

DRAINAGE AND SERVICE DUCTS

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Drainage and Service Ducts

501 Pipes for Drainage and for Service Ducts

General

- 1 Where the term drain is used in this Series it shall be deemed to include the terms sewer and piped culvert. Box culverts shall be as described in Appendix 5/1.

The Contractor shall design the box or piped culverts listed in Appendix 1/10 in accordance with the requirements of Clause 106.

- 2 Drains, excluding those constructed using corrugated steel pipes exceeding 900 mm diameter, shall comply with this Series and any additional requirements described in Appendix 5/1. Drains constructed using corrugated steel pipes exceeding 900 mm diameter shall comply with the 2500 Series. Unless otherwise described in Appendix 5/1 or agreed by the Engineer, only one type of pipe shall be used within any individual drain or service duct between consecutive chambers. The Contractor shall ensure that plastics pipes are not subject to deterioration due to sunlight during the period between manufacture and installation in the ground.

Pipes for Drainage

- 3 Pipes for drainage shall be selected from the alternatives in Table 5/1 and shall comply with the standards and particular requirements therein. The Contractor shall show that the pipes he selects have hydraulic flow capacity equal to that adopted in the hydraulic design of the system as described in Appendix 5/1.

On completion of the whole of the drainage works, the Contractor shall provide the Engineer with a schedule showing details of all pipe types used, including quality, joints and name of manufacturer.

Corrugated Steel Pipes Not Exceeding 900 mm Diameter

- 4 Corrugated steel pipes shall be manufactured from either:
- bolted segmental plate pipes complying with sub-Clause 6 of this Clause and having plate thicknesses as described in Appendix 5/1; or
 - galvanized steel sheet suitable for lock seam fabrication complying with BS 2989

Grade Z2, Coating Type G600 or aluminium coated steel sheet complying with AASHTO specification M274-87I.

Corrugated steel pipes complying with (ii) above shall be manufactured from steel of minimum thickness 1.25 mm unless otherwise described in Appendix 5/1.

- 5 Where described in Appendix 5/1 corrugated steel pipes not exceeding 900 mm diameter shall be provided with additional protection of hot applied bitumen complying with AASHTO specification M190-80, or an approved equivalent coating system.

- 6 Bolted segmental plate pipes shall meet the following requirements:

(i) Steel for the plates shall comply with BS 1449: Part 1, Grade 3 or Grade 4, Condition HR.

(ii) After forming, the depth of the corrugations shall be within a tolerance of $\pm 6\%$ and the pitch of the corrugations within a tolerance of $\pm 4\%$ of the nominal dimensions. Plates shall have a minimum lip of 45 mm beyond each end crest. Cut edges shall be free from notches, gouges, rust or burrs.

(hi) Bolts and nuts for connecting plates shall comply with BS 3692, grade designation 8.8, nominal size M20, or with BS 4395, nominal size M20, or with BS 6104: Part 1 grade designation 10.9 and BS 6104: Part 2.

(iv) When all the plates have been assembled, the nuts shall be tightened against a domed washer. The tightening shall be repeated if necessary to achieve the torque recommended by the manufacturer.

(v) Steel plate shall be galvanized in compliance with Clause 1911. Plates shall be galvanized after forming the corrugations and completing all necessary cutting, punching and drilling. Units in which the zinc coating has been burned by welding or otherwise damaged in fabrication, transport or handling at Site shall be made good in compliance with Clauses 1905 and 1906. Bolts and nuts shall also be galvanized in compliance with Clause 1911.

Pipes for Service Ducts

- 7 Pipes for service ducts shall be selected from the alternatives in Table 5/2 and shall comply with the standards and particular

