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Notes for Guidance on the Specification for Road Works Series NG 500 - Drainage and Service Ducts

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Standards

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Document Attributes

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For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

DRAINAGE AND SERVICE DUCTS

Contents

Drainage and Service Ducts

NG 501 Pipes for Drainage and for Service Ducts

1 Pipes can be made of materials that deflect relatively little under load before cracking (rigid pipes) or of materials that will tolerate large deflections under load before inward buckling occurs (flexible pipes). Flexible joints enable either type of pipe to take up differential settlement within the ground.

2 The Specification includes a wide range of pipe materials. The Contractor should normally be offered in Appendix 5/1 the full selection of alternative pipe and bedding combinations as detailed in the NRA Road Construction Details for pipes up to 900mm diameter. Advice on the determination of alternative pipe and bedding combinations can be obtained in the NRA DMRB HD 140. The required pipe stiffness and impact resistance for plastics pipes should be specified in Appendix 5/1. The requirements will normally be:

(i) ultimate pipe stiffness (STES) in excess of 1400N/m² when tested in accordance with BS 4962; and

(ii) resistance to impact complying with BS 4962 except that the striker used in the test shall have a mass of 1kg and a 25mm hemispherical radius.

Drains exceeding 900mm diameter should be designed as structures. Wherever possible, the Contractor should be offered a choice and the NRA consulted during the scheme preparation. Box culverts, piped culverts (and other drains) of clear span or internal diameter exceeding 2000mm are structures subject to NRA technical approval. Care should be taken to ensure that there are no inconsistencies between any specific requirements for a particular drain and the general requirements of the 500 Series. Where necessary, contract-specific amendments should be included in Appendix 0/1 or 0/2 to achieve consistency.

Most of the pipes included in the Specification will normally be satisfactory from the hydraulic flow capacity factor. However some products, can vary from the norm (e.g. clay / concrete) and between manufacturers. The effect of a rougher pipe should be considered on the system as a whole and not just on the length in question. A pipe which is not acceptable on a straight exchange basis may be acceptable if diameters on adjacent lengths are adjusted. Appendix 5/1 should provide the basis on which the Contractor is to submit his proposals for pipe types and makes.

3 Any tendency to attack by acidic groundwater or sulphates present in the backfill or the ground should be taken into account when the use of concrete, steel or iron pipes is being considered for inclusion in the schedule of acceptable alternatives in Appendix 5/1. When acid soils (pH less than 6.5) are encountered expert advice should be sought. There is some evidence that pipes made of sulphate-resisting cement will tolerate a pH as low as 6.0. The limiting value may be reduced to pH 5.5 when a bitumen coating is applied to the pipe. Sulphate attack on concrete is dealt with in Building Research Establishment Special Digest 1:2005. Iron pipes are treated with a pitch or bitumen coating and have high durability in most soils, but when acid conditions are known to be present the additional protection of a

polyethylene sleeve is desirable. Clay, pitch fibre and UPVC pipes are resistant to a wide range of groundwater chemicals.

4 Plastics pipes may deteriorate after a long period in sunlight. Where pipes have been manufactured and stored before being delivered to the site, it may be necessary for the Contractor to cover them until they are installed.

5 Any individual cable duct under a road may have to accept a power or a communication cable although these are normally placed in separate ducts. Certain pipe materials have been excluded from the Specification for use as ducts because cables cannot be readily drawn through them. Clause NG 1421 gives further information on the use of ducts for electrical work. Ducts should be scheduled in a similar way to pipes in Appendix 5/2. Any special requirements of Statutory Undertakers etc. should be stated clearly.

6 Ducting for motorway communication shall met the requirements of NRA TA 77 Traffic Control and Communications Infrastructure Design and the 1500 Series.

NG 502 Excavation for Pipes and Chambers

1 In the preparation of Appendix 6/3, it may be considered appropriate to permit battering of slopes where this would not affect adversely the permanent Works or the basis of structural design of the pipe / trench.

2 In the event of excavation to a greater depth than necessary the Contractor is obliged to reinstate. The use of concrete to remedy excess excavation should be restricted to areas where compaction is impracticable. Where the floor of the trench passes through a localised area of disturbed and uncompacted soil or softened clay further excavation and replacement with appropriate material may be required to allow pipe laying to proceed.

3 Where pipes are to be installed beneath heavily trafficked existing roads, etc., where it is undesirable that the existing ground surface should be disturbed, consideration should always be given to the possibility of inserting the pipe by suitable thrustboring or jacking processes.

