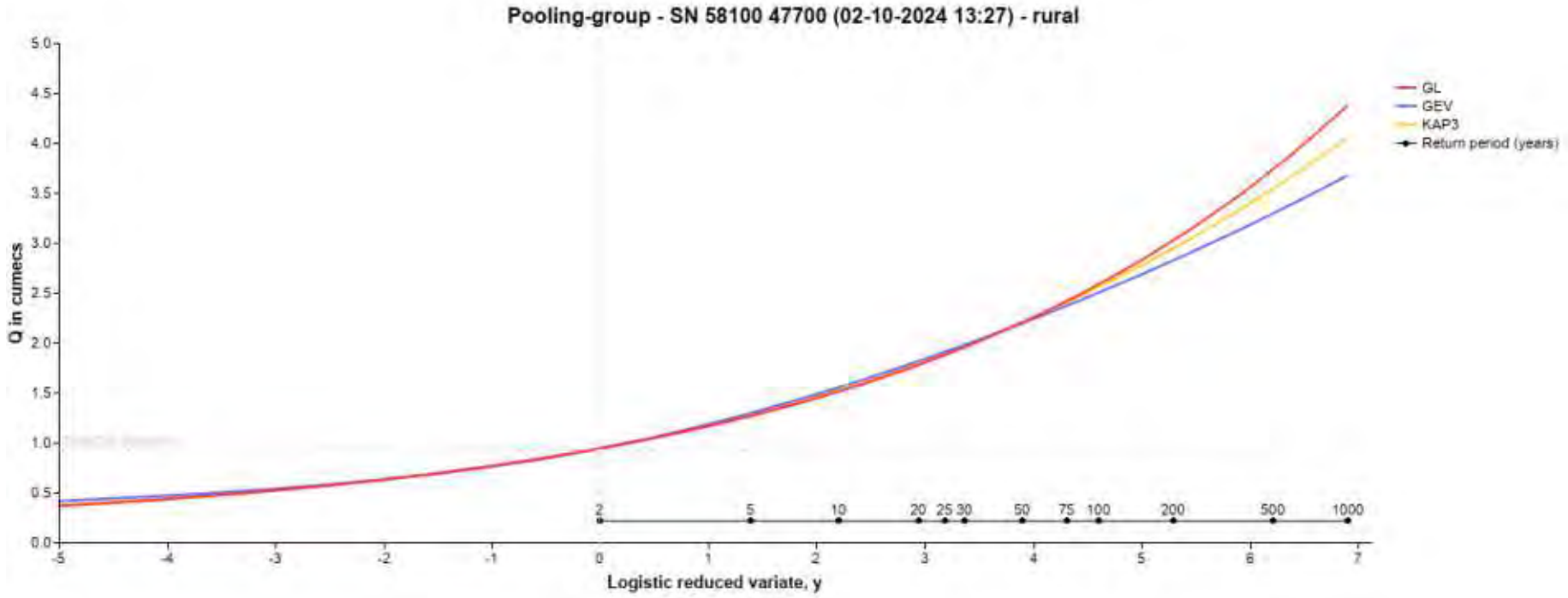
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.939	0.939	0.939
5	1.262	1.292	1.275
10	1.506	1.549	1.526
20	1.777	1.816	1.797
25	1.872	1.904	1.891
30	1.953	1.978	1.969
50	2.197	2.190	2.201
75	2.411	2.367	2.400
100	2.576	2.496	2.549
200	3.020	2.823	2.941
500	3.730	3.291	3.537
1000	4.379	3.675	4.056

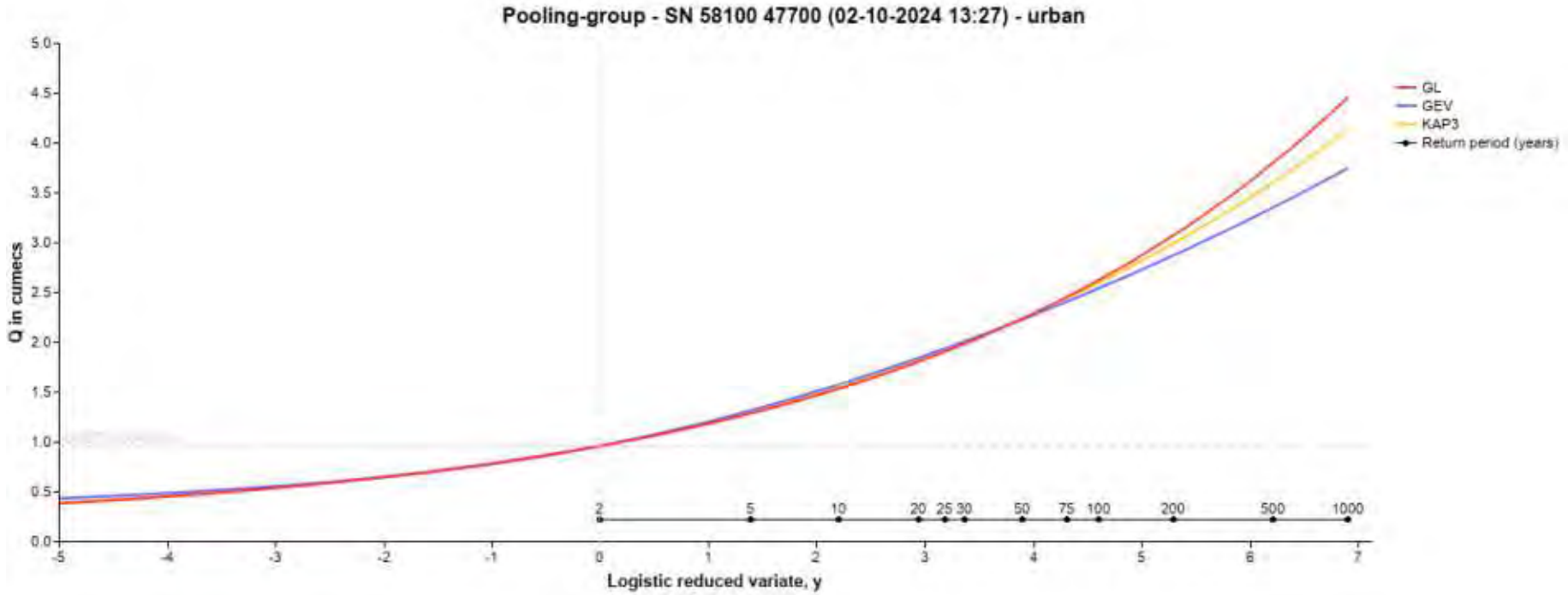
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	0.954	0.954	0.954
5	1.280	1.310	1.292
10	1.526	1.570	1.547
20	1.801	1.840	1.821
25	1.897	1.930	1.916
30	1.979	2.005	1.995
50	2.227	2.221	2.231
75	2.445	2.400	2.434
100	2.612	2.532	2.586
200	3.065	2.866	2.986
500	3.789	3.347	3.595
1000	4.453	3.742	4.128



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

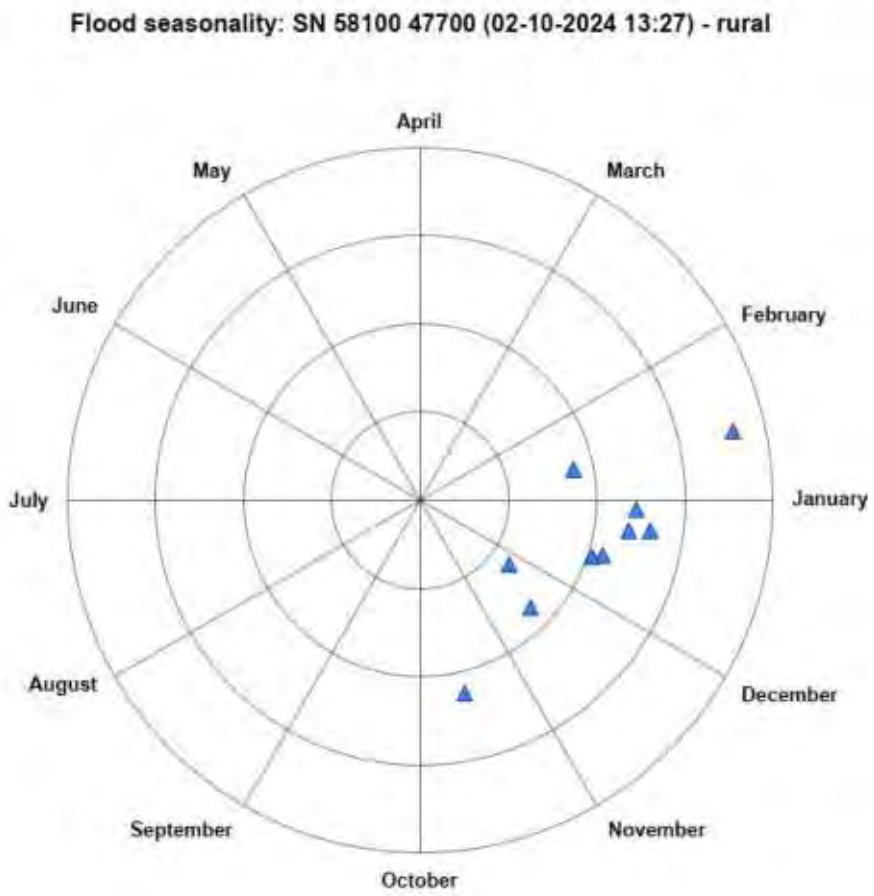


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

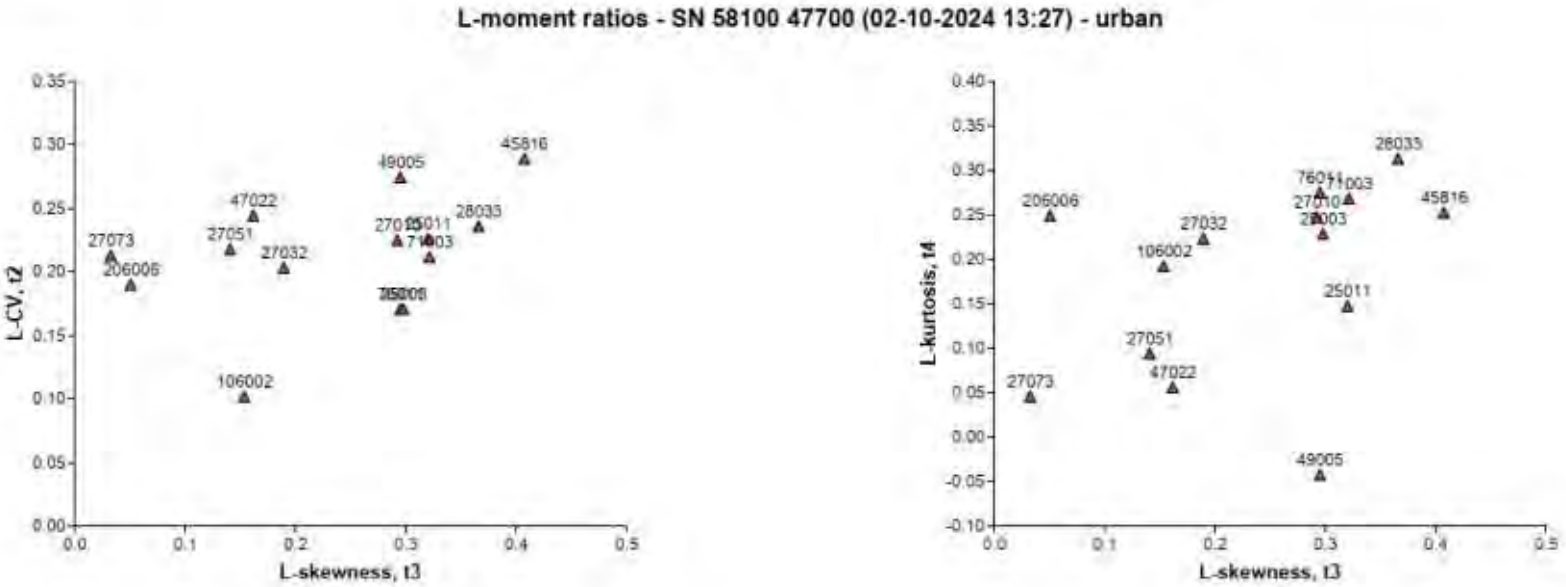


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

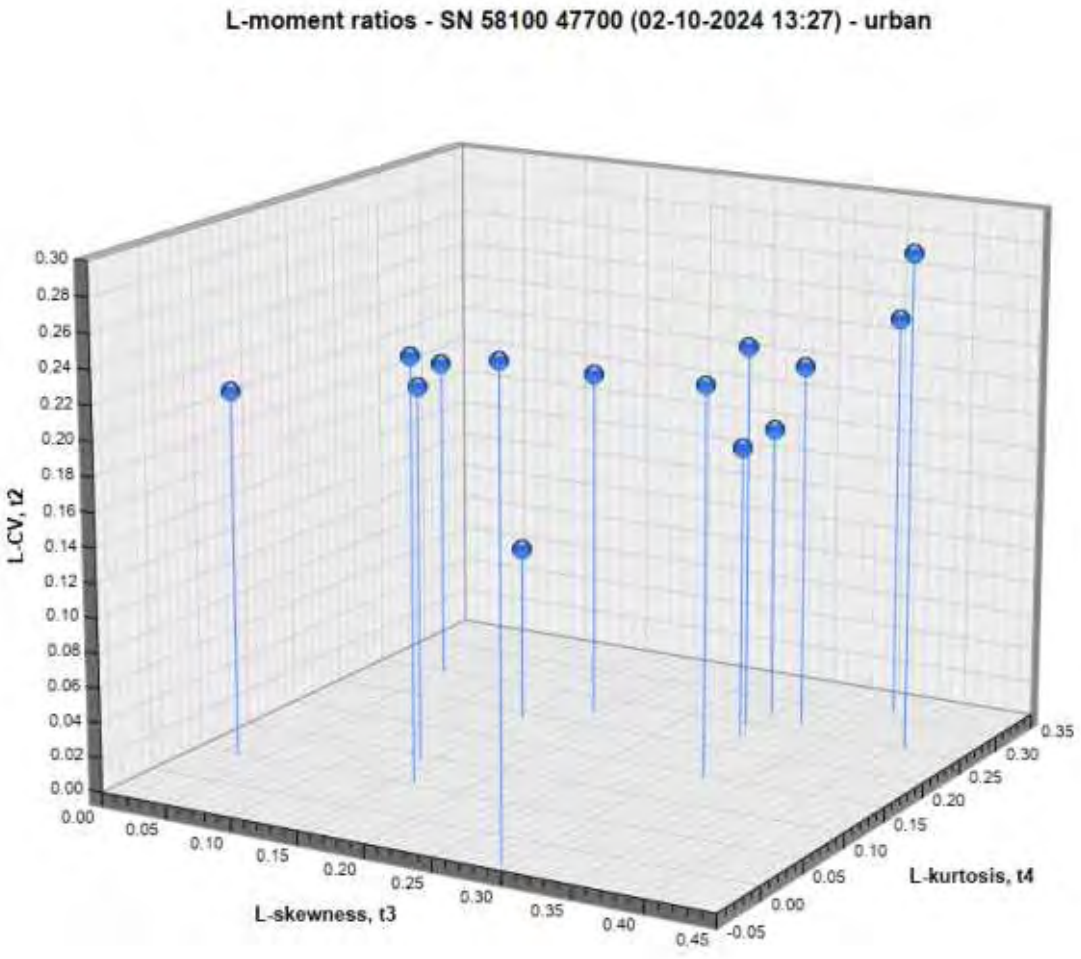
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

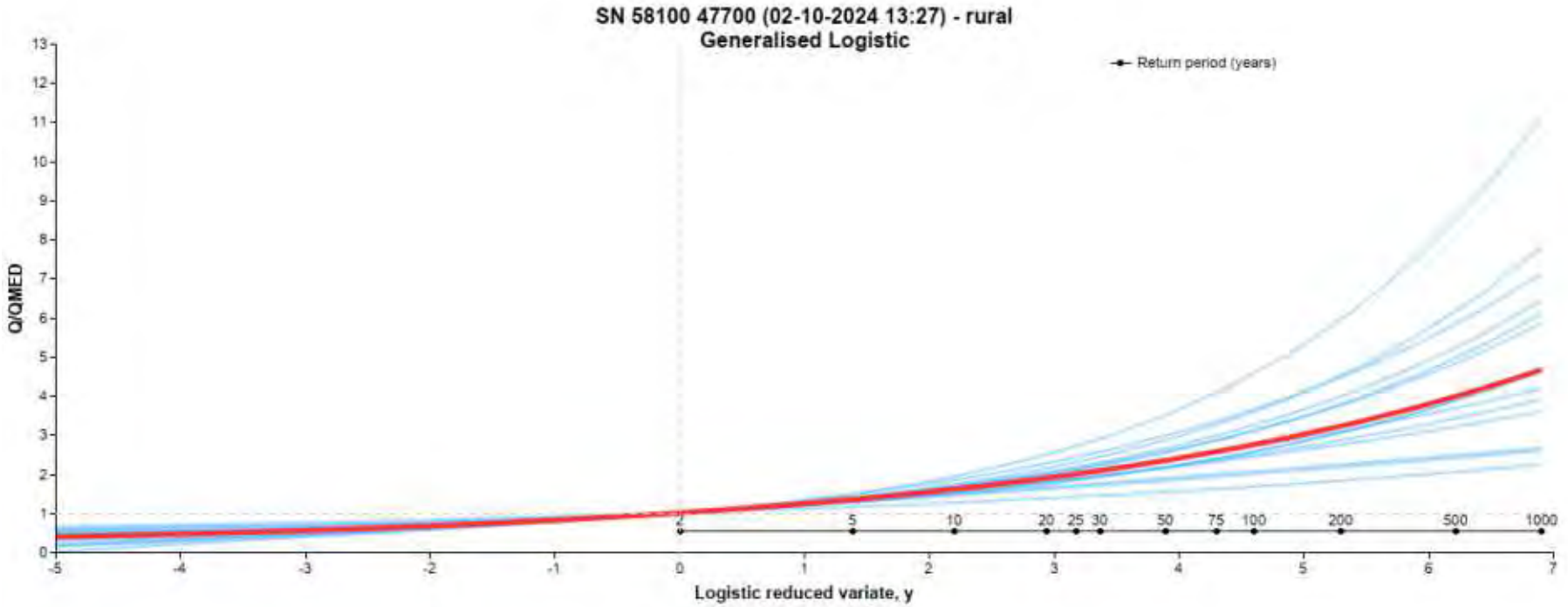
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

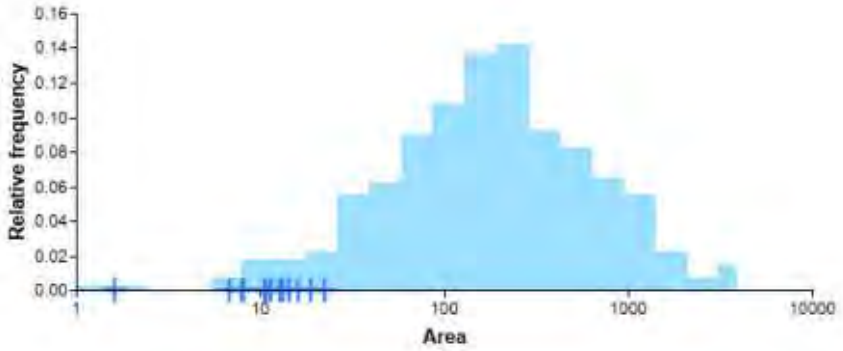
Pooling group growth curves

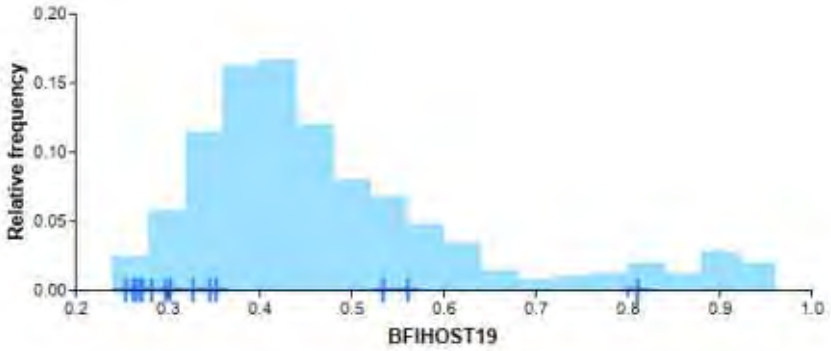


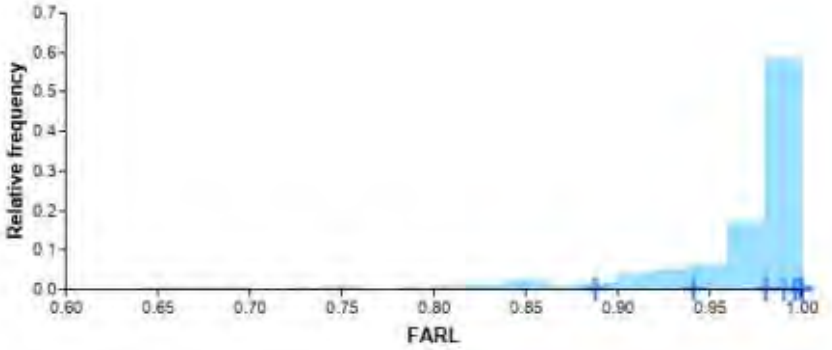
UK Design Flood Estimation

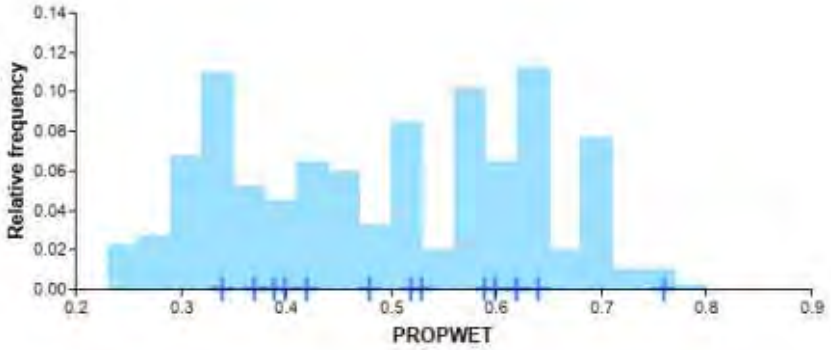
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



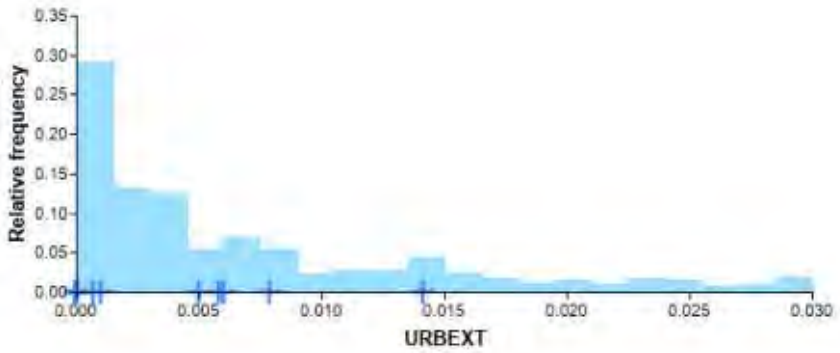


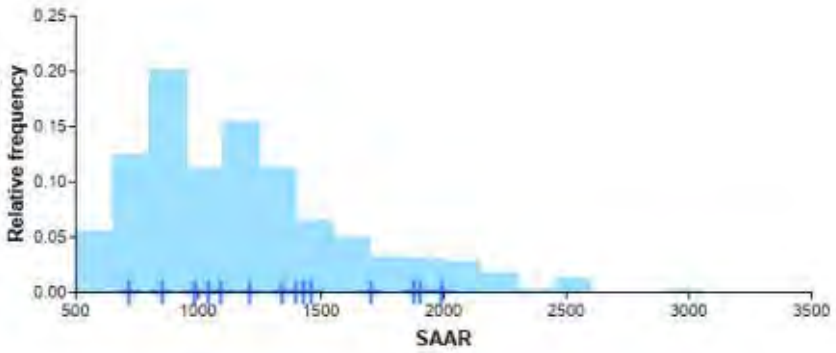


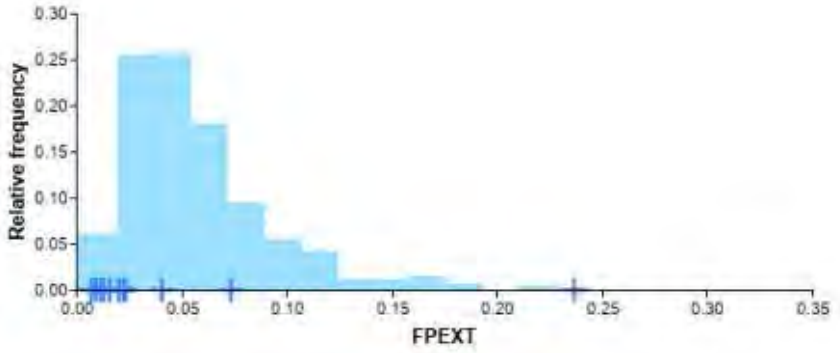


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:30:29
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	2116441437
Site name:	FEH_Catchment_Descriptors_257900_249400_v5_0_1
Site location:	SN 57900 49400
Easting:	257900
Northing:	249400
Catchment area:	28.73 km²
SAAR:	1262 mm
BFIHOST19:	0.478
FPEXT:	0.054
FARL:	0.995
URBEXT2000:	0.0054

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.24 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.00603

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
72007 (Brock @ upstream of A6)	0.197	45	28.972	0.191	**0.191**	0.223	**0.223**
73015 (Keer @ High Keer Weir)	0.310	33	12.421	0.204	**0.205**	0.189	**0.189**
72014 (Conder @ Galgate)	0.360	56	16.971	0.228	**0.229**	0.133	**0.132**
76023 (Dacre Beck @ Dacre Bridge)	0.390	23	35.266	0.184	**0.184**	0.238	**0.238**
48004 (Warleggan @ Trengoffe)	0.396	54	9.865	0.254	**0.254**	0.266	**0.265**
47021 (Kensey @ Launceston Newport)	0.455	21	13.800	0.197	**0.199**	0.265	**0.262**
47009 (Tiddy @ Tideford)	0.504	54	6.890	0.198	**0.199**	0.208	**0.206**
28041 (Hamps @ Waterhouses)	0.517	38	26.313	0.213	**0.214**	0.284	**0.283**
27032 (Hebden Beck @ Hebden)	0.573	55	4.052	0.203	**0.203**	0.190	**0.190**
24006 (Rookhope Burn @ Eastgate)	0.573	20	24.620	0.152	**0.152**	0.117	**0.117**
48009 (St Neot @ Craigshill Wood)	0.590	12	8.465	0.245	**0.245**	0.373	**0.372**
25012 (Harwood Beck @ Harwood)	0.605	54	33.426	0.181	**0.181**	0.219	**0.219**
49003 (De Lank @ De Lank)	0.638	57	14.299	0.209	**0.209**	0.158	**0.158**
Total		**522**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
72007 (Brock @ upstream of A6)	Yes	Yes	45	0	0.00	-0.42	None	0.699	
73015 (Keer @ High Keer Weir)	Yes	Yes	33	1	3.03	3.30	5	0.195	
72014 (Conder @ Galgate)	Yes	Yes	56	3	5.36	1.39	None	1.756	
76023 (Dacre Beck @ Dacre Bridge)	Yes	Yes	23	1	4.35			0.977	
48004 (Warleggan @ Trengoffe)	Yes	Yes	54	4	7.41	0.65	None	1.354	
47021 (Kensey @ Launceston Newport)	Yes	Yes	21	0	0.00			0.561	
47009 (Tiddy @ Tideford)	Yes	Yes	54	1	1.85	1.44	None	0.185	
28041 (Hamps @ Waterhouses)	Yes	Yes	38	2	5.26			1.273	
27032 (Hebden Beck @ Hebden)	Yes	Yes	55	2	3.64	0.53	None	0.379	
24006 (Rookhope Burn @ Eastgate)	Yes	Yes	20	0	0.00			1.493	
48009 (St Neot @ Craigshill Wood)	Yes	Yes	12	0	0.00			2.631	
25012 (Harwood Beck @ Harwood)	Yes	Yes	54	0	0.00	0.83	None	0.847	
49003 (De Lank @ De Lank)	Yes	Yes	57	0	0.00	-0.10	None	0.650	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
72007 (Brock @ upstream of A6)	31.510	1361	0.053	1.000	0.000	0.318
73015 (Keer @ High Keer Weir)	30.043	1158	0.074	0.976	0.003	0.455
72014 (Conder @ Galgate)	28.992	1183	0.082	0.975	0.006	0.427
76023 (Dacre Beck @ Dacre Bridge)	33.913	1429	0.072	0.999	0.000	0.411
48004 (Warleggan @ Trengoffe)	25.260	1445	0.035	0.978	0.003	0.432
47021 (Kensey @ Launceston Newport)	34.830	1298	0.022	0.998	0.017	0.514
47009 (Tiddy @ Tideford)	37.398	1276	0.024	1.000	0.011	0.536
28041 (Hamps @ Waterhouses)	37.040	1085	0.033	1.000	0.004	0.311
27032 (Hebden Beck @ Hebden)	22.245	1433	0.021	0.997	0.000	0.272
24006 (Rookhope Burn @ Eastgate)	36.597	1126	0.018	0.994	0.000	0.297
48009 (St Neot @ Craigshill Wood)	22.973	1511	0.023	0.982	0.002	0.388
25012 (Harwood Beck @ Harwood)	24.582	1577	0.021	1.000	0.000	0.283
49003 (De Lank @ De Lank)	21.610	1628	0.064	0.998	0.000	0.288

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.205	Urban L-CV:	0.205
Rural L-Skewness:	0.214	Urban L-Skewness:	0.215

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.205	-0.214		0.045
GEV	0.889	0.300	-0.068		-3.548
KAP3	0.944	0.247	-0.148	-0.400	-0.722

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.204	-0.215		0.053
GEV	0.889	0.299	-0.069		-3.437
KAP3	0.944	0.245	-0.149	-0.400	-0.702

Goodness of fit

GL:	0.6756 *
GEV:	-1.1007 *
P3:	-2.5339
GP:	-5.2111
KAP3:	0.0450 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: -1.8188

The pooling group is acceptably homogeneous and a review of the pooling group is not required.

