Work Package 04B – Drainage (Major Projects)

Presentation to the 'NRA Roadshow'

April, 2015.

Christian Nea

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National Roads Authority
Environment

Revision of the NRA's Drainage Standards

Contents

Contents of Presentation

- History.
- Previous NRA's Drainage Standards.
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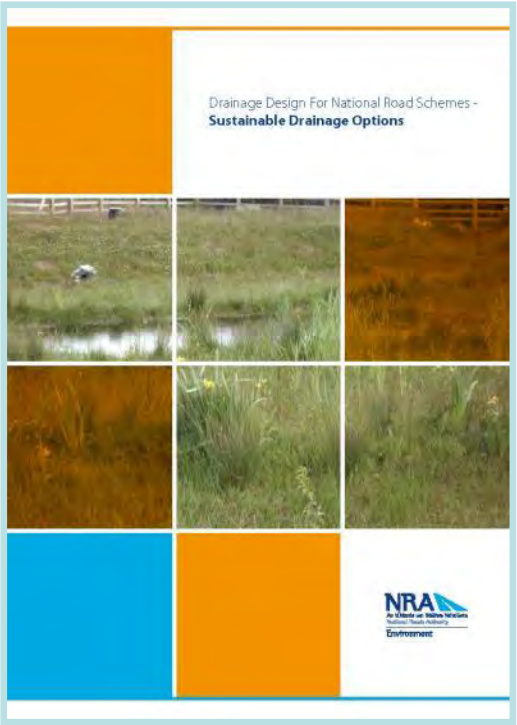
Revision of the NRA's Drainage Standards

History

History

April 2008 – September 2011: NRA Research Fellowship Programme

- NRA funded Post-Doctoral Research Fellowship to look at the impacts of national road drainage systems on surface and ground water.
- Result: NRA drainage standards need to be expanded to promote the use of SuDS and to maximise the environmental benefits achieved from drainage systems.



Drainage Design for National Road Schemes – Sustainable Drainage Options **(NRA, 2014).**

http://nrastandards.nra.ie/latest/other-nra-documents

Revision of the NRA's Drainage Standards

History

History

May 2012 – May 2013: Work Package 04A (Scoping)

- **May 2012**: ARUP procured to scope the works required to revise the NRA's drainage standards.
- **October 2012**: First Technical Steering Committee meeting.
- **December 2012**: Second Technical Steering Committee meeting.
- **February 2013**: Met with IFI, the OPW and the EPA.
- **March 2013**: Scoping finalised.

Revision of the NRA's Drainage Standards

History

History

May 2013 – March 2015: Work Package 04B (Major Projects)

- **May 2013**: ARUP procured to revise the NRA's drainage standards for major projects.
- **May 2013 – March 2015**: Production of Technical Notes on key issues.
- **May 2013 – March 2015**: Production of Commentaries on UK Design Manual for Roads and Bridges documents.
- **May 2013 – March 2015**: Production of NRA Design Manual for Roads and Bridges and NRA Manual of Contract Documents for Roadworks.

Revision of the NRA's Drainage Standards

History

History

May 2013 – March 2015: Work Package 04B

- **August 2013**: Third Technical Steering Committee meeting.
- **September 2013**: Met with Stakeholders to discuss issues of relevant in the draft Technical Notes.
- **March 2014**: Fourth Technical Steering Committee meeting.
- **April 2014**: Meeting with Stakeholders to recap on draft Technical Notes and discuss Commentaries on UK Design Manual for Roads and Bridges documents.
- **December 2014**: Fifth Technical Steering Committee meeting.
- **March 2015**: Publication of new NRA Drainage Standards.

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Revision of the NRA's Drainage Standards

Previous NRA Drainage Standards

Previous NRA Drainage Standards

- Volume 4 (Geotechnics and Drainage) of NRA Design Manual for Roads and Bridges (NRA DMRB):
  - NRA Addendum to UK HD 33/06 *Sub-Surface Drainage Systems for Highways.*

National Roads Authority
Design Manual for Roads and Bridges
Addendum

Volume 4 Section 2
Part 3 HD 33/06

NRA ADDENDUM TO

HD 33/06

SURFACE AND SUB-SURFACE DRAINAGE SYSTEMS FOR HIGHWAYS

Standard HD 33/06 – Surface and Sub-surface Drainage Systems For Highways – supersedes HD33/99. This Addendum supersedes the NRA Addendum dated December 2000 and its associated Erratum No 1 dated June 2001.

Standard HD 33/06 – Surface and Sub-surface Drainage Systems For Highways – is applicable in Ireland with the following amendments:

INTRODUCTION

The principle changes from the addendum to HD 33/06 are as follows:-

Reference is included to the following Advice Notes which have been published since the original version of HD 33/06: TA 80, HA 83, HA102, HA103, HA 104, HA 105, HA 106, HA 113, HA 118, HA 119, and HA 216.

In particular HA 104 sets out procedures and defines materials which will provide the best possible performance of road chamber top and gully top installations in national roads and motorways.

In Chapter Three a section on Combined Channel & Pipe Systems has been added. Table 3.1 has changed as a result and a new Table 3.2 has been added listing guidance documents. In addition Figures 3.1 and 3.2 now impose mandatory requirements and the use of alternative drainage systems will require a departure from standards.

In Chapter 4 Table 4.1 reference to HA 48 has been replaced by reference to HD 41 published in 2003.

In Chapter 5 reference is now made to HA 106 published in 2004.

Chapter 6 now requires that the rainfall intensities used in the design of drainage systems be increased by 20% in order to allow for the future effects of climate change.

Chapter 6 also includes new sections regarding Combined Channel & Pipe Systems and Discharges to Outfalls and Soakaways.

A new Chapter 7 Control of Pollution and Flooding has been added. This lists systems with the potential for control of pollution or flooding.

All Road Construction Details previously included in NRA Addendum to HD 33/06 have now been included in Volume 4 of the NRA Manual of Contract Documents for Road Works.

Jan 2009

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Previous NRA Drainage Standards

Previous NRA Drainage Standards

- NRA Manual of Contract Documents for Road Works:
  - Volume 1: NRA Specification for Road Works – Series 500 – Drainage and Service Ducts;
  - Volume 2: Note for Guidance on the Specification of Road Works – NG Series 500 – Drainage and Service Ducts;
  - Volume 3: Method of Measurement for Road Works and Notes for Guidance on the Method of Measurement for Road Works; and,
  - Volume 4: Road Construction Details (RCDs).