NG 503 Bedding, Laying and Surrounding of Pipes

1 Pipe bedding material should be readily obtainable since a wide grading envelope is permitted including most gradings complying with IS EN 12620. It needs to flow readily and compact uniformly, thus a low coefficient of uniformity is necessary. In order to make savings in coarser granular materials a sand bed may be adopted. Surround to pipes should be in bedding material as appropriate to the alternatives shown in the NRA Road Construction Details. In some situations a lower provision of acceptable material (Class 8) may be satisfactory.

2 A distinction is to be made between the requirements of bedding, haunching and surrounding and those of backfilling. The former comprise all operations of trench fill up to a level 300mm above the top of the barrel of the pipe. Backfilling constitutes the remaining operations up to ground level in verges and open ground and up to formation or sub-formation level under carriageways. Work above formation level constitutes construction or reinstatement of the pavement (see NG 706).

3 Concrete surround should be used exceptionally, e.g. for protection of pipes against mechanical damage from subsequent operations after construction of the pipeline and where remedial measures due to over excavation are required. Protection of existing pipes where necessary may take the form of a concrete arch or slab above the pipe.

NG 504 Jointing of Pipes

1 Pipe joints for surface water drains, unlike foul drains, do not always have to be completely watertight. Small amounts of seepage as allowed in Sub-clause 509.3 can be tolerated particularly where pipes are laid in cuttings or below the watertable. However, joints in pipes in soils that are predominantly fine sands or coarse silts should have watertight joints to prevent soil particles passing through the joint into the pipe leaving voids on the outside of the pipe. Where fine sands or coarse silts might be a problem but the more expensive rubber ring flexible joint is unwarranted, consideration can be given to certain proprietary wrap type joints that are available. These may also be specified where root penetration needs to be prevented. Requirements should be given in Appendix 5/1.

2 Most watertight joints will be flexible joints although rigid joints are occasionally used on clay pipes. In and under embankments or if differential settlement is expected in compressible soils subject to non-uniform loading, then flexible joints and (except for pipes below the watertable laid in non-erodible soils) watertight joints should be specified. The maximum length of pipe between flexible joints may have to be limited where considerable movement is expected. The limits of the exclusions should be shown in Appendix 5/1.

NG 505 Backfilling of Trenches and Filter Drains

1 When soils to be drained require a particular grading of filter aggregate it should be specified in Appendix 5/1. Guidance on the design of filter materials is given in Transport Research Laboratory Report LR 346. The filter material in Table 5/5 is intended for use where the drain is designed to intercept surface water flowing to the pipe. Grit from the carriageway may slowly block this type of filter and it may require cleaning or replacement periodically.

NG 507 Chambers

1 Concrete chambers, precast or cast insitu against forms, do not require strengthening with additional concrete surround. Access shafts in precast concrete should be strengthened, however, as a protection against loads from backfilling operations. Brick chambers, including shafts do not need a concrete surround for strengthening. It may however be necessary to backfill with concrete where space is insufficient to permit compaction of one of the earthworks acceptable materials. Inspection chambers are those that can be maintained from the surface and do not need to be entered. The types of brick to be used for brick chambers, and beneath chamber frames, in normal circumstances are specified in Clause 2406. Where a different type of brick is required this should be described in Appendix 24/1. Any brickwork upon which chamber frames are seated shall be properly constructed.

2 Safety precautions require that chamber covers have a minimum opening of 750mm diameter where personnel may be required to enter completely. In carriageways, hard shoulders and verges, chamber covers, frames and gratings should be a minimum of Class D400.

NG 508 Gullies and Pipe Junctions

1 Trapped gullies are essential only on connections to combined or foul drains in urban areas or on roads where traps are regularly and frequently emptied. In terms of pollution there is little difference in water quality between the flow through trapped or untrapped gullies although a trapped gully would normally retain the contents of a vehicle's sump in the event of an accident.

2 Where concrete trapped gullies are cast insitu using a permanent plastic mould, the part forming the trap should be equal in all respects to that of precast concrete or clay gullies.

3 Any brickwork upon which gully frames are seated should be properly constructed.

4 Dished gullies should not be used in areas trafficked by cyclists or pedestrians.

NG 509 Testing and Cleaning

1 Requirements for drain testing should be specified in Appendix 1/5. The air test does not indicate the location of any large leaks that may be present. A water test may follow the failure of an air test.

2 Fall of the test water level may be due to one or more of the following causes:

(i) Absorption by pipes or joints.

(ii) Excessive sweating of pipes or joints.

(iii) Leakage from defective pipes or joints or plugs.

(iv) Trapped air.

Some pipes absorb more water or trap more air at the joints than others. Allowance should be made for this by adding water to maintain the test head for appropriate periods. While the aim should be to commence the test period proper 2 hours after filling, the appropriate period may best be determined by conferring with the Pipe Manufacturers.

