Design Manual for Roads and Bridges

Drainage
Design

CD 522
Drainage of runoff from natural catchments

(formerly HA 106/04)

Revision 0

Summary
This document provides requirements and advice for dealing with surface water runoff from natural catchments draining towards motorways or all-purpose trunk roads, in order to limit the frequency and severity of flooding incidents caused by runoff from beyond the highway boundary.

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
0	Mar 2020	CD 522 replaces HA 106/04. This full document has been re-written to make it compliant with the new Highways England drafting rules.

Foreword

Publishing information

This document is published by Highways England.

This document supersedes HA 106/04, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This document sets out the requirements and advice for dealing with surface water runoff from natural catchments draining towards motorways and all-purpose trunk roads, in order to limit the frequency and severity of flooding incidents caused by runoff from beyond the highway boundary. By enhancing flood risk management design requirements, the impact of extreme storm events, such as those experienced during autumn 2000, will be minimised.

Surface water runoff to road drainage systems is conventionally assumed to derive from the road cross-section. This includes the road surface, verges and adjacent cuttings or embankments (known as interior catchment). Additional surface flow may also be produced by runoff draining to the road from land outside the highway boundary known as exterior catchment.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 5.N] apply to this document.

Exterior catchments can be rural, urban or a combination of both. This document deals solely with rural (natural) catchments since exterior urban catchments have their own specific drainage systems.

Abbreviations

Abbreviations

Abbreviation	Definition
EPA	Environmental Protection Agency

Terms and definitions

Terms

Term	Definition
Catchment length	The distance of natural catchment adjacent to the highway boundary, measured parallel to the road.
Catchment width	For valley catchments – the distance between the top end of the catchment and the top of the cutting, or the pavement edge, measured along the valley, perpendicular to the ground contours (distance A-B in Figure 3.2.N2). For strip catchments – the distance between the highest point of the catchment and the top of the cutting, or the pavement edge (distance C-D in Figure 3.2.N2).
Exterior catchment	Land outside the highway boundary.
Interior catchment	Includes the road surface, verges and adjacent cuttings or embankments.
Strip catchments	Catchments with no defined valley, forming a strip of fairly uniform width along the highway boundary.
Valley catchments	Catchments formed by a well-defined valley, either dry or drained by a watercourse (including ephemeral streams).

1. Scope

Aspects covered

1.1 The requirements, advice and methodologies contained within this document shall apply to new road projects as well as to drainage improvement schemes on existing roads.

1.2 To ensure resilience of the road network during extreme weather conditions, all runoff from natural catchments draining to the road shall be intercepted and prevented from entering the road drainage network.

NOTE 1 Natural catchments adjacent to roads vary significantly in size, shape, type of soil and vegetation cover, and the amount of runoff contributing to existing road drainage systems can range from negligible to significant.

NOTE 2 Natural catchment drainage systems are separated from the road drainage systems with both systems retained in the ownership of the Overseeing Organisation.

1.3 Roads with a history of flooding from smaller catchments (less than 0.01 km^2, or 1ha) shall be re-mediated.

1.4 Sites with a history of frequent flooding shall be re-mediated on a site-specific basis.

1.5 Where flooding and inundation of the road drainage network is the consequence of changes in groundwater levels, an assessment of the causes shall be undertaken before implementing a design solution.

1.6 In undertaking an assessment of the source of road flooding from changes in groundwater levels, the relevant environment protection agency (EPA) or the British Geological Society shall be consulted.

NOTE In certain areas of the UK and in periods of high groundwater levels, springs can appear at the surface in catchments adjacent to roads. These springs can generate significant flows and potentially cause or increase the risk of road flooding.

Implementation

1.7 This document shall be implemented forthwith on all schemes involving the drainage of runoff from natural catchments on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 5.N].

Use of GG 101

1.8 The requirements contained in GG 101 [Ref 5.N] shall be followed in respect of activities covered by this document.

Health and safety

1.9 Safety risk mitigation measures shall follow the ERIC hierarchy - eliminate, reduce, isolate and control for each identified safety risk.

2. Methodology

2.1 When determining the procedure for dealing with runoff from natural catchments, the stages identified in Figure 2.1N1 shall be followed.