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

New NRA Drainage Standards

- Revised NRA Design Manual for Roads and Bridges (NRA DMRB)(1 amended and 13 new documents).
- Revised NRA Manual of Contract Documents for Roadworks (NRA MCDRW).

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 *Drainage Systems for National Roads*

- Provides guidance on the selection of drainage systems for national roads.


NRA

NRA Design Standards and Specification for Roads and Bridges

Drainage Systems for National Roads

[Doc Ref: D7436-04B-D04-HD0033X-P02]

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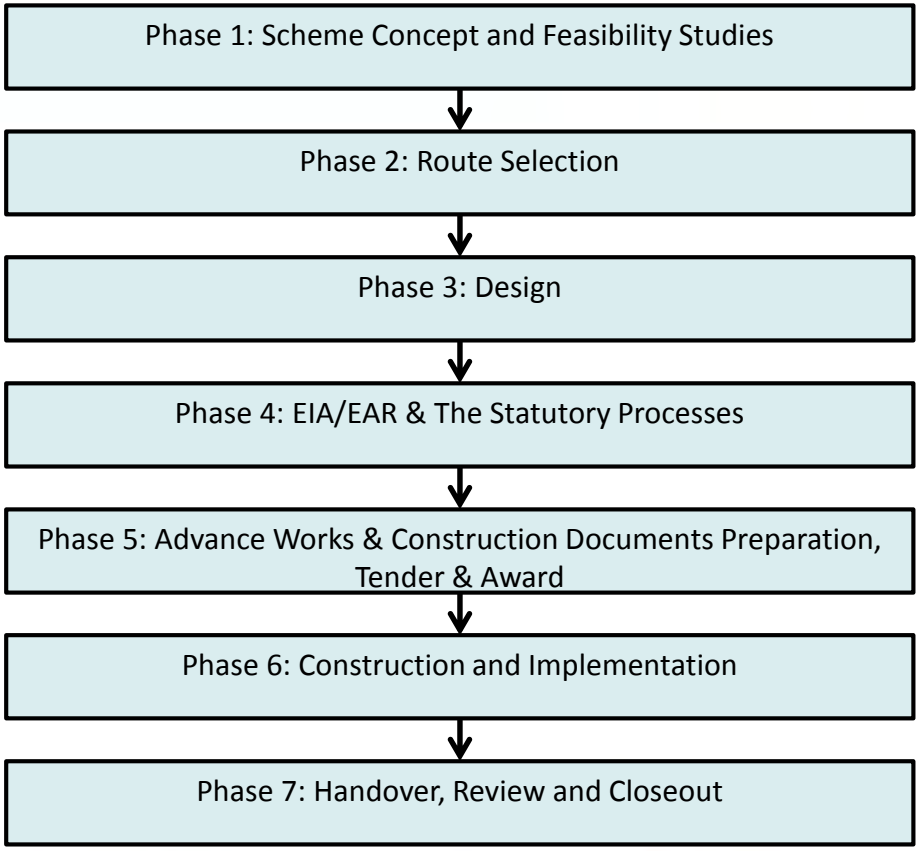
New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

- The drainage design, including pollution control measures, must be developed to an adequate level of detail at Phases 3/4.



Revision of the NRA's Drainage Standards

New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

- Maximum length of carrier pipe between access chambers is 100m.
- 'No worsening' of flow rates up to and including the 1 in 100 year storm.
- 25m^3 spillage containment capacity.
- No use of access chambers within carriageways.

Access chamber within carriageway.

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

- Geogrid on combined filter drains required at locations likely to experience vehicular overrun. Use of geogrid mandated:
  a) hard shoulder/hard strip < 2.5m;
  b) lay-bys;
  c) approaches to slip roads;
  d) toll plazas.

Surface of combined filter drain with geogrid.

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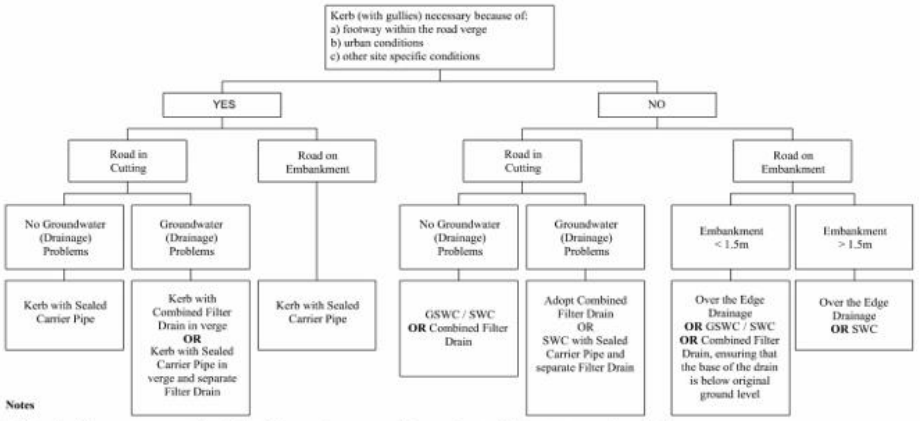
New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15

[Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage



Notes

1. Alternative drainage arrangements to those indicated above require an approved departure from standard/aspect not covered by standard.
2. A separate sub-surface drain shall be incorporated with all drainage options shown in this figure with the exception of a Combined Filter Drain. Separate sub-surface drains include the choice of Fin Drain, Narrow Filter Drain and Extension of Capping Layer. Extended capping is only allowable where the base of the extended capping layer is above the adjacent ground level and not subject to groundwater inundation. Fin Drain usage with road gullies should only be permitted if gully connections have no adverse effect on the Fin Drain.
3. GSWC denotes a Grassed Surface Water Channel and SWC denotes a concrete Surface Water Channel. Drainage channel blocks may only be used as an alternative to GSWC & SWC where sufficient distance between the channel and pavement edge is present in accordance with NRA HD 39 and RCD/100/8.
4. Kerbed Drainage Systems include Kerb & Gully system, Combined Kerb & Drainage system, and Kerb & Drainage Channel Blocks. Linear Drainage Channels are not permitted in verge-side edge drainage.
5. Careful consideration should be given to the type of drainage system to be used in conjunction with the pollution protection assessments provided in NRA HD 45. Site specific conditions for an 'impermeable system' may preclude some of the options provided above. Refer to clause 1.7, 4.12 and 4.14.
6. Groundwater (Drainage) Problems refer to those areas where there is a risk of rising groundwater levels saturating the 300mm zone below pavement formation level (or sub-formation level if a capping is present).