Standardised growth curves

Rural

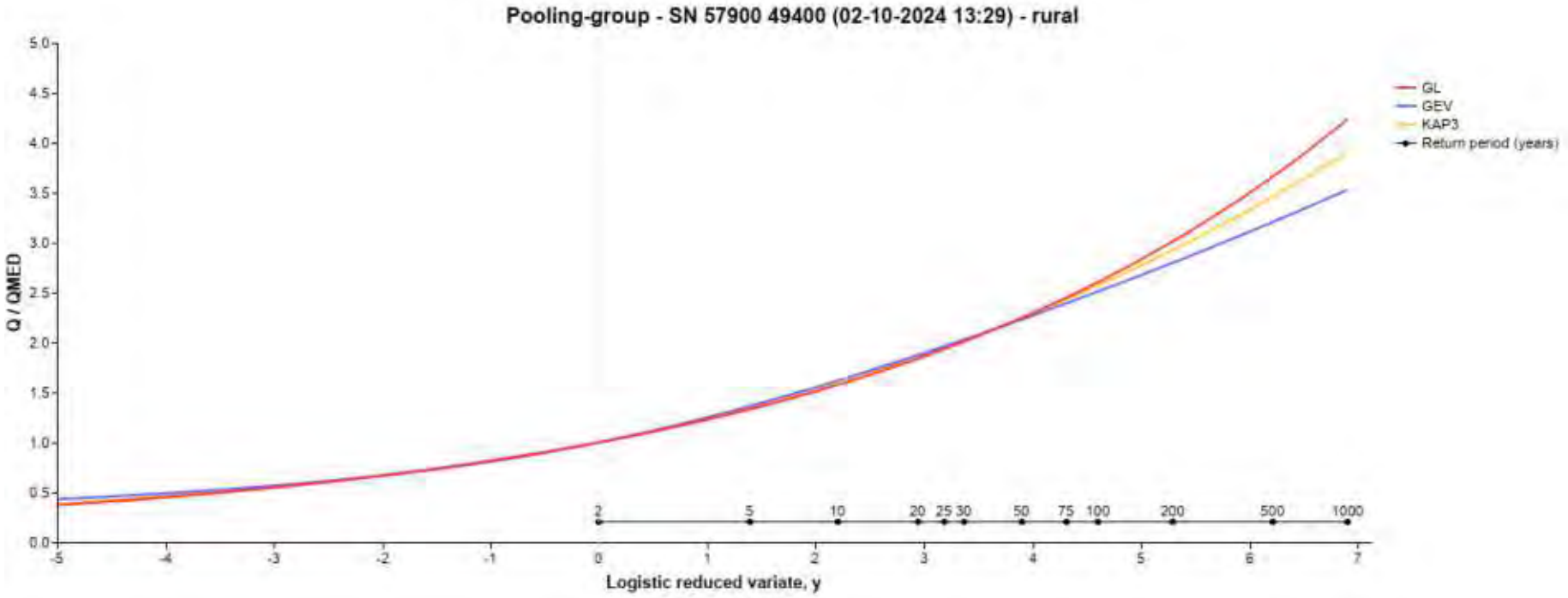
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.330	1.362	1.344
10	1.574	1.618	1.595
20	1.839	1.876	1.859
25	1.931	1.960	1.949
30	2.009	2.030	2.024
50	2.243	2.228	2.244
75	2.445	2.390	2.429
100	2.600	2.508	2.567
200	3.012	2.800	2.925
500	3.657	3.206	3.455
1000	4.236	3.530	3.907

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.329	1.361	1.343
10	1.572	1.616	1.593
20	1.837	1.874	1.857
25	1.929	1.958	1.947
30	2.007	2.028	2.022
50	2.240	2.227	2.242
75	2.443	2.389	2.427
100	2.598	2.506	2.566
200	3.010	2.799	2.923
500	3.657	3.207	3.455
1000	4.237	3.533	3.909

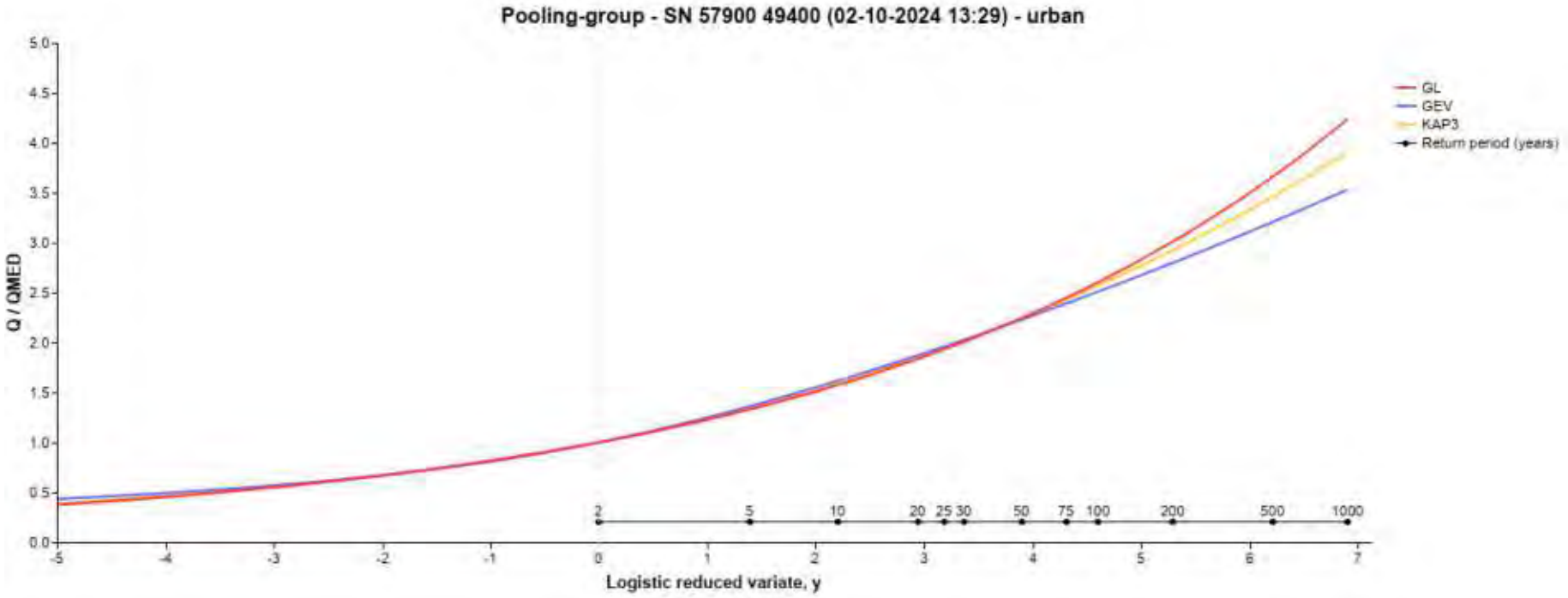
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.252
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62002 (Teifi @ Llanfair)	1.04	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_257900_249400_v5_0_1 @ SN 57900 49400)	28.727	259327	252857	1262	0.054	0.995	0.005	0.478
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
60012 (Twrch @ Ddol Las)	8.67	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
62001 (Teifi @ Glanteifi)	11.36	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes
60013 (Cothi @ Pont Ynys Brechfa)	13.35	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
60002 (Cothi @ Felin Mynachdy)	15.15	0.001	Yes	179.150	**178.999**	171.073	171.073	260063	237727	298.730	1551	0.444	0.997	62	Yes	Yes
62003 (Teifi @ Pont Llanio)	16.11	0.002	Yes	40.600	**40.513**	107.335	107.335	271146	263799	175.385	1448	0.397	0.983	25	Yes	No
63003 (Wyre @ Llanrhystud)	16.45	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
60007 (Tywi @ Dolau Hirion)	17.58	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
60001 (Tywi @ Ty Castell)	19.76	0.002	Yes	399.100	**398.361**	502.115	502.115	269002	235627	1090.835	1535	0.432	0.984	51	Yes	Yes
60016 (Tywi @ Manorafon)	22.36	0.002	Yes	257.918	**257.504**	300.566	300.566	276653	238720	580.870	1564	0.417	0.973	26	Yes	No

QMED

Rural:	10.582 m³/s
Urban:	10.646 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

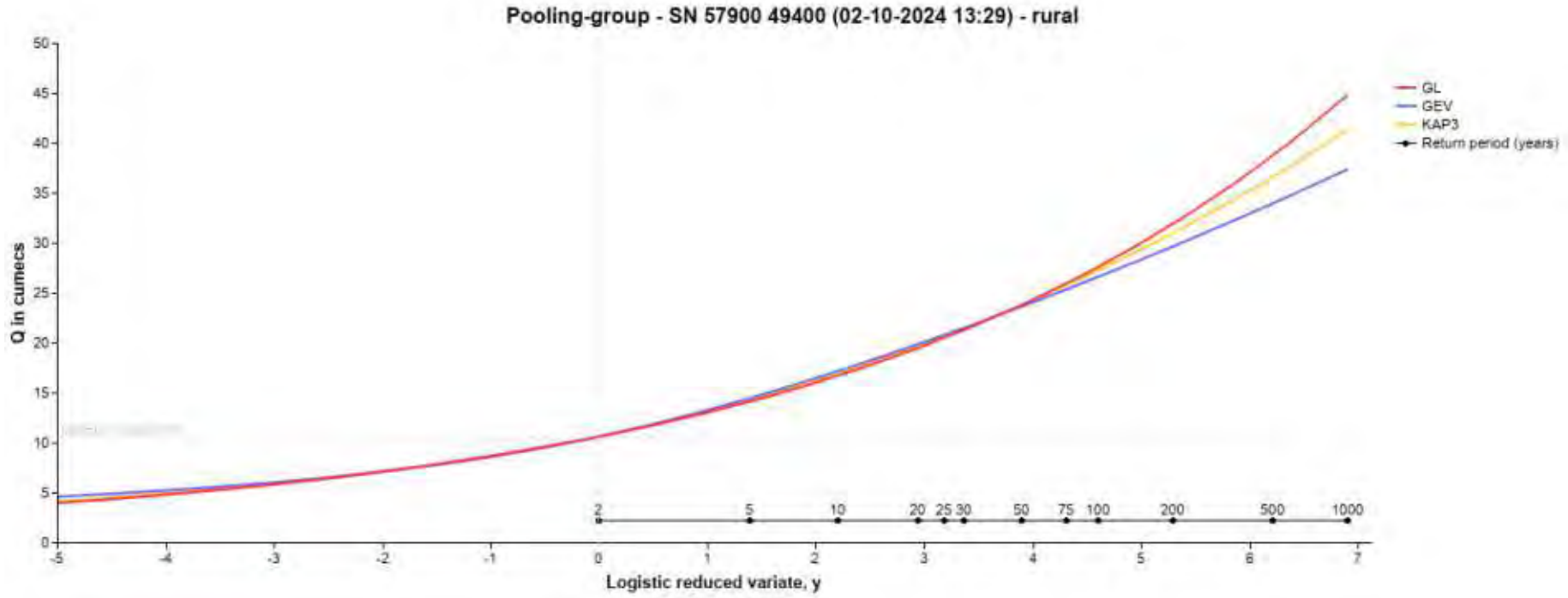
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	10.582	10.582	10.582
5	14.075	14.416	14.220
10	16.653	17.121	16.874
20	19.461	19.848	19.674
25	20.435	20.741	20.621
30	21.260	21.478	21.415
50	23.731	23.581	23.740
75	25.877	25.295	25.704
100	27.510	26.537	27.167
200	31.870	29.624	30.946
500	38.700	33.925	36.563
1000	44.826	37.358	41.343

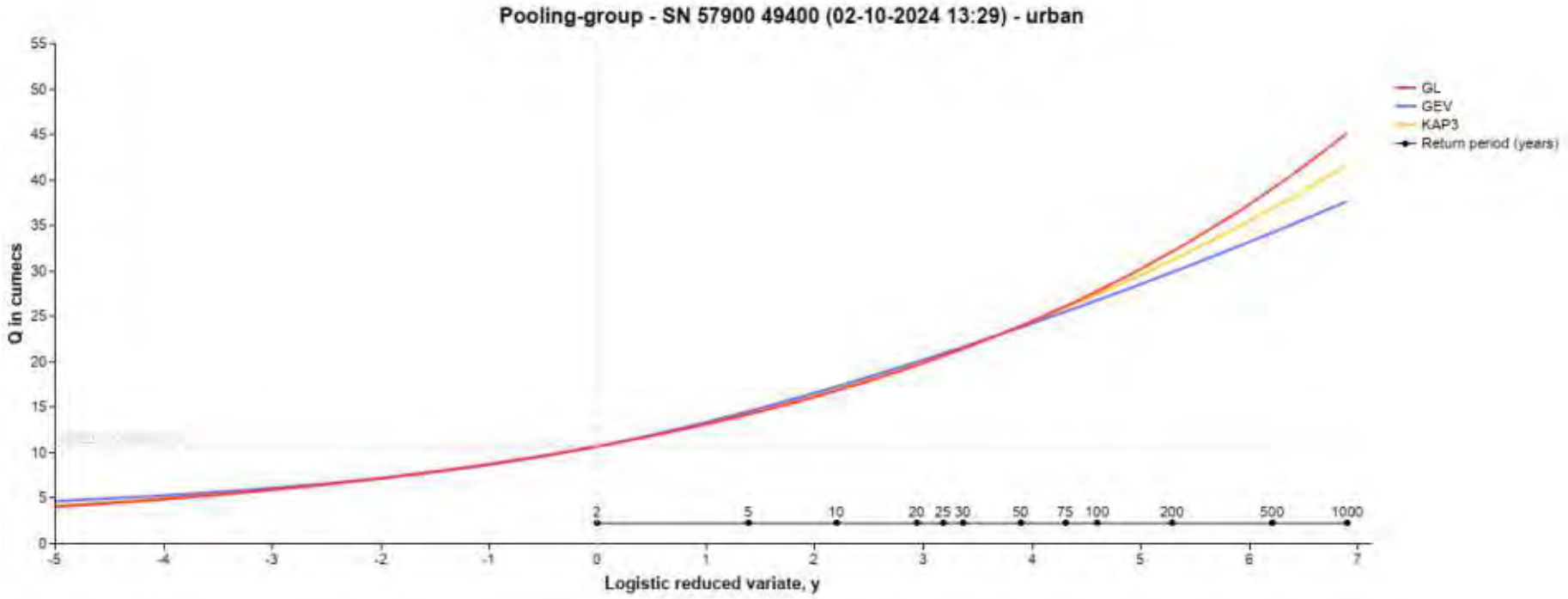
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	10.646	10.646	10.646
5	14.149	14.490	14.295
10	16.738	17.206	16.959
20	19.558	19.948	19.772
25	20.537	20.846	20.724
30	21.367	21.587	21.522
50	23.851	23.704	23.862
75	26.010	25.430	25.839
100	27.654	26.682	27.312
200	32.044	29.795	31.120
500	38.927	34.138	36.785
1000	45.104	37.607	41.610



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

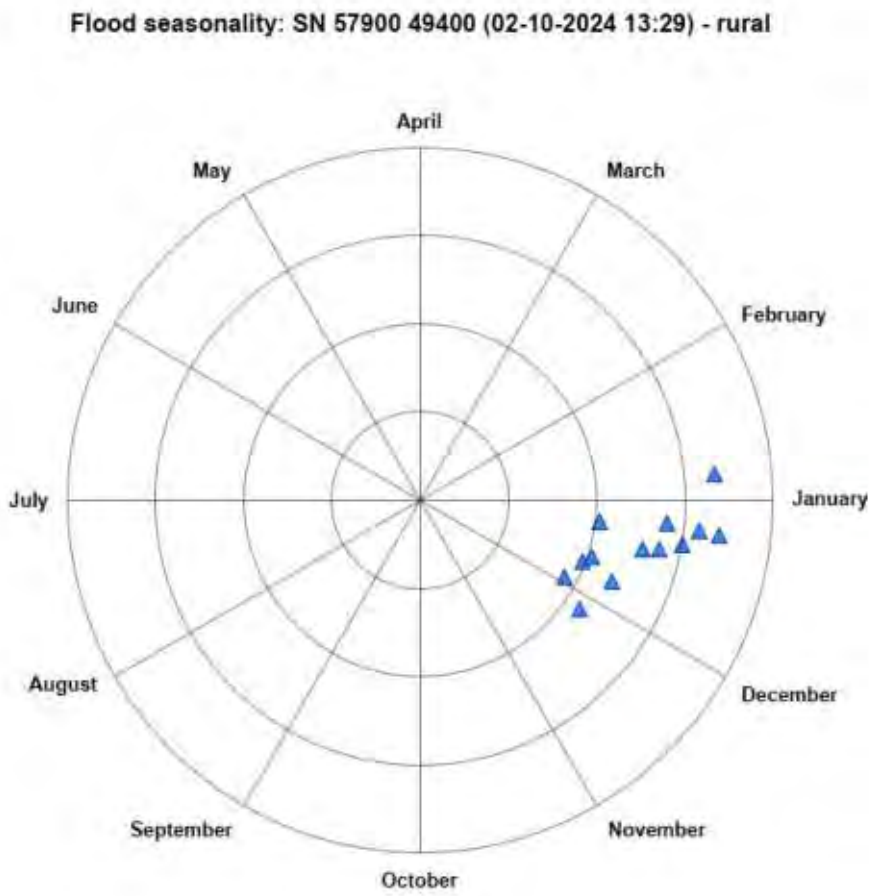


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

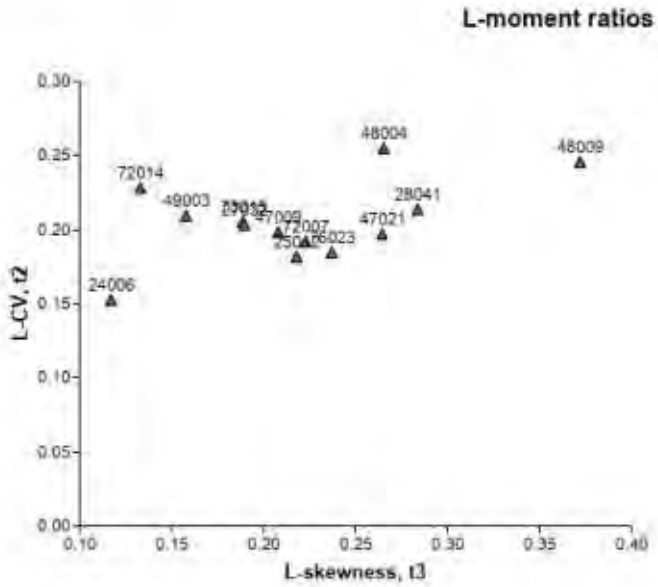


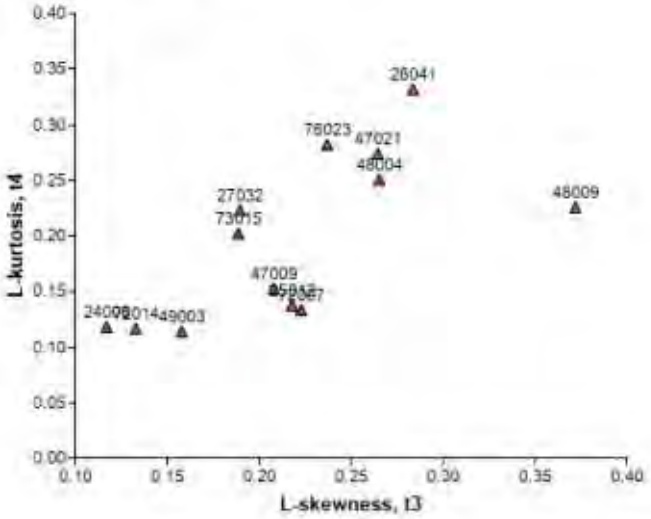
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

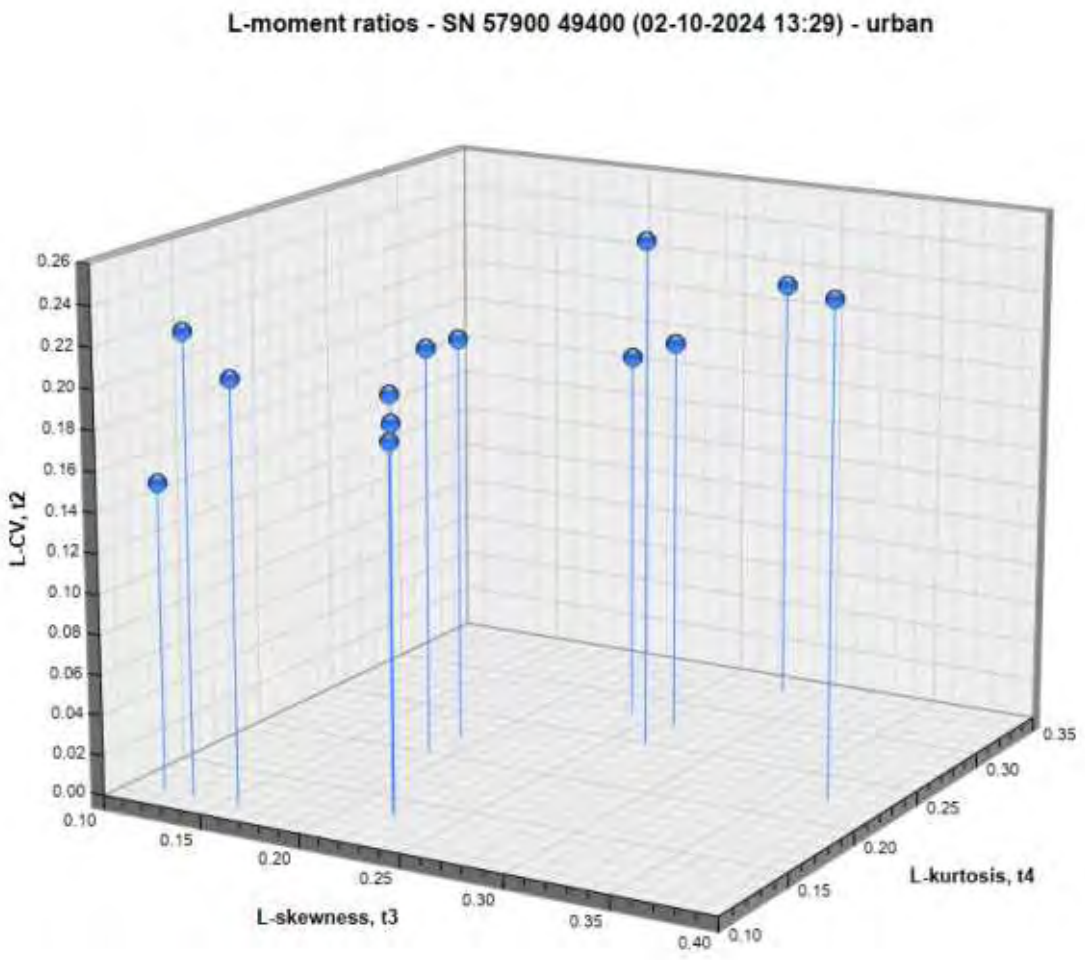
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method





UK Design Flood Estimation

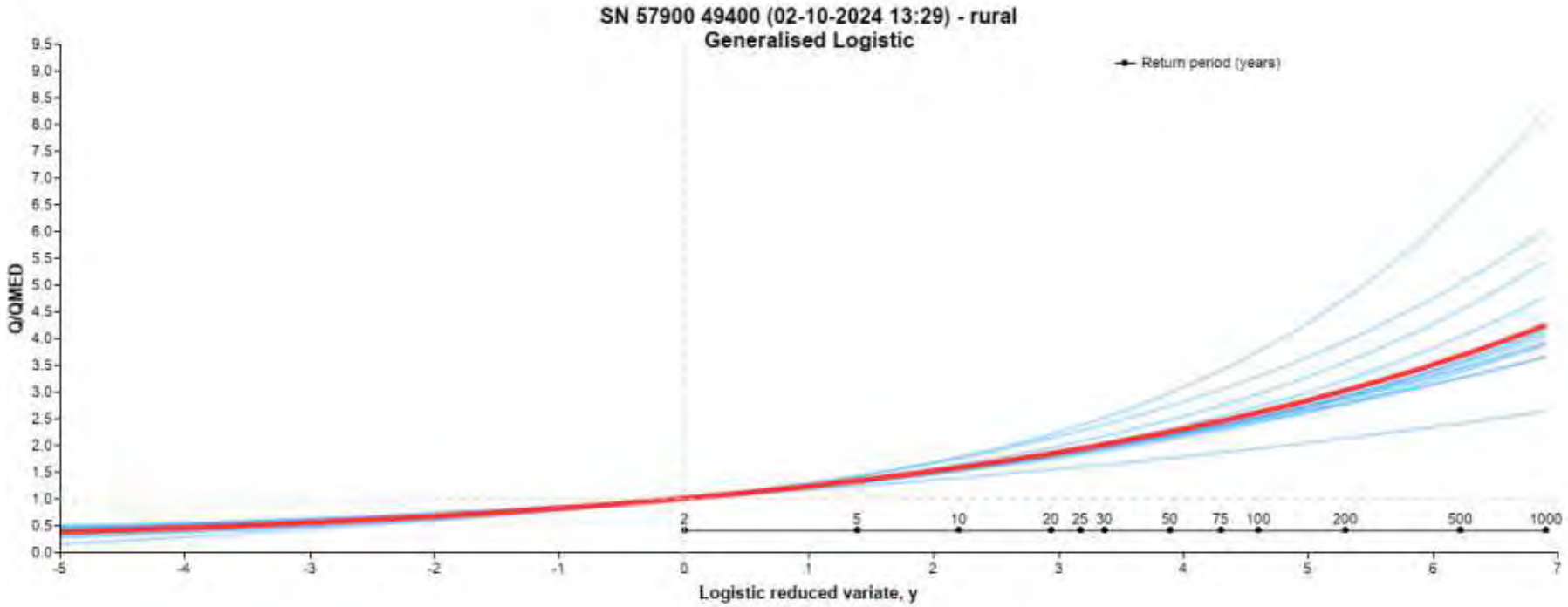
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

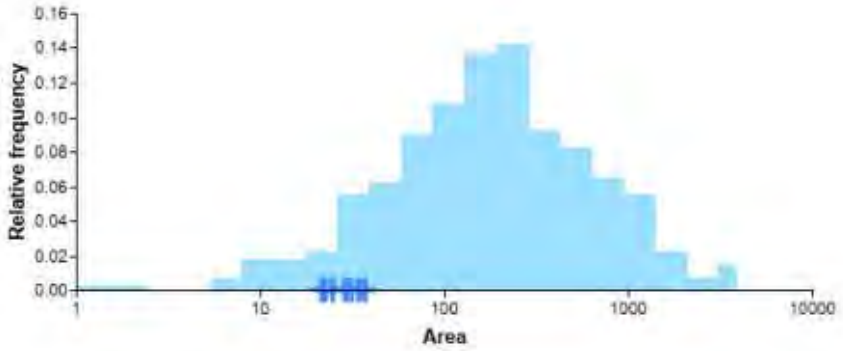
Pooling group growth curves

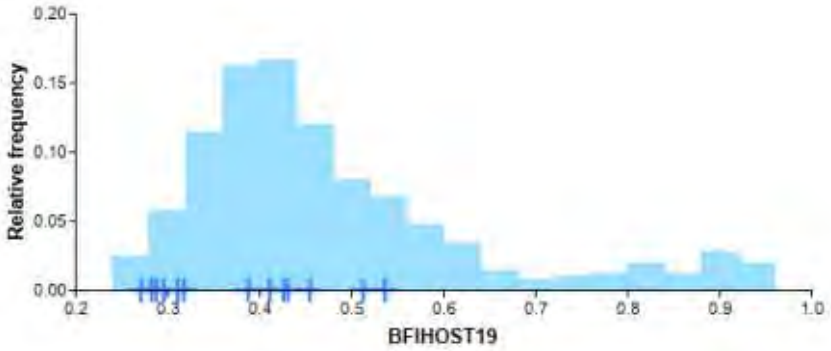


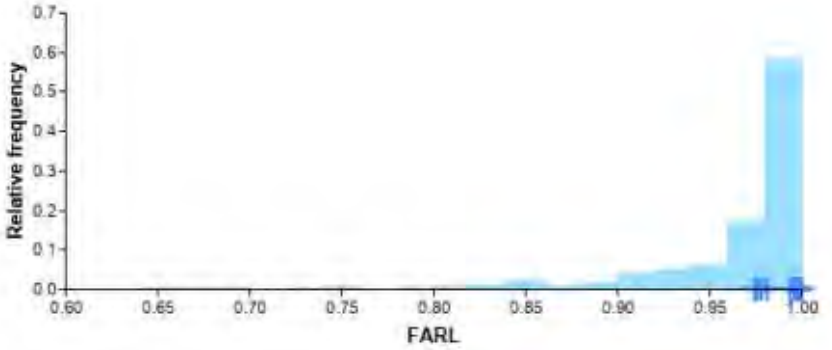
UK Design Flood Estimation

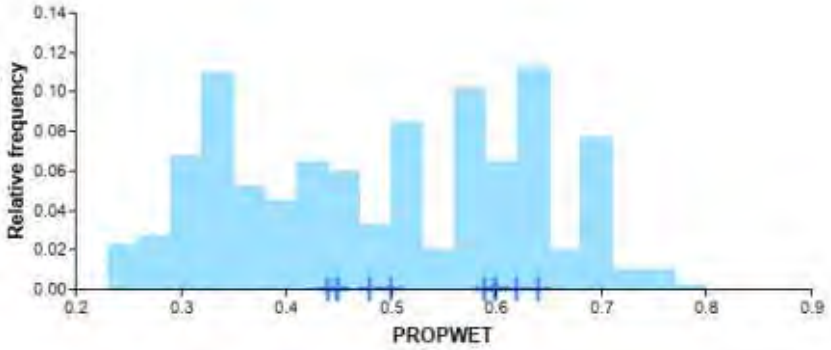
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