Table 5/1: Pipes for Drainage

Material	Usage	Standard	Particular Requirements
Vitrified Clay	Foul Drains	BS 65 or BS EN 295	"Normal" pipes as defined in BS 65
Concrete (With Portland cement or sulphate-resisting cement when required in Appendix 5/1. Supersulphated cement shall not be used)	Foul & surface water drains not exceeding 900mm internal diameter	IS 6 or BS 5911: Part 100	
	Surface water drains not exceeding 900mm internal diameter	IS 6 or IS 166 or BS 5911: Part 3	For use with joints complying with sub-Clause 504.4
	Filter Drains	IS 6 or IS 166 or BS 5911: Part 3	Imperforated not exceeding 2m in length with open joints or castellated rebated joints with the total slot area between castellations being at least 100mm- per metre length of pipe OR Perforated with circular holes not greater than 10mm or less than 3mm in diameter
	Drains exceeding 900mm diameter	IS 6 or IS 166 or BS 5911: Part 100	Pipes having a concrete mix meeting the following requirements (Testing in accordance with the relevant BS and sampling in accordance with Clause 509): A total chloride ion content as described in Appendix 1/10 AND A 28-day minimum works cube strength of not less than 50N/mm'
Iron	Foul & surface water drains	BS 437 (Cast Iron)	
		BS 4772 (Ductile Iron)	
Unplasticised polyvinyl-chloride (UPVC)	Foul & surface water drains	IS 424 or BS 4660 or BS 5481	
	Filter drains	IS 424 or BS 5481	Perforated with not less than 100mm- of holes per metre length of pipe. The perforations shall not reduce the pipe stiffness by more than 5%. Circular perforations not greater than 10mm or less than 3mm in diameter or rectangular slots not greater than 4mm or less than 0.6mm in width.
Plastics	Surface water drains	BS 4962	Unperforated with water-tight joints and with a pipe stiffness and impact resistance as described in Appendix 5/1
	Filter drains	BS 4962	Perforated and with a pipe stiffness and impact resistance as described in Appendix 5/1
	Subsoil field drains	BS 4962	
Corrugated Steel	Surface water drains, filter drains and piped culverts not exceeding 900mm diameter	AASHTO Specification M36M-89I except as otherwise required in sub-Clauses 501.4,5 and 6	
	Drains exceeding 900mm diameter shall comply with the 2500 Series		

Table 5/2: Pipes for Ducts

Material	Standard	Particular Requirements
Iron	BS 4772 (Ductile Iron i	
Unplasticised Polyvinyl-chloride (UPVC)	IS 424 or BS 4660 or BS 5481 or BS 3505 (Class C) or BS 3506 (Class C)	When pipes to BS 3505 (Class C) or BS 3506 (Class C) are used, joints shall comply with BS 4346: Part 2

requirements therein. Pipes for service ducts shall have a smooth internal bore without any sharp edges to the ends of pipes. They shall comply with any additional requirements described in Appendix 5/2, and be of 100 mm internal diameter unless otherwise described therein. Their alignment shall be tested in accordance with sub-Clause 509.9.

- 8 Each duct shall be fitted with a pigmented, stranded polypropylene or approved equivalent rot-proof material draw rope of 5 kN breaking load and having a design life of not less than 20 years, the ends of which shall be made fast to marker blocks as shown on the NRA Road Construction Details listed in Appendix 5/6. The ends of a duct shall be sealed by removable stoppers immediately it has been laid.

502 Excavation for Pipes and Chambers

- 1 Excavation shall comply with Clause 602 and with the following:
- (i) soft spots existing below the bottom of an excavation shall be removed as directed by the Engineer and the resulting voids backfilled with Granular Material Type B complying with Clause 804 or pipe bedding material complying with Clause 503, both well compacted, or mix ST1 concrete;
 - (ii) any additional excavation below the bottom of an excavation that is required because the Contractor has allowed the bottom to become soft or otherwise unacceptable for the construction of the pipeline or chambers shall be made good as described in sub-Clause Hi) of this Clause;
 - (hi) any excavation greater than the net volume required for the Permanent Works below the level of any pipe surround shall be made good as described in (i) above.

503 Bedding, Laying and Surrounding of Pipes

- 1 Immediately following the excavation of the trench, the pipes shall be laid and jointed on the pipe bed. Pipes shall be laid so that each one is in contact with the bed throughout the length of its barrel. The pipes shall be laid at the level and gradients shown on the Drawings and schedules. The deviation in level from that specified at any point shall not exceed 20 mm and in addition the algebraic difference of the deviation in level at any two points on each pipe shall not exceed 30 mm unless otherwise agreed by the Engineer. In the case of socketed or sleeve jointed pipes the bed shall be cut away and removed at each socket or sleeve to give a clearance of at least 50 mm, or 100 mm for trenches in material designated as Hard Material, so that the socket or sleeve does not bear on the bed. Pipes shall be laid on setting blocks only where a concrete bed or cradle is used.

Pipes and fittings shall be examined for damage and the joint surfaces and components shall be cleaned immediately before laying. Measures shall be taken to prevent soil or other material from entering pipes, and to anchor each pipe to prevent movement before the work is complete.