Figure 3.1: Design Options for Verge-side Edge Drainage

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New NRA Drainage Standards

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NRA HD 33/15

[Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage - Notes

1. Alternative drainage arrangements to those indicated above require an approved departure from standard/aspect not covered by standard.
2. A separate sub-surface drain shall be incorporated with all drainage options shown in this figure with the exception of a Combined Filter Drain. Separate sub-surface drains include the choice of Fin Drain, Narrow Filter Drain and Extension of Capping Layer. Extended capping is only allowable where the base of the extended capping layer is above the adjacent ground level and not subject to groundwater inundation. Fin Drain usage with road gullies should only be permitted if gully connections have no adverse effect on the Fin Drain.
3. GSWC denotes a Grassed Surface Water Channel and SWC denotes a concrete Surface Water Channel. Drainage channel blocks may only be used as an alternative to GSWC & SWC where sufficient distance between the channel and pavement edge is present in accordance with NRA HD 139 and RCD/100/8.
4. Kerbed Drainage Systems include Kerb & Gully system, Combined Kerb & Drainage system, and Kerb & Drainage Channel Blocks. Linear Drainage Channels are not permitted in verge-side edge drainage.
5. Careful consideration should be given to the type of drainage system to be used in conjunction with the pollution protection assessments provided in NRA HD 45. Site specific conditions for an 'impermeable system' may preclude some of the options provided above. Refer to clause 1.7, 4.12 and 4.14.
6. Groundwater (Drainage) Problems refer to those areas where there is a risk of rising groundwater levels saturating the 300mm zone below pavement formation level (or sub-formation level if a capping is present).

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Notes

- Alternative drainage arrangements require a departure.
- Extended capping is allowed as sub-surface drainage where the base is above adjacent ground level and not subject to groundwater inundation.
- Nearside linear drainage channels not permitted.

Nearside linear drainage channels.

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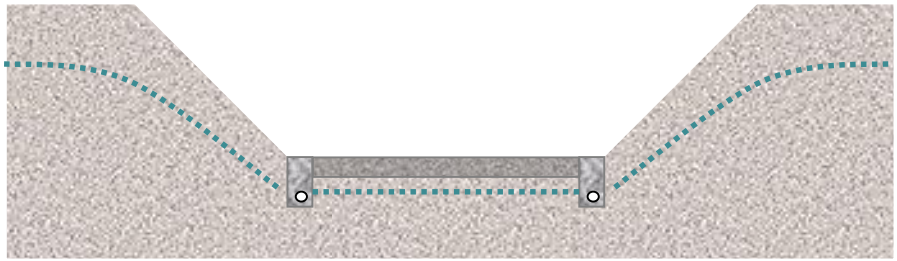
New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Notes

- 'Large' filter drains required for 'Groundwater (Drainage) Problems'.
- 'Groundwater (Drainage) Problems': '*… areas where there is a risk of rising groundwater levels saturating the 300mm zone below pavement formation level (or sub-formation level if a capping is present).*'



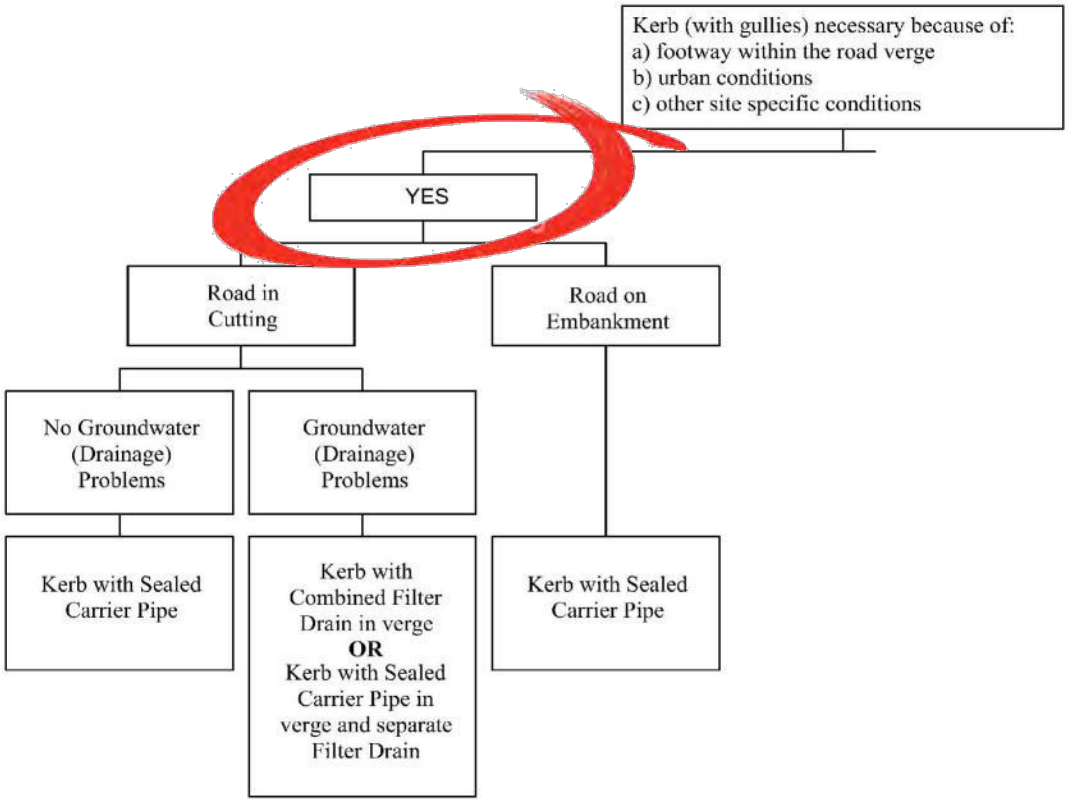
Revision of the NRA's Drainage Standards

New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Left-hand side: kerbs necessary



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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Left-hand side: kerbs necessary

- Kerbed drainage systems in the nearside verge permitted where there is:
  - a footway in the verge;
  - urban conditions; and/or,
  - other site-specific conditions.

Example of kerb on N5 Ballaghaderreen Bypass.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Left-hand side: kerbs necessary

- 'Kerbed drainage systems' include:
  - kerb & gully;
  - combined kerb & drainage system; and,
  - kerb & drainage channel block.

Example of combined kerb and drainage system on M3/N3 Clonee to Kells.