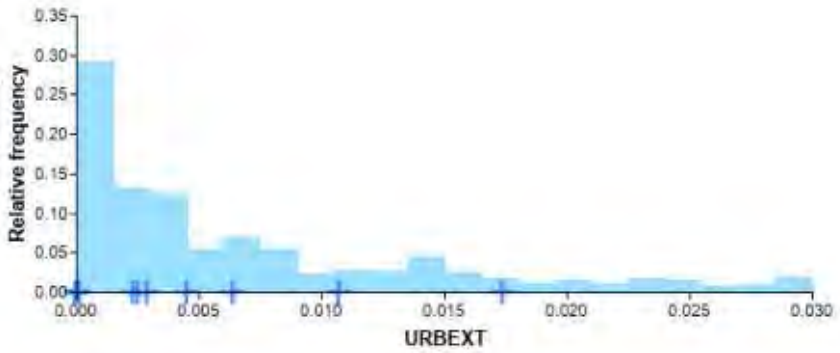


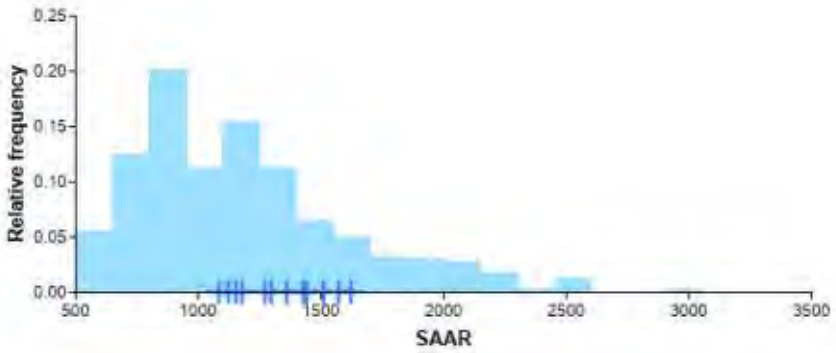


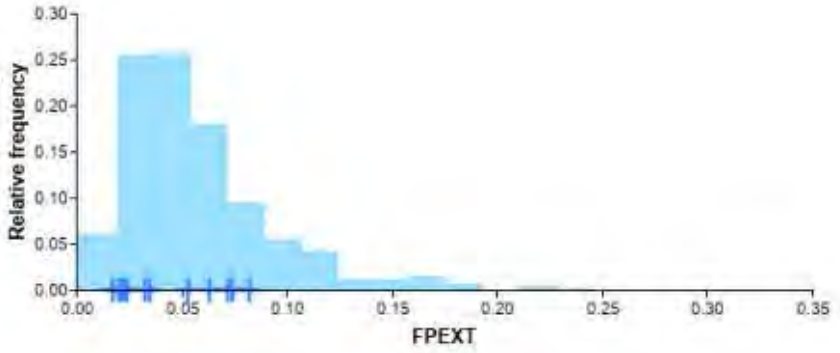


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:32:39
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	2861058051
Site name:	FEH_Catchment_Descriptors_256400_246600_v5_0_1
Site location:	SN 56400 46600
Easting:	256400
Northing:	246600
Catchment area:	310.85 km²
SAAR:	1409 mm
BFIHOST19:	0.422
FPEXT:	0.071
FARL:	0.990
URBEXT2000:	0.0041

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	2.00 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.00416

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
202001 (Roe @ Ardnargle)	0.348	48	154.975	0.087	**0.087**	-0.051	**-0.052**
84014 (Avon Water @ Fairholm)	0.351	59	162.681	0.173	**0.174**	0.128	**0.126**
83005 (Irvine @ Shewalton)	0.376	30	200.492	0.145	**0.147**	0.196	**0.192**
79005 (Cluden Water @ Fiddlers Ford)	0.392	60	108.468	0.151	**0.151**	0.265	**0.265**
236005 (Colebrooke @ Ballindarragh Bridge)	0.398	41	109.461	0.090	**0.091**	0.149	**0.149**
27035 (Aire @ Kildwick Bridge)	0.416	54	57.618	0.183	**0.185**	0.414	**0.410**
71008 (Hodder @ Hodder Place)	0.419	54	222.340	0.162	**0.163**	0.210	**0.210**
76022 (Caldew @ Cummersdale)	0.432	26	156.751	0.191	**0.191**	0.212	**0.211**
201005 (Camowen @ Camowen Terrace)	0.442	51	89.663	0.170	**0.170**	0.383	**0.383**
12007 (Dee @ Mar Lodge)	0.445	32	183.215	0.150	**0.150**	0.237	**0.237**
23006 (South Tyne @ Featherstone)	0.472	57	243.670	0.141	**0.141**	0.248	**0.248**
Total		**512**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
202001 (Roe @ Ardnargle)	Yes	Yes	48	0	0.00	2.83	5	1.847	
84014 (Avon Water @ Fairholm)	Yes	Yes	59	0	0.00	0.44	None	1.115	
83005 (Irvine @ Shewalton)	Yes	Yes	30	0	0.00			0.011	
79005 (Cluden Water @ Fiddlers Ford)	Yes	Yes	60	0	0.00	1.24	None	0.599	
236005 (Colebrooke @ Ballindarragh Bridge)	Yes	Yes	41	0	0.00			1.428	
27035 (Aire @ Kildwick Bridge)	Yes	Yes	54	0	0.00	3.04	5	1.000	
71008 (Hodder @ Hodder Place)	Yes	Yes	54	1	1.85	0.62	None	0.693	
76022 (Caldew @ Cummersdale)	Yes	Yes	26	1	3.85			1.397	
201005 (Camowen @ Camowen Terrace)	Yes	Yes	51	0	0.00	1.97	5	0.708	
12007 (Dee @ Mar Lodge)	Yes	Yes	32	0	0.00	-0.66	None	2.061	
23006 (South Tyne @ Featherstone)	Yes	Yes	57	0	0.00	1.95	10	0.142	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
202001 (Roe @ Ardnargle)	365.730	1250	0.059	0.993	0.006	0.360
84014 (Avon Water @ Fairholm)	263.067	1264	0.057	0.986	0.010	0.384
83005 (Irvine @ Shewalton)	367.572	1228	0.081	0.980	0.027	0.362
79005 (Cluden Water @ Fiddlers Ford)	237.225	1422	0.062	0.985	0.001	0.468
236005 (Colebrooke @ Ballindarragh Bridge)	313.580	1156	0.082	0.987	0.001	0.373
27035 (Aire @ Kildwick Bridge)	283.392	1151	0.073	0.977	0.019	0.362
71008 (Hodder @ Hodder Place)	258.150	1602	0.055	0.970	0.002	0.328
76022 (Caldew @ Cummersdale)	249.697	1211	0.078	0.998	0.002	0.415
201005 (Camowen @ Camowen Terrace)	276.382	1144	0.080	0.989	0.003	0.415
12007 (Dee @ Mar Lodge)	291.995	1334	0.033	0.989	0.000	0.357
23006 (South Tyne @ Featherstone)	323.050	1331	0.030	0.995	0.002	0.291

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.149	Urban L-CV:	0.149
Rural L-Skewness:	0.215	Urban L-Skewness:	0.216

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.146	-0.215		0.322
GEV	0.921	0.213	-0.069		-2.165
KAP3	0.960	0.175	-0.149	-0.400	-0.216

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.145	-0.216		0.326
GEV	0.921	0.213	-0.070		-2.107
KAP3	0.960	0.175	-0.150	-0.400	-0.206

Goodness of fit

GL:	0.5859 *
GEV:	-1.0539 *
P3:	-2.6023
GP:	-4.9227
KAP3:	0.0123 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 1.7815

The pooling group is possibly heterogeneous and a review of the pooling group is optional.

Standardised growth curves

Rural

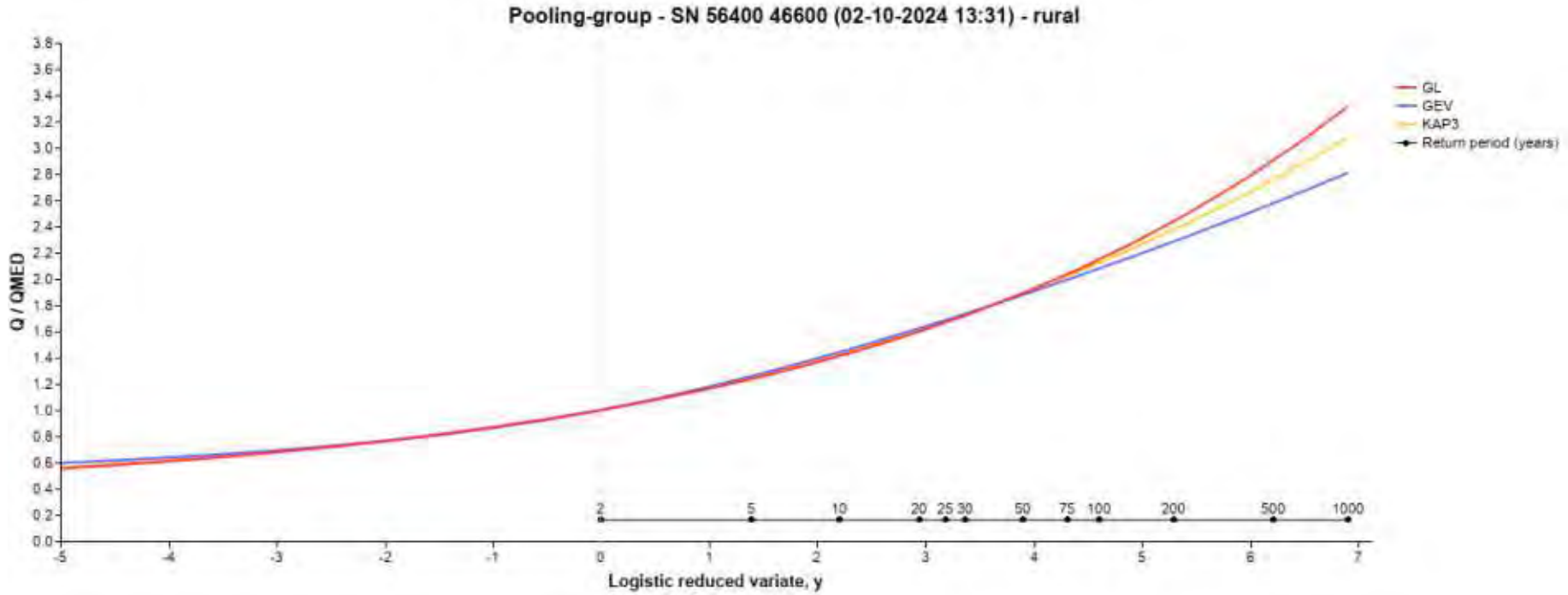
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.236	1.258	1.245
10	1.410	1.440	1.424
20	1.599	1.624	1.613
25	1.665	1.684	1.677
30	1.721	1.734	1.731
50	1.888	1.876	1.888
75	2.033	1.992	2.020
100	2.144	2.076	2.119
200	2.439	2.285	2.375
500	2.902	2.577	2.756
1000	3.317	2.809	3.080

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.235	1.257	1.244
10	1.409	1.439	1.423
20	1.598	1.623	1.612
25	1.664	1.683	1.676
30	1.720	1.733	1.729
50	1.887	1.875	1.887
75	2.032	1.991	2.019
100	2.142	2.075	2.118
200	2.438	2.285	2.375
500	2.901	2.577	2.756
1000	3.317	2.811	3.081

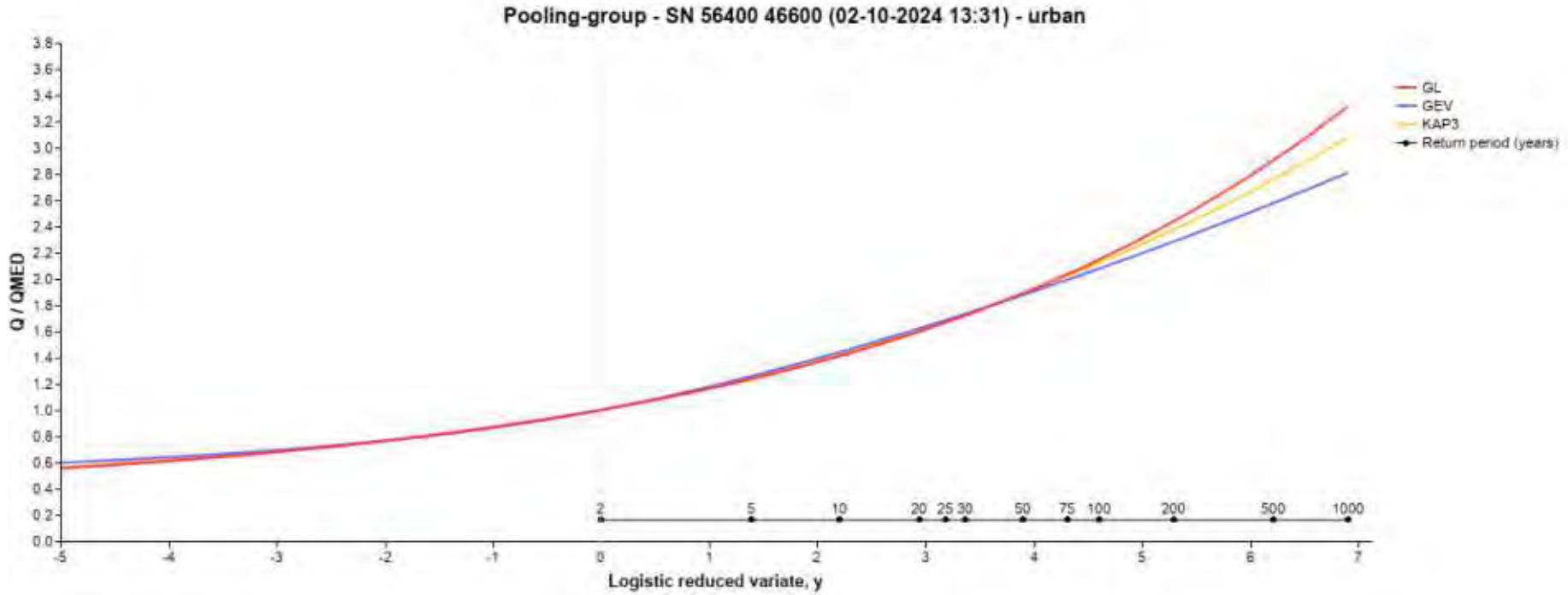
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.383
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62003 (Teifi @ Pont Llanio)	6.51	Yes	40.600	**40.513**	107.335	107.335

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62003 (Teifi @ Pont Llanio)	Yes	No	25	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_256400_246600_v5_0_1 @ SN 56400 46600)	310.850	267260	258571	1409	0.071	0.990	0.004	0.422
62003 (Teifi @ Pont Llanio)	175.385	271146	263799	1448	0.075	0.983	0.002	0.397

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
62002 (Teifi @ Llanfair)	8.80	0.004	Yes	138.800	**138.261**	233.987	233.987	259932	253697	517.582	1392	0.445	0.993	33	Yes	No
60012 (Twrch @ Ddol Las)	10.73	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
60007 (Tywi @ Dolau Hirion)	12.60	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
63003 (Wyre @ Llanrhystud)	12.99	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
63001 (Ystwyth @ Pont Llolwyn)	16.34	0.001	Yes	94.514	**94.398**	99.230	99.230	271973	274219	170.100	1456	0.430	0.990	62	Yes	Yes
55004 (Irfon @ Abernant)	18.64	0.003	Yes	56.542	**56.375**	80.866	80.866	284963	252747	73.013	1845	0.342	1.000	45	Yes	Yes
60013 (Cothi @ Pont Ynys Brechfa)	19.50	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
55032 (Elan @ Caban Dam)	21.02	0.000	Yes	120.200	**120.200**	68.461	68.461	286480	267070	183.775	1825	0.342	0.761	41	Yes	No
62001 (Teifi @ Glanteifi)	21.03	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes

QMED

Rural:	106.912 m³/s
Urban:	107.357 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

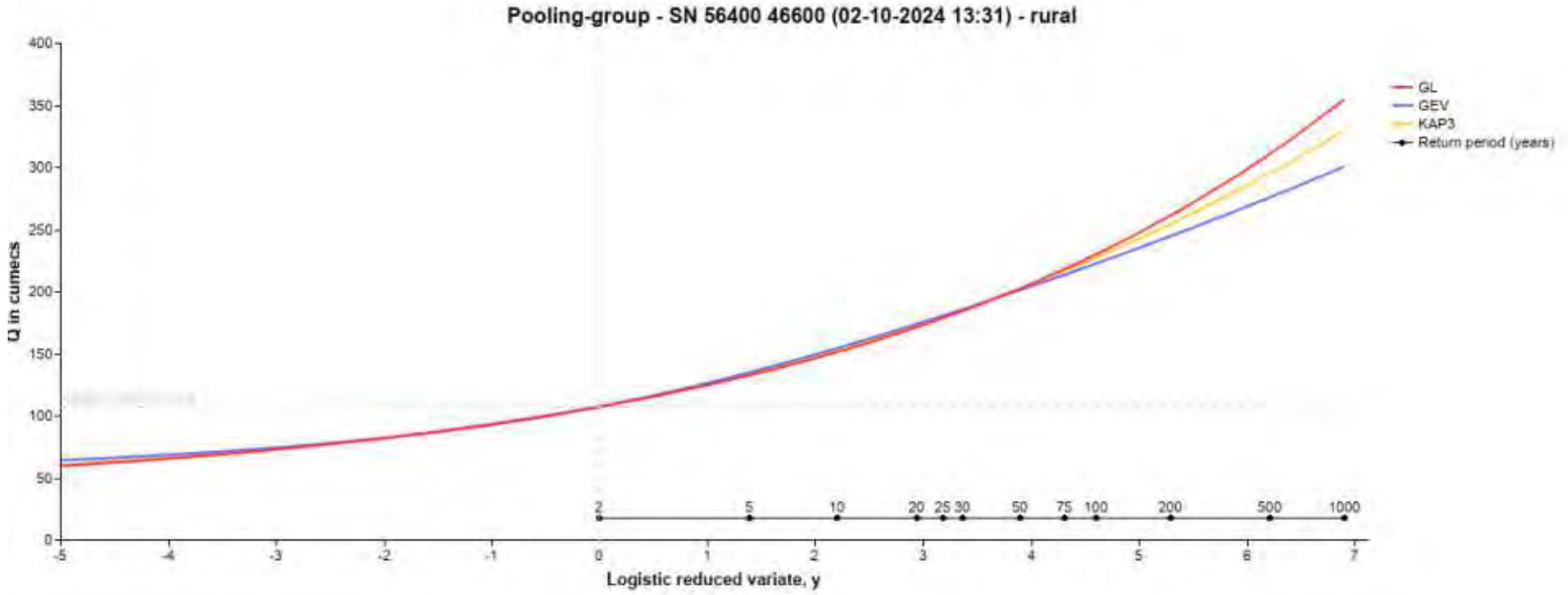
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	106.912	106.912	106.912
5	132.090	134.493	133.113
10	150.700	153.980	152.244
20	170.972	173.646	172.443
25	178.008	180.091	179.284
30	183.973	185.411	185.015
50	201.833	200.599	201.819
75	217.356	212.985	216.015
100	229.174	221.965	226.590
200	260.731	244.304	253.943
500	310.213	275.469	294.630
1000	354.626	300.370	329.286

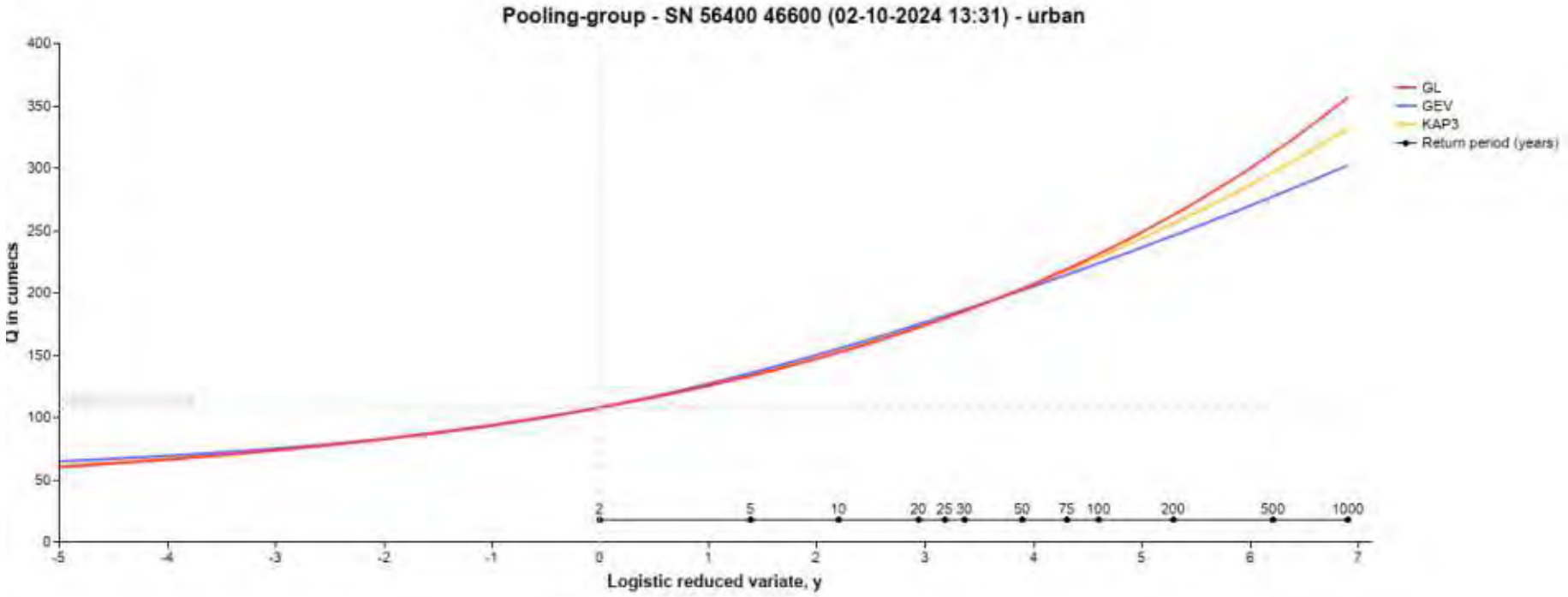
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	107.357	107.357	107.357
5	132.580	134.983	133.602
10	151.236	154.522	152.782
20	171.571	174.256	173.047
25	178.632	180.727	179.913
30	184.618	186.069	185.666
50	202.548	201.326	202.540
75	218.135	213.775	216.801
100	230.006	222.805	227.429
200	261.715	245.277	254.927
500	311.464	276.656	295.861
1000	356.142	301.749	330.752



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

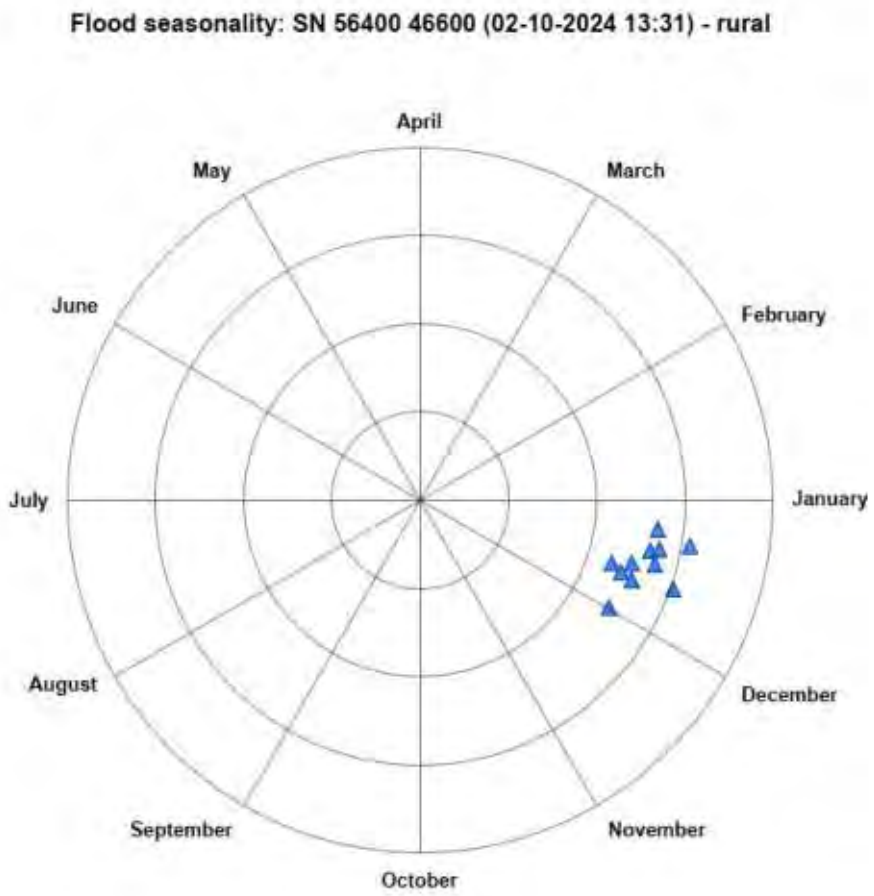


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

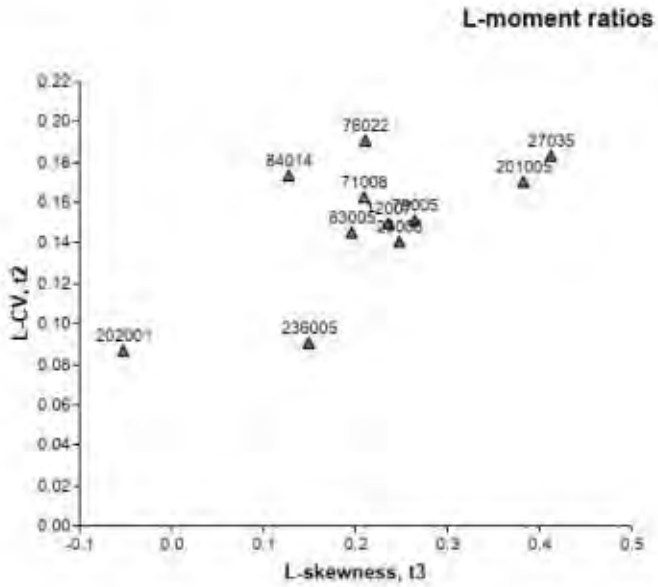


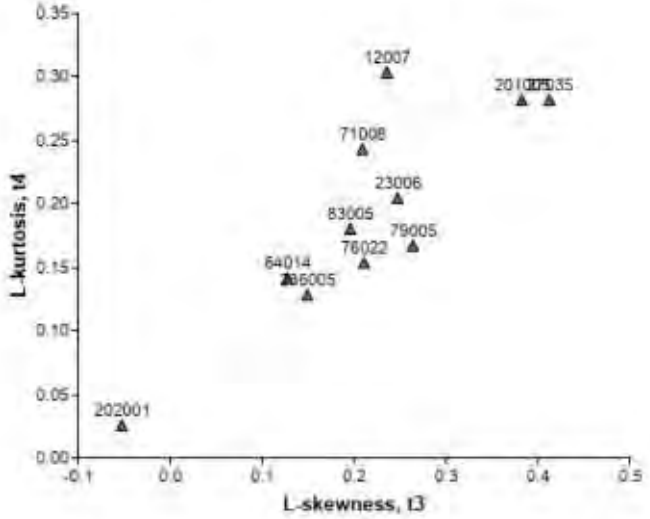
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

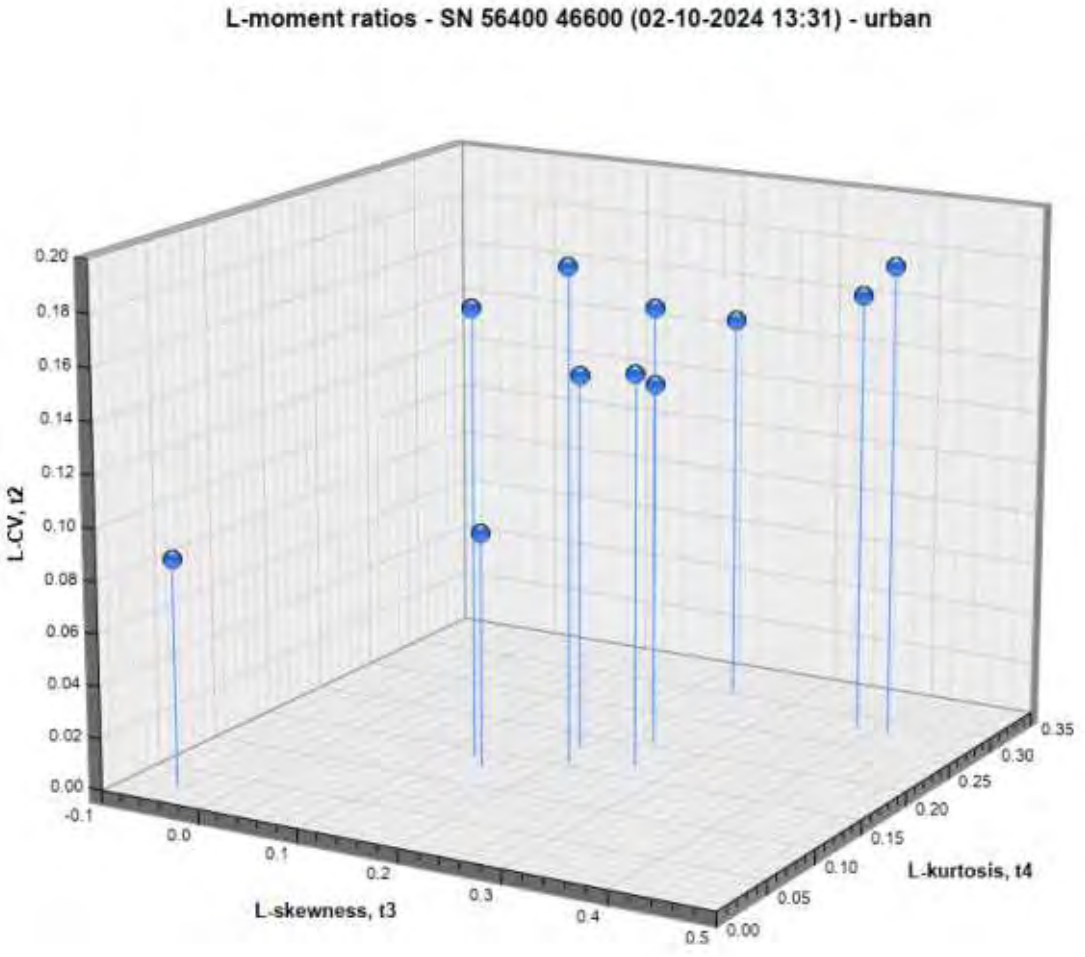
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method





