# Area Data Recommendations - R Chapman, WRc

## WALLINGFORD PROCEDURE

## RUNOFF EQUATIONS AND CATCHMENT DATA

M P Osborne

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**INTRODUCTION**

One of the difficult parts of building a WASSP or WALLRUS model is defining the catchment areas and the percentage of impermeable surfaces in those areas. There have been several sets of advice given on this subject;

in the original manuals,
in WaPUG user notes 5 and 9,
in various lectures and training courses.

Parts of these appear to contradict each other.

This note is the result of consultation between the WaPUG committee, HRL and WRc in an attempt to clarify the situation, and produce firm advice.

**THE PROBLEMS**

There are four main problems to be addressed in the definition of sub catchment data. These are:

Definition of the total area.

Definition of total impermeable area.

Partially separate drainage systems.

Runoff from permeable areas excluded from the model.

**DEFINITION OF TOTAL AREA**

The boundaries of urban catchments are affected much more by the drainage system than by natural fall of the ground. The natural watershed is therefore not generally important in deciding on the catchment boundary.

The original advice was that the catchment should extend to the property boundaries on the edge of the built up area, and that all areas within this, whether permeable or impermeable, should be included in the model. This was the rule used for the catchments from which the runoff equation was derived.
Later experience was that the inclusion of large permeable areas within a catchment could give anomalous results, and it was advised that these should be omitted.

This advice is now given more rigorously.

1 The catchment should extend to the property boundaries of the built up area. Areas outside of this should only be included in exceptional circumstances, and should be treated under item 5 below.

2 A line is drawn around the paved area which includes all parts of the catchment which are within approximately 10 m of a paved area which is positively connected to the drainage system. This is intended as a rule of thumb, and it is not necessary to spend a lot of effort in accurately drawing the 10 m boundary line. Note that only paved areas, not roof areas are used to define this line. Any permeable areas within this line must be included.

3 Any roof areas which are positively connected to the drainage system but which lie outside of the 10 m line are also included in the total area, but without any extra permeable area.

4 Permeable areas further than 10 m from a connected paved area are excluded if they are positively drained by another system, such as a natural water course.

5 Other permeable areas more than 10 m from a connected paved area should be included if this leads to an increase in total runoff from the catchment as a whole. This can be tested by hand calculation of the PR equation for the entire catchment. Any impermeable areas which are completely surrounded by and drain to these permeable areas (such as pathways and sports pavilions) should be taken into account in making this check. The effect may vary with catchment wetness. The check should therefore be made using the design value of UCWI. See also the comments on runoff from permeable areas later in this note.

**DEFINITION OF IMPERMEABLE AREA**

The total impermeable area will generally include all paved and roof areas in the catchment with the following exceptions.

1 Impermeable surfaces which are not directly drained and which are completely surrounded by permeable areas which have been excluded under item 4 or 5 above. These are excluded.

2 Impermeable surfaces which are not directly drained, but which are within permeable areas which are included (such as driveways, garden sheds, paths etc.). These should be included if they might indirectly contribute runoff to the drainage system.

**SAMPLING OF UNIFORM AREAS**

If a catchment is composed of large areas of uniform development then a sample of the sub-catchments can be measured in detail, and the relationships appropriate to these applied to other similar areas. The most accurate way to do this is to measure the impermeable surface for every pipe, and to use the relationships from the sample catchments to derive the total area. Where the total area line is easily defined and measured, it is satisfactory to measure the total area for each pipe, and to use the relationship from the sample catchments to give the percentage of impermeable area.

**PARTIALLY SEPARATE SYSTEMS**

Where an area is drained by partially separate systems, for example one taking the roof and one taking the road drainage there are further difficulties in deciding on the contributing area. The total catchment area and the total impermeable area should still be allocated following the rules given above. This must then be divided between the two systems. A correct division will show sensible values for both systems.

The division of the impermeable areas is generally straightforward as they will be positively drained to one system.