3 Closed circuit television (CCTV) inspection is a suitable alternative to the mandrel test and should always be used on foul sewers and connections to sewers. To avoid subsequent disputes it is essential to liaise with the drainage authority when checking connections to existing sewers to ensure acceptability of the work and to determine the extent of the survey required on existing sewers.

4 The test for partly watertight joints must be carried out before the pipe is laid because the water escaping from the joint has to be measured. The purpose of the test is to prove that the joint does not leak so excessively as to cause piping in any granular surround.

NG 510 Surface Water Channels, Swales and Drainage Channel Blocks

1 Requirements for these should be included in Appendix 5/3 and be compatible with the NRA Road Construction Details.

NG 511 Land Drains

1 The Works are likely to disturb and render ineffective existing drainage systems in adjoining land; it will therefore be necessary for the Contractor to carry out without delay any such temporary or permanent remedial works as may be described in Appendix 5/1. The Designer should consider whether the most suitable arrangement for land drainage remedial works is to provide a system of drainage of land adjoining the road separate from the road drainage so that the reinstatement of the system is on the Owner's land and the matter falls to be dealt with as a matter of accommodation works. When such arrangements are not practicable or the cost is excessive, the existing land drainage system should be linked with the drainage system of the road.

NG 512 Backfilling to Pipe Bays and Verges on Bridges

1 Any special filling material, e.g. lightweight material, should be described by providing additional information on the Drawings, cross-referenced in Appendix 5/1.

NG 513 Permeable Backing to Earth Retaining Structures

1 For granular backing, where the designer wants a filter compatible with a particular type of filling he wishes to be employed adjacent to the structure, any proposal to amend the Specification shall be agreed with NRA structures department.

2 Fin drains are not allowed as permeable backing to structures because it is not yet possible to demonstrate that any of them will have the required design life of 120 years.

NG 514 Fin Drains

1. These consist of a core which will allow the free drainage of water entering through geotextile filters on the outside of the core. The core may consist of nets, webs, grids or preformed plastic sheets or strips. Some restrict entry through one side or confine water entering to part of the cross-sectional area of the core. Any such restrictions should be taken into account in assessing the flow characteristics of the drain. Fin drains are intended to be used for subsurface drainage, as shown in the RCD's, to remove and keep out water from the road structure. They are provided to remove surface infiltration from the pavement layers, to prevent infiltration from shoulders, medians and verges into the pavement, and sometimes to cut off shallow groundwater seepage.

They thus act as low-capacity filter drains. In normal circumstances, the Contractor should be permitted the choice of any of the types shown in the RCD's. If however, for engineering reasons, exclusion of a particular type is required, this should be stated in Appendix 5/4. The minimum values for mechanical and hydraulic properties given in Clause 514 are intended for this particular usage and may not be relevant to fin drains used elsewhere. Additionally, the Clause requires specification of the pore size distribution of the geotextile and the inflow and discharge capacity of the fin drain determined for the site conditions.

2. The pore size for the geotextile should be selected using filtration criteria to be compatible with the adjacent soil or construction layer in order to prevent the occurrence of piping. The following soil retention criteria may be used in determining O90. Other criteria are available

	Woven and Meltbonded Geotextiles	Needle punched Geotextiles
1 to 5	O90/d50 = 1 to O90/d50 = 3	O90/d50 = 4 to O90/d50 = 6
> 5	O90/d90 < 1 to O90/d50 <3	O90/d90 < 1.8 to O90/d50 < 6

dn = n% size in base soil (n% is finer)
O90 = 90% opening (pore) size of geotextile (90% of openings are smaller)

In general, it will be sufficient to specify only the maximum value of O90 that will satisfactorily retain the adjacent soil particles as the minimum O90 size will be governed by the permeability requirements in Sub-clause 514.5. Geotextiles will usually be in contact with variable surface soil deposits, as well as the more uniform materials composing the pavement and great accuracy in specification may not therefore be feasible. The finest O90 relevant to the various soil deposits likely to be encountered may be specified. An O90 value of 1mm should be considered as the upper limit even with large grained soils. With cohesive fine grained soils such as clays the use of the above criteria will result in such small pore sizes that sufficient water flow cannot be obtained. In such cases the cohesion of the soil particles themselves is relied upon to prevent piping and a maximum O90 value of 250 microns may be chosen. Dispersive silts can present particular problems and in these cases the O90 value may be less than 250 microns: however, the value to be specified should be carefully considered in order both to avoid piping and to ensure sufficient long- term flow.