UK Design Flood Estimation

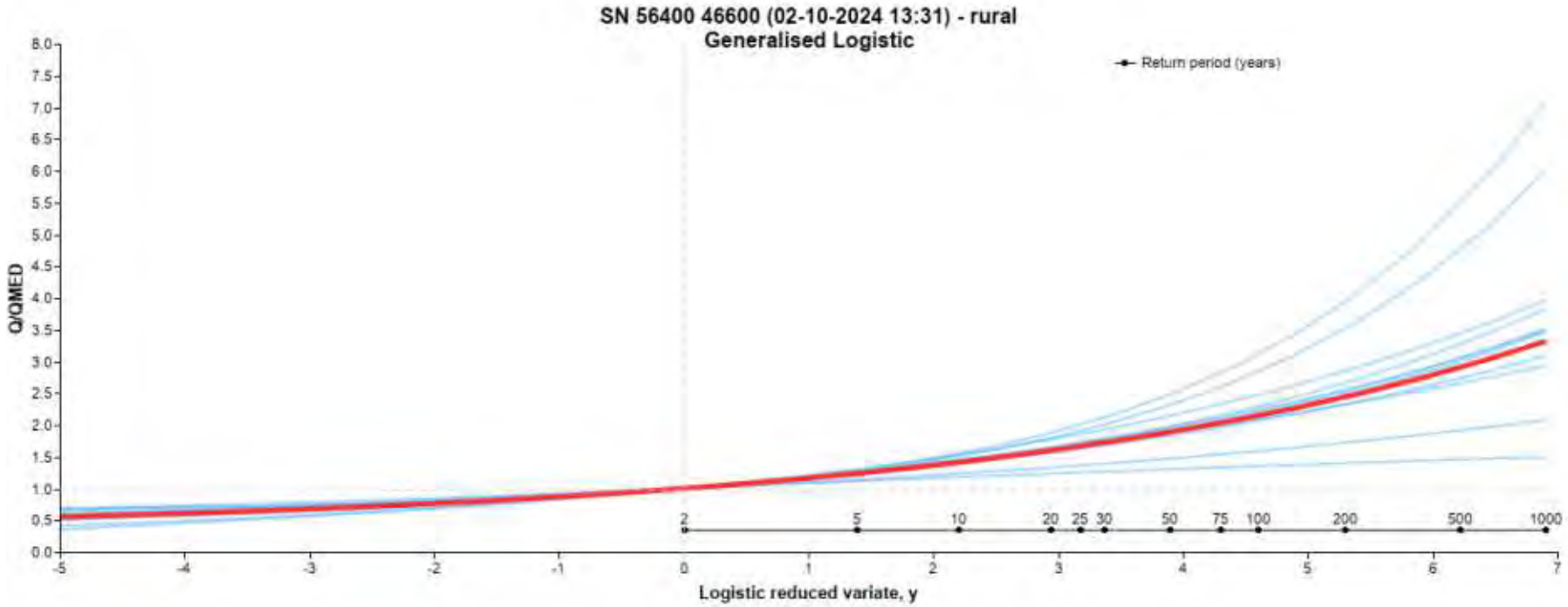
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

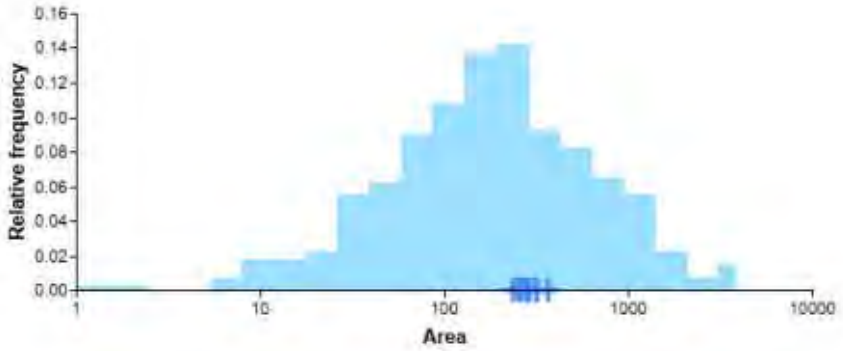
Pooling group growth curves

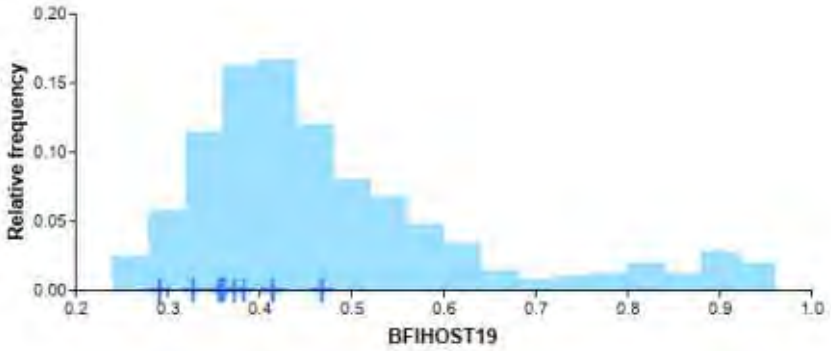


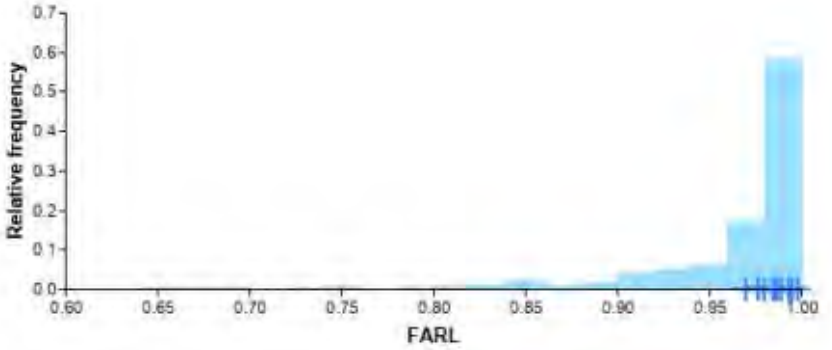
UK Design Flood Estimation

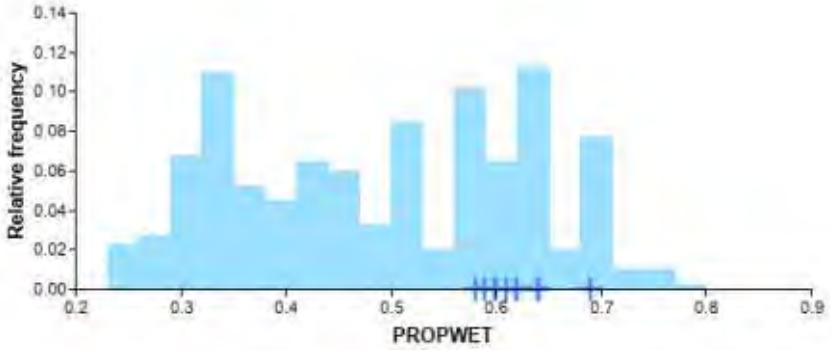
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



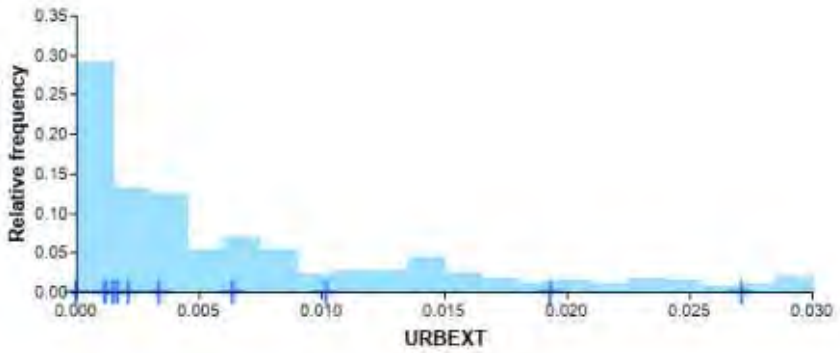


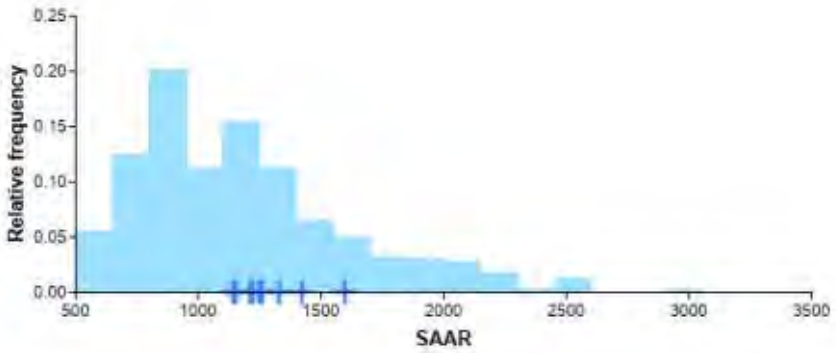


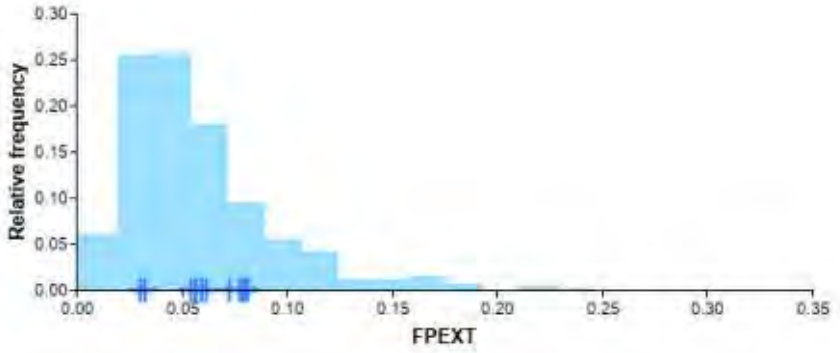


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	02-10-2024 14:36:35
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	2861058051
Site name:	FEH_Catchment_Descriptors_256400_246600_v5_0_1
Site location:	SN 56400 46600
Easting:	256400
Northing:	246600
Catchment area:	18.86 km²
SAAR:	1409 mm
BFIHOST19:	0.422
FPEXT:	0.071
FARL:	0.990
URBEXT2000:	0.0106

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.31 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.01078

Growth curve settings

Distance Measure Method:	Small catchment
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
27032 (Hebden Beck @ Hebden)	0.139	55	4.052	0.203	**0.203**	0.190	**0.190**
48004 (Warleggan @ Trengoffe)	0.242	54	9.865	0.254	**0.254**	0.266	**0.265**
48009 (St Neot @ Craigshill Wood)	0.254	12	8.465	0.245	**0.245**	0.373	**0.372**
47022 (Tory Brook @ Newnham Park)	0.269	28	6.134	0.243	**0.245**	0.163	**0.160**
18014 (Bannock Burn @ Bannockburn)	0.283	31	15.727	0.226	**0.227**	0.171	**0.169**
25011 (Langdon Beck @ Langdon)	0.326	37	15.647	0.225	**0.225**	0.321	**0.321**
48007 (Kennal @ Ponsanooth)	0.372	55	4.180	0.192	**0.193**	0.217	**0.215**
25012 (Harwood Beck @ Harwood)	0.385	54	33.426	0.181	**0.181**	0.219	**0.219**
72007 (Brock @ upstream of A6)	0.418	45	28.972	0.191	**0.191**	0.223	**0.223**
49003 (De Lank @ De Lank)	0.428	57	14.299	0.209	**0.209**	0.158	**0.158**
76023 (Dacre Beck @ Dacre Bridge)	0.466	23	35.266	0.184	**0.184**	0.238	**0.238**
47021 (Kensey @ Launceston Newport)	0.539	21	13.800	0.197	**0.199**	0.265	**0.262**
206006 (Annalong @ Recorder)	0.584	48	15.330	0.189	**0.189**	0.052	**0.052**
Total		**520**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
27032 (Hebden Beck @ Hebden)	Yes	Yes	55	2	3.64	0.53	None	0.200	
48004 (Warleggan @ Trengoffe)	Yes	Yes	54	4	7.41	0.65	None	1.728	
48009 (St Neot @ Craigshill Wood)	Yes	Yes	12	0	0.00			1.564	
47022 (Tory Brook @ Newnham Park)	Yes	Yes	28	1	3.57			1.802	
18014 (Bannock Burn @ Bannockburn)	Yes	Yes	31	1	3.23	-0.88	None	0.458	
25011 (Langdon Beck @ Langdon)	Yes	Yes	37	0	0.00			0.816	
48007 (Kennal @ Ponsanooth)	Yes	Yes	55	1	1.82	0.54	None	0.333	
25012 (Harwood Beck @ Harwood)	Yes	Yes	54	0	0.00	0.83	None	0.993	
72007 (Brock @ upstream of A6)	Yes	Yes	45	0	0.00	-0.42	None	0.632	
49003 (De Lank @ De Lank)	Yes	Yes	57	0	0.00	-0.10	None	0.477	
76023 (Dacre Beck @ Dacre Bridge)	Yes	Yes	23	1	4.35			0.984	
47021 (Kensey @ Launceston Newport)	Yes	Yes	21	0	0.00			0.722	
206006 (Annalong @ Recorder)	Yes	Yes	48	4	8.33	2.25	None	2.292	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
27032 (Hebden Beck @ Hebden)	22.245	1433	0.021	0.997	0.000	0.272
48004 (Warleggan @ Trengoffe)	25.260	1445	0.035	0.978	0.003	0.432
48009 (St Neot @ Craigshill Wood)	22.973	1511	0.023	0.982	0.002	0.388
47022 (Tory Brook @ Newnham Park)	13.432	1403	0.023	0.942	0.014	0.353
18014 (Bannock Burn @ Bannockburn)	25.372	1333	0.054	0.893	0.011	0.407
25011 (Langdon Beck @ Langdon)	12.787	1463	0.012	1.000	0.001	0.264
48007 (Kennal @ Ponsanooth)	26.892	1294	0.026	0.867	0.011	0.700
25012 (Harwood Beck @ Harwood)	24.582	1577	0.021	1.000	0.000	0.283
72007 (Brock @ upstream of A6)	31.510	1361	0.053	1.000	0.000	0.318
49003 (De Lank @ De Lank)	21.610	1628	0.064	0.998	0.000	0.288
76023 (Dacre Beck @ Dacre Bridge)	33.913	1429	0.072	0.999	0.000	0.411
47021 (Kensey @ Launceston Newport)	34.830	1298	0.022	0.998	0.017	0.514
206006 (Annalong @ Recorder)	14.438	1704	0.023	0.981	0.000	0.267

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.212	Urban L-CV:	0.211
Rural L-Skewness:	0.213	Urban L-Skewness:	0.215

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.212	-0.213		0.006
GEV	0.885	0.311	-0.066		-3.834
KAP3	0.942	0.255	-0.147	-0.400	-0.801

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.210	-0.215		0.022
GEV	0.886	0.308	-0.069		-3.602
KAP3	0.942	0.253	-0.149	-0.400	-0.760

Goodness of fit

GL:	1.0882 *
GEV:	-0.7880 *
P3:	-2.2459
GP:	-5.1107
KAP3:	0.4200 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: -1.0111

The pooling group is acceptably homogeneous and a review of the pooling group is not required.

Standardised growth curves

Rural

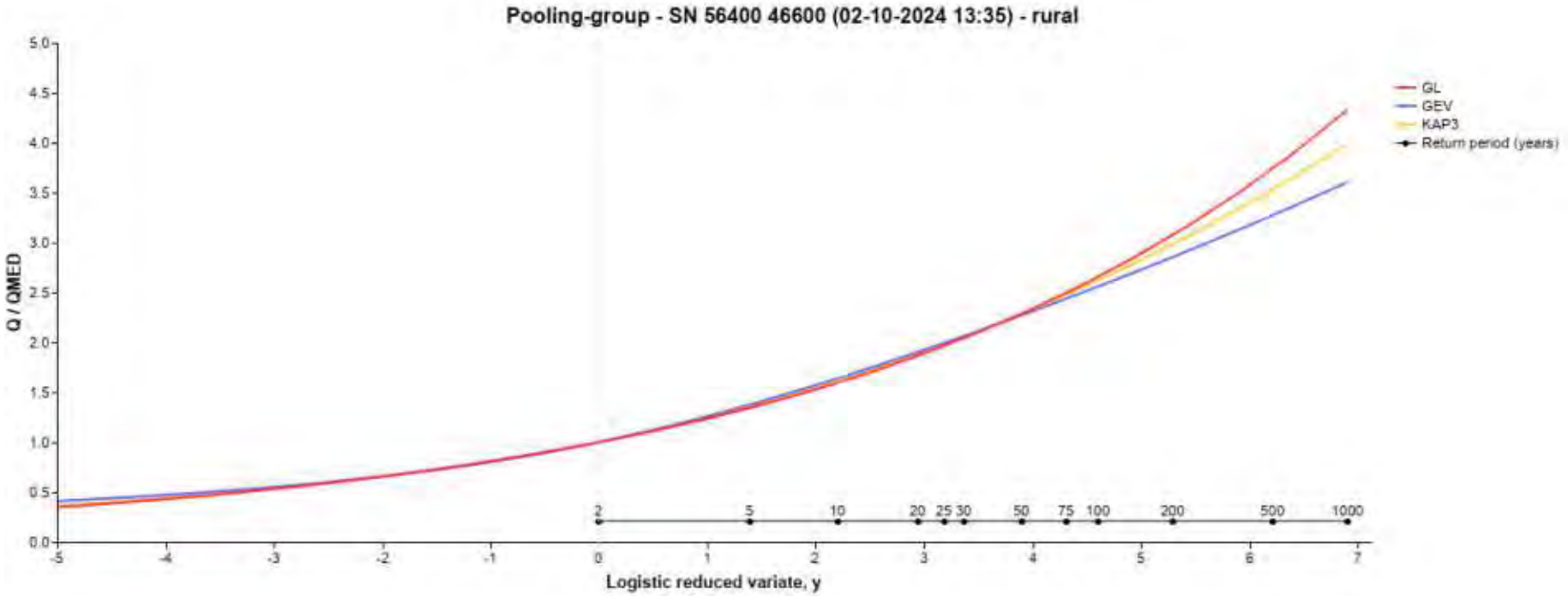
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.341	1.375	1.356
10	1.593	1.639	1.615
20	1.867	1.905	1.888
25	1.962	1.992	1.980
30	2.043	2.064	2.058
50	2.283	2.269	2.284
75	2.492	2.435	2.475
100	2.651	2.556	2.618
200	3.075	2.856	2.985
500	3.739	3.273	3.531
1000	4.334	3.605	3.994

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.339	1.373	1.354
10	1.590	1.636	1.612
20	1.863	1.901	1.884
25	1.958	1.988	1.976
30	2.038	2.060	2.054
50	2.279	2.265	2.280
75	2.488	2.432	2.472
100	2.647	2.553	2.614
200	3.072	2.854	2.983
500	3.738	3.275	3.531
1000	4.336	3.610	3.998

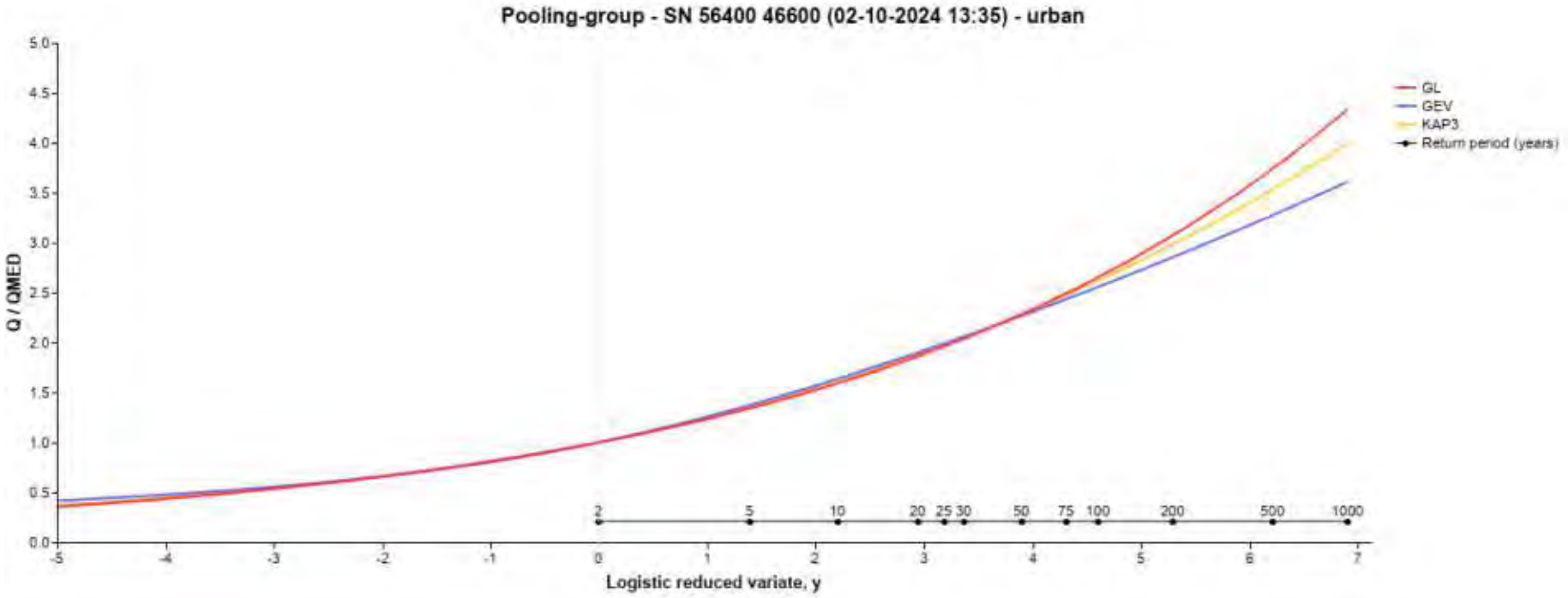
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.383
No. of donors:	1

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62003 (Teifi @ Pont Llanio)	6.51	Yes	40.600	**40.513**	107.335	107.335

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62003 (Teifi @ Pont Llanio)	Yes	No	25	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_256400_246600_v5_0_1 @ SN 56400 46600)	18.863	267260	258571	1409	0.071	0.990	0.011	0.422
62003 (Teifi @ Pont Llanio)	175.385	271146	263799	1448	0.075	0.983	0.002	0.397

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
62002 (Teifi @ Llanfair)	8.80	0.004	Yes	138.800	**138.261**	233.987	233.987	259932	253697	517.582	1392	0.445	0.993	33	Yes	No
60012 (Twrch @ Ddol Las)	10.73	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
60007 (Tywi @ Dolau Hirion)	12.60	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
63003 (Wyre @ Llanrhystud)	12.99	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
63001 (Ystwyth @ Pont Llolwyn)	16.34	0.001	Yes	94.514	**94.398**	99.230	99.230	271973	274219	170.100	1456	0.430	0.990	62	Yes	Yes
55004 (Irfon @ Abernant)	18.64	0.003	Yes	56.542	**56.375**	80.866	80.866	284963	252747	73.013	1845	0.342	1.000	45	Yes	Yes
60013 (Cothi @ Pont Ynys Brechfa)	19.50	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
55032 (Elan @ Caban Dam)	21.02	0.000	Yes	120.200	**120.200**	68.461	68.461	286480	267070	183.775	1825	0.342	0.761	41	Yes	No
62001 (Teifi @ Glanteifi)	21.03	0.005	Yes	213.000	**211.917**	353.433	353.433	248977	248169	897.585	1379	0.463	0.995	64	Yes	Yes

QMED

Rural:	9.849 m³/s
Urban:	9.956 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

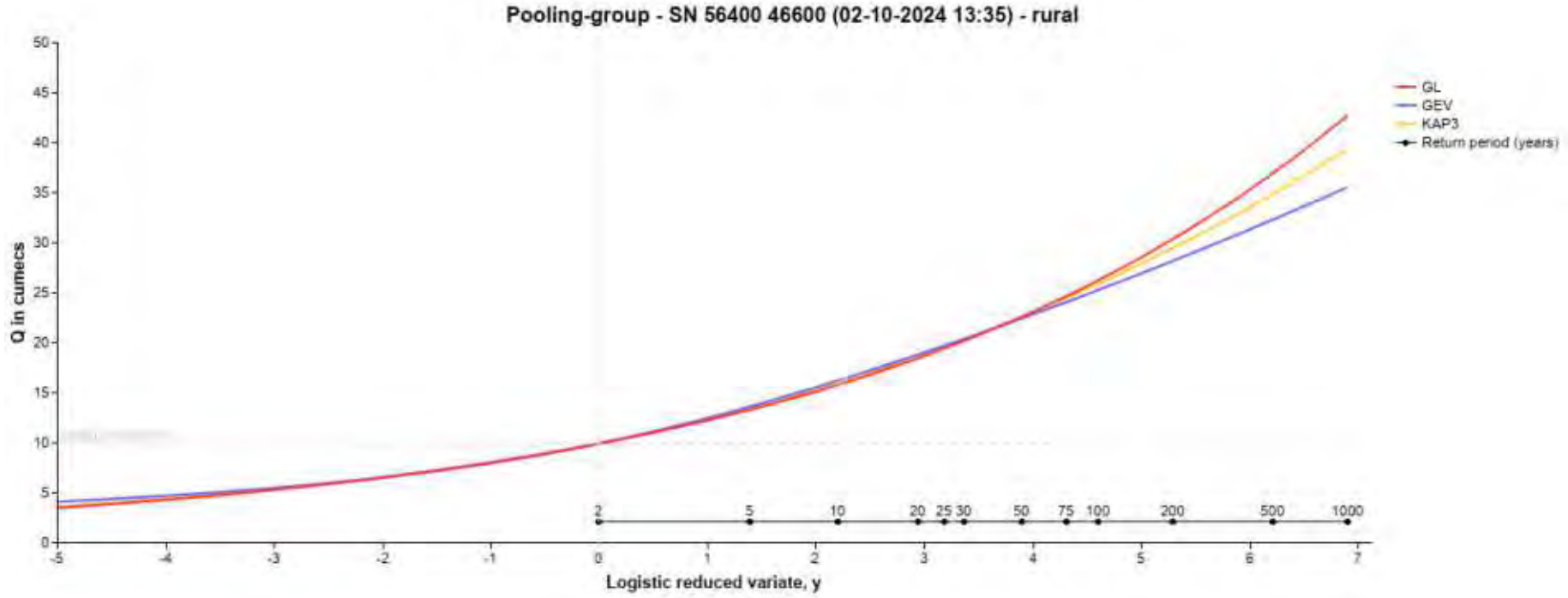
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	9.849	9.849	9.849
5	13.213	13.543	13.354
10	15.693	16.144	15.906
20	18.390	18.764	18.596
25	19.325	19.621	19.505
30	20.118	20.328	20.267
50	22.489	22.344	22.498
75	24.547	23.986	24.381
100	26.114	25.175	25.782
200	30.291	28.128	29.401
500	36.830	32.237	34.773
1000	42.689	35.512	39.340

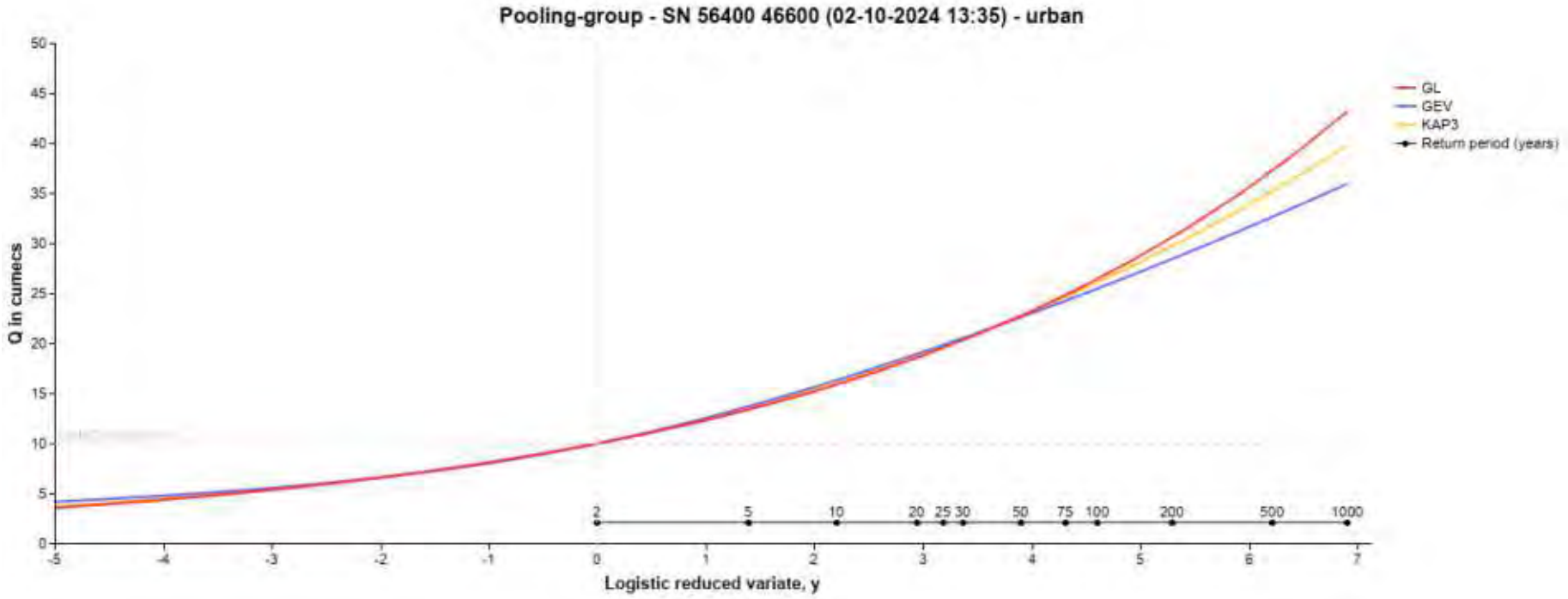
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	9.956	9.956	9.956
5	13.334	13.665	13.476
10	15.831	16.285	16.045
20	18.550	18.928	18.757
25	19.494	19.794	19.676
30	20.294	20.508	20.445
50	22.688	22.549	22.700
75	24.770	24.212	24.605
100	26.354	25.418	26.024
200	30.584	28.417	29.694
500	37.215	32.600	35.151
1000	43.165	35.940	39.798