- 2 Pipes complying with BS 4962 which are corrugated coilable perforated pipes shall be laid only by automatic single pass drain laying machines.
- 3 Drainage pipe and bedding combinations shall be selected from the alternatives described in Appendix 5/1. Pipe bedding, haunching and surrounding material shall be as shown on the 500 Series of the NRA Road Construction Details, and shall comply with the following:
- (i) For pipes on beds shown on the NRA Road Construction Details listed in Appendix 5/6 the granular material shall have:
 - (a) a grading in accordance with Table 5/3; and
 - (b) a water soluble sulphate content of less than 1.9 grams of sulphate (as SO₂) per litre when tested in accordance with BS 1377 : Part 3.
 - (ii) For pipes on beds specified in Appendix 5/1 the granular material shall comply either with sub-Clause 3(i) of this Clause or with Table 5/4, with the water soluble sulphate content complying with (i) above.
 - (iii) For pipes on beds shown on the NRA Road Construction Details listed in Appendix 5/6 concrete shall be mix ST4. Backfilling shall not be carried out until after the concrete has cured.

Table 5/3: Granular Materials to BS 882

Nominal Pipe Diameter (mm)	BS 882:1992 Coarse Aggregate (Table 3)	
	Graded Aggregate Ranges (mm)	Single Sized Aggregate Sizes (mm)
Not exceeding 140		10
Exceeding 140 but not exceeding 400	20 to 5 or 14 to 5	10,14 or 20
Exceeding 400	14 to 5, 20 to 5 or 40 to 5	10,14, 20 or 40

Table 5/4: Granular Materials to BS 882

Nominal Pipe Diameter (mm)	BS 882:1992 Sand (Table 4)	BS 882:1992 All-in Aggregate (Table 5)
	Limits	Nominal Sizes (mm)
Not exceeding 140	Overall Limits	10
Exceeding 140 but not exceeding 400	Overall Limits	10 or 20
Exceeding 400	Overall Limits	10, 20 or 40

(iv) Except for filter drains any Class 1 or Class 2 material above the bed, haunch and surround described above, shall be provided to a height of 300 mm above the top of the surround without any large stones or lumps of clay and in compliance with the 600 Series.

(v) Unless otherwise described in Appendix 5/1 the materials used for the bedding, haunching and surrounding of filter drains shall comply with the appropriate bedding, haunching and surrounding materials specified in sub-Clauses 503.3.(i) to 503.3.(iv) and with the requirements for backfilling specified in sub-Clause 505.3.

(vi) Granular materials used for bedding, haunching and surrounding of pipes shall have a 10% fines value of not less than 50 kN when tested in accordance with BS 812 : Part 111, with samples in a soaked condition.

4 Except where the pipeline is to be tested in compliance with Clause 509 before backfilling, the completion of the bedding, haunching and

surrounding of the pipes is to be carried out immediately after jointing. The bed, haunch and surround shall be brought up equally on both sides of the pipe ensuring that it is in contact with the underside of the pipe barrel and be carefully compacted in layers not exceeding 150 mm thickness ensuring full compaction next to the trench walls. Pipes shall be maintained to line and level during the bedding, haunching and surrounding operations. Where pipelines are to be tested before being covered, the bedding, haunching and surrounding material shall only be brought up sufficiently to support the pipeline and the joints shall be left exposed until the test is completed and the pipeline accepted by the Engineer.

5 Duct construction shall comply with the requirements of Appendix 5/2.

504 Jointing of Pipes

1 Rigid joints shall mean joints made solid by caulking the sockets, or bolting together flanges integral with the pipes. Flexible joints shall mean joints made with deformable rings or gaskets held between pipe spigots and sockets, sleeves or collars.

2 Joints in surface water drains shall be watertight complying with sub-Clause 3 of this Clause or partly watertight complying with sub-Clause 4 of this Clause as described in Appendix 5/1. Foul drains shall have watertight joints. Filter drains shall have joints complying with sub-Clause 6 of this Clause. Ducts need not have watertight joints unless otherwise described in Appendix 5/2.

3 Watertight joints shall comply with the appropriate British Standards, the manufacturers instructions and the following:

(i) Rigid joints shall be used only with the approval of the Engineer. Spigots and sockets of rigid joints may be caulked with tarred rope yarn or equivalent and the socket completely filled with mortar designation (i) complying with Clause 2404, excluding lime; a fillet of mortar being worked around the socket extending for a length of not less than 50 mm from the face of the socket. Iron pipes with open sockets shall have rigid joints caulked with lead wool or equivalent.

(ii) Joints in UPVC pipes shall not be made with plastic solvent.