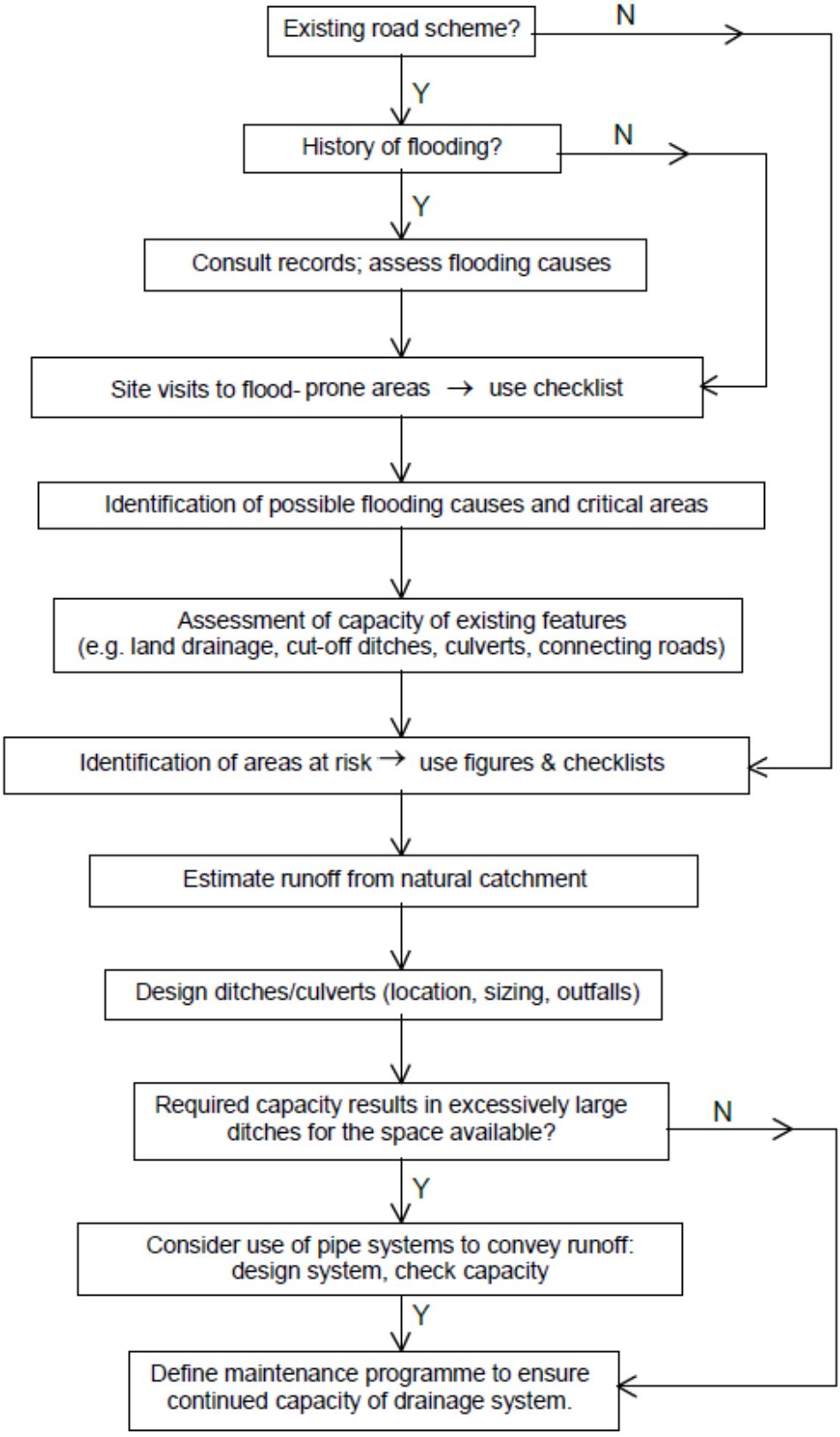
NOTE 1 The most important stages for dealing with runoff from natural catchments are:

1) identification of flood prone areas and characterisation of natural catchment;

2) estimation of runoff; and

3) hydraulic design of ditches/culverts and/or upgrade of existing road drainage system.

Figure 2.1N1 Methodology flowchart



NOTE 2 For the design of ditches, see CD 532 [Ref 6.N].