3. Sub-clause 5(v) of Clause 514 requires the designer to specify the flow rate normal to the geotextile wrapping to the filter drain. The specified flow rate should incorporate a margin of safety to allow for the impeded flow due to the adjacent core of the fin drain (or the filter material in a narrow filter drain) as described in Sub-clause 14 of Clause 514. It should also incorporate a substantial margin to allow for the reduction of flow with time due to clogging.

The long-term flow through a geotextile in contact with the coarse gravel may not differ significantly from the short-term flow measured in the standard test. In contrast, the long-term flow through a geotextile in contact with a dispersive silt may be one thousand times smaller than the short-term flow. There is some evidence that chemical or biological leachates may also cause severe clogging. Different rates of flow into the two sides of the fin drain may be specified, for example, if the water flows from the verges are expected to be very different to those from the pavement structure. A value of 10 litres/m²/sec is suggested for use against the unbound mixture for sub-base and capping specified in Series 600 and 800. Very much smaller values are adequate for soils and backfills other than coarse gravels, and possibly dispersive silts or contaminated sites. It should be appreciated that, because of such long-term effects, these flow rates should not be used to determine the in-plane design requirements of the fin drain.

4. Sub-clause 6 of Clause 514 requires specification of the in-plane flow capacity of the fin drain. This design capacity should allow for infiltration through the pavement and verges and any other source of groundwater ingress. Until more accurate means of establishing infiltration rates through the pavement are available a value not less than the mean intensity of a one year 2 hour rainfall should be assumed. The fin drain Type 5 of RCD/500/41 acts both as a filter drain and a carrier pipe. Thus in-plane flow must be specified for flow both along the drain parallel to the road edge and near-vertically down the drain. For all other drain types, only near-vertical downward flow need be specified.

   Fin drains are normally laid at constant depth below the carriageway and their gradient will therefore follow that of the road. Drainage capacities should be designed for these gradients and outfall lengths determined accordingly. For drain Type 5 the flow rates that are stated in Appendix 5/4 should be the capacity required linearly extrapolated to the standard gradients in Table 5/8. Where fin drains utilise a pipe, capacities may be obtained from hydraulic tables and the required diameter specified.

5. Sub-clause 10 of Clause 514 specifies the use of as-dug material for trench backfill. If this material when compacted is sufficiently less permeable to affect the efficiency of the drain, or contains stones larger than about 100mm which could damage the drain, an alternative material compatible with the geotextile should be used.

6. Proper functioning of the fin drain and its ancillary components depends critically on adequate installation and joining procedures. Fin drains can be problematical during construction phase for the following reasons.

   (i) They do not provide immediate drainage for the unpaved sub-base.
   (ii) They are not designed for surface water flows.
   (iii) Fine particles transported by surface water or vehicles may clog the filter or silt the drain.
   (iv) They may be damaged by the passage of construction traffic.

   Appropriate protection measures must be taken, e.g. polythene sheeting, temporary drainage channels, or warning fence. Alternatively, the drains may be installed towards the end of the construction phase.

7. All fin drains and their constituents must be the subject of an Irish Agrément Board Certificate which certifies the values achieved for the specified properties when tested in accordance with Clause 514. Fin drains are available in a variety of configurations with different types of core structure. In addition, several tests described in Clause 514 are modified British Standard tests or have been developed especially for the Specification and as yet there is little experience of their use. These two factors mean that some variation or interpretation of the test method may sometimes be necessary. The Irish Agrément Board will agree details of any appropriate variations in the specified test methods following consultation with the Manufacturer. It is intended that whenever the Contractor proposes the use of any fin drain or constituent material he must supply copies of the appropriate Irish Agrément Board Certificate to confirm that the material complies with the Contract requirements. (Further guidance may be sought from the National Roads Authority)

NG 515 Narrow Filter Drains

1 Narrow filter drains are intended for use as edge of pavement sub-surface drains and are suitable alternatives to fin drains for this purpose. Both types have the same requirements of performance and the guidance given in NG 514 is equally applicable to determining the soil retention and permeability criteria of the geotextile used in narrow filter drains and to the discharge capacity of the drain. In normal circumstances, the Contractor should be permitted the choice of any of the types shown in the RCD's. If however, for engineering reasons, exclusion of a particular type is required, this should be stated in Appendix 5/4.

2 In drain Type 8 the filtration function is achieved by a granular filter material and geotextile sock and in Type 9 by means of a geotextile wrapping to the drain. Both filters should be designed to be compatible with the adjacent soil or construction layer. For the Type 8 drain granular material the value of D15 to be specified (Table 5/9) should be based on the criteria D15F less than or equal to 5 x D85S (TRRL Report LR346) where D85S is the sieve size passing 85% by weight of the adjacent soil. The geotextile sock round the pipe is a second stage filter where it is required to retain the particles of the first stage granular material. However, the pipe when laid in the narrow trench may have insufficient granular surround for fully effective first stage filtration to be achieved. Pore sizes for the sock material should therefore be designed to also retain the finer soil particles outside the trench.