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

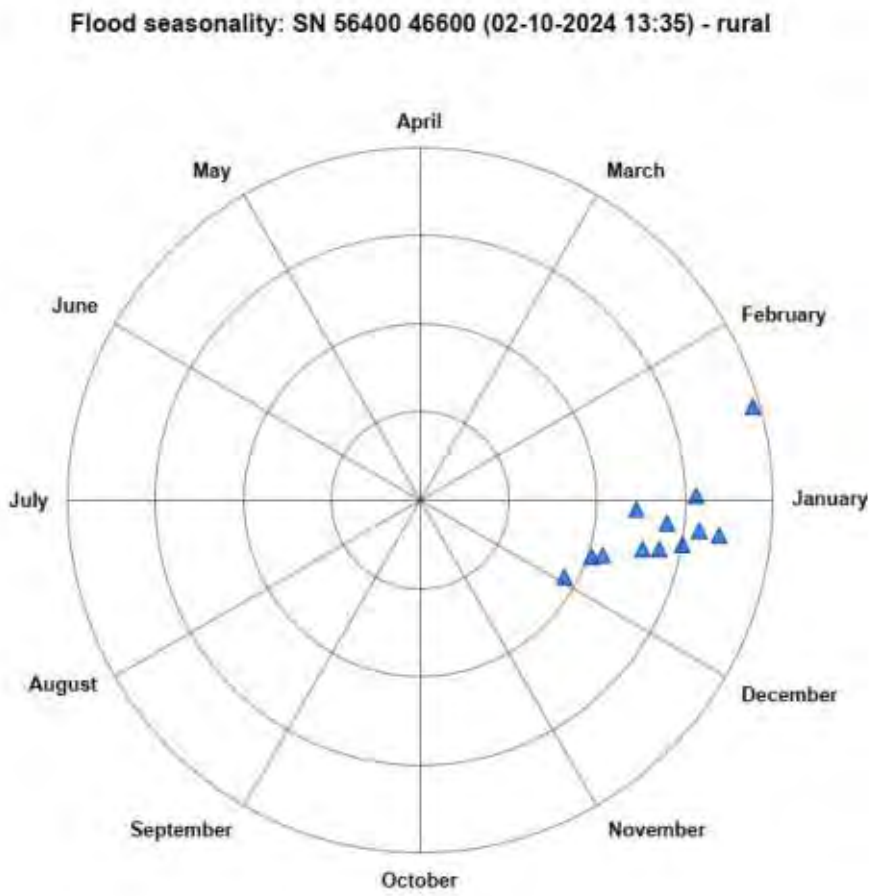


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

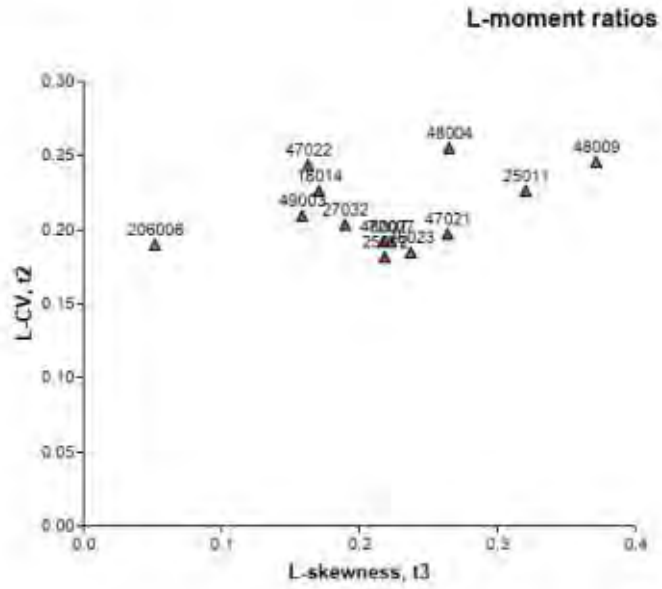


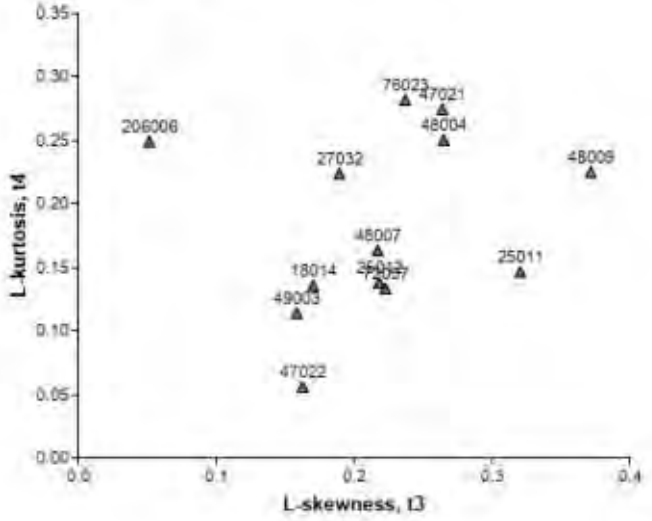
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

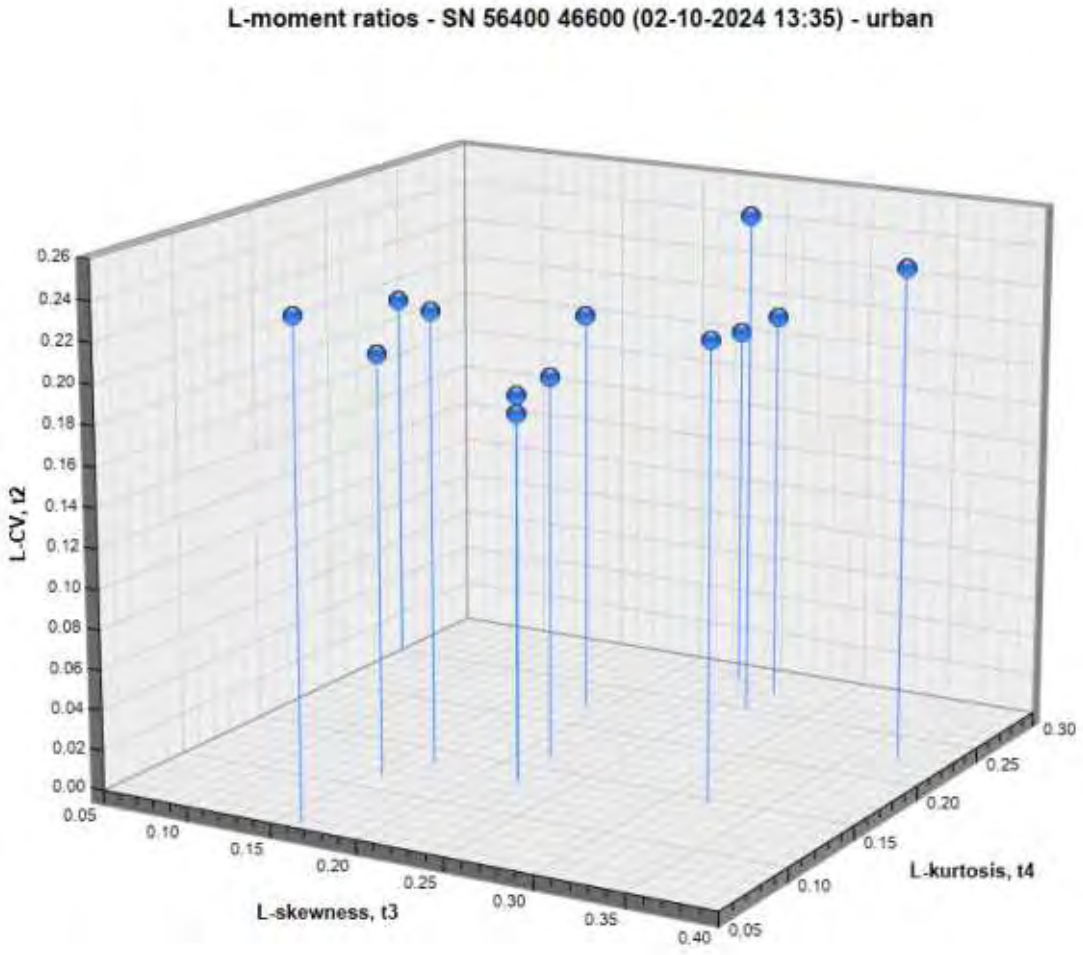
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method





UK Design Flood Estimation

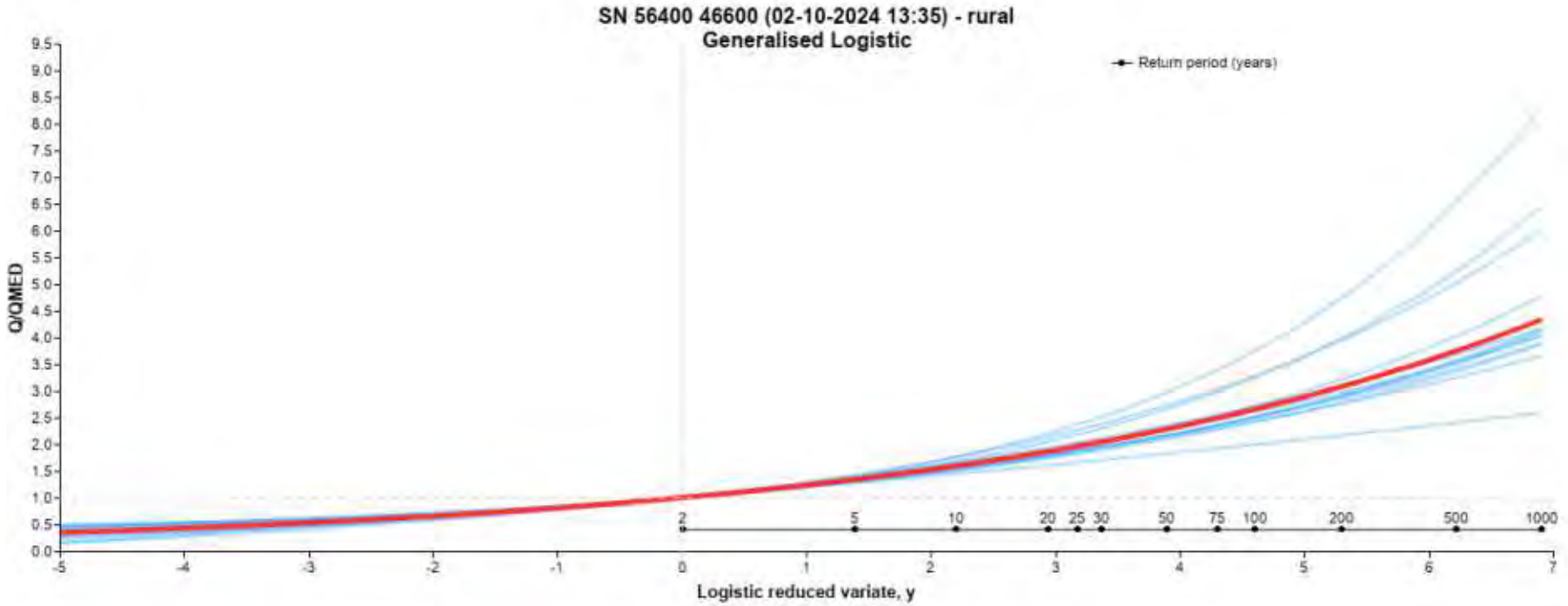
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

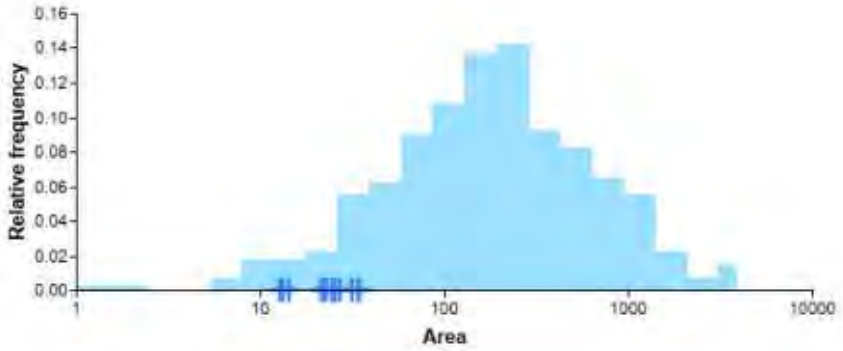
Pooling group growth curves

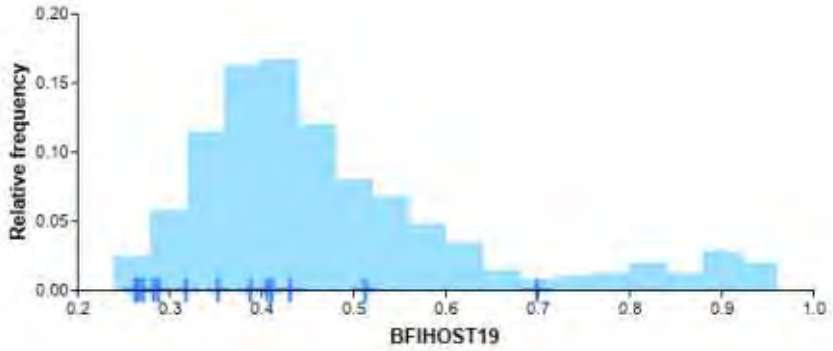


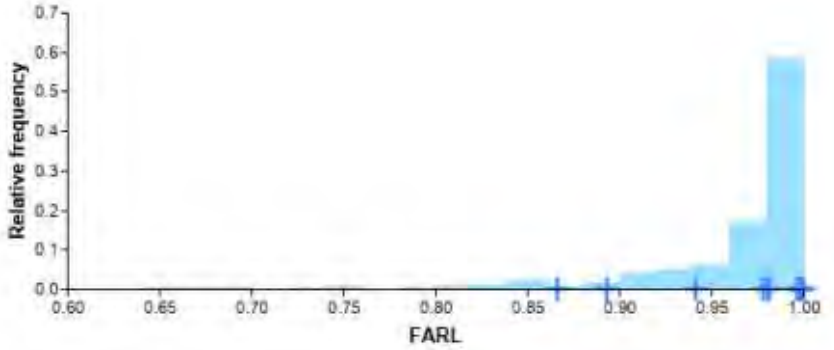
UK Design Flood Estimation

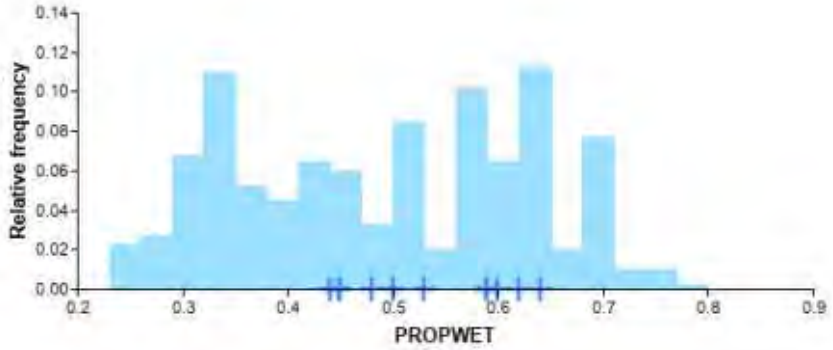
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



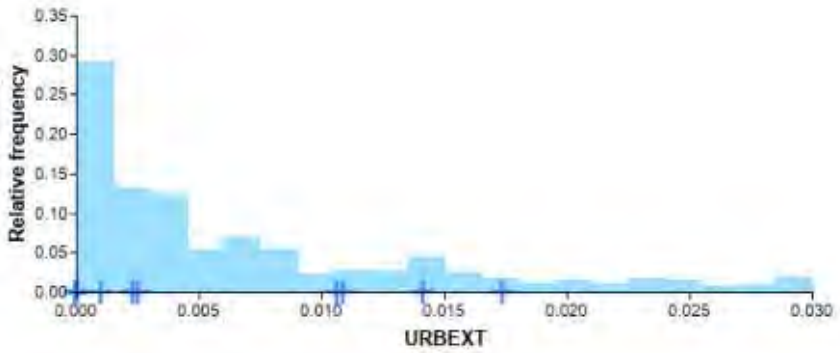


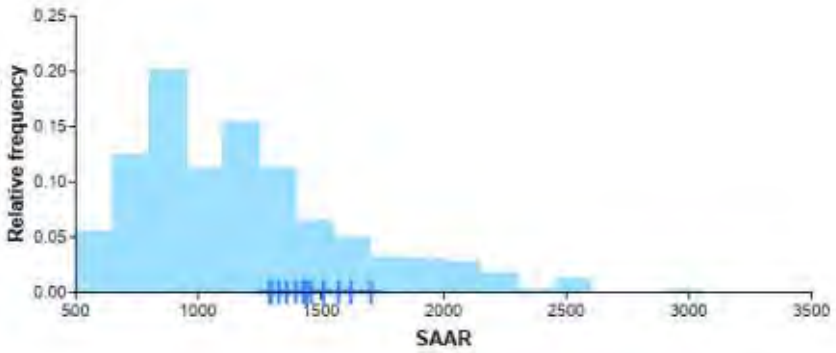


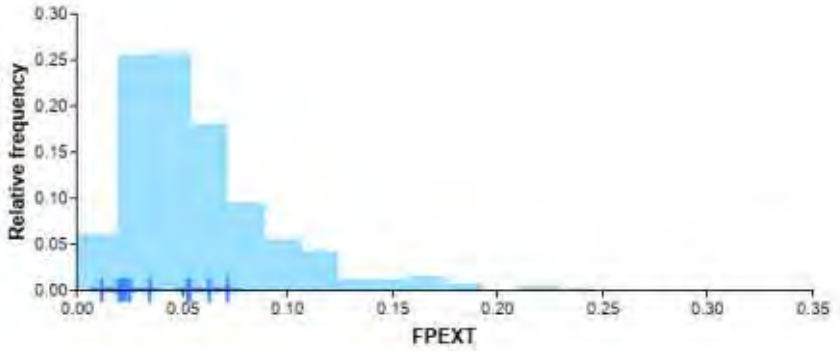


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Date of creation:	09-10-2024 09:40:11
Software:	WINFAP Version: 5.2.9014 (11448)
Peak Flow dataset:	Peak Flow Dataset 13.0.3
Supplementary data used:	No

Site details

Site number:	1044144519
Site name:	FEH_Catchment_Descriptors_259900_248800_v5_0_1
Site location:	SN 59900 48800
Easting:	259900
Northing:	248800
Catchment area:	250.80 km²
SAAR:	1438 mm
BFIHOST19:	0.405
FPEXT:	0.071
FARL:	0.988
URBEXT2000:	0.0021

Site data

At-site data

At-site data present: No

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Analysis settings

Urbanisation settings

User defined:	No
Urban area:	0.83 km²
PRimp:	70.00%
Impervious Factor:	0.300
UAF:	1.00207

Growth curve settings

Distance Measure Method:	Standard
Pooling group URBEXT2000 Threshold:	0.030
Deurbanise Pooling Group L-moments:	Yes

QMED settings

Use at-site data:	No
Method:	Donor Station(s)

Growth curve data and results

Pooling group AM data

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised
79005 (Cluden Water @ Fiddlers Ford)	0.129	60	108.468	0.151	**0.151**	0.265	**0.265**
71008 (Hodder @ Hodder Place)	0.299	54	222.340	0.162	**0.163**	0.210	**0.210**
84014 (Avon Water @ Fairholm)	0.301	59	162.681	0.173	**0.174**	0.128	**0.126**
76022 (Caldew @ Cummersdale)	0.344	26	156.751	0.191	**0.191**	0.212	**0.211**
76021 (Eden @ Great Musgrave Bridge)	0.397	23	180.155	0.192	**0.192**	0.194	**0.193**
8013 (Feshie @ Feshie Bridge)	0.419	31	116.085	0.162	**0.162**	0.298	**0.298**
72005 (Lune @ Killington)	0.428	54	271.444	0.191	**0.192**	0.122	**0.121**
73005 (Kent @ Sedgwick)	0.428	55	165.082	0.214	**0.216**	0.275	**0.271**
54038 (Tanat @ Llanyblodwel)	0.440	50	79.320	0.159	**0.159**	0.193	**0.193**
60013 (Cothi @ Pont Ynys Brechfa)	0.443	10	122.902	0.207	**0.207**	0.256	**0.256**
27035 (Aire @ Kildwick Bridge)	0.464	54	57.618	0.183	**0.185**	0.414	**0.410**
84040 (Clyde @ Abington)	0.466	18	142.586	0.214	**0.214**	0.242	**0.242**
201005 (Camowen @ Camowen Terrace)	0.468	51	89.663	0.170	**0.170**	0.383	**0.383**
Total		**545**					

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Pooling group suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MK)	MK significance (%)	Discordancy	Comments
79005 (Cluden Water @ Fiddlers Ford)	Yes	Yes	60	0	0.00	1.24	None	1.401	
71008 (Hodder @ Hodder Place)	Yes	Yes	54	1	1.85	0.62	None	1.144	
84014 (Avon Water @ Fairholm)	Yes	Yes	59	0	0.00	0.44	None	0.782	
76022 (Caldew @ Cummersdale)	Yes	Yes	26	1	3.85			0.112	
76021 (Eden @ Great Musgrave Bridge)	Yes	Yes	23	1	4.35			0.238	
8013 (Feshie @ Feshie Bridge)	Yes	Yes	31	0	0.00	1.44	None	0.449	
72005 (Lune @ Killington)	Yes	Yes	54	2	3.70	3.01	5	1.652	
73005 (Kent @ Sedgwick)	Yes	Yes	55	0	0.00	3.56	5	1.133	
54038 (Tanat @ Llanyblodwel)	Yes	Yes	50	0	0.00	1.53	None	0.949	
60013 (Cothi @ Pont Ynys Brechfa)	Yes	Yes	10	0	0.00			0.675	
27035 (Aire @ Kildwick Bridge)	Yes	Yes	54	0	0.00	3.04	5	1.541	
84040 (Clyde @ Abington)	Yes	Yes	18	0	0.00			1.746	
201005 (Camowen @ Camowen Terrace)	Yes	Yes	51	0	0.00	1.97	5	1.179	

Pooling group catchment descriptors

Station	Area	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
79005 (Cluden Water @ Fiddlers Ford)	237.225	1422	0.062	0.985	0.001	0.468
71008 (Hodder @ Hodder Place)	258.150	1602	0.055	0.970	0.002	0.328
84014 (Avon Water @ Fairholm)	263.067	1264	0.057	0.986	0.010	0.384
76022 (Caldew @ Cummersdale)	249.697	1211	0.078	0.998	0.002	0.415
76021 (Eden @ Great Musgrave Bridge)	223.025	1270	0.047	0.997	0.004	0.414
8013 (Feshie @ Feshie Bridge)	229.627	1286	0.041	0.993	0.000	0.385
72005 (Lune @ Killington)	219.235	1670	0.048	0.995	0.002	0.390
73005 (Kent @ Sedgwick)	212.240	1726	0.074	0.976	0.018	0.467
54038 (Tanat @ Llanyblodwel)	241.125	1274	0.038	0.996	0.001	0.427
60013 (Cothi @ Pont Ynys Brechfa)	243.005	1538	0.034	0.997	0.001	0.439
27035 (Aire @ Kildwick Bridge)	283.392	1151	0.073	0.977	0.019	0.362
84040 (Clyde @ Abington)	251.805	1540	0.043	0.937	0.001	0.320
201005 (Camowen @ Camowen Terrace)	276.382	1144	0.080	0.989	0.003	0.415

Pooling Group Rejected Stations

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Comments
71011 (Ribble @ Arnford)	0.432	53	121.978	0.068	0.069	-0.008	-0.009	Removed due to negative l-skew

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Growth curve L-moments

Rural L-CV:	0.180	Urban L-CV:	0.180
Rural L-Skewness:	0.244	Urban L-Skewness:	0.244

Rural fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.175	-0.244		0.280
GEV	0.906	0.251	-0.112		-1.340
KAP3	0.952	0.209	-0.184	-0.400	-0.179

Urban fitted parameters

Distribution	Location	Scale	Shape	H	Bound
GL	1.000	0.175	-0.244		0.283
GEV	0.906	0.250	-0.112		-1.325
KAP3	0.952	0.208	-0.185	-0.400	-0.175

Goodness of fit

GL:	0.8793 *
GEV:	-0.6324 *
P3:	-2.5271
GP:	-4.3461
KAP3:	0.3672 *

** Distribution gives an acceptable fit (absolute Z value < 1.645)*

Heterogeneity

Standardised test value H2: 0.5252

The pooling group is acceptably homogeneous and a review of the pooling group is not required.

Standardised growth curves

Rural

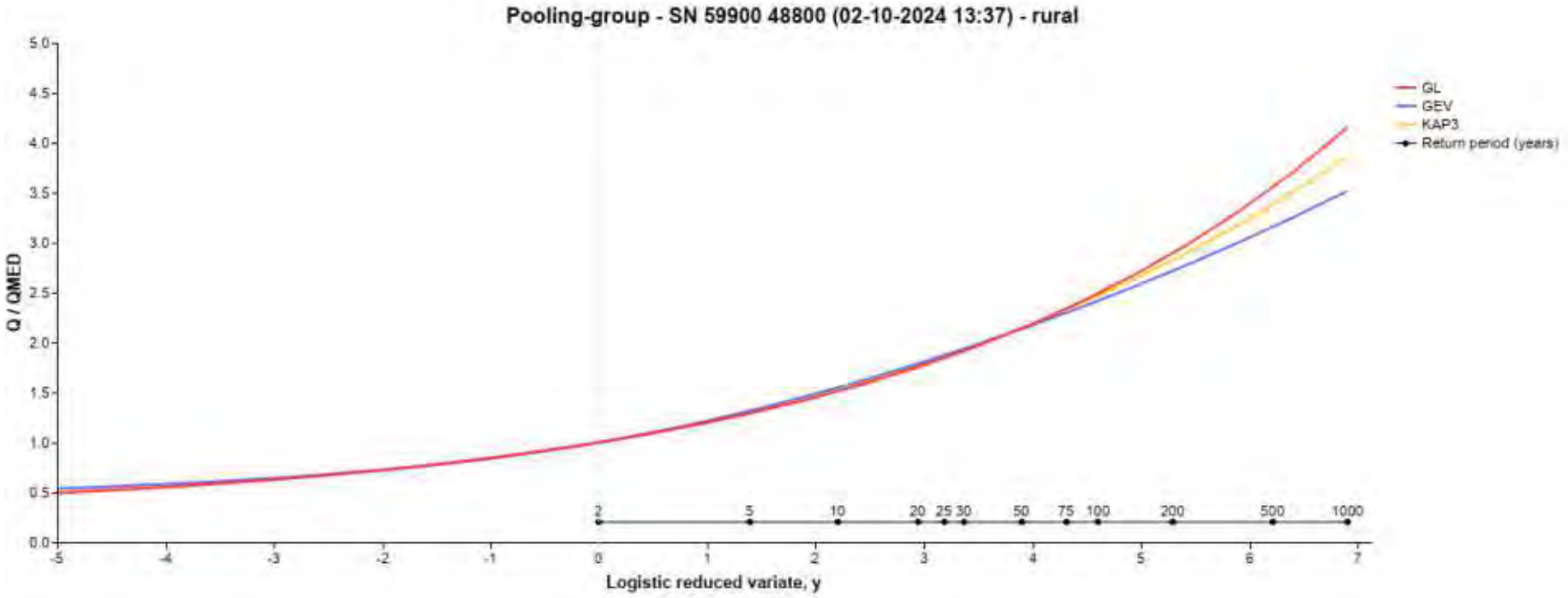
Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.289	1.316	1.300
10	1.510	1.548	1.528
20	1.756	1.790	1.774
25	1.842	1.871	1.859
30	1.916	1.938	1.930
50	2.139	2.133	2.143
75	2.335	2.296	2.325
100	2.486	2.415	2.463
200	2.896	2.719	2.825
500	3.553	3.157	3.379
1000	4.156	3.519	3.865

Urban

Return period	GL	GEV	KAP3
2	1.000	1.000	1.000
5	1.289	1.315	1.300
10	1.509	1.548	1.527
20	1.755	1.789	1.773
25	1.841	1.870	1.858
30	1.915	1.937	1.929
50	2.138	2.133	2.142
75	2.334	2.295	2.324
100	2.486	2.415	2.462
200	2.895	2.718	2.824
500	3.552	3.157	3.379
1000	4.156	3.520	3.866

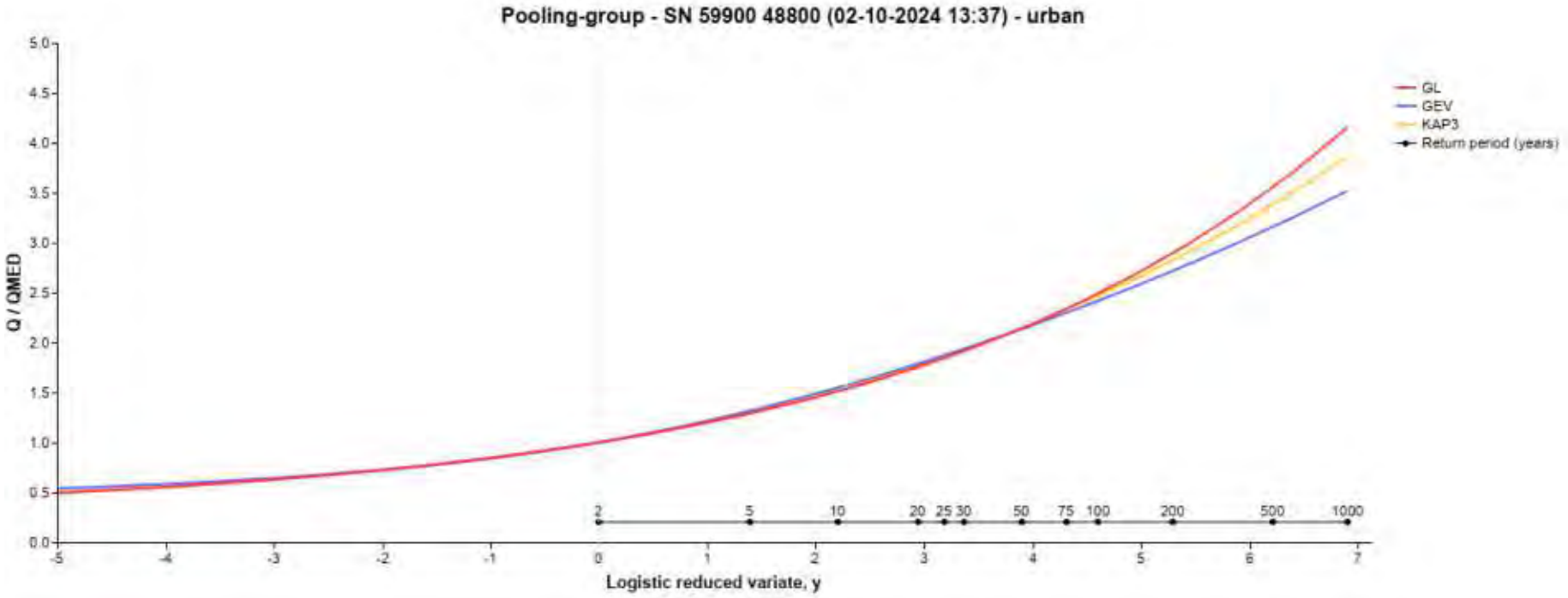
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

QMED data and results

Donor selection criteria

Only sites suitable for QMED:	Yes
URBEXT2000:	<0.030
Donor adjusted FSE:	1.348
No. of donors:	2

Donor stations

Station	Distance	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural
62003 (Teifi @ Pont Llanio)	3.75	Yes	40.600	**40.513**	107.335	107.335
62002 (Teifi @ Llanfair)	11.61	Yes	138.800	**138.261**	233.987	233.987

Donor suitability

Station	Suitability for QMED	Suitability for pooling	Years	Non-flood years	Percentage non-flood years	Mann Kendall (MKZ)	MKZ significance (%)	Comments
62003 (Teifi @ Pont Llanio)	Yes	No	25	0	0.00			
62002 (Teifi @ Llanfair)	Yes	No	33	0	0.00			

Donor catchment descriptors

Station	Area	Centroid X	Centroid Y	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19
*FEH_Catchment_Descriptors_259900_248800_v5_0_1 @ SN 59900 48800)	250.805	269333	260513	1438	0.071	0.988	0.002	0.405
62003 (Teifi @ Pont Llanio)	175.385	271146	263799	1448	0.075	0.983	0.002	0.397
62002 (Teifi @ Llanfair)	517.582	259932	253697	1392	0.062	0.993	0.004	0.445