(iii) Flexible mechanical joints may be used with surface water pipes complying with

- BS 65 provided that the performance requirements of BS 65 are fulfilled.
- (iv) Joints for cast iron pipes to BS 437 shall comply with BS 6087.
- (v) Joints in plastics pipes to BS 4962 shall comply with BS 4962.
- 4 Partly watertight joints for surface water drains shall be tested in accordance with sub-Clause 509.7 and shall be British Standard joints or non-British Standard joints. Push fit joints shall have a register to ensure that the pipe is fully pushed into the joint. Corrugated steel pipes of lock seam fabrication, not exceeding 900 mm diameter, shall be joined in accordance with the manufacturer's instructions. Bolted segmental plate pipe arches or circular pipes, not exceeding 900 mm diameter, shall be joined in accordance with sub-Clause 501.6 (iv) and the manufacturer's instructions.
- 5 Where a concrete bed, cradle, arch or surround is used with rigid pipes having flexible joints, joint filler board complying with Clause 1015 shall be placed in contact with the end of the socket at a pipe joint and shall extend through the full thickness of the concrete in contact with the pipe. Such joints in the concrete bed, haunch or surround shall be at intervals not exceeding 5 metres except where the spacing of joints in the pipe exceeds 5 metres when they shall be at each pipe joint.
- 6 Joints in pipes for filter drains shall comply with the appropriate British Standard and with the following:
- (i) Non-porous and unperforated concrete pipes with spigot and socket, rebated or ogee joints shall be laid with unsealed joints and with a gap of 10 mm between the end of the pipe and the inner end of the socket or rebate. The pipes shall be supported with tarred rope yarn or equivalent flexible jointing material within the sockets over the lower third of the circumference so that there are no vertical steps between one pipe and another. Such pipes shall only be used with Type B filter material as described in Clause 505.
- (ii) The ends of perforated or castellated concrete pipes with rebated joints shall be pushed tightly together. The width of slots measured along the length of the pipeline formed by jointing castellated pipes shall not exceed 10 mm.
- (iii) Perforated or slotted UPVC pipes with spigots and sockets or sleeves may be dry-jointed or jointed as described in sub-Clauses 3 and 4 of this Clause.

- (iv) Other perforated pipes shall be jointed as unperforated pipes of the same material.

- 7 Joints in pipes for service ducts shall comply with the appropriate British Standard and with the following:
- (i) Pipes for ducts shall be jointed so that no silt, grit, grout or concrete surround is able to enter the duct. Pipes with push-fit joints shall have a register to ensure that the pipe is fully pushed into the joint.
- (ii) Joints in pipes to BS 3506 or BS 3505 shall comply with BS 4346 : Part 2.

505 Backfilling of Trenches and Filter Drains

- 1 Backfilling shall be undertaken immediately after the specified operations preceding it have been completed. The material as described in the Contract shall be deposited in layers, compacted in accordance with Clause 612. Care should be taken to compact the material evenly without dislodging or damaging pipes. Power rammers are not to be used within 300mm of any part of the pipe or joint.
- 2 Except where otherwise described in Appendix 5/1, trenches other than filter drain trenches shall be backfilled above the pipe surround material described in Clause 503 with Class 1 or 2 general fill material complying with the 600 Series. Backfill of trenches, other than in carriageways and other paved areas, shall be brought up to ground level. Where the ground surface on the line of the trench consists of top soil, the upper section of the backfill shall be top soil of the thickness described, or of the same thickness and quality of soil as the surrounding ground. For trenches in carriageways or other paved areas the backfill shall be brought up to formation level, or sub-formation level where capping is required, unless a lower level is described in Appendix 5/1.
- 3 Trenches for Filter drains shall be backfilled with filter materials within the grading limits of Table 5/5 or such other limits as described in Appendix 5/1. All filter material shall be hard, clean crushed rock or gravel. The material shall have a 10% fines value of not less than 50kN when tested in accordance with BS 812: Part 111 with samples in a soaked condition. The material passing the 425 um BS Sieve shall be non-plastic when tested in accordance with BS 1377. The material shall not have a soluble sulphate content exceeding 2g of sulphate (as SO₄) per litre when tested as described in BS 1377: Part 3.

Table 5/5: Range of Grading of Filter Drain Material

Material	Percentage by Mass Passing Sieve BS Sieve Sizes (mm)					
	63	37.5	20	14	10	5
TypeB	100	85-100	0-20	-	0-5	-
TypeC			100	85-100	0-50	0-10

The filter material shall be deposited in layers each not exceeding 225 mm loose depth and each layer shall be lightly compacted.

The position of service ducts shall be marked when the trenches are backfilled and permanent marker blocks and location posts provided as described in Appendix 5/2.

