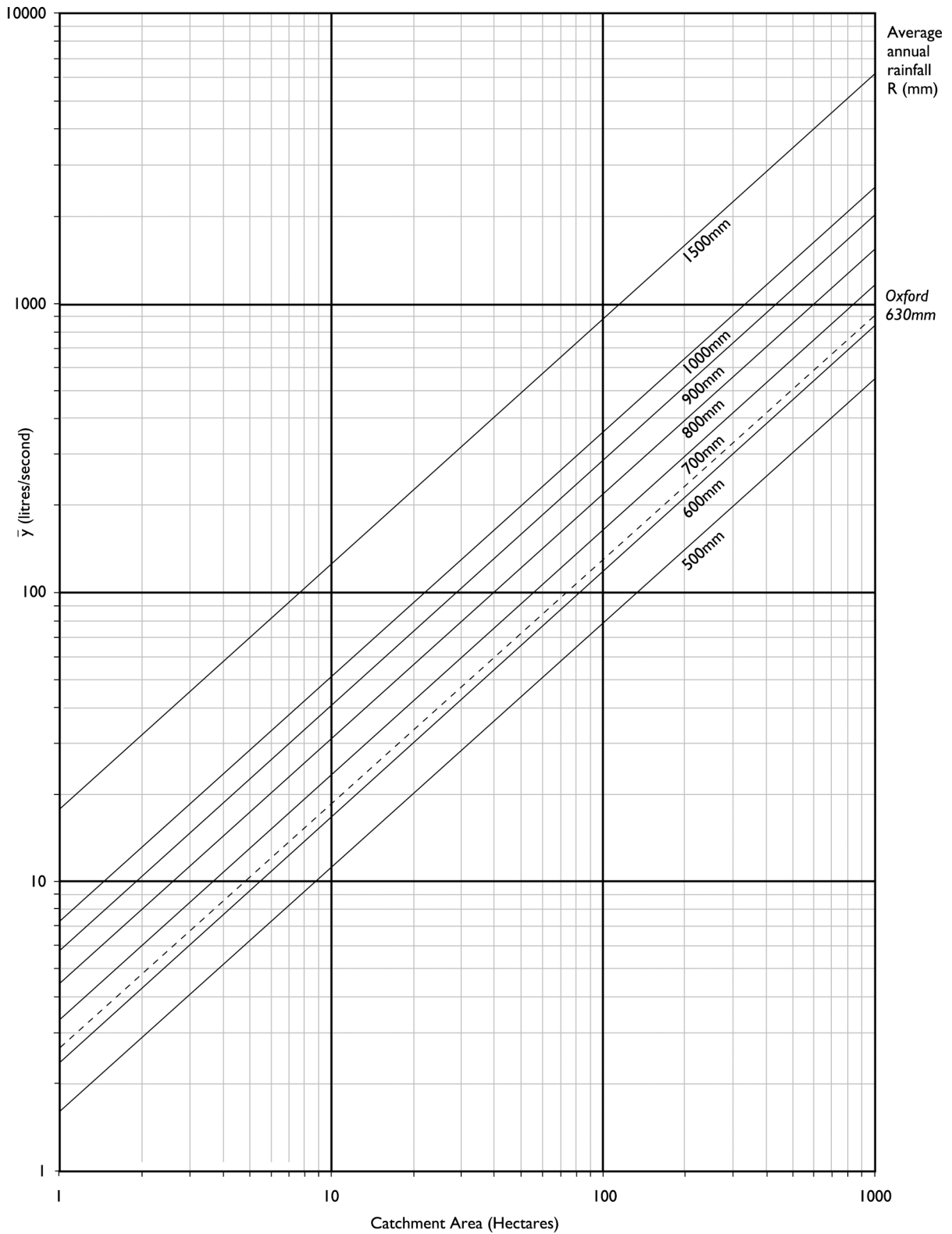


Appendix B: Chart to Determine Flow Rates (based on Nash & Shaw Formula)



NASH & SHAW FORMULA: $= 1.84 \times 10^{-6} \cdot A^{0.85} R^{2.2}$
 1 Year Flood = 0.58y 5 Year Flood = 1.48y 25 Year Flood = 1.76y

Calculation of Run-Off from Catchment Areas for Determination of Pipe Culvert Sizes on Existing Watercourses

1. The graph (Appendix B cont.) has been produced from Nash's formula, Derived from studies of river floods and correlation of observed data. This Work was carried out for large catchments of major rivers and subsequently modified by Shaw for smaller catchments and it is in this form that it is reproduced here.

2. Notes on Use

- Determine the catchment area by marking the watershed on a plan as accurately as possible and then measure the area by planimeter. No impermeability factor is used.
- Obtain the average annual rainfall for the catchment area by reference to maps available in the Highway Management Group Bridge Office.
- Read off Y (the mean of annual floods in litres/sec) from the graph.

The mean of annual floods is calculated to occur every 2.33 years. For consideration of other periods of time, multiplying factors are given at the top left-hand corner of the graph sheet. Pipes carrying watercourses under road works should be designed to carry at least a 10 year storm. Where the consequences of flooding are likely to be very serious the design must be based on 50 year storms.

- The diameter of the required pipe will then be selected by referring to the Hydraulics Research Station Design Tables 6th Edition.
- Examine existing culverts on the same watercourse within a short distance of the site, particularly upstream, and always allow for at least an equivalent waterway area for the pipe. Local knowledge of flooding of the watercourse can also be useful in deciding on a pipe size and the Area Engineer should be consulted in all cases.
- Ultimately authority will have to be sought from the Environment Agency under section 23 and 24 of the Land Drainage Act 1991.