3 The specification for granular material in Table 5/9 is intended to permit the widest range of available material to be used. These limits have been set to reduce the risk of damage to the geotextile, to avoid gap grading of the filter material and to ensure an adequate degree of permeability. For the material as specified a minimum value of permeability of about 1 x 10-4 m/second which is similar to that obtained by a clean coarse sand may be assumed. A higher permeability will rarely be necessary but if required it may be specified in Appendix 5/4.

4 Narrow filter drains require protection during the construction phase similar to that provided for fin drains (see NG 514.6).

5 The geotextiles used in narrow filter drains require Irish Agrément Board Certification (see NG 514.7).

NG 516 Combined Drainage and Kerb Systems

1 The drawings should show the location and gradient(s) of the combined drainage and kerb system, the position of access, silt trap, outfall and end units together with the position and invert level of the surface water outfall connection. The position of any movement joints required in the system, e.g. at joints in bridge decks or concrete carriageways, should be shown. Details of any ducts, cabling, etc., required to pass under the kerb should be shown. The extent of the work to be designed by the Contractor should be clearly defined.

2 Combined drainage and kerb systems should be scheduled in Appendix 1/11 and cross- reference made to the design requirements given in Appendix 5/5.

NG 517 Linear Drainage Channel Systems

1 The drawings should show the location of the linear drainage systems and the positions of the surface water outfall chambers into which the systems are to outfall. The position of any movement joints required in the system, e.g. at joints in bridge decks or concrete carriageways, should be shown. Details of any ducts, cabling, etc. required to pass under the systems should be shown. The extent of the work to be designed by the Contractor should be clearly defined.

2 Linear drainage channel systems should be scheduled in Appendix 1/11 and cross reference made to the design requirements given in Appendix 5/6.

a) With the standards of the chambers shown on the Drawings and any longitudinal drains connecting such chambers should also be connected into the intermediate chambers.
b) Not more than one intermediate chamber should be permitted between the upstream and downstream chambers of any drain shown on the Drawings.
c) Not more than one additional chamber should be permitted upstream of each upstream chamber shown on the Drawings.

3 Variations to stated dimensions may be considered providing that the product will meet the requirements of this specification.

4 A system comprising units which may be otherwise too small to accommodate design flows without surcharge may be acceptable in conjunction with the provision of additional intermediate or upstream chambers subject to the following requirements:

a) Intermediate chambers should be compatible with the standards of the chambers shown on the drawings and any longitudinal drains connecting such chambers should also be connected into the intermediate chambers.
b) Not more than one intermediate chamber should be permitted between the upstream and downstream chambers of any drain shown on the drawings.
c) Not more than one additional chamber should be permitted upstream of each upstream chamber shown on the drawings.

NG 518 Thermoplastics Structured Wall Pipes and Fittings

1 Where thermoplastics structured wall pipes and fittings are included in the schedules of permitted alternatives in Appendix 5/1, the material properties required of the different pipe materials should be specified by the manufacturer in the format given in Appendix 5/8.

2 Most thermoplastics are stable against common chemicals found in groundwater and in surface water run-off. The pipes and fittings should be protected against prolonged exposure to sunlight and it may be necessary for the Contractor to cover the pipes prior to installation.

3 Table 5/10 gives the requirements for structured wall pipes. Where reference is made to Irish, European or International Standards, these standards should be consulted to discern the relevant test conditions for the product. Where no standard test method is available, the test method is described in Sub-clauses 518.11 to 518.13. Additional information, is given in Table NG 5/1.

4 Table 5/11 gives the requirements for the fittings for use with structured wall pipes. Where reference is made to Irish, European or International Standards, these standards should be consulted to discern the relevant test conditions for the product.

5 Table 5/12 gives the requirements of the system. Where reference is made to Irish, European or International Standards, these standards should be consulted to discern the relevant test conditions for the product.

6 Test Method for Longitudinal Bending
The test is intended to eliminate very flexible pipe (e.g. coilable pipe) and pipe which is so weak that it might deform whilst being handled on site. The two level support blocks at least 250mm wide and of sufficient height to allow the pipe to sag over its length without touching the ground could consist of standard building blocks stood on their ends.

7 Test Method for Rodding Resistance (Internal Puncture)
The test is intended to simulate damage which might be caused by the ferrule of a drain cleaning rod being impacted against the inside of the pipe or fitting during cleaning operations and is intended to ensure the structural integrity of the inner layer. A segment of pipe or a section from a fitting is subjected to impact on its internal surface whilst fully supported by its external surface.