506 Connecting to Existing Sewers, Drains, Chambers and Channels

- Where described in Appendix 5/1, existing sewers and drains shall be extended, connected and jointed to new drains, chambers or channels. All such connections shall be made during the construction of the new sewer, drain or other work and their positions recorded by the Contractor who shall hand to the Engineer a copy of the record of the connections made the previous day. Where pipe connections are made to existing brick concrete or stone sewers, drains, chambers or channels, the pipes shall be well and tightly built into the concrete, brick or masonry work and be so placed as to discharge at an angle not greater than 60° to the direction of flow of the sewer, drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe sewers or drains, special connecting pipes shall be laid and jointed as described in Appendix 5/1.
- Before entering or breaking into an existing sewer or drain, the Contractor shall give notice of his intention to do so to the authority responsible for the pipeline to which the connection is to be made.
- Existing sewers or drains no longer required shall, at the direction of the Engineer, be sealed with mix ST2 concrete or removed and replaced with acceptable fill material deposited in layers and compacted in accordance with Clause 612.

507 Chambers

- Chambers shall include manholes, catchpits, inspection chambers, draw pits and walled soakaways. Chambers shall be of the type specified in Appendix 5/1, constructed in accordance with the 500 Series of the NRA Road Construction Details as appropriate to that type.
- Foundations to chambers shall be of mix ST4 concrete. Channels for chambers shall be formed and finished smooth in the foundation concrete or constructed of preformed half circle channels, with sides benched in mix ST2 concrete, or mortar designation (i) complying with Clause 2404 excluding lime. Alternatively for inspection chambers not exceeding 1.3 metres in depth to invert, complete plastics units or other units in equivalent material surrounded by 150 mm of mix ST4 concrete may be used.
- Brickwork and Blockwork shall comply with the 2400 Series and be built with mortar designation (i) in English bond. The joints of brickwork where exposed shall be finished as specified for unpointed joints in Clause 2412. The ends of all pipes shall be neatly built into the brickwork and finished flush with mortar designation (i).
- Precast concrete chambers shall comply with BS 5911 : Part 200. Cast in situ concrete chambers shall be constructed of mix ST4 concrete complying with Clause 2602 unless otherwise described in Appendix 5/1.
- Corrugated galvanized steel chambers shall comply with Clause 501 with in situ mix ST4 concrete inverts and precast concrete cover slabs complying with BS 5911 : Part 200 and the particular requirements described in Appendix 5/1. They shall be surrounded with well graded granular material Class 6M as described in Table 6/1 compacted in accordance with Clause 612.
- Where the depth of invert of chambers exceeds 900 mm below the finished surface of the carriageway or the adjacent ground, manhole steps complying with BS 1247 : Part 1 or Part 2 shall be built in as specified in BS 5911 : Part 200. Steelwork used for ladders, handholds and other fittings shall comply with BS 970 : Part 1 and be galvanized in compliance with Clause 1911 after fabrication. Threaded components shall also be galvanized in compliance with Clause 1911.
- Excavation around chambers, except those described in sub-Clause 5 of this Clause, shall be backfilled with general fill material as described in Table 6/1 and compacted in compliance with

Clause 612. Where mechanical compaction is impracticable, the excavation shall be backfilled with mix ST2 concrete. Where there are precast concrete access shafts to precast concrete chambers, the shafts shall be surrounded by a minimum thickness of 150 mm of mix ST4 concrete, and the remaining excavation backfilled with general fill material as described in Table 6/1 compacted in compliance with Clause 612.

- 8 Chambers for foul sewers and drains shall be tested for watertightness as and where required in Appendix 5/1.
- 9 Chamber covers, gratings and frames shall be as described in Appendix 5/1 and shall comply with EN 124. They shall be either coated or uncoated unless otherwise described in sub-Clause 11 of this Clause.
- 10 Chamber cover bolts shall comply with BS 4190 : 1967 and be galvanized in compliance with Clause 1911.
- 11 Requirements for special duty covers for use in carriageways shall be as described in Appendix 5/1.
- 12 Gratings for catchpit chambers shall have a minimum waterway area as described in Appendix 5/1.
- 13 Two sets of lifting keys shall be delivered to the Engineer for each type of cover supplied.
- 14 Frames for chamber covers and gratings shall be set in cement mortar designation (i) complying with Clause 2404 or a proprietary quick setting mortar approved by the Engineer.
- 15 For all pipelines except those constructed with corrugated pipes the nearest joint to any chamber shall be not more than 500 mm from the inner face of the wall and shall not be restricted by any concrete. Between this and the next joint, the length of the articulated pipe shall be in accordance with Table 5/6.
- 16 Where the adjustment or replacement of existing frames and covers or gratings is required, the units shall be taken up and refixed or replaced with new units complying with sub-Clauses 9 to 13 of this Clause, or such other specification as required by the

responsible authority, on a mortar bed complying with sub-Clause 14 of this Clause. The finished thickness of the mortar bed shall be between 10 mm and 25 mm. Unless otherwise described in Appendix 5/1 adjusted or replaced chamber frames and covers or gratings shall be set flush with the new surface. Any additional adjustments shall be by modifying the brickwork in compliance with sub-Clause 507.3 or by using a frame of a suitable depth.