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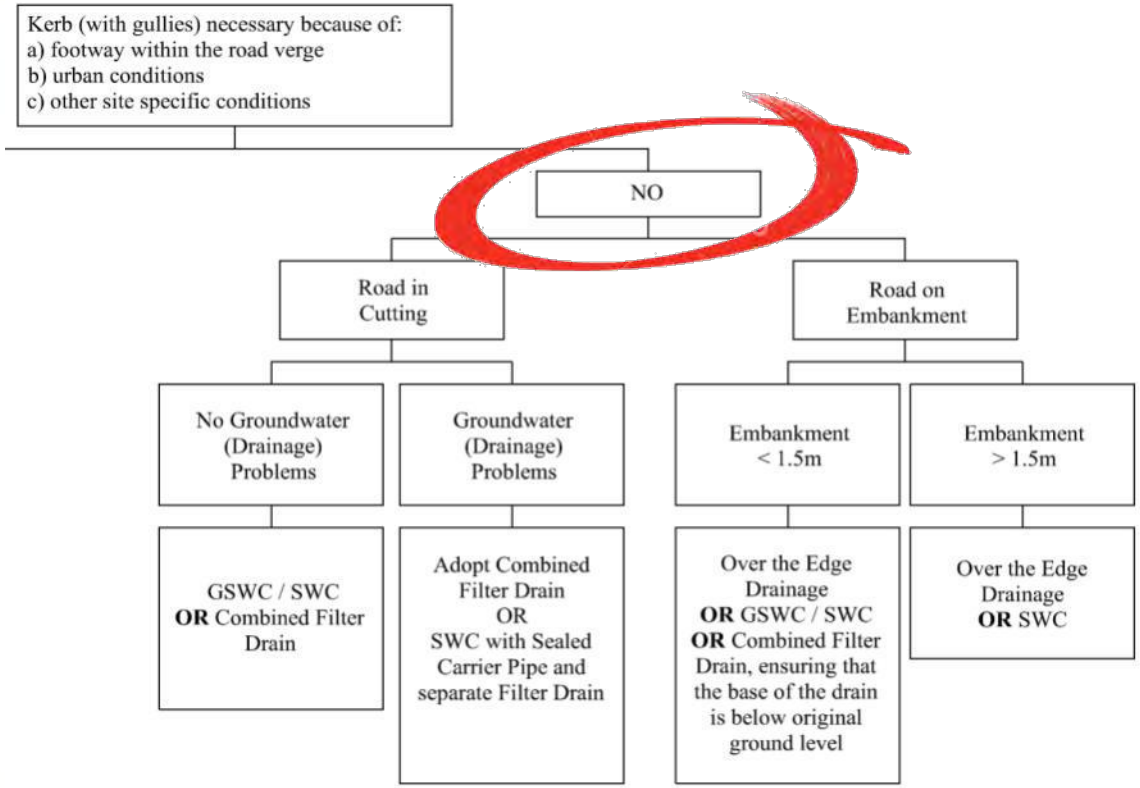
New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Right-hand side: kerbs unnecessary



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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 33/15 [Continued]

Figure 3.1: Design Options for Verge-side Edge Drainage – Right-hand side: kerbs unnecessary

- Grassed surface water channels now permitted, but not lined or on embankments greater than 1.5m in height.
- Over-the-edge drainage being permitted in all embankment scenarios.
- 'Encouragement' of combined filter drains in cuttings.

Combined filter drain on the N5 Ballaghdereen Bypass.

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New NRA Drainage Standards

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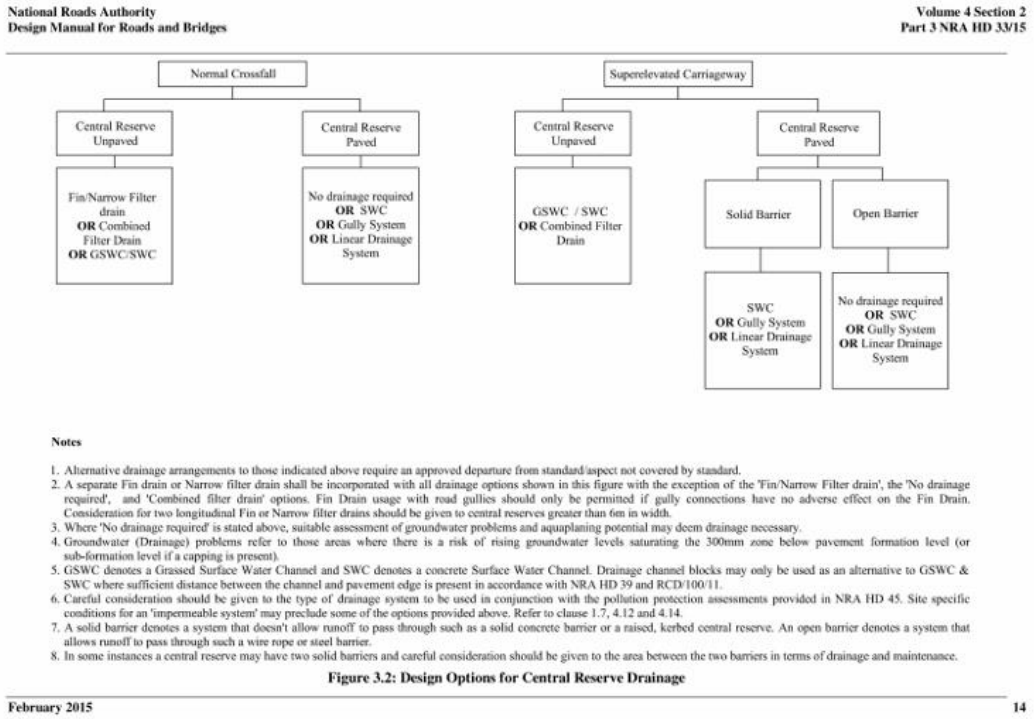
NRA HD 33/15 [Continued]

Figure 3.2: Design Options for Central Reserve Drainage



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Design Manual for Roads and Bridges

Volume 4 Section 2
Part 3 NRA HD 33/15

Notes

1. Alternative drainage arrangements to those indicated above require an approved departure from standard/aspect not covered by standard.
2. A separate Fin drain or Narrow filter drain shall be incorporated with all drainage options shown in this figure with the exception of the 'Fin/Narrow Filter drain', the 'No drainage required', and 'Combined filter drain' options. Fin Drain usage with road gullies should only be permitted if gully connections have no adverse effect on the Fin Drain. Consideration for two longitudinal Fin or Narrow filter drains should be given to central reserves greater than 6m in width.
3. Where 'No drainage required' is stated above, suitable assessment of groundwater problems and aquaplaning potential may deem drainage necessary.
4. Groundwater (Drainage) problems refer to those areas where there is a risk of rising groundwater levels saturating the 300mm zone below pavement formation level (or sub-formation level if a capping is present).
5. GSWC denotes a Grassed Surface Water Channel and SWC denotes a concrete Surface Water Channel. Drainage channel blocks may only be used as an alternative to GSWC & SWC where sufficient distance between the channel and pavement edge is present in accordance with NRA HD 39 and RCD/100/11.
6. Careful consideration should be given to the type of drainage system to be used in conjunction with the pollution protection assessments provided in NRA HD 45. Site specific conditions for an 'impermeable system' may preclude some of the options provided above. Refer to clause 1.7, 4.12 and 4.14.
7. A solid barrier denotes a system that doesn't allow runoff to pass through such as a solid concrete barrier or a raised, kerbed central reserve. An open barrier denotes a system that allows runoff to pass through such a wire rope or steel barrier.
8. In some instances a central reserve may have two solid barriers and careful consideration should be given to the area between the two barriers in terms of drainage and maintenance.