WaPUG user note 5 strictly followed the original analysis to give equal runoff from the impermeable surfaces connected to both systems.

User note 9 took into account more recent research which accepts that the surfaces will have different runoff and attempts to calculate this.

The recommended method is:

1 Roof surfaces are allocated with no surrounding permeable surfaces. A pipe taking only roof drainage will therefore have 100% roof surfaces.

2 Paved surfaces will be associated with all of the included permeable surface. Where the paved surfaces in one sub-catchment drain to two different systems, the permeable areas shall be allocated according to which system they are likely to drain to. All of the total area defined using the rules above must be allocated to one of the drainage systems. Checks should be made that the effective PIMP for one system has not become so low that the minimum value of 40% for PR / PIMP is reached.

**The ideal situation is for both systems to be modelled and verified, as this will show up discrepancies more clearly.**

If these rules are followed then even complex catchments with some areas combined and some partially separate and separate can be modelled correctly.

**RUNOFF FROM PERMEABLE AREAS EXCLUDED FROM THE MODEL**

**Where there are significant large permeable areas in the catchment, which have been considered under rule 5 for total area (whether they have then been included or excluded) extra checks should be made on the operation of the system. In these circumstances the high runoff in winter conditions when the catchment is wet may become more critical than the conditions in summer. Some guidance on how to analyse this situation is given in Wapug user note 10, but familiarity with the use of the percentage runoff equation and Flood Studies Report is essential for this type of study.**

**RUNOFF IN WALLRUS**

The advice for using WALLRUS is essentially the same as that given above for using WASSP.

WALLRUS is less susceptible to the inclusion of extra permeable areas within the total area. This is because the PR equation is applied to each sub-catchment separately. Rule 5 for total area should therefore be modified as given below.

5 Other permeable areas more than 10 m from a connected paved area should be included if hand calculation of the PR equation for the permeable area plus any impermeable areas which are completely surrounded by and drain to these permeable areas (such as pathways and sports pavilions) gives a positive value of PR. The effect will vary with catchment wetness, and the check should be made using a high value of UCWI. This area can then be allocated to a separate pipe which does not take any directly connected impermeable area. The runoff of the area will then be assessed alone. (Note that if the model is then used with a lower value of UCWI such that the PR on these areas becomes negative, then it is automatically ignored.) See also the comments on runoff from permeable areas in this note.

**OTHER RUNOFF MODELS IN WALLRUS**

WALLRUS also includes other runoff models which are intended primarily for use overseas. They are not recommended for use in this country as they will generally be inferior to the standard model. Most Water Authorities will be reluctant to accept any calculations made using the alternative models. They should only be used, if at all, supported by expert advice and calculations to demonstrate that they are necessary and appropriate.

## Area-data Recommendations : R Chapman, WRc

D Beale : Howard Humphries : Referring to the Hertsmere experience presented at the last Autumn Meeting, would you increase the 10m figure in these circumstances ? Also, what would you do if UCWI > 300 ?

Answer : The forthcoming User Note will address such circumstances. See also User Note 10, and the use of Flood Studies Report may be appropriate. We are talking about circumstances for which WASSP was not calibrated.

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D Walters : Bolton MBC : The 10m figure is a nice round number, how derived ?

Answer : It is a guesstimate based on experience. Within reason, the actual figure is not that sensitive, hence no need to accurately trace round your paved areas.

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A R Eadon : Severn-Trent Water : The WaPUG Committee has discussed the actual method of inputting area-data into the record cards, and would like to be able to input values directly instead of having to convert them to percentages.

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R Long : Scott, Wilson Kirkpatrick : At present it is easier to incorporate new development by measuring the gross area and specifying %impermeable area.

Answer : True, the new rules need to be applied locally, you could sample. Note that with very large catchments, using the new method will result in WASSP overestimating the area reduction factor. You should calculate this by hand based on the gross area of the catchment.