508 Gullies and Pipe Junctions

- 1 Gullies shall be untrapped, unless otherwise described in Appendix 5/1, and be in accordance with the NRA Road Construction Details listed in Appendix 5/6.
- 2 Gullies shall be constructed so that no part of the spout or trap has a cross-sectional area less than 2/3rd that of the outlet. The depth of water seal in trapped gullies shall be not less than 50 mm.
- 3 Precast concrete gullies shall comply with BS 5911 : Part 2. In situ concrete gullies shall be constructed of mix ST4 concrete or concrete blockwork of 225mm minimum thickness and be as described in Appendix 5/1.
- 4 Cast iron and cast steel gully gratings shall comply with EN 124.
- 5 The upper surface of gully gratings shall be flat except where otherwise described in Appendix 5/1. Slots in gratings or between gratings and frames shall not be orientated parallel to the direction of traffic. Gratings shall be bedded with the hinges on the side nearest on-coming traffic. Frames shall be bedded on mortar complying with sub-Clause 507.14. Brickwork shall comply with sub-Clause 507.3.
- 6 Backfilling to precast gullies shall be carried out up to formation level with general fill material Class 1, as described in Table 6/1 compacted in compliance with Clause 612. Where mechanical compaction is impracticable, the backfilling shall be in mix ST2 concrete. The remainder of the backfilling shall be in appropriate road pavement materials except that where mechanical compaction of granular sub-base is impracticable mix ST2 concrete shall be used.
- 7 Gully connection pipes shall be either flexible or rigid not exceeding 0.7 m in length with flexible joints for a distance of 2 m from the gully and shall be in accordance with sub-Clause 507.15 when entering chambers. Junction pipes shall be

Table 5/6: Length of Articulated Pipe

Nominal Pipe Diameter (mm)	Length of Pipe (mm)
450 and less	500 to 750
Greater than 450	750 to 1000

manufactured of the same type and class of material as the remainder of the pipes in the run unless otherwise agreed by the Engineer. Junction pipes which are laid but not immediately connected, shall be fitted with temporary stoppers or seals and the position of all such junctions shall be clearly defined by means of stakes or tracing wires properly marked or labelled. Only with the Engineers approval may saddles be used to form junctions. No internal projections greater than 5 mm will be permitted. Saddles for plastics pipes shall be installed in accordance with the manufacturers recommendations. Saddles with clay pipes shall be jointed with mortar designation (i) complying with Clause 2404, excluding lime. Saddles and pipes shall be surrounded with mix ST2 concrete.

- 8 Where the adjustment or replacement of existing frames and gratings or kerb type gully covers is required, the units shall be taken up and refixed or replaced with new units complying with sub-Clauses 4 and 5 of this Clause or such other specification required by the responsible authority at a level, unless otherwise described in Appendix 5/1, 6 mm below the adjoining road surface on a mortar bed complying with sub-Clause 507.14. The thickness of the mortar bed shall be between 10 mm and 25 mm. Any additional adjustment shall be made by modifying the brickwork in compliance with sub-Clause 507.3 or by using a frame of suitable depth.

509 Testing and Cleaning

- 1 Drains required in Appendix 5/1 to have watertight joints shall be tested as described in Appendix 1/5, or as required by the Engineer, in sections, eg. between chambers, by means of the air test described in sub-Clause 2 of this Clause. If a pipeline is rejected because of a failed air test the Engineer may agree to the Contractor, as part of the rectification work, carrying out a water test as described in sub-Clause 3 of this Clause as an alternative acceptability test. Before testing, the ends of the pipeline to be tested, including those of short branches, shall be plugged and sealed to the satisfaction of the Engineer.
- 2 For the pipeline air test, air shall be pumped in by suitable means until a stable pressure of 100 mm head of water is indicated in a U-tube connected to the system. The air pressure shall not fall to less than 75 mm head of water during a period of 5 minutes without further pumping, after an initial period to allow stabilization. Drains with traps shall be tested to 50 mm head of water and the permissible

loss shall then be no more than 13 mm head of water in 5 minutes without further pumping after the initial stabilising period.