8 Test Method for Resistance to Sharp Objects
The test is intended to simulate the effect of penetration due to sharp aggregate and is intended to exclude ducts with particularly thin wall section.

NG519 Geotextiles for Filter Drains

1 The pore size for the geotextile should be selected using filtration criteria to be compatible with the adjacent soil or construction layer in order to prevent the occurrence of piping. The following soil retention criteria may be used in determining 0^{90}. Other criteria are available.

In general it will be sufficient to specify only the maximum value of 0^{90} that will satisfactorily retain the adjacent soil particles as the minimum 0^{90} size will be governed by the permeability requirements in Sub-clause 519.2(iv).

However, with very fine grained soils such as clays, the use of the above criteria will result in such small pore sizes that sufficient permeability may not be obtainable. In such cases the cohesion of the soil particles themselves is relied upon to prevent migration and a maximum 0^{90} value of 100 microns may be chosen.
However, dispersive silts can present problems and in these cases the balance between the pore size and permeability requirements should be carefully considered. An 0^{90} value of 1 mm should be considered as the upper limit even with large grained material.

NG520 Attenuation

1 Attenuation requirements and site specific details should be developed by the designer and detailed on the drawings and in Appendix 5/9 to fully define the contract requirements.

NG 521 Pollution Control

1. Pollution Control requirements and site specific details should be developed by the designer and detailed on the drawings and in Appendix 5/9 to fully define the contract requirements.

NG 522 Soakaways

1. Soakaway requirements and site specific details should be developed by the designer and detailed on the drawings and in Appendix 5/9 to fully define the contract requirements.

NG 523 Drainage Outfalls

1. Where the velocity of the peak outflow is in excess of 1.0m/s then some form of energy dissipation will be required. The pipe line design should be checked to ensure that velocities at peak discharge do not exceed 2.5m/s. Where higher velocities occur and cannot be reduced within the drainage system the designer must demonstrate the impact to surrounding environment is acceptable and meets the requirements of the OPW, EPA, IFI, NPWS and the local authority.

2. The standard detail, RCD/500/50 is for bank protection to straight channels where the water velocity is less than 2.5m/s. For design of rock armour to other channels, with greater velocities, the following guidance documents should be consulted:

   - Escarameia, M. (1998), River and channel revetment-A design manual
   - Thomas Telford Limited ISBN 0 7277 2691 9 and CIRIA, CUR, CETMEF, (2007), The rock Manual. The use of rock in Hydraulic engineering, 2nd edition, C638, CIRIA, London
   - May, RWP, Ackers, JC, Kirby, AM, (2002), Manual on scour at bridges and other hydraulic structures, CSSI, CIRIA, London

   The rock used in this RCD and in alternative proposed designed protection should comply with the requirements outlined in IS EN 13383-1:2992 and IS EN 13383-2:2013.

NG 524 Pipes for Ducts

1. Service duct requirements and site specific details should be developed by the designer and detailed on the drawings and in Appendix 5/2 to fully define the contract requirements.

NG 525 Chambers for Ducts

1. Chamber requirements for Ducts, other than those used in motorway communications installations, and site specific details should be developed by the designer and detailed on the drawings and in Appendix 5/1 to fully define the contract requirements.

NG SAMPLE APPENDIX 5/1: DRAINAGE REQUIREMENTS

[Note to compiler: This should include:]

(i) requirements for box culverts [501.1];

(ii) any additional requirements for drains excluding those constructed using corrugated steel pipes [501.2];

(iii) locations where more than one pipe type is permitted within individual drain or service ducts between consecutive chambers [501.2];

(iv) the basis of the hydraulic design of the system on which the Contractor shall submit his proposals for pipe types and makes [501.3];

(v) a schedule of permitted alternative pipe and bedding combinations including those in the NRA Road Construction Details; [which should be determined in accordance with NRA DMRB HD 140] [503.3] and list of pipelines to be constructed other than in a trench [608.8];

(vi) where sulphate-resisting Portland cement is required for concrete pipes [Table 5/1];

(vii) details of materials in bedding, haunching and surrounding of filter drains if differing from the requirements of Sub-clause 503.3(iv);

(viii) whether joints in surface water drains shall be watertight or partly watertight [504.2];

(ix) where rigid joints may be used [504.3];

(x) backfilling requirements differing from Sub-clause 505.2; level of backfill for trenches in carriageways or other paved areas if differing from the requirements of Sub-clause 505.2;

(xi) grading limits for filter backfill materials in filter drains if differing from the requirements of Table 5/5 [505.3];