NOTE 3 For the design of culverts, see CD 529 [Ref 2.N].

NOTE 4 For the design of road drainage systems, see CG 501 [Ref 1.N].

3. Natural catchment identification

3.1 The size, shape and location of natural catchments draining towards motorways and all-purpose trunk roads shall be determined.

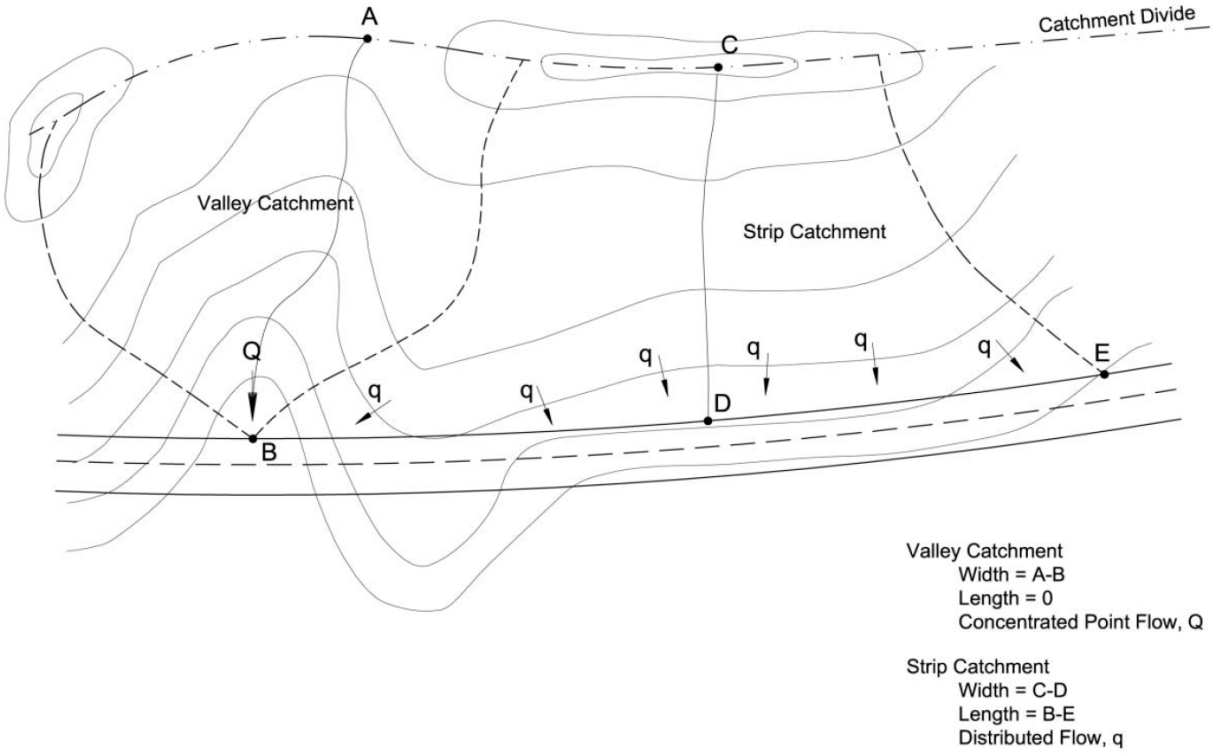
NOTE The runoff rate from natural catchments is likely to vary from negligible amounts from catchments of small dimensions to large flow rates which can adversely impact upon the safe operation of the road (e.g. overburdening of the road drainage system, soil erosion, slope stability).

3.2 Flows from natural catchments shall either discharge into ditches or pass through culverts or bridges under the road.

NOTE 1 Natural catchments are likely to vary considerably along the road alignment.

NOTE 2 There are two types of natural catchment that can be encountered alongside roads, valley catchments or strip catchments (see Figure 3.2N2).

Figure 3.2N2 Valley and strip catchments



3.3 The natural catchment type, width and length shall be determined.

3.4 Where a catchment exceeds 10km width, the methods described in the Flood Estimation Handbook FEH [Ref 3.N] shall be used.

NOTE In flat areas, the definition of the natural catchment boundary is not always obvious.

3.4.1 When defining the extent of natural catchments adjacent to roads, Ordnance Survey maps at 1:25,000 scale should be consulted.