- 3 For the pipeline water test, the pipes shall be filled with water under a head of not less than 1.2 m above the crown of the pipe at the high end and not more than 6 m above the pipe at the low end. Steeply graded pipelines shall be tested in sections so that the above maximum is not exceeded. Unless otherwise agreed by the Engineer the test shall commence two hours after filling the test section at which time the level of water at the vertical feed pipe shall be made up to produce the required 1.2 m minimum test head. The loss of water over a 30 minute period shall be measured by adding water at regular 10 minute intervals to restore the original water level and recording the amounts so added. The drain will have passed the test if the volume of water added does not exceed one litre per hour per linear metre of drain per metre of nominal internal diameter.
- 4 All pipelines less than 350 mm diameter, excluding service ducts shall be checked by drawing through each completed length of pipe a spherical mandrel of a diameter 10 mm less than the smallest internal pipe diameter permitted by the tolerances specified for the pipes being tested unless an alternative method of checking is agreed by the Engineer.
- 5 On completion of the whole of the Works or earlier if the Engineer directs, all chambers gullies and drains other than filter drains shall be flushed from end to end with water and left free from obstructions. Foul drains shall be surveyed by a video camera and a recording supplied to the Engineer. Catchpit chambers shall be left clean and free from silt.
- 6 The pipes and filter material of filter drains shall at all times be left clean and free from silt and obstruction.
- 7 Where described in Appendix 1/5, or required by the Engineer, samples of one or more partly watertight joints for pipelines up to and including 900 mm diameter shall be tested with a head of water kept level with the crown of the pipe. The joint will not be accepted if the flow through the joint in litres per minute exceeds 20 times the square of the nominal internal diameter of the pipe in metres.
- 8 For concrete pipes exceeding 900 mm internal diameter the Contractor shall submit to the Engineer test certificates provided by the manufacturer, based on the following sampling rates:
 - (i) For the hydraulic or hydrostatic test and for the works proof load test, samples shall

be taken at random from each batch of consecutively manufactured pipes of each diameter, joint type and strength class as described in Table 5/7.

- (ii) For the maximum load test, one pipe shall be taken at random from those have been selected for, and have passed the proof load test. If this pipe fails, a further two pipes taken from those which have been selected for, and have passed the proof load test shall be tested and if either pipe then fails, the whole batch shall be rejected.
- 9 Service ducts shall be checked by drawing a wooden mandrel, as shown on the NRA Road Construction Details listed in Appendix 5/6, through as the ducts are laid but where a set has to be given to the line of ducts the wooden mandrel shall be replaced by an iron mandrel 250 mm long but of the same diameter as the wooden version.

510 Surface Water Channels and Drainage Channel Blocks

- 1 Surface water channels and drainage channel blocks shall be constructed as described in Appendix 5/3.
- 2 Surface water channels shall comply with Clause 1103.
- 3 Drainage channel blocks shall comply with Clause 1101.

511 Land Drains

- 1 Existing land drains which are permanently severed by the Works shall be located and connected into a new drain, pipe or ditch all as described in Appendix 5/1. The lengths remaining within the Works shall be cleaned

out from the new drain trench face as necessary. Any pipe disturbed by the Works shall be re-laid to ensure a free discharge into the new drain. Disused ends of intercepted land drains be adequately sealed with mix ST2 concrete in compliance with Clause 2602.

- 2 Where an existing land drain is exposed and severed by temporary trench excavation, the Contractor shall mark the position of the drain and record it. The drain shall be diverted into an existing drain or watercourse. Alternatively, the normal functioning of the drain shall be continued by the construction of a pipeline or channel adequately supported across the excavation, until permanent restoration is made on the original line or as otherwise agreed by the Engineer.
- 3 The Contractor shall notify the Engineer of any land drain which is blocked or is otherwise defective when the drain is first exposed.
- 4 Severed mole drains shall be led straight into new drains; alternatively they shall where required in Appendix 5/1 be intercepted by the construction of a land drain. Where they have been disturbed mole channels shall be cleaned out and filled locally with Type B filter material or as otherwise described in Appendix 5/1.

512 Backfilling to Pipe Bays and Verges on Bridges

- 1 Unless otherwise described in Appendix 5/1, filling to pipe bays and verges on bridges shall be well graded granular material not exceeding 20 mm size containing not more than 3% of material passing the 75 micron BS sieve and with a uniformity coefficient of more than 5. It shall be laid and compacted in compliance with Clause 505 or as otherwise agreed by the Engineer. The material shall meet the sulphate requirement described in sub-Clause 503.3.