Figure 3.2: Design Options for Central Reserve Drainage

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New NRA Drainage Standards

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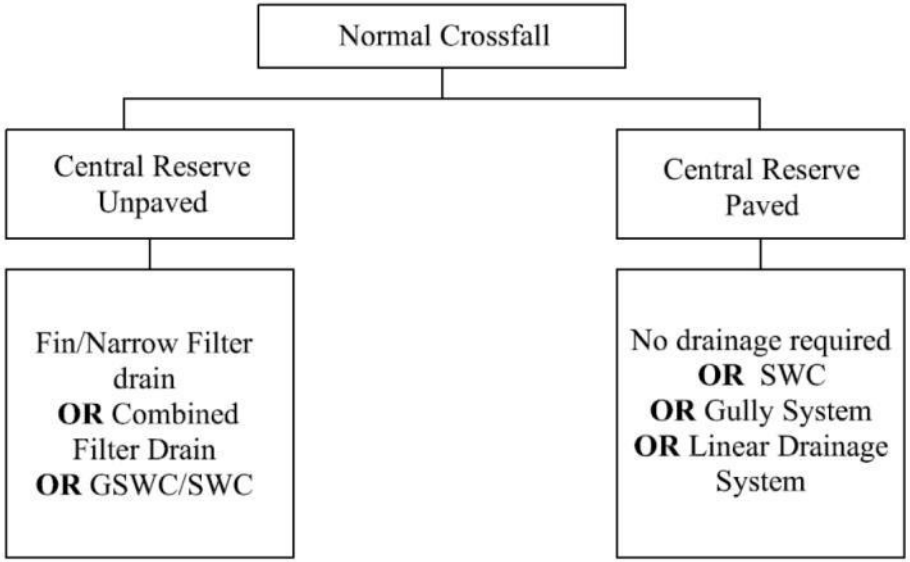
NRA HD 33/15 [Continued]

Figure 3.2: Design Options for Central Reserve Drainage – Left-hand side – Normal Crossfall



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New NRA Drainage Standards

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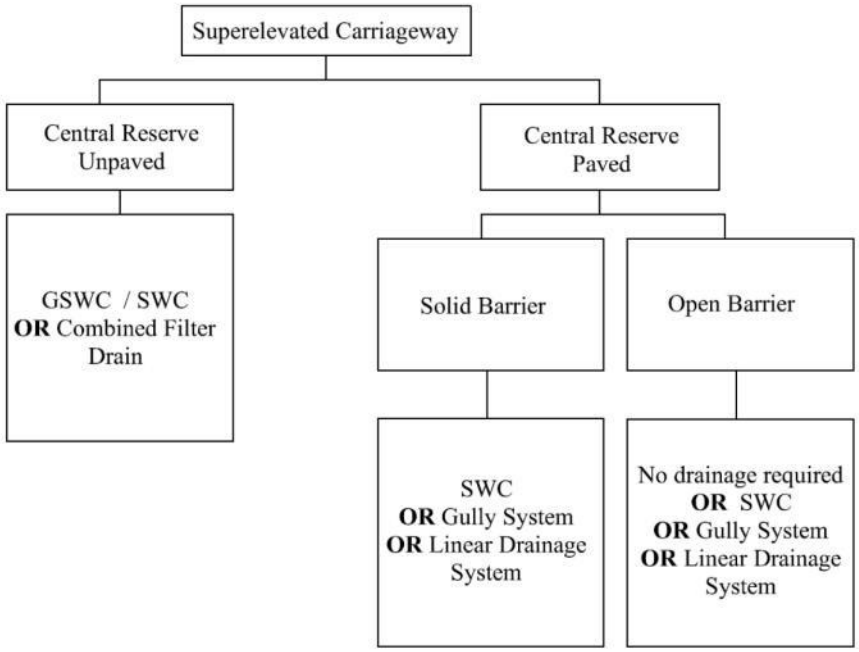
NRA HD 33/15 [Continued]

Figure 3.2: Design Options for Central Reserve Drainage – Right-hand side – Superelevated Carriageway



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NRA HD 45/15 *Road Drainage*

and the Water Environment

- Guidance on the assessment and management of impacts on the water environment.
- '*SuDS should be considered in the first instance over conventional drainage systems*.'
- Adoption of the methods laid down in UK HD 45/09 for assessing:
  - impacts of routine runoff on surface waters; and,
  - pollution risks from accidental spillages.
- Reference to the OPW's website for information on assessing flood impacts.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 45/15 [Continued]

Groundwater Protection Response

- Groundwater Protection Response (GPR): A 'brand new' risk assessment and management tool dealing with discharges of routine runoff to groundwater.
- Screening tool: '*Where relevant, a site specific risk assessment undertaken by a qualified groundwater professional may supersede the requirements of the GPR.'*

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 45/15 [Continued]

Groundwater Protection Response

- Response (i.e. whether or not an impermeable system is required) based on:
  - Aquifer Category;
  - Vulnerability Rating; and,
  - Source Protection Area.
- Thickness of unsaturated zone (1-2-3 m depending on geological environment).

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 45/15 [Continued]

Groundwater Protection Response

Vulnerability rating	Source protection area	Resource protection area (aquifer category)							
		Regionally Important Aquifer			Locally Important Aquifer			Poor aquifer	
		Rk*	Rf	Rg	Lg	Lm	Ll	Pl	Pu
Extreme: Rock near Surface or karst (X)	R4	R4	R4	R3(2)	R3(2)	R3(1)	R3(1)	R3(1)	R3(1)
Extreme (E)	R4	R2 (3)	R2 (2)	R3(2)	R3(2)	R2 (2)	R2 (2)	R2 (1)	R2 (1)
High (H)	R3(2)	R2 (2)	R2 (2)	R2(2)	R2(2)	R2 (2)	R2 (2)	R2 (1)	R2 (1)
Moderate (M)	R3(1)	R2 (1)	R2 (1)			R2 (1)	R2 (1)	R1	R1
Low (L)	R3(1)	R1	R1			R1	R1	R1	R1

Groundwater Protection Response for the use of permeable drains in national roads.