NOTE 1 Site inspections are also recommended as they provide useful information on relevant local features that impact on flow paths, such as intersecting ditches, mounds and embankments.

NOTE 2 Due to the linear nature of roads, the discharge points for the natural catchment flows is in most cases the same as those used for the discharge of road runoff.

3.4.2 The criteria to be met in terms of pollution loads is potentially less stringent for runoff from natural catchments and therefore more points of discharge may be determined to be suitable.

NOTE *Areas where the amount of silt in the runoff is expected to be very high can still be associated with a significant pollution risk.*

3.5 All natural catchments with a width greater than 50m shall be investigated.

3.6 Natural catchments that are less than 50m in width shall be investigated where there is a history of frequent local flooding.

3.7 Areas susceptible to flood risk shall be identified for design intervention.

NOTE 1 *Areas susceptible to flood risk on new schemes include (but not are limited to):*

1) low points/areas (sag);

2) inner areas of bends in road alignment where accumulation of flow can occur due to adjacent catchment;

3) connection with other roadways (e.g. slip roads) that can act as a drainage pathway;

4) large fields adjacent to the road (see Figure 3.7N3, Examples A.1, B.1 and C.1)

5) slopes intercepted by the road (see Figure 3.7N3, Examples A.2 and A.3)

6) areas of well defined stream catchment (even if stream is ephemeral) producing concentrated flows;

7) presence of natural springs.

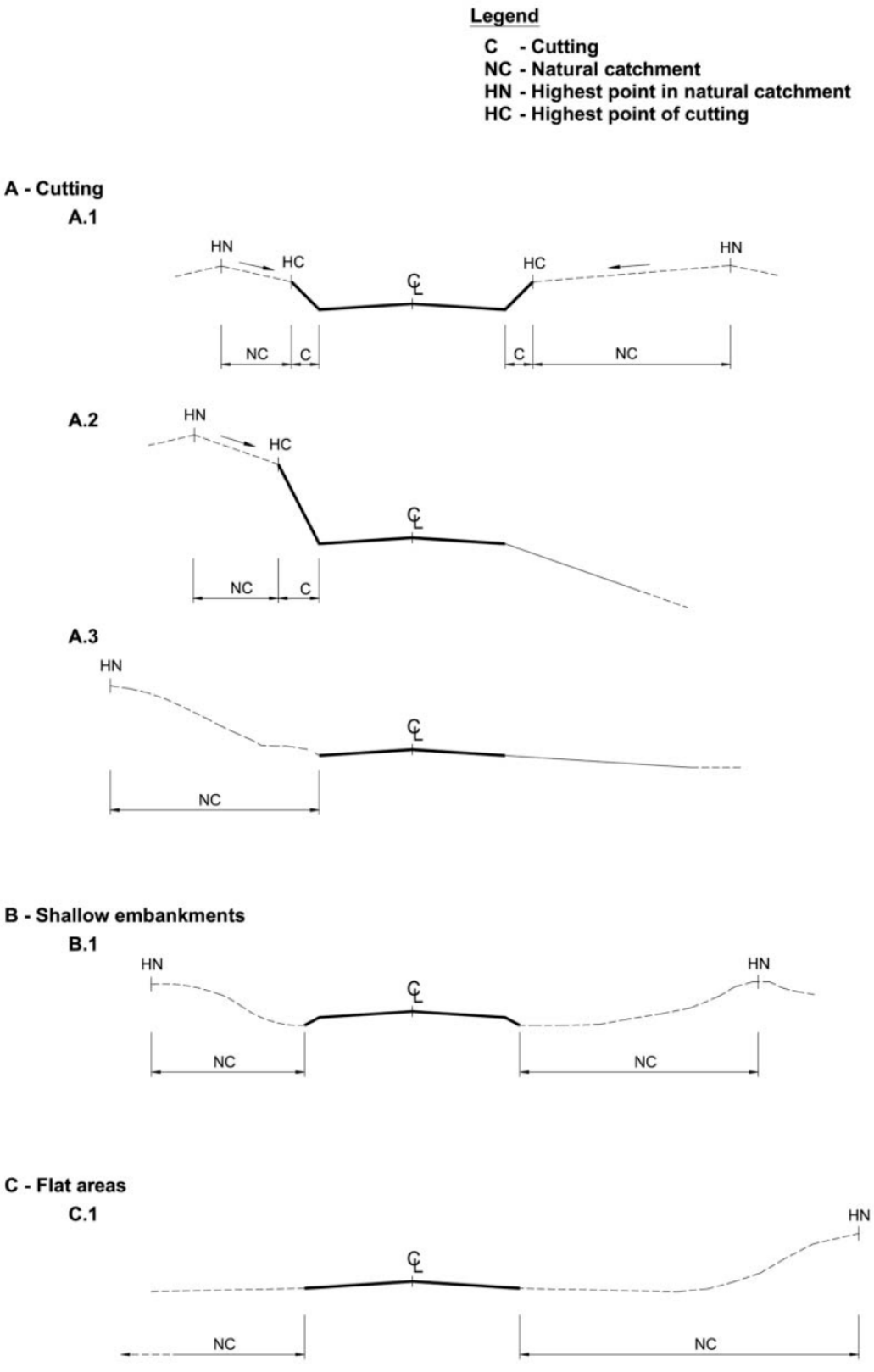
NOTE 2 *Areas susceptible to flood risk on existing schemes include (but not are limited to):*

