



Drainage Design Guide

Adoption Standards for carriageways
and other paved areas

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Transportation, Waste and Environment Service

Adoptions standards for carriageways and paved areas

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Introduction

The Highways Act (1980) sets out legislation with respect to highways. The incorporation of associated highway drainage systems usually require the developer either to enter into an agreement under Section 38 of the Highways Act if involving new development, or an agreement under Section 278 of the Act if existing arrangements are to be modified.

Highway Authorities have the power to construct, adopt, and maintain highway drainage infrastructure. This guidance aims to provide a foundation for consistency of highway drainage design to current design standards which developers must follow to ensure that systems are satisfactorily designed and constructed.

Several changes have been made from previous guidance to reflect legislative changes and the move away from merely design specifications to a modern philosophy of source control, and performance specification. For instance, high return period design storms must now be simulated, and flood flow paths examined as part of the design of highway drainage. It does not matter to the public, whom we serve, whether a pipe surcharges or a manhole floods, but rather that flooding causes nuisance, inconvenience, damage, or health and safety risks.

Section 1 Design Considerations

1.1 General Principles

Unless otherwise indicated in this design guide, highway drainage shall be in accordance with the Design Manual for Roads and Bridges (DMRB), and the latest design manuals and guidance notes published by The Construction Industry Research and Information Association (CIRIA) including:

- (i) C635 Designing for Exceedance in Urban Drainage – Good practice
- (ii) C698 Site handbook for the construction of SUDS
- (iii) C753 The SUDS manual
- (iv) C680 Structural designs of modular geocellular drainage tanks
- (v) C625 Model agreements for sustainable water management systems
- (vi) B14 Design of flood storage reservoirs
- (vii) R156 Infiltration drainage
- (viii) C582 Source control using constructed pervious surfaces

or revisions or updates to the above.

Construction details should conform to Highway Construction Details in the MCHW (MCHW HCDs) unless an equivalent detail exists in the Cornwall Council Highway Construction Details (CC HCDs). Re-instatement of carriageways should be in accordance with CC HCDs and the NRSWA Specification for the Reinstatement of Openings in Highways (Dept. for Transport/HAUC ACoP).

Designers are also referred to National Planning Policy Framework which sets out Government policy on development and flood risk.

The developer should also take account of any Strategic Flood Management Plans that have been carried out by the Council and build upon these proposals for integrated sustainable development.

1.2 Climate Change

In February 2016 the Environment Agency issued new advice relating to the climate change allowances.

Cornwall Council have therefore increased the climate change allowance to 40% for all developments and designers should ensure that their designs reflect this.

1.3 Factors of Safety

When designing infiltration systems one of the greatest uncertainties is future performance. Over time infiltration rates can reduce, particularly if little or no effective pre-treatment is included in the design or the system is poorly maintained. To account for this, a factor of safety is introduced into the design procedure. By including the factor of safety, the infiltration rate used in the design is reduced to take account of possible loss of infiltration capacity through the design life of a system.

Factors of safety are based on engineering judgement and depending upon the consequences of failure. The values in the table below are based on Table 25.2 of The SuDS Manual C753.

Cornwall Council reserves the right to apply stricter regulation within Critical Drainage Areas and locations of known flood risk and drainage issues, than those suggested by The SuDS Manual C753. This is to ensure that development has a positive, rather than just neutral, impact on flood risk.

Factors of Safety in Cornwall					
	Consequence of Failure				
	No damage or inconvenience	Minor inconvenience (e.g. surface water on minor roads, cul de sacs and car parking areas)	Damage to buildings or structures or major inconvenience (e.g. flooding of main roads, residential distributor and access roads)	Critical Drainage Areas	Non-Critical Drainage Areas with known flooding or drainage issues
Highway Drainage	5	5	10	10	10

1.4 Designing for Exceedance

Flood flow paths must be examined as part of the design of the adoptable highway drainage, as outlined in CIRIA C635: Designing for Exceedance in Urban Drainage – good practice.

Safe and appropriate flow routes as a result of blockage and exceedance of the drainage system must be evaluated, and the potential effects of flooding assessed.

Exceedance areas and overland flood routes are to be clearly indicated on the relevant drawings and these must be secured to prevent them being

blocked in the future. Where exceedance flows run on to land or into waterways belonging to third parties then evidence of consultation with, and approval from, that third party land owner and any other stakeholder must be included with the submission.

Where exceedance flows go off site the Environment Agency (EA) may be a 'statutory consultee' required to be consulted (or the Council may deem it necessary to do so on receipt of exceedance flow route drawings). In this event the design for exceedance must gain EA approval and this is to be included in the submission. As advised in CIRIA C635 it would be good practice to consult with the Council (or directly with EA or any stakeholders) regarding exceedance flows at an early stage.