Unused Donor stations

Station	Distance	URBEXT	Use QMED obs deurbanised	QMED obs	QMED deurbanised	QMED CDs urban	QMED CDs rural	Centroid X	Centroid Y	Area	SAAR	BFIHOST19	FARL	Years of data	QMED suitability	Pooling suitability
60007 (Tywi @ Dolau Hirion)	12.65	0.000	Yes	151.454	**151.425**	135.688	135.688	276709	250235	220.278	1685	0.381	0.933	50	Yes	No
63003 (Wyre @ Llanrhystud)	12.86	0.002	Yes	20.080	**20.043**	22.323	22.323	259934	269294	40.550	1182	0.433	1.000	12	Yes	No
60012 (Twrch @ Ddol Las)	12.97	0.002	Yes	15.270	**15.235**	19.662	19.662	266417	247870	19.495	1531	0.379	1.000	45	Yes	No
63001 (Ystwyth @ Pont Llolwyn)	13.96	0.001	Yes	94.514	**94.398**	99.230	99.230	271973	274219	170.100	1456	0.430	0.990	62	Yes	Yes
55004 (Irfon @ Abernant)	17.45	0.003	Yes	56.542	**56.375**	80.866	80.866	284963	252747	73.013	1845	0.342	1.000	45	Yes	Yes
55032 (Elan @ Caban Dam)	18.36	0.000	Yes	120.200	**120.200**	68.461	68.461	286480	267070	183.775	1825	0.342	0.761	41	Yes	No
60013 (Cothi @ Pont Ynys Brechfa)	21.98	0.001	Yes	122.902	**122.787**	143.995	143.995	262038	239781	243.005	1538	0.439	0.997	10	Yes	Yes
55012 (Irfon @ Cilmery)	22.57	0.002	Yes	191.021	**190.659**	180.890	180.890	289404	250198	246.657	1627	0.380	0.997	54	Yes	No

QMED

Rural:	83.439 m³/s
Urban:	83.612 m³/s

UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

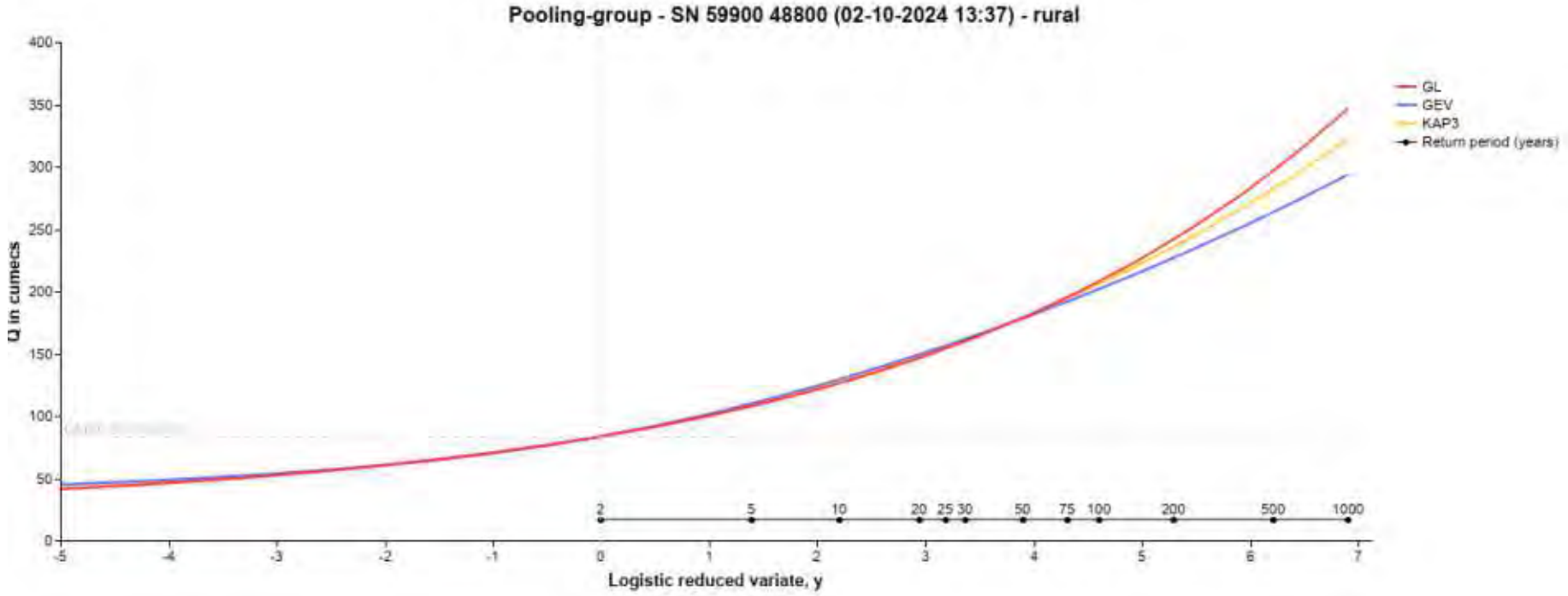
Flood Frequency Curve

Rural Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	83.439	83.439	83.439
5	107.582	109.795	108.504
10	125.984	129.174	127.455
20	146.481	149.354	148.001
25	153.694	156.101	155.076
30	159.846	161.719	161.047
50	178.458	178.003	178.777
75	194.850	191.547	194.003
100	207.457	201.513	205.485
200	241.608	226.834	235.709
500	296.421	263.398	281.975
1000	346.758	293.629	322.510

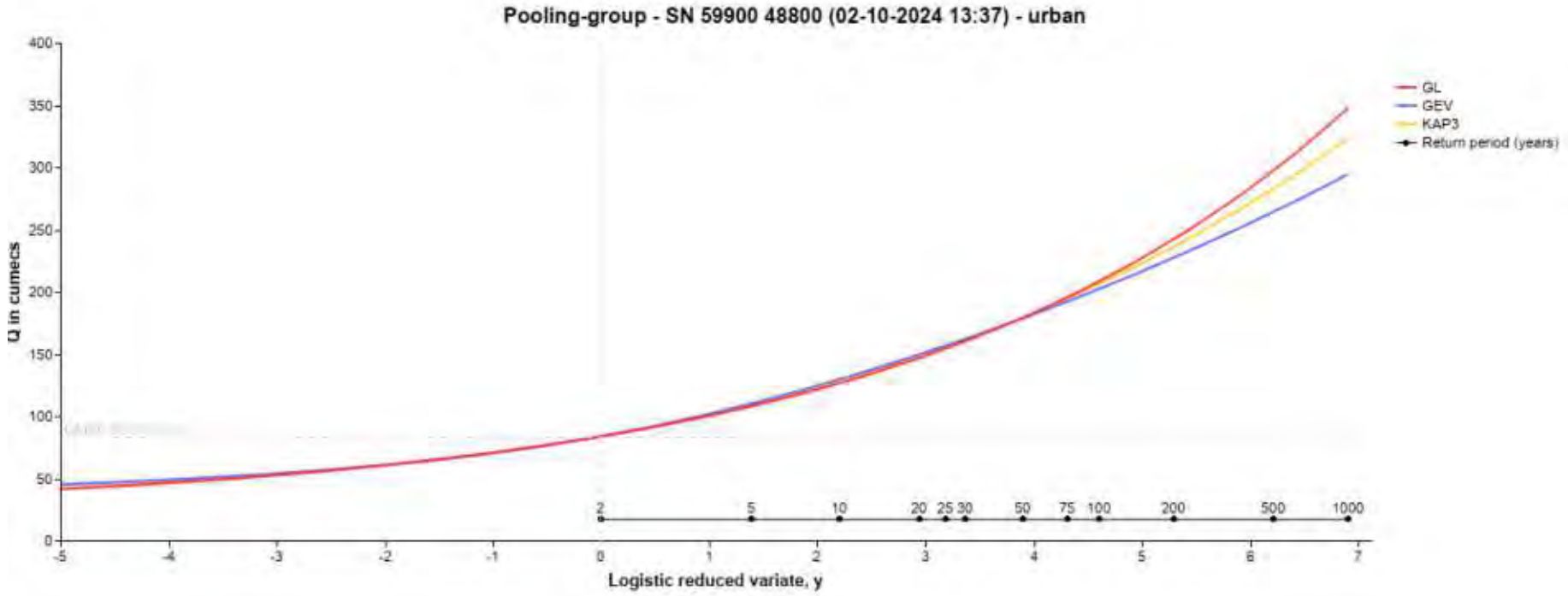
Urban Flood Frequency Curve

Return period	GL (m³/s)	GEV (m³/s)	KAP3 (m³/s)
2	83.612	83.612	83.612
5	107.775	109.988	108.696
10	126.199	129.391	127.670
20	146.727	149.604	148.248
25	153.952	156.364	155.336
30	160.114	161.994	161.318
50	178.762	178.314	179.084
75	195.188	191.891	194.344
100	207.823	201.885	205.854
200	242.055	227.281	236.159
500	297.016	263.969	282.564
1000	347.505	294.316	323.237



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

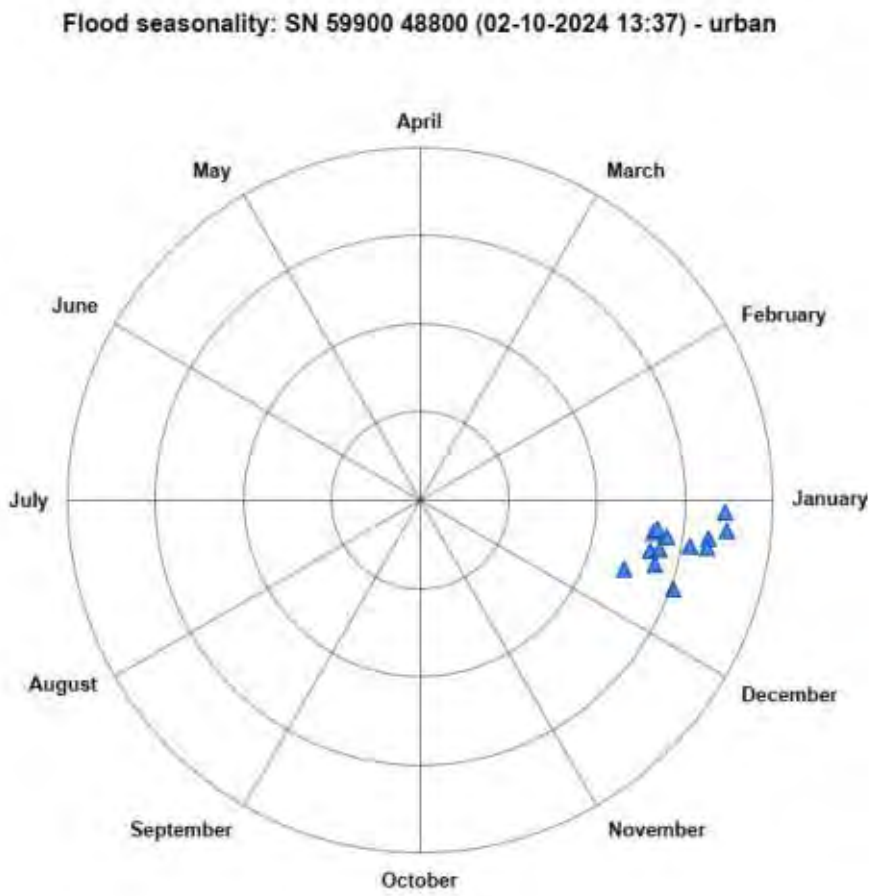


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Appendix

Station record parameters

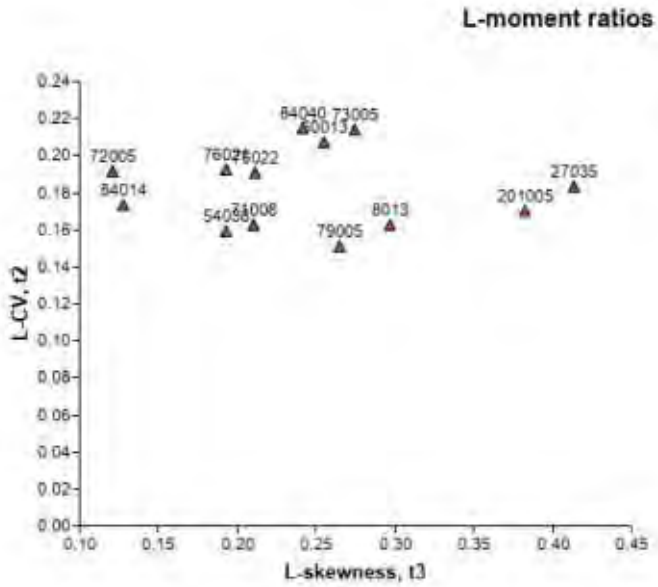


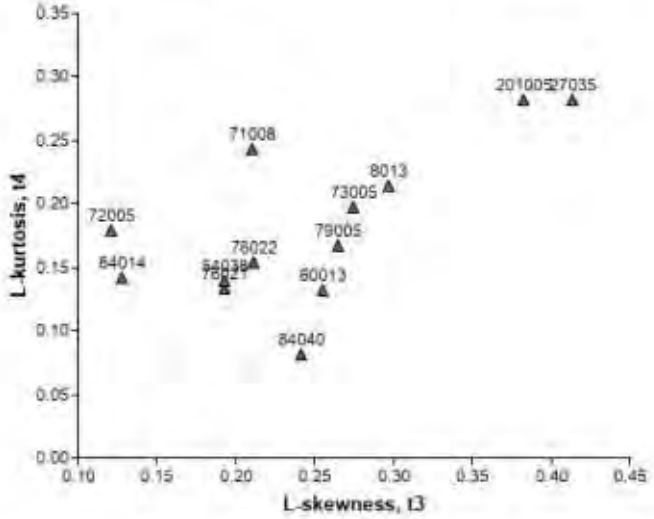
UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

UK Design Flood Estimation

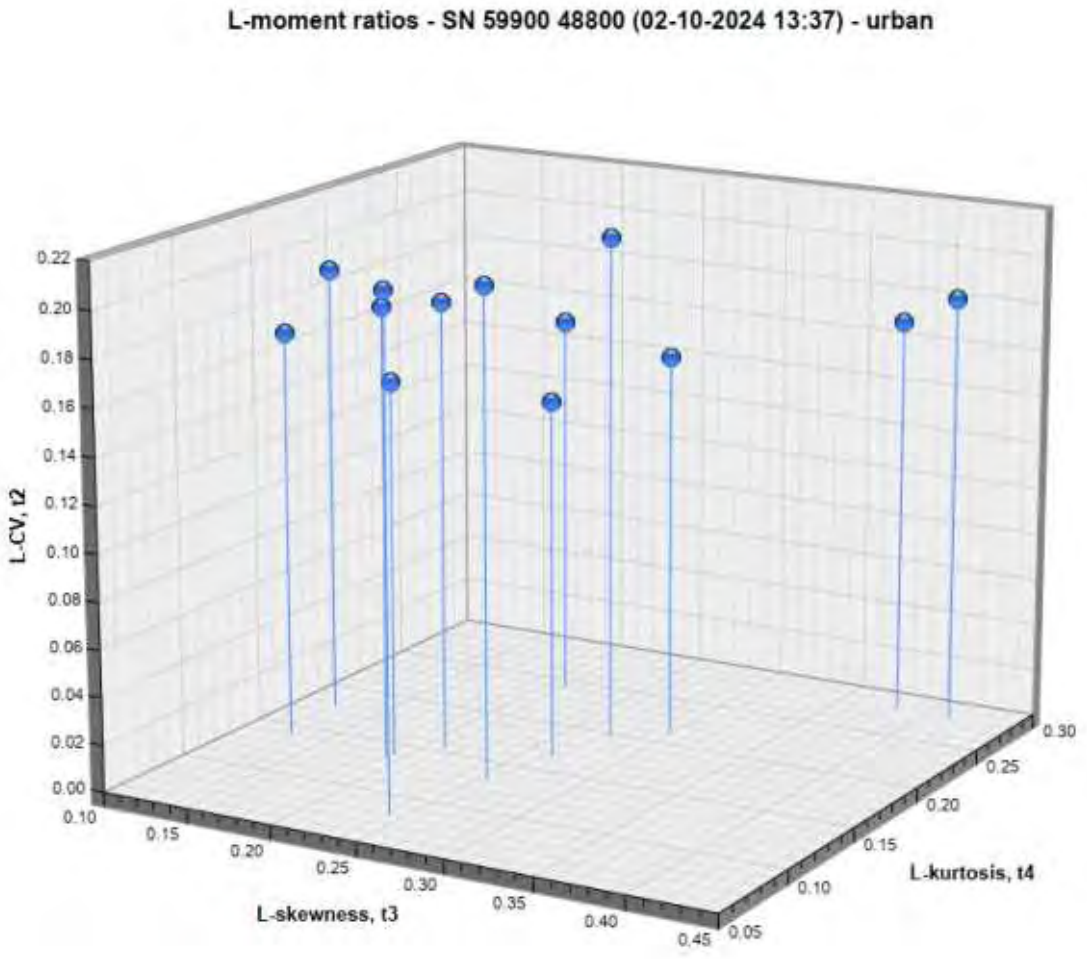
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method





UK Design Flood Estimation

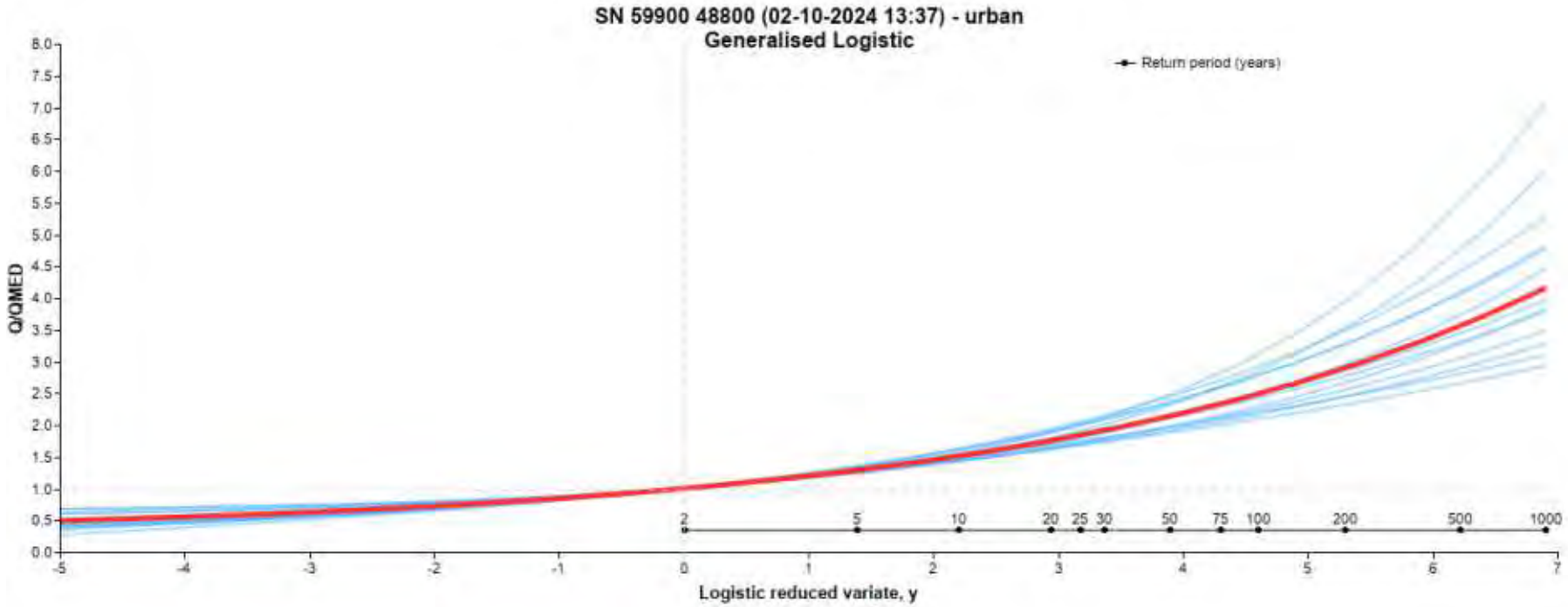
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method



UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

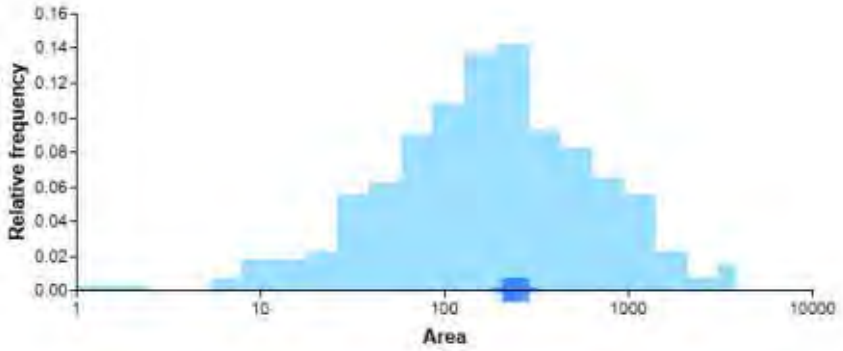
Pooling group growth curves

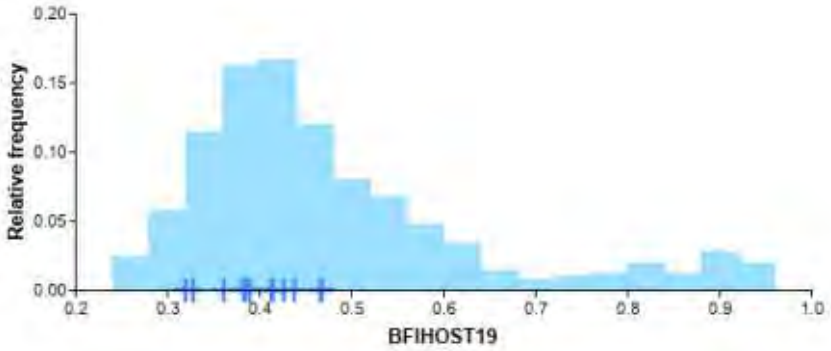


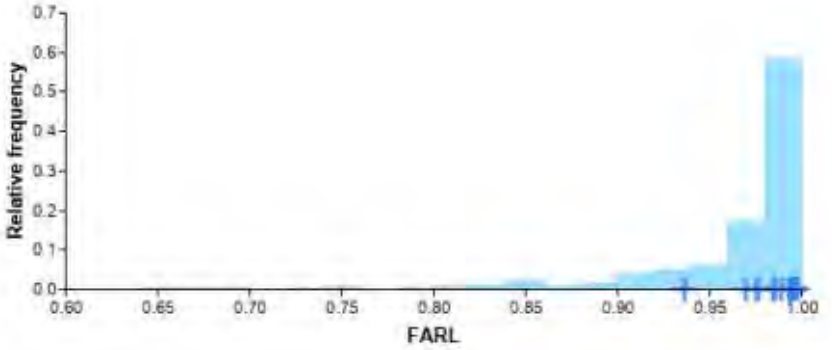
UK Design Flood Estimation

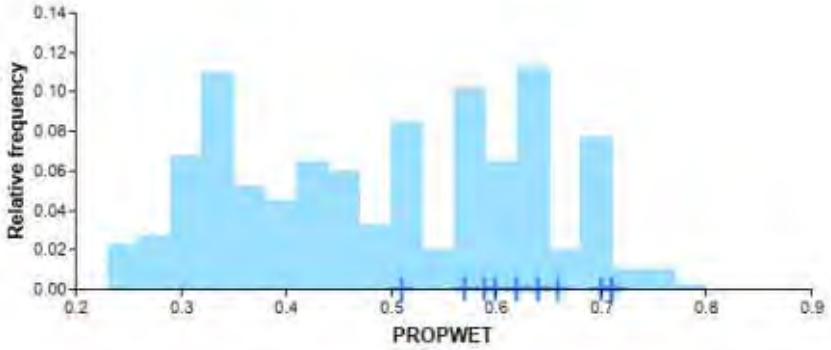
Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method

Catchment descriptors



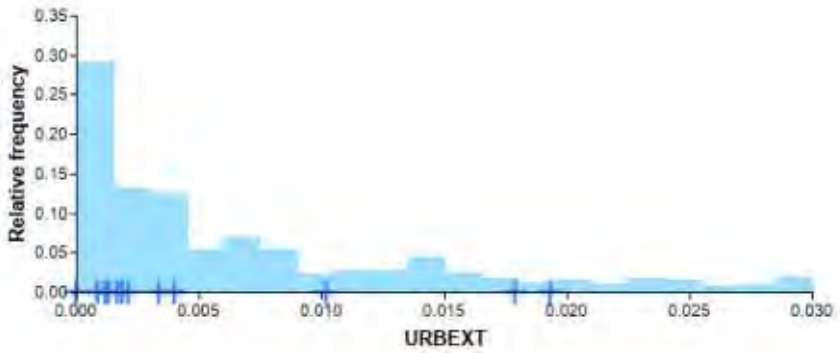


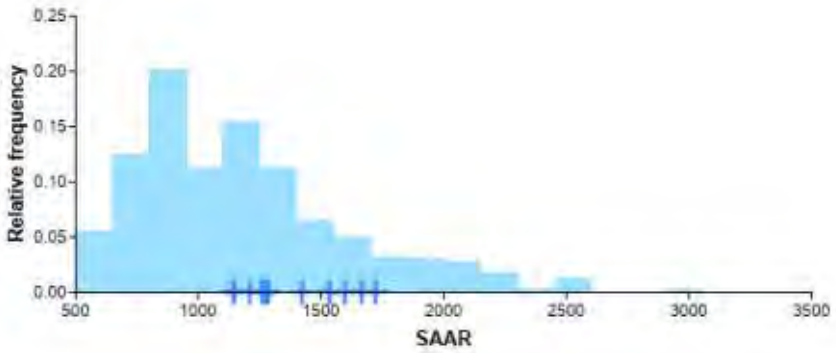


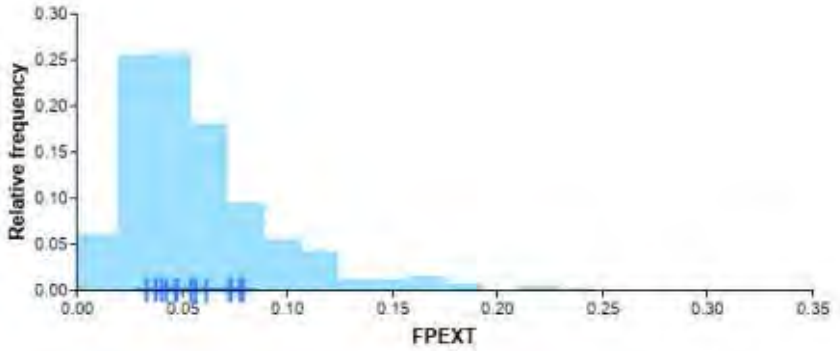


UK Design Flood Estimation

Summary of ESS/Pooled Estimation Analysis using the Flood Estimation Handbook Statistical Method







WHS Non-Flood Years Spreadsheet

Project / Site Name

PeakFlow Dataset Location C:\Users\HerringtonConsulting\Downloads\NRFAPeakFlow_v13-0-2\suitable-for-pooling

Pooling Group

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Station No	URBEXT2000	L-CVAdj	L-CVAdj (Deurban)	L-SKEWadj	L-SKEWadj (Deurban)	k (Shape)	Beta (Scale)	Notes and Warnings.
28033 (Dove @ Hollinsclough)	0.273	48	4.138	0.235	0.235	0.367	0.367	28033	0.0000	0.228	0.228	0.397	0.397	-0.397	0.201	
45816 (Haddeo @ Upton)	0.331	30	3.352	0.288	0.289	0.408	0.407	45816	0.0050	0.283	0.284	0.422	0.421	-0.421	0.253	
47022 (Tory Brook @ Newnham Park)	0.386	28	6.134	0.243	0.245	0.163	0.16	47022	0.0141	0.242	0.244	0.156	0.154	-0.154	0.249	
25011 (Langdon Beck @ Langdon)	0.471	37	15.647	0.225	0.225	0.321	0.321	25011	0.0010	0.225	0.225	0.321	0.321	-0.321	0.213	
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	0.649	13	4.072	0.274	0.275	0.295	0.294	49005	0.0060	0.274	0.275	0.295	0.294	-0.294	0.272	
27032 (Hebden Beck @ Hebden)	0.728	55	4.052	0.203	0.203	0.19	0.19	27032	0.0000	0.192	0.192	0.231	0.231	-0.231	0.189	
18014 (Bannock Burn @ Bannockburn)	0.748	31	15.727	0.226	0.227	0.171	0.169	18014	0.0109	0.222	0.223	0.174	0.172	-0.172	0.227	
48007 (Kennal @ Ponsanooth)	0.779	55	4.18	0.192	0.193	0.217	0.215	48007	0.0106	0.186	0.187	0.242	0.240	-0.240	0.183	***BFIHOST19 >=0.65.***
48004 (Warleggan @ Trengoffe)	0.827	54	9.865	0.254	0.254	0.266	0.265	48004	0.0025	0.241	0.242	0.297	0.296	-0.296	0.235	
48009 (St Neot @ Craigshill Wood)	0.836	12	8.465	0.245	0.245	0.373	0.372	48009	0.0023	0.245	0.245	0.373	0.372	-0.372	0.224	
27010 (Hodge Beck @ Bransdale Weir)	0.852	41	9.42	0.224	0.224	0.293	0.293	27010	0.0007	0.220	0.220	0.306	0.306	-0.306	0.210	
72014 (Conder @ Galgate)	0.853	55	16.912	0.23	0.231	0.143	0.142	72014	0.0064	0.215	0.216	0.165	0.164	-0.164	0.219	
73015 (Keer @ High Keer Weir)	0.895	33	12.421	0.204	0.205	0.189	0.189	73015	0.0029	0.198	0.198	0.214	0.213	-0.213	0.197	
206006 (Annalong @ Recorder)	0.914	48	15.33	0.189	0.189	0.052	0.052	206006	0.0000	0.161	0.161	0.164	0.164	-0.164	0.161	
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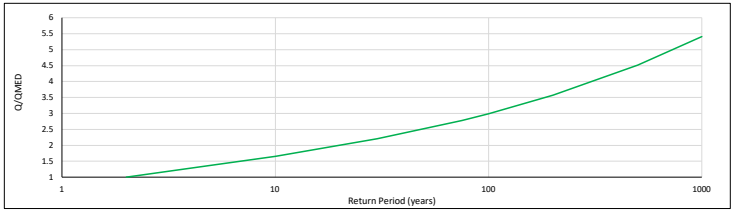
URBAN	**0.00**
URBEXT2000	0.0028

Deurbanise pooling group L-moments	Yes

SPECIFY TARGET RETURN PERIODS	**2**	**5**	**10**	**30**	**75**	**100**	**200**	**500**	**1000**
	1.000	**1.369**	**1.658**	**2.203**	**2.781**	**2.992**	**3.571**	**4.519**	**5.408**

