

# **IMPLEMENTATION SPECIFICATION FOR ROAD** **WORKS**

## **SERIES IM/500 (IMPLEMENTATION)** **DRAINAGE AND SERVICE DUCTS**



*This Specification Series implements the requirements in  
Subsidiary Legislation 499.57, Part II (New Roads and Road  
Works Regulations) in accordance with the Agency for  
Infrastructure Malta ACT XXVIII, CAP. 588, Part I*

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## **500 Drainage and Service Ducts**

### **Introduction**

- 1 This Series is part of the Specification for Road Works. Whilst this Series is particularly relevant to the subject matter in its title it must be read in conjunction with the general requirements in Series 000 and 100 and with other Series relevant to the specification of the particular works to be undertaken.

### **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. The Contractor shall design the piped culverts in accordance with the requirements of Clause 106 and this Series.
- 2 All drains constructed of pipes as well as piped culverts up to and including 900mm internal diameter shall comply with this Series and any additional requirements in contract specific IM Appendix 5/1. Drains constructed using pipes exceeding 900mm internal diameter as well as box and piped culverts shall comply with Series 2500. Unless otherwise described in contract specific IM Appendix 5/1 only one type of pipe shall be used within any individual drain or service duct between consecutive chambers. The Contractor shall ensure that all drainage materials are not subjected to any form of deterioration before installation into the works.

### **Pipes for Drainage**

- 3 Pipes for drainage shall be selected from the **Error! Reference source not found.** and shall comply with Clause 104 and contract specific IM Appendix 5/1. The Contractor shall demonstrate the pipes selected satisfy the hydraulic design of the system as described in contract specific IM Appendix 5/1. On completion of the whole of the drainage works, the Contractor shall provide the Overseeing Organisation with a schedule showing details of all pipe types used, including quality, joints and name of manufacturer. This will form the basis of a declaration of performance for the drainage.

**Table 500 - 1 Pipes for Drainage**

Material	Usage	Standard	Particular Requirements
Iron	Foul & surface water drains	BS 437 (Cast iron) MSA EN 598 (Ductile iron)	
Thermoplastics solid wall pipes and fittings Unplasticised polyvinyl-chloride (PVC-U) Polypropylene (PP)	Foul & surface water drains	BS 4660 or BS 5481 or MSA EN 1401 (PVC-U) MSA EN 1852-1 (PP) MSA EN 12666-1 (PE)	The grade appropriate for use without structural calculations shall be used i.e. SN8 for PP & PE and SN4 (SDR 41) for PVC-U
Polyethylene (PE)	Filter drains	MSA EN 13598 (BS 4660 for cleaning eyes) or MSA EN 1401 (PVC-U) MSA EN 1852-1 (PP) MSA EN 12666-1 (PE)	Perforated with not less than 1000mm <sup>2</sup> 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 nor less than 3mm in diameter or rectangular slots not greater than 4mm nor less than 0.6mm in width
Thermoplastics structured wall pipe and fittings	Surface water drains	Clause 518	Unperforated with watertight joints and with a pipe stiffness class, creep ratio and impact resistance as described in contract specific IM Appendix 5/1
	Filter drains Subsoil field drains	Clause 518 BS 4962 or Clause 518	Perforated with not less than 1000mm <sup>2</sup> of holes per metre length of pipe. The perforations shall not reduce the pipe ring stiffness by more than 5%. Circular perforations not greater than 10mm nor less than 3mm in diameter or rectangular slots not greater than 4mm nor less than 0.6mm in width

**Table 500 - 2 Pipes for Drainage**

Vitrified clay	Foul drains	MSA EN 295	
	Surface water drains	MSA EN 295	
	Filter drains	MSA EN 295	
Concrete (With Portland cement or sulfate-resisting cement when required in contract specific IM Appendix 5/1. Supersulfated cement shall not be used)	Foul & surface water drains	BS 5911-1 and MSA EN 1916 (Ordinary reinforced or unreinforced) BS 5911-5	
	Surface water drains	BS 5911-1	
	Filter drains	BS 5911-1 (Porous with ogee or rebated joints)	
		BS 5911-1	Unperforated not exceeding 2m in length with open joints or castellated rebated joints with the total slot area between castellations being at least 1000mm <sup>2</sup> per metre length of pipe OR Perforated with circular holes not greater than 10mm nor less than 3mm in diameter
Glass reinforced plastics (GRP)	Foul & surface water drains	MSA EN 14364	Class to be as specified in contract specific IM Appendix 5/1
Iron	Foul & surface water drains	BS 437 (Cast iron) MSA EN 598 (Ductile iron)	