1.5 Runoff

Equivalent impermeable areas should be obtained by applying the following factors to the measured contributing areas in accordance with the DMRB & principles of the Wallingford Procedure:-

Paved surfaces and impermeable areas	1.0 (hardstandings 100% impermeable (DMRB))
Runoff from other areas	Appropriate factor based on the Wallingford Procedure and HA 106/04 Drainage Of Runoff From Natural Catchments

The total discharge from the site should be no more than the theoretical greenfield runoff rates using the methods recommended in the DMRB. Greenfield runoff rates, allowable discharges, and long-term storage requirements should be confirmed with the Environment Agency (EA).

Pollution prevention methods should be incorporated to prevent polluted runoff. The incorporation of SUDS may prevent the need for oil separators. Refer to Pollution Prevention Guidelines (PPGs) especially PPG1 (General Guide), PPG 2 (above ground oil storage tanks) and PPG3 (Use & design of oil separators). The requirements for oil separators should be confirmed with the EA.

Section 2 Network Design

2.1 General

The system should be designed for various design storms plus a 40% allowance for climate change using an appropriate flow simulation method based on the Wallingford Procedure. The following design storms merit specific consideration:

- 1 year Return Period – Longitudinal carrier drains must accommodate a one-year storm without surcharge (DMRB).
- 5 year Return Period – Filter drains must be checked to ensure no surcharge of chambers above formation level or sub-formation level where a capping layer is present (DMRB).
- 30 year Return Period – The system must be designed not to flood.
- 100 year Return Period – No property damage and any temporary flooding retained either within the system or within the site in appropriate locations ie public open space (National Planning Policy Framework, CIRIA 697, SFA6, et al).

The minimum self cleansing velocity of drains should be 0.85m/sec at pipe full flow. The maximum velocity of drains should normally be limited to 5m/sec. For velocities in excess of 5m/sec, suitable pipe and bedding combinations should be based on manufacturer's recommendations. Acute connection angles of drains should be avoided due to susceptibility to sediment build-up.

The system should be designed with a MADD factor of 0 and an Areal Reduction factor of not less than 0.95

Plans showing catchment areas, catch pits, pipe reference numbers and overland flood routes should be included with all submissions. The pipe references in the drainage designs should be referred to on the plan.

Longitudinal sections should be provided showing the proposed drainage, pipe sizes and materials, catchpit locations and bedding factor in relation to the existing ground levels, road alignment and finished levels.

Flexible plastic pipes without BBA certification and plastic 'crate' modular units are not acceptable within the adoptable highway limits.

All pipes of 900mm diameter and culverts with a span of 900mm and above, including those installed as part of a S104 agreement, culverted watercourses or for any other reason, will require a structural check in accordance with our current standards – please refer to our Structural Design Guide for further information.

Large diameter plastic pipes may be considered on a site by site basis as part of the highway drainage network beneath areas of public open space, however this subject to suitable access and easements being provided and receipt of a satisfactory AIP or D&C Certificate – please refer to our Structural Design Guide for further information.

2.2 Minimum Pipe Depth

Pipe bedding and surround shall be in accordance with HA 40: Determination of Pipe Bedding Combinations for Drainage Works. The minimum cover to pipes shall be:

- 1.2m (in the carriageway)
- 0.9m (in footways, footpaths, service strips or verges)

Where it is physically impossible to meet these standards, Cornwall Council's Engineer may permit reductions to 0.9m and 0.6m respectively, subject to the pipes being laid on a bed of, and surrounded by, 150mm of concrete Mix ST2.

Inverted siphons and "bubble-ups" are not acceptable.

Evidence may be required that all pipe sizes, materials and bedding proposed over the range of depths proposed for all adoptable highway drainage are structurally adequate.

2.3 Minimum Conduit Size

The minimum pipe diameter shall be:

- 150mm gully connections.
- 225mm carrier drains, including combined carrier and filter drains

Minimum size of hydraulic controls shall be as follows:

- 100mm for orifice plates
- 75mm for vortex control devices (and in accordance with manufacturers recommendations)
- 150mm for throttle pipes. Throttle pipes should be less than 15m in length.

2.4 Catchpit Positions

Catchpits shall be provided in the following locations:

- at every change of alignment or gradient
- at the head of all main pipelines
- at every junction of pipelines except for single gully connections
- at every change in pipe diameters

- at a maximum spacing of 100 metres (centre to centre)

Catchpits are to have a minimum clear opening of 675mm x 675mm.

2.5 Subsoil Drainage

An adequate system of subgrade drainage to maximise longevity of the pavement and its associated earthworks shall be constructed to the satisfaction of Cornwall Council's Engineer where:

- the winter height of the water table is within 600mm of formation level; or
- the sub-soil is saturated; or
- there is a likelihood of water running from or out of adjacent ground; or
- springs, land drains, leats or other watercourses are encountered; or
- the subgrade is likely to be altered due to groundwater.