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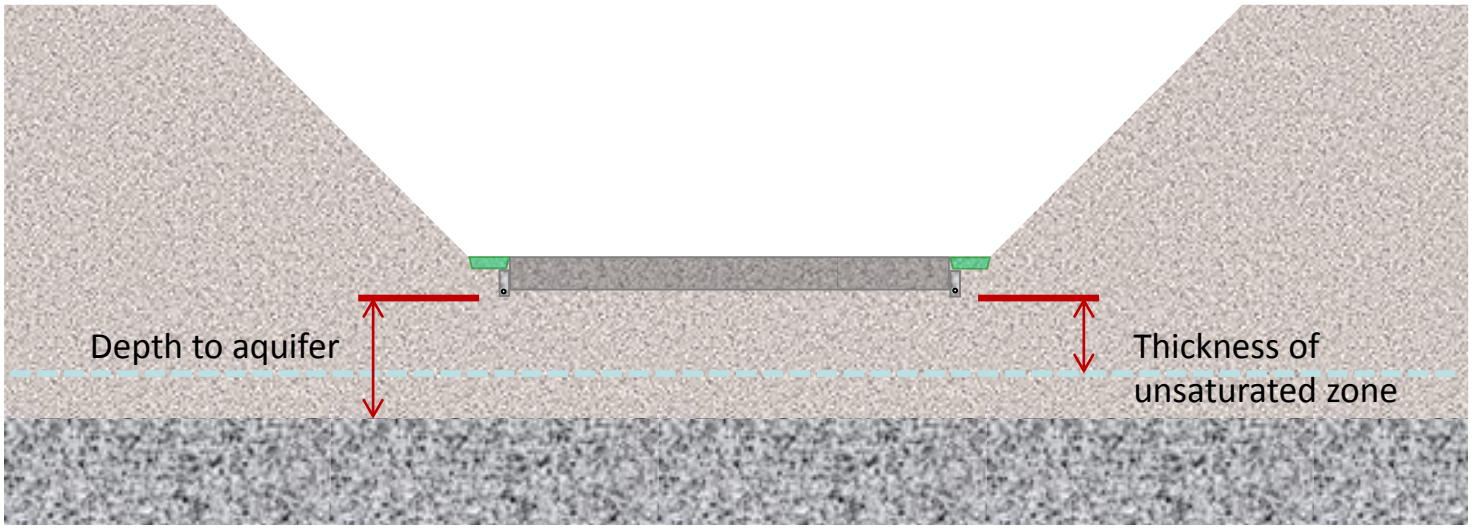
New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 45/15 [Continued]

Groundwater Protection Response



Revision of the NRA's Drainage Standards

New NRA Drainage Standards

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NRA HD 45/15 [Continued]

Groundwater Protection Response

- '*Sufficient information should be available during Phase 3 and 4 to carry out these assessments*', e.g. winter groundwater levels, site-specific geological strata.
- 'Appropriate material' may be used to artificially create a minimum thickness of unsaturated subsoil.

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New Drainage Standards

NRA DMRB: Volume 4

NRA HA 33/15 *Design of Earthworks Drainage, Network Drainage, Attenuation & Pollution Control*

- Guidance on the design of:
  - earthworks drainage,
  - road network drainage,
  - attenuation, and
  - pollution control.
- Design process flowcharts & worked examples.

N21 Castleisland Bypass:
Example of an attenuation pond.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 119/15 *Grassed Surface Water Channels for Road Runoff*

- Information on the hydraulic and structural design of grassed surface water channel for road drainage.
- More onerous requirements in relation to sub-soil in Series 500 of the Spec.
- May only be used in cuttings and in embankments < 1.5m in height.
- 100mm of topsoil instead of 35-50mm.
- Lined GSWCs **not** permitted.

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 119/15 [Continued]

M18 Gort to Crusheen: Lined GSWC construction.

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NRA DMRB:
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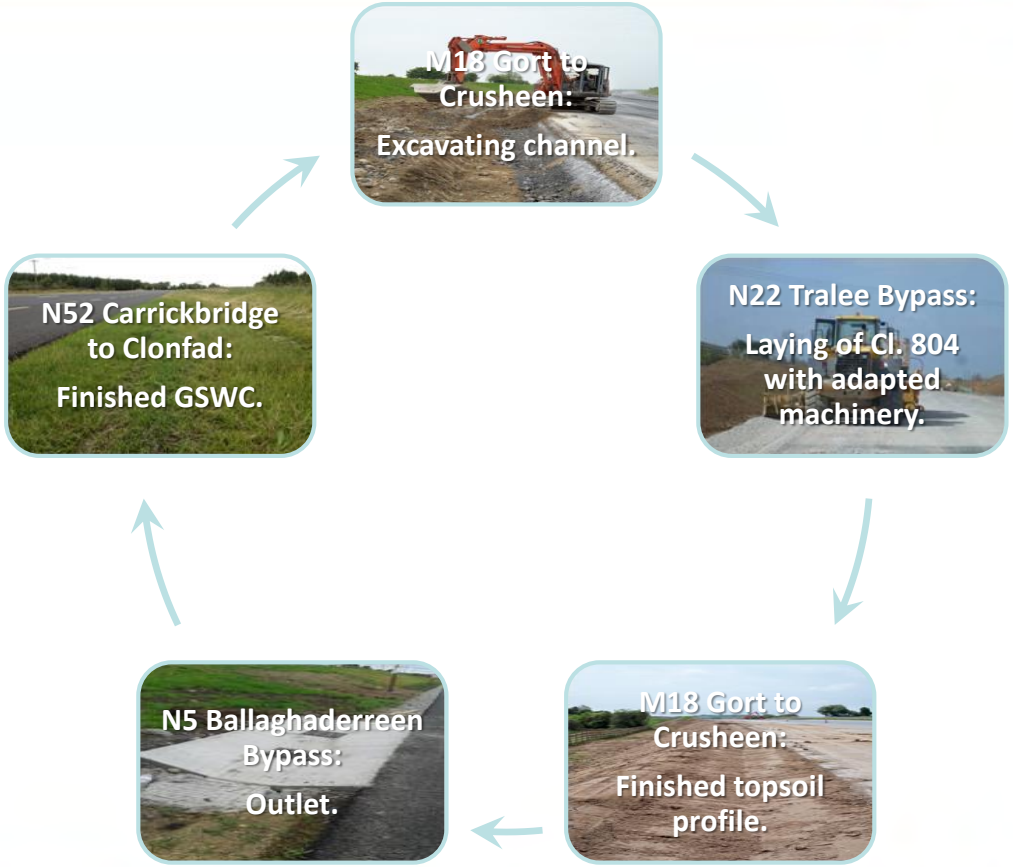
NRA HD 119/15
Grassed Surface Water Channels for Road Runoff