1) those with poor condition of existing cut-off ditches, land drainage and culverts (i.e. overgrown vegetation in ditches, blockages in culverts and ditches, collapsed drains);

2) those where the outfall does not allow free discharge.

NOTE 3 *Examples of natural catchments that can produce volumes of runoff which can impact upon safe operation are given in Figure 3.7N3. They refer to two situations, roads in cutting and in shallow embankments.*

Figure 3.7N3 Natural catchments that can produce volumes of runoff which can impact upon safe operation



4. Collection of runoff

4.1 Where natural catchments containing a well-defined watercourse are intercepted by roads, a culvert or bridge shall be provided to ensure that the runoff is conveyed away from the road construction.

NOTE The design of culverts is covered in CD 529 [Ref 2.N].

4.2 Where natural catchments without a well-defined watercourse path are intercepted by roads, ditches or pipes shall be used to convey and discharge the runoff.

NOTE 1 Natural catchments without a well-defined watercourse path can produce significant amounts of runoff.

NOTE 2 For the design of ditches see CD 532 [Ref 6.N].

NOTE 3 For the design of piped drainage see CG 501 [Ref 1.N].

5. Estimation of runoff

5.1 Flow rates from natural catchments shall be determined for a 1 in 100 year storm with the relevant allowance for climate change.

NOTE 1 For climate change allowances see CG 501 [Ref 1.N].

NOTE 2 Road drainage systems are designed to intercept and remove rainfall from short duration, high intensity events with return periods of 1 year for no surcharge of piped systems or road-edge channels or 5 years for no flooding of the carriageway.

NOTE 3 Runoff from natural catchments can have tortuous flow paths. Flood flows from natural catchments can take several hours to reach the point of discharge. The duration of a flood event from a natural catchment can therefore lead to longer periods of traffic disruption when compared with flood events occurring on the carriageway, where the time of concentration of the system is only a few minutes.

5.2 The estimation of runoff from natural catchments shall be undertaken using one of the runoff methodologies referenced below:

1) Institute of Hydrology Report 124 IH 124 [Ref 4.N];
2) Flood Estimation Handbook FEH [Ref 3.N].

5.3 IH 124 [Ref 4.N] shall only be used to estimate flood flows on catchments with surface areas less than 25 ha.

NOTE 1 IH 124 [Ref 4.N] is a runoff methodology that allows estimation of runoff from natural catchments without the need for hydraulic modelling.

NOTE 2 The design flows estimated with the runoff methodologies are surface runoff flows that take into account saturation of the soil.

6. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. CG 501, 'Design of highway drainage systems'
Ref 2.N	Highways England. CD 529, 'Design of outfall and culvert details'
Ref 3.N	Wallingford HydroSolutions. FEH, 'Flood Estimation Handbook'
Ref 4.N	Institute of Hydrology (1994). Marshall D.C.W. and Bayliss A.C. IH 124, 'Institute of Hydrology Report 124. Flood estimation for small catchments'
Ref 5.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 6.N	Highways England. CD 532, 'Vegetated drainage systems for highway runoff'