The designer is also referred to TRL report PPR341 Drainage of Earthworks Slopes. Future maintenance of drainage systems must be a principal factor in design. For this reason, fin drains should not be used.

2.6 Gully Systems

Gully spacing should be calculated in accordance with HA 102 Spacing of Road Gullies, and calculations should be provided as necessary using a catchment flow width of 0.75m. Individual gullies shall be spaced no more than 25m apart and not drain an area exceeding 120m².

Double gullies with separate connections to the main carrier pipe or catchpit are to be provided at all low points in the adoptable highway. Alternatively a single gully may be placed at the low spot with additional gullies no more than 3m either side.

Gullies are to be connected into a catchpit or manhole where reasonably practicable. Each gully shall have its own connection, not exceeding 12m.

Gully gratings and frames shall be to BS EN124 with a minimum width of 450mm, and minimum waterway area of 900cm². Distribution of waterway area shall conform to Figure 2 of BS 7903. Minimum frame depths to be:

- Class D400 - 100
- Class C250 - 75

Class D400 to be used unless specified otherwise.

Standing and running surface water at junctions, transitions, pedestrian crossings, and cycle lane entries should be minimized by installing a gully on the upstream side.

Gullies should not lie within pedestrian desire lines e.g. within pedestrian crossing points.

Footpaths and cycle ways not adjoining the carriageway are to be positively drained. Run off from adoptable footpaths and cycle ways that discharges onto adjacent private areas, including gardens, is not acceptable.

Slot drains are not normally accepted in adoptable areas

2.7 Flat Areas

New carriageways should be designed to avoid flat areas. Where there are flat areas on existing roads that are affected by the new development, the introduction of false falls should be considered, i.e. re-shape the road surface profile into peaks and troughs between gullies to achieve minimum gradients. For more information see TD 9/93 Highway Link Design Chapter 4, Para. 4.3. Alternatively, the use of flat or dished channels, combined kerb and drainage units may be considered in certain circumstances (to be approved by Cornwall Council's Engineer, due to maintenance liability).

2.8 Draining Backfalls on Footways

Where possible, footways should be designed to fall towards the carriageway at 2.5%. Where backfalls are unavoidable and if there is sufficient longitudinal fall then a "dish" should be formed in the surfacing, both slab paving or bitmac, and directed such that water flows off into the channel. At times this is not possible and a gully will be required within the footway. The use of dished channels should be avoided in footways where possible, as they can present a tripping hazard. Flat topped channels may be a solution, if required for aesthetic reasons.

The use of linear drainage channels should be carefully considered (to be approved by Cornwall Council's Engineer, due to maintenance liability and still require a positive outlet), although they can be useful at backfalls to door thresholds. Due consideration should be given to grating material and the risk of slips, for example, the risk of slips from cast iron gratings is less than that for zinc plated types.

2.9 Soakaways

Where soakaways are the proposed method of highway drainage, and are being offered for adoption as part of the S38 Agreement, the design will need to be approved by Cornwall Council

Infiltration tests shall be conducted in accordance with either BRE365 'Soakaway Design' or CIRIA R156 'Infiltration Drainage'. Soakaway designs should also take into consideration the requirements of HA118/06

In order to ensure that infiltration rates are representative of the ground that the soakaway is situated in the infiltration tests should be conducted as close as possible to the actual location of the proposed soakaway, and within the same depth range. As infiltration rates can vary significantly across a site particularly where rock may be encountered where tests taken are either more than 15m away from the centre of the final position of the soakaway or at a different depth to the final soakaway design then additional tests will be required. These tests should be taken at the location and depth of the proposed soakaway to confirm the infiltration rate. Trial pit logs are to be provided with each test pit, logged in accordance with BS EN 1997-2:2007

A minimum of three fillings should be conducted in each test pit. If it is impossible to carry out a full depth soakage test then the soil infiltration rate calculations should be based on the time of the fall of water from 75% to 25% of the actual maximum water depth achieved in the test.

The infiltration tests are to be carried out by a UKAS accredited laboratory.

The proposed soakaways should be designed using the slowest infiltration rate from one of the three tests in each pit, and a minimum 30 year return period plus the allowance for climate change should be used for design purposes.

Soakaways are to be constructed using either preformed plastic crates or perforated rings and installed in accordance with the manufacturers instructions. Filter / carrier drains can also be considered in certain circumstances; however this will need prior agreement with Cornwall Council.

Which ever type of soakaway is chosen, it must be suitable for use in trafficked areas and certified accordingly. The soakaway shall be designed with a suitable access point on it, and at the end of each inlet into it to allow future cleansing of the system in the event that it becomes silted. On larger soakaways, additional inspection chambers should be provided to allow future cleansing of the system in the event that it becomes silted.