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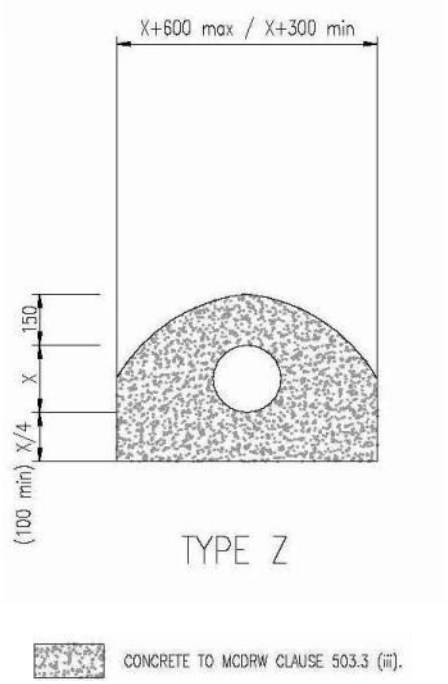
NRA HD 140/15 *Determination of Pipe and Bedding Combinations for Drainage Works*

- Description of the method of selecting suitable combinations of drainage pipes and bedding types to meet given loading requirements.
- UK HA 40 to be used '*except that all pipes under carriageway shall be encased in concrete*.' NRA Addendum to HD 33/06.
- '*Type Z is for use with any type of pipe for permanent protection against mechanical damage*.' Draft NRA HD 40/14.



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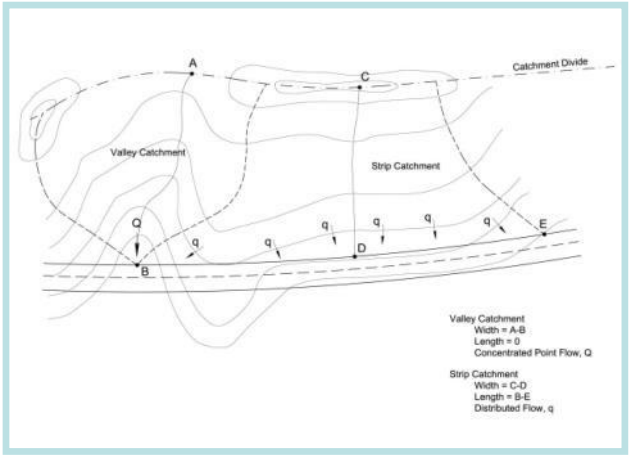
NRA HD 106/15 *Drainage of Runoff from Natural Catchments*

- <u>Design information aimed at minimising the flooding problems associated with runoff from road-adjacent catchments.</u>
- Details methods for:
  - Estimating runoff from natural catchments; and,
  - Determining suitable earthworks drainage.



Extract from UK HA 106/04.

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NRA HD 107/15 *Design of Outfall and Culvert Details*

- Guidance on:
  - Detailing of outfall structures to road drainage systems; and,
  - Design of culverts including scour, but excluding hydraulic design.
- Matters regulated by Section 50 of the Arterial Drainage Act, 1945, are not covered in this standard.

Example of 'rock armour' headwall.

Watercourse culvert.

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NRA HD 78/15 *Design of Outfalls for Surface Water Channels*

- Information on suitable outlet layouts for different types of surface water channels and provides methods for designing each type according to the flow rate in the channel.

NRA HD 137/15 *Hydraulic Design of Road-Edge Surface Water Channels*

- Description of the method of determining the length of road between outlets that can be drained by a given size of surface water channel constructed along the edge of the road.

NRA HD 102/15 *Spacing of Road Gullies*

- Design information for determining the length of road between gullies.

M3 Clonee to Kells: Concrete surface water channel and outlet.

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 103/15 *Vegetated Drainage Systems for Road Runoff*

- Guidance on how vegetated drainage systems may be used to convey, store and treat road runoff.

M18 Gort to Crusheen: Constructed wetland.

NRA HD 83/15 *Safety Aspects of Road Edge Drainage Features*

- Guidance on safety aspects of road edge drainage features.

M18 Gort to Crusheen: Hybrid Wetland with sediment forebay.

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New NRA Drainage Standards

NRA DMRB: Volume 4

NRA HD 118/15 *Design of Soakaways*

- Guidance on how soakaways shall be incorporated into systems used to treat and store runoff prior to discharging to ground.
- Alignment with NRA HD 45 and the groundwater protection response.

Example of a soakaway.

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New NRA Drainage Standards

NRA DMRB: Volume 4

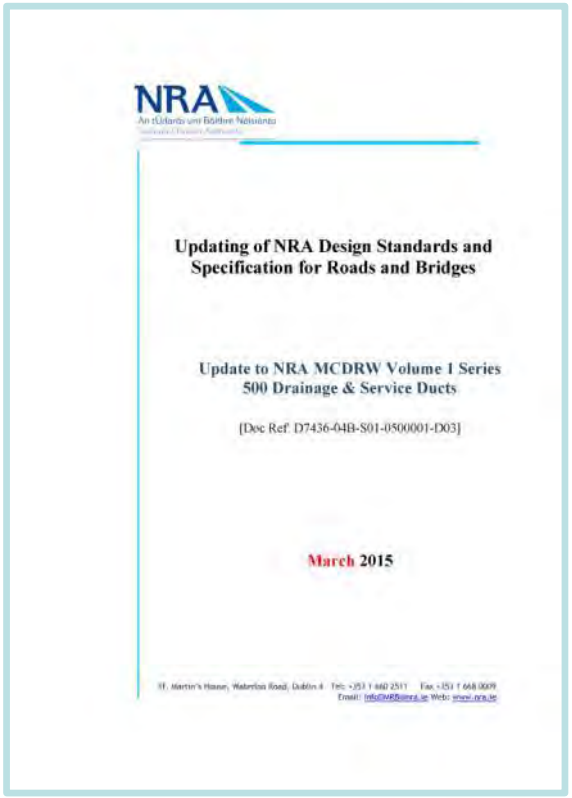
NRA HD 139/15 *Edge of Pavement Details*

- Guidance on the use of the various types of edge pavement details.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- NRA Manual of Contract Documents for Road Works (NRA MCDRW):
  - Volume 1: NRA Specification for Road Works – Series 500 – Drainage and Service Ducts:
    - Improved layout, organisation and cross-referencing;
    - Inclusion of lightweight aggregate as bedding and filter material; and,
    - Sumpless gullies not permitted.