(xii) references to drawings showing requirements for connecting existing drains to new drains and details of special connecting pipes [506.1];

(xiii) requirements for sealing, removal or grouting of existing drains [506.3];

(xiv) references to drawings which show chamber types [507.1];

(xv) requirements for concrete to cast-in sub-situ chambers if differing from the requirements of Sub-Clause 507.6;

(xvi) particular requirements for corrugated galvanised steel chambers [507.6];

(xvii) requirements for testing chambers for foul drains for watertightness [507.9] and foul drain surveys by video camera [509.5];

(xviii) details of chamber covers, gratings and frames including grades, depths of frames, hinge and locking requirements, etc. [507.7 to 9] and details for special duty covers for use in carriageways [507.10],

(xix) requirements for minimum waterway area to gratings for catch-pits [507.11];

(xx) requirements for setting existing covers and gratings to level if different from the requirements of Sub-clauses 507.15 and 508.8;

(xxi) whether gullies are to be trapped or untrapped [508.1];

(xxii) details of insitu concrete gullies [508.3];

(xxiii) the classes and sizes of cast iron and steel gully gratings [508.4];

(xxiv) requirements for gully gratings if different from the requirements of Sub-clause 508.4 and 5, including whether gully gratings are to be flat or dished;

(xxv) whether saddles are permitted [508.7];

(xxvi) requirements for the cleaning of chambers, gullies and drains [509.5];

(xxvii) requirements for permeability testing of backfill material where required [509.];

(xxviii) details of connecting existing land drains [511.1];

(xxix) whether severed mole drains are to be intercepted by construction of a land drain [511.4];

(xxx) references to drawings showing requirements for filling to pipe bays and verges if different from the requirements of Sub-clause 512.1;

(xxxi) requirements for thermoplastic structured-wall pipes and fittings if different from the requirements of Sub-clause 518.1;

(xxxii) values of pipe stiffness class, creep ratio and impact resistance for thermoplastics pipes [518.5].

NG SAMPLE APPENDIX 5/2: SERVICE DUCT REQUIREMENTS

[Note to compiler: This should include:]

(i) references to drawings which show chamber types [525.1];

(ii) a schedule of service duct requirements [501.5] [similar to those in Appendix 5/1 for pipes];

(iii) details of duct construction [524.3] **[cross-reference should be made to the NRA Road Construction Details where appropriate];**

(iv) whether joints in ducts shall be watertight [524.4];

(v) details of permanent marker blocks and location posts required for service ducts [524.2] **[cross-reference should be made to the NRA Road Construction Details where appropriate].**

(vi) requirements for permanent marker blocks and location posts [524.6];

(vii) colour coding of ducts [524.7].

NG SAMPLE APPENDIX 5/3: SURFACE WATER CHANNELS, SWALES AND DRAINAGE CHANNEL BLOCKS

[Note to compiler: State here specific requirements cross-referring to drawing numbers where appropriate, including NRA Road Construction Details listed in Appendix 0/4]

(i) requirements for the construction of surface water channels, swales and drainage channel blocks [510].

NG SAMPLE APPENDIX 5/4 : FIN DRAINS AND NARROW FILTER DRAINS AND GEOTEXTILES FOR FILTER DRAINS

[Note to compiler: This should include:]

(i) special requirements for fin drains and narrow filter drains [514.1 & 515.1];

(ii) permitted alternative types of fin drain and narrow filter drain
[Normally the choice of type of fin or narrow filter drain should be left to the Contractor];

(iii) drawing and / or schedule references showing locations and required levels;

(iv) the maximum permissible 0^{90} determined from the pore size distribution curve of the geotextile [514.5(iv) & 515.3];

(v) the permeability of the geotextile [514.5(v) & 515.3];

(vi) the long term in-plane flow for fin drains [516.2];

(vii) trench backfill material for fin drain if not as-dug material [514.10];

(viii) pipe diameters [514.11 & 515.6];

(ix) D15 particle size for granular material in narrow filter drain Type 8 [515.5];

(x) permeability of granular material in narrow filter drain where required [515.5];

(xi) maximum drain slope angle if different from 15% [514.11 and 515.6];

(xii) dimensions of fin drains and narrow filter drains if different from the requirements of Sub-clauses 514.11 and 515.6.