Table 5/7: Sampling Rates

No. of Pipes in Batch	Sample Size	If All Pass	If 2 or more Fail	If 1 Fails take a further Sample of	If 1 or more of the further Sample Fails
<40	2	ACCEPT	REJECT or test ALL remaining pipes in batch. failing pipes to be rejected	2	REJECT or test ALL remaining pipes in batch, failing pipes to be rejected
41-60	3			3	
61-80	4			4	
80-100	5			5	
101+	5 per batch of 100			5	

513 Permeable Backing to Earth Retaining Structures

1 Unless otherwise described in Appendix 5/1, permeable backing shall consist of one of the following materials:

- (i) A minimum thickness of 300 mm of granular material of 20mm nominal size, satisfying the following criteria:

Piping ratio, defined as

$$\frac{15 \text{ per cent size of the drainage material}}{85 \text{ per cent size of the backfill material}}, < 5$$

Permeability ratio, defined as

$$\frac{15 \text{ per cent size of the drainage material}}{15 \text{ per cent size of the backfill material}} \cdot 5$$

where the per cent size of a material is the size of particle corresponding to the given per cent ordinate of the particle size distribution graph.

- (ii) Porous no-fines concrete, cast in situ 225 mm thick complying with the requirements of Clause 2603.
- (iii) Precast hollow concrete blocks complying with the BS 6073 : Part 1 laid in stretcher bond with dry joints in 225 mm thick walling with holes vertical.

514 Not Used

515 Not Used

516 Combined Drainage and Kerb Systems

- 1 The Contractor shall design the combined drainage and kerb systems listed in Appendix 1/11 in accordance with the design requirements given in Appendix 5/5.
- 2 Combined drainage and kerb systems shall permit lateral entry of surface water from the channel either continuously or at intervals not exceeding 1 m.
- 3 Combined drainage and kerb systems shall be suitable for their intended application in the Works. The Contractor shall provide evidence of such suitability for the purpose to the Engineer for approval.

- 4 Proprietary systems shall be laid and jointed in accordance with the manufacturer's written instructions.
- 5 Adjacent carriageway, footway, verge or central reserve construction shall not take place within 3 days of any bedding, backing, surrounding or jointing of combined drainage and kerb units.
- 6 Joints between units and between the channel and units, shall be designed to avoid leakage of surface water. Joints between bridge deck waterproofing and component parts passing through the waterproofing shall be watertight. Sealants shall be compatible with the waterproofing system.
- 7 The system shall be cleaned out by high pressure water jetting or other appropriate means on completion of the Works or as agreed by the Engineer. The system shall be left clean and free from all obstruction.

517 Geotextiles for Filter Drains

Materials

- 1 The geotextile materials used in filter drains shall be stored so that they are protected from the deleterious effects of short term exposure to ultraviolet light, and shall be resistant to degradation by acids, alkalis, common chemicals, bacteria, fungi and moulds occurring in soils and road construction materials. After exposure to ultraviolet light the Engineer may require evidence that the materials still comply with the requirements of this Clause. They shall be protected from damage and ultraviolet light and be labelled to identify the grade and manufacturer or supplier.
- 2 The geotextile for filter drains shall:
- (i) sustain a tensile load of not less than 5.0 kN/m at break and have a minimum failure strain of 10% when determined in accordance with BS 6906: Part 1;
 - (ii) have a minimum puncture resistance of 1200 N when determined in accordance with BS 6906 : Part 4;
 - (iii) have a size distribution of pore openings such that the apparent opening size O^{\wedge} when determined in accordance with BS 6906 : Part 2, or other appropriate test, is less than 300 microns, unless otherwise specified in Appendix 5/4;
 - (iv) allow water to flow through it, in either direction, normal to its principal plane at a

rate of not less than 10 l/m²s, unless otherwise specified in Appendix 5/4, under a constant head of water of 100 mm and a maximum breakthrough head of 50 mm when determined in accordance with BS 6906 :Part 3.

- 3 Splicing of lengths of geotextile shall consist of minimum 600 mm overlap secured with pins or mechanical ties. Where an outlet pipe passes through the geotextile a separate piece of geotextile shall be wrapped round the outlet pipe, flared against the geotextile in the filter drain and secured. Where drain lengths are terminated at chambers, the geotextile shall be secured against the chamber walls by suitable means so as to prevent the ingress of soil particles or other extraneous material into the drain.

Installation and Handling

- 4 Filter drains shall be installed as shown on the NRA Road Construction Detail listed in Appendix 5/6. Before, during and after installation the geotextile shall be protected from contamination, damage and exposure to ultraviolet radiation in accordance with sub-Clause 517.1. No geotextile shall be exposed to daylight (or any source of ultraviolet radiation) for a period exceeding a cumulative total of 50 hours. Any geotextile exposed to daylight (or any source of ultraviolet light) for a period exceeding a cumulative total of 50 hours shall be replaced unless it can be demonstrated to the satisfaction of the Engineer that the geotextile still complies with the requirements of this Clause.
- 5 Trench walls shall be sufficiently clean to enable the geotextile to come into close contact with the wall when the granular material is placed inside it. The deposition and compaction of infill shall be in accordance with sub-Clause 505.4 for filter drains.