Final Non-Flood Yr Adjusted Growth Curve

Pooled L-CV	0.224
Pooled L-Skew	0.268



WHS Non-Flood Years Spreadsheet

Project / Site Name

PeakFlow Dataset Location C:\Users\HerringtonConsulting\Downloads\NRFAPeakFlow_v13-0-2\suitable-for-pooling

Pooling Group

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Station No	URBEXT2000	L-CVAdj	L-CVAdj (Deurban)	L-SKEWadj	L-SKEWadj (Deurban)	k (Shape)	Beta (Scale)	Notes and Warnings.
72007 (Brock @ upstream of A6)	0.197	45	28.972	0.191	0.191	0.223	0.223	72007	0.0000	0.191	0.191	0.223	0.223	-0.223	0.189	
73015 (Keer @ High Keer Weir)	0.31	33	12.421	0.204	0.205	0.189	0.189	73015	0.0029	0.198	0.198	0.214	0.213	-0.213	0.197	
72014 (Conder @ Galgate)	0.36	55	16.912	0.23	0.231	0.143	0.142	72014	0.0064	0.215	0.216	0.165	0.164	-0.164	0.219	
76023 (Dacre Beck @ Dacre Bridge)	0.39	23	35.266	0.184	0.184	0.238	0.238	76023	0.0000	0.172	0.172	0.302	0.302	-0.302	0.160	
48004 (Warleggan @ Trengoffe)	0.396	54	9.865	0.254	0.254	0.266	0.265	48004	0.0025	0.241	0.242	0.297	0.296	-0.296	0.235	
47021 (Kensey @ Launceston Newport)	0.455	21	13.8	0.197	0.199	0.265	0.262	47021	0.0174	0.197	0.199	0.265	0.262	-0.262	0.193	
47009 (Tiddy @ Tideford)	0.504	54	6.89	0.198	0.199	0.208	0.206	47009	0.0107	0.191	0.192	0.238	0.236	-0.236	0.188	
28041 (Hamps @ Waterhouses)	0.517	38	26.313	0.213	0.214	0.284	0.283	28041	0.0045	0.202	0.202	0.329	0.328	-0.328	0.188	
27032 (Hebden Beck @ Hebden)	0.573	55	4.052	0.203	0.203	0.19	0.19	27032	0.0000	0.192	0.192	0.231	0.231	-0.231	0.189	
24006 (Rookhope Burn @ Eastgate)	0.573	20	24.62	0.152	0.152	0.117	0.117	24006	0.0001	0.152	0.152	0.117	0.117	-0.117	0.153	
48009 (St Neot @ Craigshill Wood)	0.59	12	8.465	0.245	0.245	0.373	0.372	48009	0.0023	0.245	0.245	0.373	0.372	-0.372	0.224	
25012 (Harwood Beck @ Harwood)	0.605	54	33.426	0.181	0.181	0.219	0.219	25012	0.0000	0.181	0.181	0.219	0.219	-0.219	0.178	
49003 (De Lank @ De Lank)	0.638	57	14.299	0.209	0.209	0.158	0.158	49003	0.0000	0.209	0.209	0.158	0.158	-0.158	0.212	
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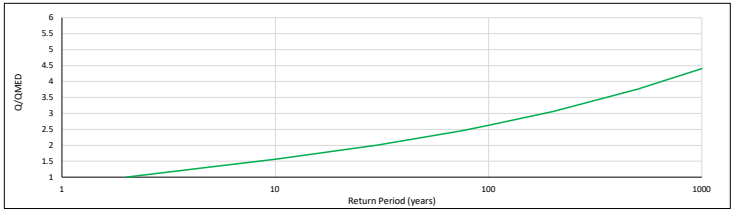
URBAN	**0.01**
URBEXT2000	0.0054

Deurbanise pooling group L-moments	Yes

SPECIFY TARGET RETURN PERIODS	**2**	**5**	**10**	**30**	**75**	**100**	**200**	**500**	**1000**
	1.000	**1.321**	**1.563**	**2.006**	**2.461**	**2.624**	**3.064**	**3.766**	**4.406**

Final Non-Flood Yr Adjusted Growth Curve

Pooled L-CV	0.199
Pooled L-Skew	0.236



WHS Non-Flood Years Spreadsheet

Project / Site Name

PeakFlow Dataset Location C:\Users\HerringtonConsulting\Downloads\NRFAPeakFlow_v13-0-2\suitable-for-pooling

Pooling Group

Station	Distance	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SKEW Observed	L-SKEW Deurbanised	Station No	URBEXT2000	L-CVAdj	L-CVAdj (Deurban)	L-SKEWadj	L-SKEWadj (Deurban)	k (Shape)	Beta (Scale)	Notes and Warnings.
79005 (Cluden Water @ Fiddlers Ford)	0.129	60	108.468	0.151	0.151	0.265	0.265	79005	0.0012	0.151	0.151	0.265	0.265	-0.265	0.143	
71008 (Hodder @ Hodder Place)	0.299	54	222.34	0.162	0.163	0.21	0.21	71008	0.0021	0.156	0.156	0.246	0.246	-0.246	0.151	
84014 (Avon Water @ Fairholm)	0.301	59	162.681	0.173	0.174	0.128	0.126	84014	0.0102	0.173	0.174	0.128	0.126	-0.126	0.176	
76022 (Caldew @ Cummersdale)	0.344	26	156.751	0.191	0.191	0.212	0.211	76022	0.0017	0.182	0.183	0.247	0.247	-0.247	0.178	
76021 (Eden @ Great Musgrave Bridge)	0.397	23	180.155	0.192	0.192	0.194	0.193	76021	0.0040	0.179	0.179	0.253	0.253	-0.253	0.174	
8013 (Feshie @ Feshie Bridge)	0.419	31	116.085	0.162	0.162	0.298	0.298	8013	0.0000	0.162	0.162	0.298	0.298	-0.298	0.151	
72005 (Lune @ Killington)	0.428	54	271.444	0.191	0.192	0.122	0.121	72005	0.0019	0.184	0.185	0.141	0.141	-0.141	0.187	
73005 (Kent @ Sedgwick)	0.428	55	165.082	0.214	0.216	0.275	0.271	73005	0.0179	0.214	0.216	0.275	0.271	-0.271	0.210	
54038 (Tanat @ Llanyblodwel)	0.44	50	79.32	0.159	0.159	0.193	0.193	54038	0.0009	0.159	0.159	0.193	0.193	-0.193	0.157	
60013 (Cothi @ Pont Ynys Brechfa)	0.443	10	122.902	0.207	0.207	0.256	0.256	60013	0.0009	0.207	0.207	0.256	0.256	-0.256	0.202	
27035 (Aire @ Kildwick Bridge)	0.464	54	57.618	0.183	0.185	0.414	0.41	27035	0.0193	0.183	0.185	0.414	0.410	-0.410	0.156	
84040 (Clyde @ Abington)	0.466	18	142.586	0.214	0.214	0.242	0.242	84040	0.0013	0.214	0.214	0.242	0.242	-0.242	0.211	
201005 (Camowen @ Camowen Terrace)	0.468	51	89.663	0.17	0.17	0.383	0.383	201005	0.0034	0.170	0.170	0.383	0.383	-0.383	0.146	
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URBAN	**0.00**
URBEXT2000	0.0021

Deurbanise pooling group L-moments	Yes

SPECIFY TARGET RETURN PERIODS	**2**	**5**	**10**	**30**	**75**	**100**	**200**	**500**	**1000**
	1.000	**1.285**	**1.505**	**1.914**	**2.343**	**2.498**	**2.921**	**3.606**	**4.241**

Final Non-Flood Yr Adjusted Growth Curve

Pooled L-CV	0.177
Pooled L-Skew	0.255

UK Design Flood Estimation

Generated on 24 September 2024 13:12:56 by HerringtonConsulting
Printed from the ReFH2 Flood Modelling software package, version 4.0.8560.23190

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 4474-2A5A

Site name: FEH_Catchment_Descriptors_257100_248650_v5_0_1

Easting: 257100

Northing: 248650

Country: England, Wales or Northern Ireland

Catchment Area (km²): 10.1

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH22 (mm):	93.01	Total runoff (ML):	263.81
Total Rainfall (mm):	72.83	Total flow (ML):	736.00
		Peak flow (m³/s):	9.81
Peak Rainfall (mm):	4.68		

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	20:30:00 [04:30:00]*	Yes
Timestep (hh:mm:ss)	00:30:00*	No
SCF (Seasonal correction factor)	0.85	No
ARF (Areal reduction factor)	0.92 [0.97]	Yes
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	94.04	No
Cmax (mm)	355.66	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.1	No
Up	0.65	No

Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.53	No
BL (hr)	36.57	No
BR	1.73	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.04	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.351	0.000	0.093	0.000	0.531	0.531
00:30:00	0.404	0.000	0.108	0.010	0.524	0.533
01:00:00	0.464	0.000	0.124	0.040	0.517	0.557
01:30:00	0.533	0.000	0.144	0.095	0.513	0.607
02:00:00	0.612	0.000	0.166	0.177	0.511	0.687
02:30:00	0.703	0.000	0.192	0.281	0.512	0.793
03:00:00	0.807	0.000	0.222	0.391	0.517	0.908
03:30:00	0.925	0.000	0.257	0.506	0.526	1.032
04:00:00	1.061	0.000	0.297	0.629	0.539	1.168
04:30:00	1.216	0.000	0.341	0.760	0.557	1.317
05:00:00	1.393	0.000	0.395	0.907	0.579	1.486
05:30:00	1.595	0.000	0.459	1.071	0.607	1.678
06:00:00	1.825	0.000	0.534	1.256	0.639	1.895
06:30:00	2.086	0.000	0.622	1.465	0.677	2.142
07:00:00	2.381	0.000	0.725	1.703	0.720	2.423
07:30:00	2.716	0.000	0.847	1.977	0.770	2.747
08:00:00	3.091	0.000	0.989	2.294	0.828	3.122
08:30:00	3.509	0.000	1.155	2.666	0.895	3.561
09:00:00	3.967	0.000	1.329	3.103	0.973	4.075
09:30:00	4.438	0.000	1.539	3.612	1.063	4.675
10:00:00	4.680	0.000	1.683	4.203	1.166	5.369
10:30:00	4.438	0.000	1.653	4.876	1.283	6.159
11:00:00	3.967	0.000	1.524	5.601	1.411	7.012
11:30:00	3.509	0.000	1.385	6.314	1.550	7.864
12:00:00	3.091	0.000	1.249	6.936	1.697	8.632
12:30:00	2.716	0.000	1.119	7.386	1.850	9.236
13:00:00	2.381	0.000	0.999	7.622	2.005	9.627
13:30:00	2.086	0.000	0.864	7.650	2.159	9.809
14:00:00	1.825	0.000	0.766	7.502	2.307	9.809
14:30:00	1.595	0.000	0.677	7.217	2.445	9.662
15:00:00	1.393	0.000	0.598	6.833	2.571	9.403
15:30:00	1.216	0.000	0.526	6.376	2.682	9.058
16:00:00	1.061	0.000	0.462	5.873	2.778	8.650
16:30:00	0.925	0.000	0.406	5.346	2.858	8.204
17:00:00	0.807	0.000	0.356	4.816	2.923	7.739
17:30:00	0.703	0.000	0.311	4.300	2.975	7.275
18:00:00	0.612	0.000	0.260	3.816	3.015	6.831
18:30:00	0.533	0.000	0.227	3.372	3.044	6.416
19:00:00	0.464	0.000	0.198	2.969	3.063	6.032
19:30:00	0.404	0.000	0.173	2.606	3.074	5.680
20:00:00	0.351	0.000	0.151	2.281	3.077	5.358
20:30:00	0.000	0.000	0.000	1.991	3.075	5.066
21:00:00	0.000	0.000	0.000	1.723	3.067	4.790
21:30:00	0.000	0.000	0.000	1.462	3.054	4.516

22:00:00	0.000	0.000	0.000	1.205	3.037	4.243
22:30:00	0.000	0.000	0.000	0.955	3.016	3.970
23:00:00	0.000	0.000	0.000	0.723	2.990	3.712
23:30:00	0.000	0.000	0.000	0.535	2.961	3.496
24:00:00	0.000	0.000	0.000	0.387	2.929	3.316
24:30:00	0.000	0.000	0.000	0.275	2.895	3.170
25:00:00	0.000	0.000	0.000	0.191	2.860	3.052
25:30:00	0.000	0.000	0.000	0.127	2.824	2.951
26:00:00	0.000	0.000	0.000	0.078	2.788	2.866
26:30:00	0.000	0.000	0.000	0.043	2.751	2.794
27:00:00	0.000	0.000	0.000	0.019	2.714	2.733
27:30:00	0.000	0.000	0.000	0.005	2.678	2.683
28:00:00	0.000	0.000	0.000	0.000	2.641	2.641
28:30:00	0.000	0.000	0.000	0.000	2.606	2.606
29:00:00	0.000	0.000	0.000	0.000	2.570	2.570
29:30:00	0.000	0.000	0.000	0.000	2.535	2.535
30:00:00	0.000	0.000	0.000	0.000	2.501	2.501
30:30:00	0.000	0.000	0.000	0.000	2.467	2.467
31:00:00	0.000	0.000	0.000	0.000	2.433	2.433
31:30:00	0.000	0.000	0.000	0.000	2.400	2.400
32:00:00	0.000	0.000	0.000	0.000	2.368	2.368
32:30:00	0.000	0.000	0.000	0.000	2.336	2.336
33:00:00	0.000	0.000	0.000	0.000	2.304	2.304
33:30:00	0.000	0.000	0.000	0.000	2.273	2.273
34:00:00	0.000	0.000	0.000	0.000	2.242	2.242
34:30:00	0.000	0.000	0.000	0.000	2.211	2.211
35:00:00	0.000	0.000	0.000	0.000	2.181	2.181
35:30:00	0.000	0.000	0.000	0.000	2.152	2.152
36:00:00	0.000	0.000	0.000	0.000	2.122	2.122
36:30:00	0.000	0.000	0.000	0.000	2.094	2.094
37:00:00	0.000	0.000	0.000	0.000	2.065	2.065
37:30:00	0.000	0.000	0.000	0.000	2.037	2.037
38:00:00	0.000	0.000	0.000	0.000	2.009	2.009
38:30:00	0.000	0.000	0.000	0.000	1.982	1.982
39:00:00	0.000	0.000	0.000	0.000	1.955	1.955
39:30:00	0.000	0.000	0.000	0.000	1.929	1.929
40:00:00	0.000	0.000	0.000	0.000	1.903	1.903
40:30:00	0.000	0.000	0.000	0.000	1.877	1.877
41:00:00	0.000	0.000	0.000	0.000	1.851	1.851
41:30:00	0.000	0.000	0.000	0.000	1.826	1.826
42:00:00	0.000	0.000	0.000	0.000	1.801	1.801
42:30:00	0.000	0.000	0.000	0.000	1.777	1.777
43:00:00	0.000	0.000	0.000	0.000	1.753	1.753
43:30:00	0.000	0.000	0.000	0.000	1.729	1.729
44:00:00	0.000	0.000	0.000	0.000	1.705	1.705
44:30:00	0.000	0.000	0.000	0.000	1.682	1.682
45:00:00	0.000	0.000	0.000	0.000	1.659	1.659
45:30:00	0.000	0.000	0.000	0.000	1.637	1.637

46:00:00	0.000	0.000	0.000	0.000	1.615	1.615
46:30:00	0.000	0.000	0.000	0.000	1.593	1.593
47:00:00	0.000	0.000	0.000	0.000	1.571	1.571
47:30:00	0.000	0.000	0.000	0.000	1.550	1.550
48:00:00	0.000	0.000	0.000	0.000	1.529	1.529
48:30:00	0.000	0.000	0.000	0.000	1.508	1.508
49:00:00	0.000	0.000	0.000	0.000	1.487	1.487
49:30:00	0.000	0.000	0.000	0.000	1.467	1.467
50:00:00	0.000	0.000	0.000	0.000	1.447	1.447
50:30:00	0.000	0.000	0.000	0.000	1.428	1.428
51:00:00	0.000	0.000	0.000	0.000	1.408	1.408
51:30:00	0.000	0.000	0.000	0.000	1.389	1.389
52:00:00	0.000	0.000	0.000	0.000	1.370	1.370
52:30:00	0.000	0.000	0.000	0.000	1.352	1.352
53:00:00	0.000	0.000	0.000	0.000	1.333	1.333
53:30:00	0.000	0.000	0.000	0.000	1.315	1.315
54:00:00	0.000	0.000	0.000	0.000	1.297	1.297
54:30:00	0.000	0.000	0.000	0.000	1.280	1.280
55:00:00	0.000	0.000	0.000	0.000	1.262	1.262
55:30:00	0.000	0.000	0.000	0.000	1.245	1.245
56:00:00	0.000	0.000	0.000	0.000	1.228	1.228
56:30:00	0.000	0.000	0.000	0.000	1.212	1.212
57:00:00	0.000	0.000	0.000	0.000	1.195	1.195
57:30:00	0.000	0.000	0.000	0.000	1.179	1.179
58:00:00	0.000	0.000	0.000	0.000	1.163	1.163
58:30:00	0.000	0.000	0.000	0.000	1.147	1.147
59:00:00	0.000	0.000	0.000	0.000	1.132	1.132
59:30:00	0.000	0.000	0.000	0.000	1.116	1.116
60:00:00	0.000	0.000	0.000	0.000	1.101	1.101
60:30:00	0.000	0.000	0.000	0.000	1.086	1.086
61:00:00	0.000	0.000	0.000	0.000	1.071	1.071
61:30:00	0.000	0.000	0.000	0.000	1.057	1.057
62:00:00	0.000	0.000	0.000	0.000	1.043	1.043
62:30:00	0.000	0.000	0.000	0.000	1.028	1.028
63:00:00	0.000	0.000	0.000	0.000	1.014	1.014
63:30:00	0.000	0.000	0.000	0.000	1.001	1.001
64:00:00	0.000	0.000	0.000	0.000	0.987	0.987
64:30:00	0.000	0.000	0.000	0.000	0.974	0.974
65:00:00	0.000	0.000	0.000	0.000	0.960	0.960
65:30:00	0.000	0.000	0.000	0.000	0.947	0.947
66:00:00	0.000	0.000	0.000	0.000	0.934	0.934
66:30:00	0.000	0.000	0.000	0.000	0.922	0.922
67:00:00	0.000	0.000	0.000	0.000	0.909	0.909
67:30:00	0.000	0.000	0.000	0.000	0.897	0.897
68:00:00	0.000	0.000	0.000	0.000	0.885	0.885
68:30:00	0.000	0.000	0.000	0.000	0.873	0.873
69:00:00	0.000	0.000	0.000	0.000	0.861	0.861
69:30:00	0.000	0.000	0.000	0.000	0.849	0.849

70:00:00	0.000	0.000	0.000	0.000	0.838	0.838
70:30:00	0.000	0.000	0.000	0.000	0.826	0.826
71:00:00	0.000	0.000	0.000	0.000	0.815	0.815
71:30:00	0.000	0.000	0.000	0.000	0.804	0.804
72:00:00	0.000	0.000	0.000	0.000	0.793	0.793
72:30:00	0.000	0.000	0.000	0.000	0.782	0.782
73:00:00	0.000	0.000	0.000	0.000	0.772	0.772
73:30:00	0.000	0.000	0.000	0.000	0.761	0.761
74:00:00	0.000	0.000	0.000	0.000	0.751	0.751
74:30:00	0.000	0.000	0.000	0.000	0.741	0.741
75:00:00	0.000	0.000	0.000	0.000	0.731	0.731
75:30:00	0.000	0.000	0.000	0.000	0.721	0.721
76:00:00	0.000	0.000	0.000	0.000	0.711	0.711
76:30:00	0.000	0.000	0.000	0.000	0.701	0.701
77:00:00	0.000	0.000	0.000	0.000	0.692	0.692
77:30:00	0.000	0.000	0.000	0.000	0.682	0.682
78:00:00	0.000	0.000	0.000	0.000	0.673	0.673
78:30:00	0.000	0.000	0.000	0.000	0.664	0.664
79:00:00	0.000	0.000	0.000	0.000	0.655	0.655
79:30:00	0.000	0.000	0.000	0.000	0.646	0.646
80:00:00	0.000	0.000	0.000	0.000	0.637	0.637
80:30:00	0.000	0.000	0.000	0.000	0.629	0.629
81:00:00	0.000	0.000	0.000	0.000	0.620	0.620
81:30:00	0.000	0.000	0.000	0.000	0.612	0.612
82:00:00	0.000	0.000	0.000	0.000	0.603	0.603
82:30:00	0.000	0.000	0.000	0.000	0.595	0.595
83:00:00	0.000	0.000	0.000	0.000	0.587	0.587
83:30:00	0.000	0.000	0.000	0.000	0.579	0.579
84:00:00	0.000	0.000	0.000	0.000	0.571	0.571
84:30:00	0.000	0.000	0.000	0.000	0.563	0.563
85:00:00	0.000	0.000	0.000	0.000	0.556	0.556
85:30:00	0.000	0.000	0.000	0.000	0.548	0.548
86:00:00	0.000	0.000	0.000	0.000	0.541	0.541
86:30:00	0.000	0.000	0.000	0.000	0.534	0.534

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	10.1	No
ALTBAR	204	No
ASPBAR	138	No
ASPVAR	0.08	No
BFIHOST	0.51	No
BFIHOST19	0.48	No
DPLBAR (km)	3.86	No
DPSBAR (mkm-¹)	102.6	No
FARL	1	No
LDP	6.92	No
PROPWET	0.5	No
RMED1H	10.4	No
RMED1D	39	No
RMED2D	53.6	No
SAAR (mm)	1258	No
SAAR4170 (mm)	1315	No
SPRHOST	34.37	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
DDF parameter C	-0.03	No
DDF parameter D1	0.42	No
DDF parameter D2	0.46	No
DDF parameter D3	0.36	No
DDF parameter E	0.29	No
DDF parameter F	2.37	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.45	No
DDF parameter D3 (1km grid value)	0.36	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.38	No

UK Design Flood Estimation

Generated on 24 September 2024 13:17:24 by HerringtonConsulting
Printed from the ReFH2 Flood Modelling software package, version 4.0.8560.23190

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 49F2-011B

Site name: FEH_Catchment_Descriptors_257900_249400_v5_0_1

Easting: 257900

Northing: 249400

Country: England, Wales or Northern Ireland

Catchment Area (km²): 28.73

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH22 (mm):	92.20	Total runoff (ML):	749.46
Total Rainfall (mm):	72.26	Total flow (ML):	2076.12
		Peak flow (m³/s):	26.58
Peak Rainfall (mm):	4.64		

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	20:30:00 [05:30:00]*	Yes
Timestep (hh:mm:ss)	00:30:00*	No
SCF (Seasonal correction factor)	0.85	No
ARF (Areal reduction factor)	0.92 [0.96]	Yes
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	92.89	No
Cmax (mm)	351.32	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.47	No
Up	0.65	No

Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	1.5	No
BL (hr)	38.6	No
BR	1.72	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.23	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.348	0.000	0.093	0.000	1.492	1.492
00:30:00	0.401	0.000	0.107	0.020	1.474	1.493
01:00:00	0.460	0.000	0.124	0.083	1.456	1.539
01:30:00	0.529	0.000	0.143	0.196	1.442	1.638
02:00:00	0.607	0.000	0.165	0.366	1.433	1.799
02:30:00	0.697	0.000	0.191	0.601	1.430	2.031
03:00:00	0.800	0.000	0.221	0.876	1.436	2.312
03:30:00	0.918	0.000	0.255	1.171	1.452	2.623
04:00:00	1.053	0.000	0.296	1.488	1.477	2.965
04:30:00	1.207	0.000	0.343	1.832	1.514	3.345
05:00:00	1.382	0.000	0.398	2.207	1.561	3.768
05:30:00	1.582	0.000	0.456	2.627	1.622	4.249
06:00:00	1.810	0.000	0.530	3.103	1.696	4.798
06:30:00	2.069	0.000	0.618	3.642	1.784	5.427
07:00:00	2.363	0.000	0.720	4.258	1.888	6.145
07:30:00	2.694	0.000	0.841	4.962	2.006	6.968
08:00:00	3.067	0.000	0.982	5.772	2.140	7.912
08:30:00	3.482	0.000	1.147	6.708	2.292	9.000
09:00:00	3.935	0.000	1.338	7.796	2.464	10.260
09:30:00	4.403	0.000	1.549	9.069	2.661	11.730
10:00:00	4.643	0.000	1.693	10.557	2.888	13.445
10:30:00	4.403	0.000	1.662	12.270	3.151	15.420
11:00:00	3.935	0.000	1.505	14.150	3.454	17.604
11:30:00	3.482	0.000	1.368	16.065	3.799	19.864
12:00:00	3.067	0.000	1.233	17.842	4.181	22.023
12:30:00	2.694	0.000	1.105	19.303	4.590	23.893
13:00:00	2.363	0.000	0.986	20.297	5.011	25.308
13:30:00	2.069	0.000	0.877	20.764	5.430	26.194
14:00:00	1.810	0.000	0.777	20.754	5.831	26.585
14:30:00	1.582	0.000	0.687	20.351	6.208	26.560
15:00:00	1.382	0.000	0.606	19.642	6.557	26.199
15:30:00	1.207	0.000	0.533	18.709	6.874	25.583
16:00:00	1.053	0.000	0.469	17.617	7.159	24.776
16:30:00	0.918	0.000	0.394	16.408	7.411	23.820
17:00:00	0.800	0.000	0.346	15.118	7.630	22.748
17:30:00	0.697	0.000	0.303	13.778	7.815	21.594
18:00:00	0.607	0.000	0.265	12.428	7.967	20.395
18:30:00	0.529	0.000	0.231	11.104	8.087	19.191
19:00:00	0.460	0.000	0.202	9.843	8.177	18.020
19:30:00	0.401	0.000	0.176	8.682	8.240	16.923
20:00:00	0.348	0.000	0.154	7.638	8.281	15.919
20:30:00	0.000	0.000	0.000	6.707	8.302	15.008
21:00:00	0.000	0.000	0.000	5.850	8.306	14.156
21:30:00	0.000	0.000	0.000	5.035	8.294	13.329

22:00:00	0.000	0.000	0.000	4.259	8.268	12.528
22:30:00	0.000	0.000	0.000	3.519	8.229	11.749
23:00:00	0.000	0.000	0.000	2.814	8.178	10.992
23:30:00	0.000	0.000	0.000	2.192	8.116	10.308
24:00:00	0.000	0.000	0.000	1.682	8.045	9.726
24:30:00	0.000	0.000	0.000	1.270	7.966	9.236
25:00:00	0.000	0.000	0.000	0.945	7.882	8.828
25:30:00	0.000	0.000	0.000	0.696	7.795	8.491
26:00:00	0.000	0.000	0.000	0.501	7.704	8.205
26:30:00	0.000	0.000	0.000	0.345	7.612	7.957
27:00:00	0.000	0.000	0.000	0.224	7.519	7.743
27:30:00	0.000	0.000	0.000	0.133	7.425	7.558
28:00:00	0.000	0.000	0.000	0.068	7.332	7.400
28:30:00	0.000	0.000	0.000	0.026	7.238	7.264
29:00:00	0.000	0.000	0.000	0.005	7.145	7.150
29:30:00	0.000	0.000	0.000	0.000	7.053	7.053
30:00:00	0.000	0.000	0.000	0.000	6.962	6.962
30:30:00	0.000	0.000	0.000	0.000	6.873	6.873
31:00:00	0.000	0.000	0.000	0.000	6.784	6.784
31:30:00	0.000	0.000	0.000	0.000	6.697	6.697
32:00:00	0.000	0.000	0.000	0.000	6.611	6.611
32:30:00	0.000	0.000	0.000	0.000	6.526	6.526
33:00:00	0.000	0.000	0.000	0.000	6.442	6.442
33:30:00	0.000	0.000	0.000	0.000	6.359	6.359
34:00:00	0.000	0.000	0.000	0.000	6.277	6.277
34:30:00	0.000	0.000	0.000	0.000	6.196	6.196
35:00:00	0.000	0.000	0.000	0.000	6.116	6.116
35:30:00	0.000	0.000	0.000	0.000	6.038	6.038
36:00:00	0.000	0.000	0.000	0.000	5.960	5.960
36:30:00	0.000	0.000	0.000	0.000	5.883	5.883
37:00:00	0.000	0.000	0.000	0.000	5.808	5.808
37:30:00	0.000	0.000	0.000	0.000	5.733	5.733
38:00:00	0.000	0.000	0.000	0.000	5.659	5.659
38:30:00	0.000	0.000	0.000	0.000	5.586	5.586
39:00:00	0.000	0.000	0.000	0.000	5.514	5.514
39:30:00	0.000	0.000	0.000	0.000	5.443	5.443
40:00:00	0.000	0.000	0.000	0.000	5.373	5.373
40:30:00	0.000	0.000	0.000	0.000	5.304	5.304
41:00:00	0.000	0.000	0.000	0.000	5.236	5.236
41:30:00	0.000	0.000	0.000	0.000	5.168	5.168
42:00:00	0.000	0.000	0.000	0.000	5.102	5.102
42:30:00	0.000	0.000	0.000	0.000	5.036	5.036
43:00:00	0.000	0.000	0.000	0.000	4.971	4.971
43:30:00	0.000	0.000	0.000	0.000	4.907	4.907
44:00:00	0.000	0.000	0.000	0.000	4.844	4.844
44:30:00	0.000	0.000	0.000	0.000	4.782	4.782
45:00:00	0.000	0.000	0.000	0.000	4.720	4.720
45:30:00	0.000	0.000	0.000	0.000	4.660	4.660