NG SAMPLE APPENDIX 5/5: COMBINED DRAINAGE AND KERB SYSTEMS

[Note to compiler: Include here:]

(i) hydraulic design parameters including design flows [516.5]; [roughness coefficients should not be specified]

(ii) limiting dimensions [516.6]:

a. Maximum width and depth of units [if applicable]

b. Kerb upstand

c. Kerb profile [if applicable];

(iii) requirements of inlets where used with porous asphalt [516.7];

(iv) strength requirements [516.8] and class of concrete or mortar bedding/surround; **[units should normally be capable of bearing a wheel load of 11.5 tonnes];**

(v) requirements for junctions, connecting pipes and any other fittings comprising the combined drainage and kerb system [516.11];

NG SAMPLE APPENDIX 5/6: LINEAR DRAINAGE CHANNEL SYSTEMS

[Note to compiler: Include here:]

(i) drawing reference showing locations, etc.

(ii) hydraulic design parameters including design flows [517.3]; [roughness coefficients should not be specified]

(iii) limiting dimensions [517.4]:

a. Maximum width and depth of units [517.4]

b. Dimensions of side-entry inlets of units to be used in or adjacent to porous asphalt **[517.7];**

(iv) requirements for grade of weathering resistance [517.7];

(v) strength requirements [517.8]
[units must be specified as Class D or Class C. Class D units must be used where there is a possibility of impact from all types of road vehicle that are permitted on trunk roads including motorways. Class C units must only be installed in locations which are protected from direct traffic loading, e.g. in areas behind safety barriers. Further advice on other permitted classes can be found in Clause 5 of IS EN 1433.]

(vi) any special fittings required [517.10]

NG SAMPLE APPENDIX 5/7: DRAINAGE AND SERVICE DUCTS: NRA ROAD CONSTRUCTION DETAILS

Clause No.	Road Construction Detail
503.3 (i)	RCD/500/20 & 21
503.3 (iii)	RCD/500/20 & 21
505.7	RCD/500/20
507.1	RCD/500/1 to RCD/500/6 and RCD/500/16
507.7	RCD/500/15
508.1	RCD/500/11 & 12
508.4	RCD/500/14
509.11	RCD/50062
514.10	RCD/500/41
519.4	RCD/500/20

NG SAMPLE APPENDIX 5/8: THERMOPLASTICS STRUCTURAL WALL PIPES AND FITTINGS

Information to be provided by the Contractor

The Contractor shall provide the following information, in accordance with Sub-clause 518.2, for the range of pipes and fittings (to be verified by the Certification body - see Sub-clause 518.10):

(i) Technical drawings showing dimensions and tolerances including sealing rings and weight per metre, together with properties, as specified in Sub-clauses 518.3 and 518.5.

(ii) Material specification, as required in Sub-clause 518.2:

Table 1: Unplasticised Polyvinyl-Chloride (PVC-U)

Property	**Test method reference**	**Specification**
Tensile Properties	IS EN ISO 6259, IS EN ISO 527-1	
Vicat	IS EN ISO 2505	
Longitudinal reversion	IS EN 743	
K-value	IS EN 922	
PVC content	IS EN 1905	
Density	IS EN ISO 1183-3, ISO 4451	
Heat Reversion	ISO 12091	
Effects of heating (injection moulded fittings only)	IS EN ISO 580	

Table 2: Polyethylene (PE)

Property	Test method reference	Specification
Tensile Properties	IS EN ISO 6259 IS EN ISO	
Oxygen induction time	IS EN 728	
Melt Flow Rate	IS EN ISO 1133	
Density	IS EN ISO 1183-3, ISO 4451	
Melt Flow Rate	ISO 4440	
Heat Reversion	ISO 12091	
Effects of heating (injection moulded fittings only)	IS EN ISO 580	

Table 3: Polypropylene (PP)

Property	Test method reference	Specification
Tensile Properties	BS EN ISO 6259, BS EN ISO 527-1	
Oxygen induction time	BS EN 728	
Melt Flow Rate	BS EN ISO 1133	
Density	BS EN ISO 1183-3, ISO 4451	
Melt Flow Rate	ISO 4440	
Heat Reversion	ISO 12091	
Effects of heating (injection moulded fittings only)	BS EN ISO 580	

NG SAMPLE APPENDIX 5/9: ATTENUATION

[Note to the compiler: This should include]

(i) Attenuation design requirements e.g. storm return period and storm duration to be attenuated as per NRA HD 33;

(ii) Location of attenuation pond with reference to drawings and drainage schedules;

(iii) Attenuation requirements – Volume to be attenuated, maximum discharge rate;

(iv) Pond Geometry – Existing ground level, pond invert level, top length and width, side slopes;

(v) Requirements for pond lining e.g. Clay Liner, Impermeable Geomembrane;

(vi) Requirement for bunding around pond – Bund level, Side slopes;

(vii) Requirement for fencing around pond;

(viii) Additional water quality treatment requirements – volume to be treated, depressed invert, vegetation.

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