NRA

An tÚdarás um Bóithre Náisiúnta

Updating of NRA Design Standards and Specification for Roads and Bridges

Update to NRA MCDRW Volume 1 Series 500 Drainage & Service Ducts

[Doc Ref. D7436-04B-S01-0500001-D03]

March 2015

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- NRA Manual of Contract Documents for Road Works (NRA MCDRW):
  - Volume 2: Note for Guidance on the Specification of Road Works – NG Series 500 – Drainage and Service Ducts.
  - Volume 3: Method of Measurement for Road Works and Notes for Guidance on the Method of Measurement for Road Works.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

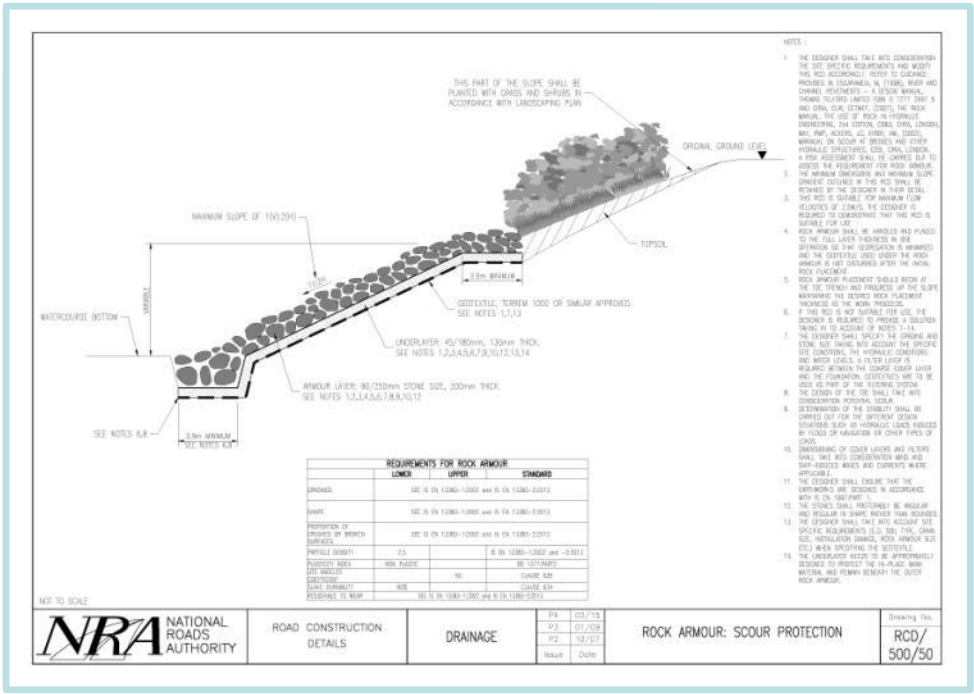
- NRA MCDRW:
  - Volume 4: Road Construction Details (RCDs)
    - Complete revision, e.g. cross-referencing, and multiple amendments.
    - Brand new Series 100 – Edge of Pavement Details.
    - Revised Series 500 – Drainage and Ducts.
    - Other relevant RCDs.

N22 Tralee Bypass:
Grassed Surface Water Channel.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- NRA MCDRW:
  - Volume 4: Road Construction Details (RCDs)
    - New RCD/500/50 illustrating 'Rock Armour: Scour Protection'.



Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- Volume 4: Road Construction Details (RCDs)
  - Significant revisions to RCDs for 'Access Chambers,' including:
    - Reductions in plan areas;
    - Removal of steps, handholds and ladders to encourage:
      - working from surface; and,
      - entry in accordance with health and safety legislation, e.g. accompanied manhole entry *via* tripod and winch.
    - Concrete apron added around covers to prevent damage to landscape machinery during maintenance.

M3 Clonee to Kells: Manhole.

Accompanied manhole entry with tripod and winch.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- Volume 4: Road Construction Details (RCDs)
  - RCD/500/19, 20 & 21 to be replaced by new RCD/500/53 'G.A. of Formed Headwalls – 150 – 1800 Diameter Pipes';
  - Reinforced Concrete (insitu or pre-cast) headwalls now required;
  - Rendered concrete blockwork headwalls (pipes <300mm) only exception; and,
  - Rock armour/gabions headwalls prohibited.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- Volume 4: Road Construction Details (RCDs)

'Rock armour' headwall.

Revision of the NRA's Drainage Standards

New NRA Drainage Standards

- Volume 4: Road Construction Details (RCDs)
  - RCD/400/7 *Central Reserve Detail of Type 1 Dual Carriageway/Standard Motorway with In-situ Concrete Barrier*;
  - RCD/1000/28 *Gullies in Continuously Reinforced Concrete Pavement or Reinforced Concrete Base*; and,
  - RCD/700/6 *Access Road/Service Road*.

Revision of the NRA's Drainage Standards

Conclusion

Contents of Presentation

- History.
- Previous NRA's Drainage Standards.
- New NRA's Drainage Standards.

Revision of the NRA's Drainage Standards

List of Stakeholders

Technical Committee

Albert Daly	NRA
Ambrose Clarke	Westmeath PO
Billy O'Keeffe	NRA/TCD
Bryan Kennedy	Kildare NRO
Christian Nea	NRA
David Morgan	TCD
Declan Bowles	Arup
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John Fitzsimons	NRA
Michael Lyons	Mayo Co. Co.
Michael Mongan	Mayo Co. Co.
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Peter Walsh	NRA
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Arup

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Other Stakeholders

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Other NRA

Alastair De Beer	NRA
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Harry Cullen	NRA

NRA An tÚdarás um Bóithre Náisiúnta National Roads Authority

ARUP

Kildare nro National Roads Office

OPW The Office of Public Works

epa Environmental Protection Agency

National Parks & Wildlife Service

GSI

Iascach Intíre Éireann Inland Fisheries Ireland

NRA An tÚdarás um Bóithre Náisiúnta National Roads Authority Environment

Revision of the NRA's Drainage Standards

Thank you!