All soakaways and filter drains are to be encased in a suitable geotextile to prevent fines being washed away

The position of the soakaways should be considered early in the design process. They must not be located beneath the adopted highway or areas subjected to regular HGV traffic. They should be situated not less than 3m from the edge of the carriageway (or any other area subject to highway vehicular loading) in areas of public open space or private car parking areas. The bottom of the soakaway should not extend below a line drawn at 45 degrees from the edge of the carriageway. Soakaways will not be accepted within the curtilage of private properties.

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Soakaways should be a minimum of 5m from any buildings, walls and structures. No permanent structures, play equipment, steps or significant landscaping should be placed on or adjacent to the soakaway or within the easement areas.

When determining the location of the soakaway, due consideration should be given to future maintenance. Provision must be made for pedestrian and vehicular access from the adopted highway to the whole of the soakaway and associated drainage runs without significant changes in ground level. Gradients within the easements should not normally be steeper than 1:20 across grassed or landscaped areas without suitable reinforcement.

Easements are required for any drainage outside of the adoptable highway and these should be a minimum of 3m around a soakaway and 3m either side of the centre of any pipe. Additional areas for access may be required.

When submitting a soakaway design for approval the following information must be provided to ensure that the design can be promptly checked and subsequently approved:

- Impermeable drainage area assumed in the calculations.
- Infiltration rate assumed for design purposes.
- Confirmation that a 30 year return storm period has been used in the calculations.
- The design method adopted (BRE 365 or CIRIA 156).
- Confirmation of the Factor of Safety assumed in the design (applies to CIRIA 156),
- Soakaway dimensions proposed and construction detail.
- Proposed invert level and effective drainage depth.
- Porosity of proposed drainage medium.
- Location plan(s), indicating the position of the infiltration test(s) with respect to the location of the proposed soakaway(s).
- The design submission must provide evidence that contaminated land does not exist, or that the construction of the drainage system will not harm the environment.
- Where appropriate, the design submission must provide evidence that the effects of past mining/quarrying activity has been considered and addressed.
- Ground water levels

2.10 Connection into Open Water Features

Where it is proposed to connect the highway drainage outfall into 3rd Party systems, evidence of a right to discharge in perpetuity will be required in all cases. In addition, for privately maintained features evidence of the proposed maintenance regime will also be required. Connections into 3rd party systems will only be accepted for discharge into open features such as ditches and ponds. Connection to 3rd party soakaways will not be accepted.

Proposed flows should enter ditches and watercourse etc in line with the flow, generally not exceeding 45 degrees.

Drainage should be designed to have a maximum discharge rate into open water features not exceeding 1 m/s for all storm events. Additional energy dispersion techniques should be considered to prevent scour at all outfalls.

Headwalls are to generally comply with the 500 series drawings, and they will be considered on a site by site basis. Access to the base of the headwall for maintenance purposes must be considered, and safe routes are to be provided where applicable.

2.11 Flow Control Devices

Flow control devices (weirs, plate orifices, hydrobrakes etc) are often a necessary part of a drainage design. Where a structure is involved for either the device or the storage (for example a pond with weir) then fully detailed structural engineering drawings will also be required for approval. Any device or structure should be designed in a way that enables easy and safe access for future inspections after structure and device is up and running.

Where a flow control is proposed then manufacturers' specifications must be provided for approval and any control device or structure must be modelled within the submitted drainage design network calculations to verify its performance in accordance with all the design year requirements.

Section 3 Construction

3.1 Inspections

CCTV surveys and reports are to be provided by the developer for all adoptable highway drainage including all gully connections, catchpits, inspection chambers, soakaways and headwalls.

If as a result of the CCTV and as-built surveys it is found that the constructed drainage differs significantly to the original designs provided, then a full set of revised calculations reflecting all the changes are to be resubmitted to demonstrate that the networks remain satisfactory.

3.2 CCTV Surveys

CCTV surveys and reports are to be provided for all adoptable highway drainage including gully connections using 'Wincan' survey and reporting software. In addition to traditional paper copies and DVDs, we will require copies of the survey, reports and drawings in electronic format.

Reports are to include:

- As built plans identifying the runs surveyed with catchpit, gully and pipe line references
- Sizes of all pipes surveyed
- Cover levels and the invert levels of all pipes entering the catchpits together with the size of all catchpits
- A video of all drainage runs with reports identifying all defects and their locations. Relevant stills taken from the videos are to be provided as required.
- PDF copies of the report, all plans, notes and defects sheets in accordance with Sewerage Rehabilitation Manual, 4th Edition.
- JPGs of all pictures.
- A copy of the video in .AVI format

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8 August 2017

Appendix 1 - Contact details

All enquiries concerning construction and adoption of Infrastructure

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