46:00:00	0.000	0.000	0.000	0.000	4.600	4.600
46:30:00	0.000	0.000	0.000	0.000	4.540	4.540
47:00:00	0.000	0.000	0.000	0.000	4.482	4.482
47:30:00	0.000	0.000	0.000	0.000	4.424	4.424
48:00:00	0.000	0.000	0.000	0.000	4.367	4.367
48:30:00	0.000	0.000	0.000	0.000	4.311	4.311
49:00:00	0.000	0.000	0.000	0.000	4.256	4.256
49:30:00	0.000	0.000	0.000	0.000	4.201	4.201
50:00:00	0.000	0.000	0.000	0.000	4.147	4.147
50:30:00	0.000	0.000	0.000	0.000	4.093	4.093
51:00:00	0.000	0.000	0.000	0.000	4.041	4.041
51:30:00	0.000	0.000	0.000	0.000	3.989	3.989
52:00:00	0.000	0.000	0.000	0.000	3.937	3.937
52:30:00	0.000	0.000	0.000	0.000	3.887	3.887
53:00:00	0.000	0.000	0.000	0.000	3.837	3.837
53:30:00	0.000	0.000	0.000	0.000	3.787	3.787
54:00:00	0.000	0.000	0.000	0.000	3.739	3.739
54:30:00	0.000	0.000	0.000	0.000	3.690	3.690
55:00:00	0.000	0.000	0.000	0.000	3.643	3.643
55:30:00	0.000	0.000	0.000	0.000	3.596	3.596
56:00:00	0.000	0.000	0.000	0.000	3.550	3.550
56:30:00	0.000	0.000	0.000	0.000	3.504	3.504
57:00:00	0.000	0.000	0.000	0.000	3.459	3.459
57:30:00	0.000	0.000	0.000	0.000	3.415	3.415
58:00:00	0.000	0.000	0.000	0.000	3.371	3.371
58:30:00	0.000	0.000	0.000	0.000	3.327	3.327
59:00:00	0.000	0.000	0.000	0.000	3.284	3.284
59:30:00	0.000	0.000	0.000	0.000	3.242	3.242
60:00:00	0.000	0.000	0.000	0.000	3.200	3.200
60:30:00	0.000	0.000	0.000	0.000	3.159	3.159
61:00:00	0.000	0.000	0.000	0.000	3.119	3.119
61:30:00	0.000	0.000	0.000	0.000	3.078	3.078
62:00:00	0.000	0.000	0.000	0.000	3.039	3.039
62:30:00	0.000	0.000	0.000	0.000	3.000	3.000
63:00:00	0.000	0.000	0.000	0.000	2.961	2.961
63:30:00	0.000	0.000	0.000	0.000	2.923	2.923
64:00:00	0.000	0.000	0.000	0.000	2.885	2.885
64:30:00	0.000	0.000	0.000	0.000	2.848	2.848
65:00:00	0.000	0.000	0.000	0.000	2.811	2.811
65:30:00	0.000	0.000	0.000	0.000	2.775	2.775
66:00:00	0.000	0.000	0.000	0.000	2.740	2.740
66:30:00	0.000	0.000	0.000	0.000	2.704	2.704
67:00:00	0.000	0.000	0.000	0.000	2.670	2.670
67:30:00	0.000	0.000	0.000	0.000	2.635	2.635
68:00:00	0.000	0.000	0.000	0.000	2.601	2.601
68:30:00	0.000	0.000	0.000	0.000	2.568	2.568
69:00:00	0.000	0.000	0.000	0.000	2.535	2.535
69:30:00	0.000	0.000	0.000	0.000	2.502	2.502

70:00:00	0.000	0.000	0.000	0.000	2.470	2.470
70:30:00	0.000	0.000	0.000	0.000	2.438	2.438
71:00:00	0.000	0.000	0.000	0.000	2.407	2.407
71:30:00	0.000	0.000	0.000	0.000	2.376	2.376
72:00:00	0.000	0.000	0.000	0.000	2.345	2.345
72:30:00	0.000	0.000	0.000	0.000	2.315	2.315
73:00:00	0.000	0.000	0.000	0.000	2.285	2.285
73:30:00	0.000	0.000	0.000	0.000	2.256	2.256
74:00:00	0.000	0.000	0.000	0.000	2.227	2.227
74:30:00	0.000	0.000	0.000	0.000	2.198	2.198
75:00:00	0.000	0.000	0.000	0.000	2.170	2.170
75:30:00	0.000	0.000	0.000	0.000	2.142	2.142
76:00:00	0.000	0.000	0.000	0.000	2.114	2.114
76:30:00	0.000	0.000	0.000	0.000	2.087	2.087
77:00:00	0.000	0.000	0.000	0.000	2.060	2.060
77:30:00	0.000	0.000	0.000	0.000	2.034	2.034
78:00:00	0.000	0.000	0.000	0.000	2.008	2.008
78:30:00	0.000	0.000	0.000	0.000	1.982	1.982
79:00:00	0.000	0.000	0.000	0.000	1.956	1.956
79:30:00	0.000	0.000	0.000	0.000	1.931	1.931
80:00:00	0.000	0.000	0.000	0.000	1.906	1.906
80:30:00	0.000	0.000	0.000	0.000	1.882	1.882
81:00:00	0.000	0.000	0.000	0.000	1.857	1.857
81:30:00	0.000	0.000	0.000	0.000	1.833	1.833
82:00:00	0.000	0.000	0.000	0.000	1.810	1.810
82:30:00	0.000	0.000	0.000	0.000	1.787	1.787
83:00:00	0.000	0.000	0.000	0.000	1.764	1.764
83:30:00	0.000	0.000	0.000	0.000	1.741	1.741
84:00:00	0.000	0.000	0.000	0.000	1.718	1.718
84:30:00	0.000	0.000	0.000	0.000	1.696	1.696
85:00:00	0.000	0.000	0.000	0.000	1.675	1.675
85:30:00	0.000	0.000	0.000	0.000	1.653	1.653
86:00:00	0.000	0.000	0.000	0.000	1.632	1.632
86:30:00	0.000	0.000	0.000	0.000	1.611	1.611
87:00:00	0.000	0.000	0.000	0.000	1.590	1.590
87:30:00	0.000	0.000	0.000	0.000	1.570	1.570
88:00:00	0.000	0.000	0.000	0.000	1.549	1.549
88:30:00	0.000	0.000	0.000	0.000	1.529	1.529
89:00:00	0.000	0.000	0.000	0.000	1.510	1.510

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	28.73	No
ALTBAR	185	No
ASPBAR	173	No
ASPVAR	0.12	No
BFIHOST	0.51	No
BFIHOST19	0.48	No
DPLBAR (km)	5.58	No
DPSBAR (mkm-¹)	97.9	No
FARL	1	No
LDP	11.31	No
PROPWET	0.53	No
RMED1H	10.2	No
RMED1D	39	No
RMED2D	53.5	No
SAAR (mm)	1262	No
SAAR4170 (mm)	1302	No
SPRHOST	34.82	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.44	No
URBLOC	0.74	No
DDF parameter C	-0.03	No
DDF parameter D1	0.42	No
DDF parameter D2	0.47	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.37	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.44	No
DDF parameter D2 (1km grid value)	0.46	No
DDF parameter D3 (1km grid value)	0.36	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.37	No

UK Design Flood Estimation

Generated on 24 September 2024 13:21:14 by HerringtonConsulting
Printed from the ReFH2 Flood Modelling software package, version 4.0.8560.23190

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: D34C-39E8

Site name: FEH_Catchment_Descriptors_259900_248800_v5_0_1

Easting: 259900

Northing: 248800

Country: England, Wales or Northern Ireland

Catchment Area (km²): 250.81

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH22 (mm):	100.52	Total runoff (ML):	10179.99
Total Rainfall (mm):	81.23	Total flow (ML):	20372.89
		Peak flow (m³/s):	270.39
Peak Rainfall (mm):	5.22		

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	20:30:00 [10:30:00]*	Yes
Timestep (hh:mm:ss)	00:30:00*	No
SCF (Seasonal correction factor)	0.88	No
ARF (Areal reduction factor)	0.92 [0.92]	Yes
Seasonality	Winter	No

Loss model parameters

Name	Value	User-defined?
Cini (mm)	100.73	No
Cmax (mm)	278.39	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	4.38	No
Up	0.65	No

Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	16.77	No
BL (hr)	43.95	No
BR	0.97	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0.79	No
Urbext 2000	0	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (m^3/s)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.392	0.000	0.142	0.000	16.750	16.750
00:30:00	0.450	0.000	0.164	0.084	16.561	16.645
01:00:00	0.517	0.000	0.190	0.350	16.376	16.726
01:30:00	0.594	0.000	0.219	0.825	16.200	17.024
02:00:00	0.683	0.000	0.253	1.542	16.033	17.575
02:30:00	0.784	0.000	0.293	2.538	15.881	18.419
03:00:00	0.899	0.000	0.338	3.857	15.747	19.605
03:30:00	1.032	0.000	0.392	5.550	15.637	21.187
04:00:00	1.183	0.000	0.454	7.674	15.555	23.229
04:30:00	1.356	0.000	0.527	10.289	15.508	25.796
05:00:00	1.554	0.000	0.611	13.291	15.502	28.793
05:30:00	1.779	0.000	0.711	16.670	15.541	32.211
06:00:00	2.035	0.000	0.827	20.486	15.633	36.118
06:30:00	2.326	0.000	0.963	24.814	15.781	40.595
07:00:00	2.656	0.000	1.124	29.743	15.995	45.737
07:30:00	3.029	0.000	1.312	35.376	16.282	51.657
08:00:00	3.447	0.000	1.534	41.836	16.652	58.488
08:30:00	3.914	0.000	1.793	49.270	17.119	66.388
09:00:00	4.424	0.000	2.093	57.854	17.695	75.550
09:30:00	4.950	0.000	2.425	67.832	18.398	86.230
10:00:00	5.220	0.000	2.652	79.437	19.249	98.686
10:30:00	4.950	0.000	2.516	92.830	20.270	113.100
11:00:00	4.424	0.000	2.323	107.867	21.479	129.346
11:30:00	3.914	0.000	2.114	124.119	22.883	147.002
12:00:00	3.447	0.000	1.908	141.072	24.477	165.549
12:30:00	3.029	0.000	1.711	158.157	26.251	184.409
13:00:00	2.656	0.000	1.528	174.757	28.188	202.945
13:30:00	2.326	0.000	1.359	190.201	30.261	220.462
14:00:00	2.035	0.000	1.205	203.768	32.438	236.206
14:30:00	1.779	0.000	1.065	214.706	34.675	249.380
15:00:00	1.554	0.000	0.940	222.419	36.922	259.341
15:30:00	1.356	0.000	0.827	226.862	39.135	265.997
16:00:00	1.183	0.000	0.727	228.284	41.285	269.569
16:30:00	1.032	0.000	0.638	227.039	43.350	270.389
17:00:00	0.899	0.000	0.559	223.486	45.314	268.800
17:30:00	0.784	0.000	0.490	217.993	47.162	265.154
18:00:00	0.683	0.000	0.428	210.930	48.884	259.814
18:30:00	0.594	0.000	0.374	202.666	50.475	253.141
19:00:00	0.517	0.000	0.327	193.562	51.934	245.496
19:30:00	0.450	0.000	0.285	183.917	53.260	237.177
20:00:00	0.392	0.000	0.249	173.900	54.456	228.356
20:30:00	0.000	0.000	0.000	163.629	55.522	219.151
21:00:00	0.000	0.000	0.000	153.073	56.457	209.530
21:30:00	0.000	0.000	0.000	142.204	57.261	199.465

22:00:00	0.000	0.000	0.000	131.130	57.935	189.065
22:30:00	0.000	0.000	0.000	119.951	58.480	178.432
23:00:00	0.000	0.000	0.000	108.764	58.899	167.663
23:30:00	0.000	0.000	0.000	97.662	59.195	156.857
24:00:00	0.000	0.000	0.000	86.742	59.373	146.115
24:30:00	0.000	0.000	0.000	76.105	59.439	135.543
25:00:00	0.000	0.000	0.000	65.869	59.400	125.269
25:30:00	0.000	0.000	0.000	56.423	59.265	115.688
26:00:00	0.000	0.000	0.000	47.962	59.048	107.011
26:30:00	0.000	0.000	0.000	40.517	58.763	99.279
27:00:00	0.000	0.000	0.000	34.029	58.420	92.448
27:30:00	0.000	0.000	0.000	28.417	58.029	86.445
28:00:00	0.000	0.000	0.000	23.597	57.597	81.194
28:30:00	0.000	0.000	0.000	19.488	57.131	76.619
29:00:00	0.000	0.000	0.000	16.013	56.638	72.651
29:30:00	0.000	0.000	0.000	13.093	56.123	69.216
30:00:00	0.000	0.000	0.000	10.603	55.591	66.193
30:30:00	0.000	0.000	0.000	8.482	55.044	63.526
31:00:00	0.000	0.000	0.000	6.688	54.487	61.175
31:30:00	0.000	0.000	0.000	5.183	53.922	59.104
32:00:00	0.000	0.000	0.000	3.931	53.351	57.282
32:30:00	0.000	0.000	0.000	2.903	52.777	55.680
33:00:00	0.000	0.000	0.000	2.070	52.202	54.272
33:30:00	0.000	0.000	0.000	1.409	51.626	53.035
34:00:00	0.000	0.000	0.000	0.898	51.052	51.950
34:30:00	0.000	0.000	0.000	0.518	50.481	50.998
35:00:00	0.000	0.000	0.000	0.252	49.913	50.165
35:30:00	0.000	0.000	0.000	0.087	49.350	49.437
36:00:00	0.000	0.000	0.000	0.010	48.792	48.801
36:30:00	0.000	0.000	0.000	0.000	48.240	48.240
37:00:00	0.000	0.000	0.000	0.000	47.694	47.694
37:30:00	0.000	0.000	0.000	0.000	47.154	47.154
38:00:00	0.000	0.000	0.000	0.000	46.621	46.621
38:30:00	0.000	0.000	0.000	0.000	46.094	46.094
39:00:00	0.000	0.000	0.000	0.000	45.572	45.572
39:30:00	0.000	0.000	0.000	0.000	45.057	45.057
40:00:00	0.000	0.000	0.000	0.000	44.547	44.547
40:30:00	0.000	0.000	0.000	0.000	44.043	44.043
41:00:00	0.000	0.000	0.000	0.000	43.545	43.545
41:30:00	0.000	0.000	0.000	0.000	43.052	43.052
42:00:00	0.000	0.000	0.000	0.000	42.565	42.565
42:30:00	0.000	0.000	0.000	0.000	42.083	42.083
43:00:00	0.000	0.000	0.000	0.000	41.607	41.607
43:30:00	0.000	0.000	0.000	0.000	41.137	41.137
44:00:00	0.000	0.000	0.000	0.000	40.671	40.671
44:30:00	0.000	0.000	0.000	0.000	40.211	40.211
45:00:00	0.000	0.000	0.000	0.000	39.756	39.756
45:30:00	0.000	0.000	0.000	0.000	39.306	39.306

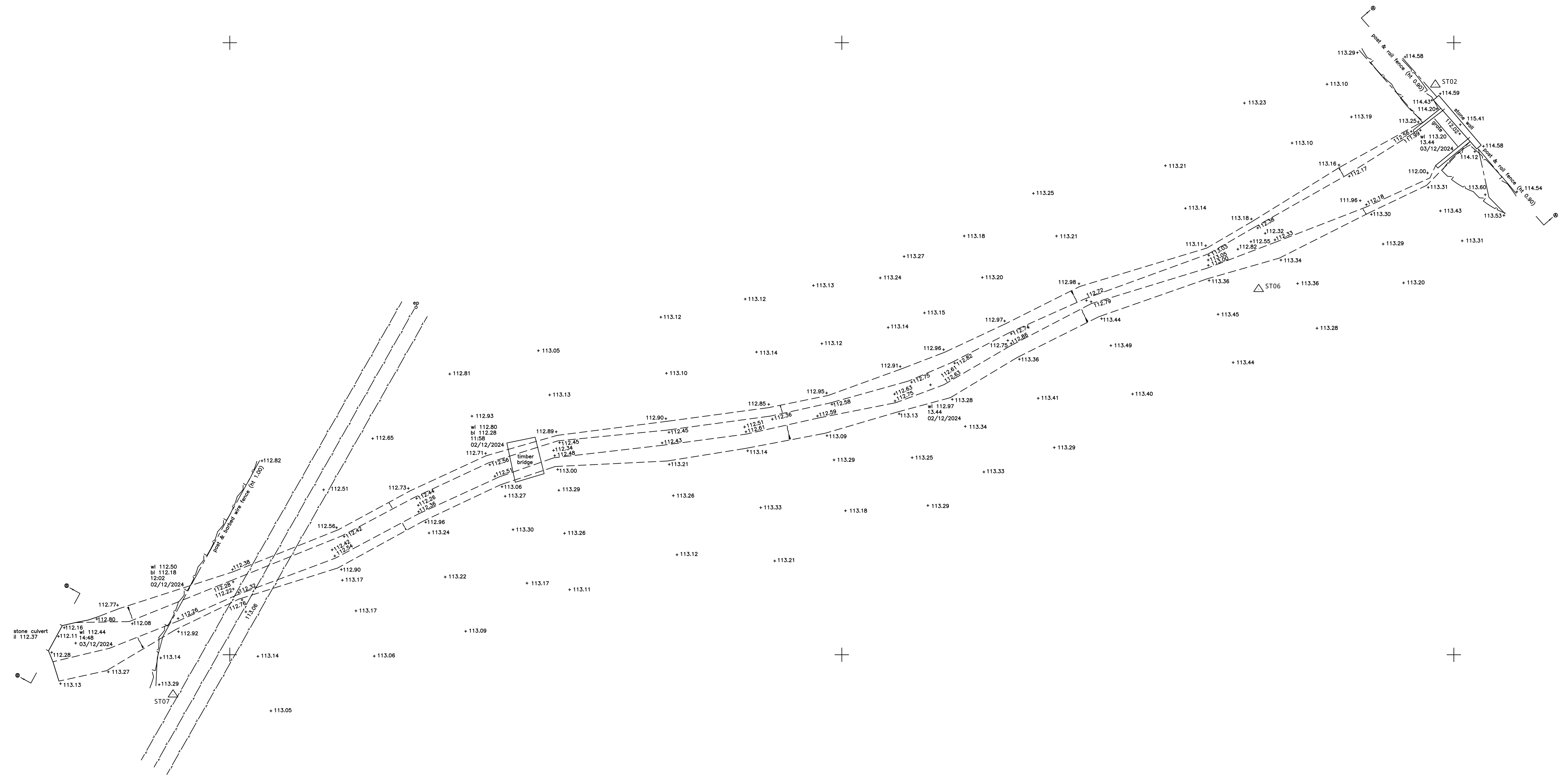
46:00:00	0.000	0.000	0.000	0.000	38.862	38.862
46:30:00	0.000	0.000	0.000	0.000	38.422	38.422
47:00:00	0.000	0.000	0.000	0.000	37.987	37.987
47:30:00	0.000	0.000	0.000	0.000	37.558	37.558
48:00:00	0.000	0.000	0.000	0.000	37.133	37.133
48:30:00	0.000	0.000	0.000	0.000	36.713	36.713
49:00:00	0.000	0.000	0.000	0.000	36.297	36.297
49:30:00	0.000	0.000	0.000	0.000	35.887	35.887
50:00:00	0.000	0.000	0.000	0.000	35.481	35.481
50:30:00	0.000	0.000	0.000	0.000	35.079	35.079
51:00:00	0.000	0.000	0.000	0.000	34.682	34.682
51:30:00	0.000	0.000	0.000	0.000	34.290	34.290
52:00:00	0.000	0.000	0.000	0.000	33.902	33.902
52:30:00	0.000	0.000	0.000	0.000	33.519	33.519
53:00:00	0.000	0.000	0.000	0.000	33.139	33.139
53:30:00	0.000	0.000	0.000	0.000	32.765	32.765
54:00:00	0.000	0.000	0.000	0.000	32.394	32.394
54:30:00	0.000	0.000	0.000	0.000	32.027	32.027
55:00:00	0.000	0.000	0.000	0.000	31.665	31.665
55:30:00	0.000	0.000	0.000	0.000	31.307	31.307
56:00:00	0.000	0.000	0.000	0.000	30.953	30.953
56:30:00	0.000	0.000	0.000	0.000	30.602	30.602
57:00:00	0.000	0.000	0.000	0.000	30.256	30.256
57:30:00	0.000	0.000	0.000	0.000	29.914	29.914
58:00:00	0.000	0.000	0.000	0.000	29.576	29.576
58:30:00	0.000	0.000	0.000	0.000	29.241	29.241
59:00:00	0.000	0.000	0.000	0.000	28.910	28.910
59:30:00	0.000	0.000	0.000	0.000	28.583	28.583
60:00:00	0.000	0.000	0.000	0.000	28.260	28.260
60:30:00	0.000	0.000	0.000	0.000	27.940	27.940
61:00:00	0.000	0.000	0.000	0.000	27.624	27.624
61:30:00	0.000	0.000	0.000	0.000	27.311	27.311
62:00:00	0.000	0.000	0.000	0.000	27.002	27.002
62:30:00	0.000	0.000	0.000	0.000	26.697	26.697
63:00:00	0.000	0.000	0.000	0.000	26.395	26.395
63:30:00	0.000	0.000	0.000	0.000	26.096	26.096
64:00:00	0.000	0.000	0.000	0.000	25.801	25.801
64:30:00	0.000	0.000	0.000	0.000	25.509	25.509
65:00:00	0.000	0.000	0.000	0.000	25.221	25.221
65:30:00	0.000	0.000	0.000	0.000	24.935	24.935
66:00:00	0.000	0.000	0.000	0.000	24.653	24.653
66:30:00	0.000	0.000	0.000	0.000	24.374	24.374
67:00:00	0.000	0.000	0.000	0.000	24.099	24.099
67:30:00	0.000	0.000	0.000	0.000	23.826	23.826
68:00:00	0.000	0.000	0.000	0.000	23.556	23.556
68:30:00	0.000	0.000	0.000	0.000	23.290	23.290
69:00:00	0.000	0.000	0.000	0.000	23.026	23.026
69:30:00	0.000	0.000	0.000	0.000	22.766	22.766

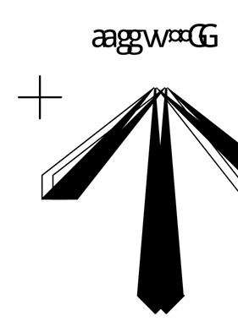
70:00:00	0.000	0.000	0.000	0.000	22.508	22.508
70:30:00	0.000	0.000	0.000	0.000	22.254	22.254
71:00:00	0.000	0.000	0.000	0.000	22.002	22.002
71:30:00	0.000	0.000	0.000	0.000	21.753	21.753
72:00:00	0.000	0.000	0.000	0.000	21.507	21.507
72:30:00	0.000	0.000	0.000	0.000	21.264	21.264
73:00:00	0.000	0.000	0.000	0.000	21.023	21.023
73:30:00	0.000	0.000	0.000	0.000	20.785	20.785
74:00:00	0.000	0.000	0.000	0.000	20.550	20.550
74:30:00	0.000	0.000	0.000	0.000	20.318	20.318
75:00:00	0.000	0.000	0.000	0.000	20.088	20.088
75:30:00	0.000	0.000	0.000	0.000	19.860	19.860
76:00:00	0.000	0.000	0.000	0.000	19.636	19.636
76:30:00	0.000	0.000	0.000	0.000	19.414	19.414
77:00:00	0.000	0.000	0.000	0.000	19.194	19.194
77:30:00	0.000	0.000	0.000	0.000	18.977	18.977
78:00:00	0.000	0.000	0.000	0.000	18.762	18.762
78:30:00	0.000	0.000	0.000	0.000	18.550	18.550
79:00:00	0.000	0.000	0.000	0.000	18.340	18.340
79:30:00	0.000	0.000	0.000	0.000	18.133	18.133
80:00:00	0.000	0.000	0.000	0.000	17.927	17.927
80:30:00	0.000	0.000	0.000	0.000	17.725	17.725
81:00:00	0.000	0.000	0.000	0.000	17.524	17.524
81:30:00	0.000	0.000	0.000	0.000	17.326	17.326
82:00:00	0.000	0.000	0.000	0.000	17.130	17.130
82:30:00	0.000	0.000	0.000	0.000	16.936	16.936

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	250.81	No
ALTBAR	285	No
ASPBAR	277	No
ASPVAR	0.16	No
BFIHOST	0.45	No
BFIHOST19	0.41	No
DPLBAR (km)	24.54	No
DPSBAR (mkm-¹)	111.6	No
FARL	0.99	No
LDP	44.03	No
PROPWET	0.65	No
RMED1H	10.5	No
RMED1D	43.2	No
RMED2D	58.6	No
SAAR (mm)	1438	No
SAAR4170 (mm)	1496	No
SPRHOST	42.36	No
Urbext2000	0	No
Urbext1990	0	No
URBCONC	0	No
URBLOC	0	No
DDF parameter C	-0.03	No
DDF parameter D1	0.45	No
DDF parameter D2	0.47	No
DDF parameter D3	0.37	No
DDF parameter E	0.3	No
DDF parameter F	2.4	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.45	No
DDF parameter D2 (1km grid value)	0.46	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.38	No





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- bos – bottom of shaft
- bt – telecom
- c/b fence – closeboard fence
- c/box – control box
- catv – cable television
- cl – cover level
- con – conifer
- cr – cable riser
- cws – combined water sewer
- d/chan – drainage channel
- ejb – electric junction box
- elec – electric
- eot – end of trace
- ep – electric pole
- er – earth rod
- f/bed – flower bed
- fh – fire hydrant
- fl – floor level
- fs – fire switch
- fws – foul water sewer
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- lp – lamp post
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- pd – pit depth
- pr – pipe riser
- ptg – pipe to ground
- pts – pipe to surface
- re – rodding eye
- ret wall – retaining wall
- rs – road sign
- rwp – rain water pipe
- s/birch – silver birch
- s/p – safety paving
- sap – sapling
- sec fence – security fence
- sfc – soil filled chamber
- sl – spot light
- sp – soil pipe
- st – stop tap
- sv – stop valve
- svp – soil vent pipe
- sws – storm water sewer
- TBM – temporary bench mark
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- tp – telecom pole
- ts – traffic signal
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- u/s – underside
- utl – unable to lift
- utr – unable to rod
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- wfc – water filled chamber
- wl – water level
- wm – water meter
- wp – waste pipe
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SURVEY CONTROL :-

STATION	EASTINGS	NORTHINGS	LEVEL
ST01	258227.547	247354.653	114.069
ST02	258198.488	247496.573	114.595
ST03	258251.911	247336.856	115.396
ST04	258081.424	247352.550	112.972
ST05	257966.083	247111.455	112.719
ST06	258184.052	247479.867	113.412
ST07	258095.362	247446.747	113.192
ST08	257931.740	247107.423	112.648
ST09	257893.171	247088.139	111.993
ST10	258142.991	247143.625	115.268
ST11	258081.472	247165.948	114.049
ST12	258082.094	247179.002	113.646
ST13	257986.144	247204.254	113.380
ST14	257994.317	247218.602	112.584
ST15	257965.254	247210.900	114.077
ST16	257884.055	247077.695	112.048

SHEET LAYOUT :-

A0-SHEET 654220/1

A0-SHEET 654220/2

A0-SHEET 654220/3

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UTILITY SURVEY KEY :-

HATCHED AREA
BOREHOLE
CPT
TRIAL PIT
HAND PIT
WINDOW SAMPLE

ELECTRIC CABLE
W — WATER PIPE
FOUL SEWER
STORM SEWER
COMBINED SEWER
D — DUCTS
TV — CABLE TELEVISION
COM — DATA CABLE
TELECOM CABLE
G — GAS PIPE
U — UNIDENTIFIED SERVICE
OTHER
CCTV — CCTV
TL — TRAFFIC LIGHT
O — OFFSET FILL
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0 2 4 8 12 16 20

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Tel: 01926 810811 Email: mail@luciongroup.com Website: www.luciongroup.com

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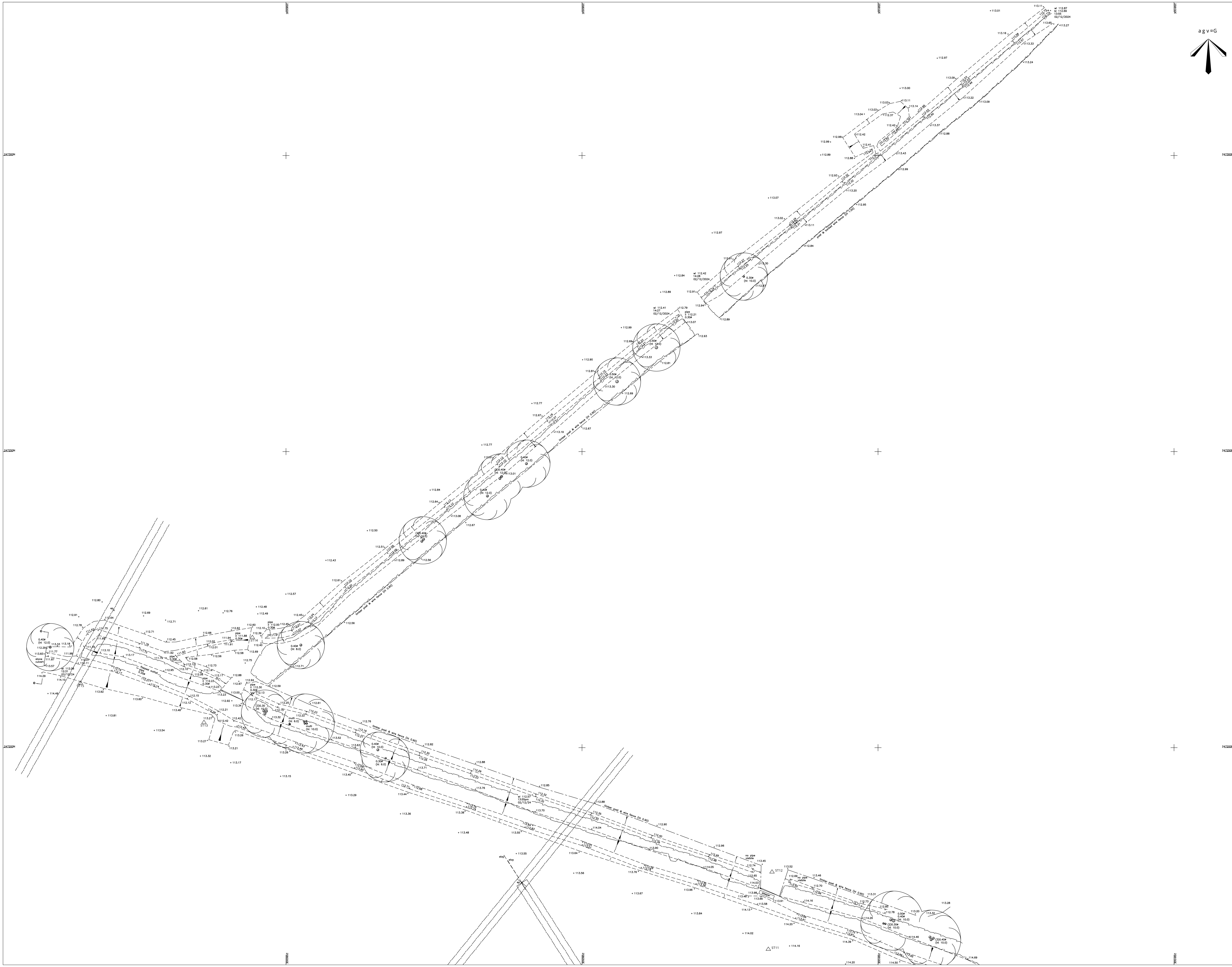
Project	WATERCOURSE SURVEY, SA48 8DT – A482 AND A485 JUNCTION
Title	TOPOGRAPHICAL SURVEY
Date	DECEMBER 2024
Scale	1:200@A0
Dwg No	654220/1
Surveyor	T.J/J.F.S
Checked	J.S

Revisions



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Revisions