**Pipes for Service Ducts**

- 4 Pipes for service ducts, excluding those used in highway communications installations, shall be uPVC to EN 61386-1, 21 and 24, Class 250 / 450 / 750 at 50 degrees Celsius as described in IM Appendix 5/2 or as required by the Overseeing Organisation.
- 5 The alternatives in **Table 500 - 3** may be permitted and shall comply with the standards and particular requirements therein. Pipes for service ducts shall have a smooth internal bore without any sharp edges to the ends of pipes, shall comply with contract specific IM Appendix 5/2, and be of 100mm internal diameter unless otherwise described therein. Their alignment shall be tested in accordance with sub-Clause 509.9.

- 6 The use of pipes and fittings other than those included in **Table 500 - 3** shall be permitted provided that they hold current Product Acceptance Scheme certification in accordance with sub-Clauses 104.15 and 104.16 stating that they are a suitable alternative to those listed in **Table 500 - 3**.
- 7 Each duct shall be fitted with a pigmented, stranded polypropylene or equivalent rot-proof material draw rope of 5kN breaking load and having a design life of not less than 20 years, the ends of which shall be either made fast to marker blocks or secured inside chambers. The ends of a duct shall be either sealed by removable stoppers immediately it has been laid or terminated in chambers of the type specified in contract specific IM Appendix 5/2.

**Table 500 - 3 Pipes for Ducts**

Material	Standard	Particular Requirements
Thermoplastics solid wall Unplasticised polyvinyl-chloride (PVC-U) Polypropylene (PP) Polyethylene (PE)	BS 4660 and MSA EN 13598  Or BS 3506 (Class C) or (PVC-U) MSA EN 1401, MSA EN ISO 1452-1 to 5 as appropriate class PN10. MSA EN 1852-1 (PP) MSA EN 12666-1 (PE)	When pipes to BS 3506 (Class C) are used, joints shall comply with MSA EN ISO 1452-1 to 5 as appropriate
Thermoplastics single wall (Restricted to ducts buried a minimum of 600mm below the surface)	MSA EN 61386-24	Ducts to MSA EN 61386-24 shall be classified as normal duty, corrugated have a degree of protection against ingress of foreign objects classification rating of 3 or 4 and a degree of protection against ingress of water classification rating of 7. Resistance to bending requirements shall be as stated in contract specific IM Appendix 5/2.
Thermoplastics structured wall	MSA EN 61386-24 and Clause 518	Ducts to MSA EN 61386-24 shall be classified as normal duty, corrugated have a degree of protection against ingress of foreign objects classification rating of 3 or 4 and a degree of protection against ingress of water classification rating of 7. Resistance to bending requirements shall be as stated in contract specific IM Appendix 5/2



## **502 Excavation for Pipes and Chambers**

- 8 Excavation shall comply with Clause 602 and with the following:
- a) Soft spots existing below the bottom of an excavation shall be removed and the resulting voids backfilled with Type 1 unbound mixture for subbase complying with Clause 802 or pipe bedding material complying with Clause 503, both well compacted, or ST1 concrete in compliance to Clause 2602;
  - b) 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 1(a) of this Clause; and,
- 9 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 (a) above.
- 10 Unless otherwise described in contract specific IM Appendix 5/1, all pipes in or under new embankments shall be laid only when the embankment has been formed and compacted to formation level under paved areas, to finished earthworks level in other areas, or to a level which will give a minimum cover of 1.2m to the pipes, whichever is the lowest.

## **503 Bedding, Laying and Surrounding of Pipes**

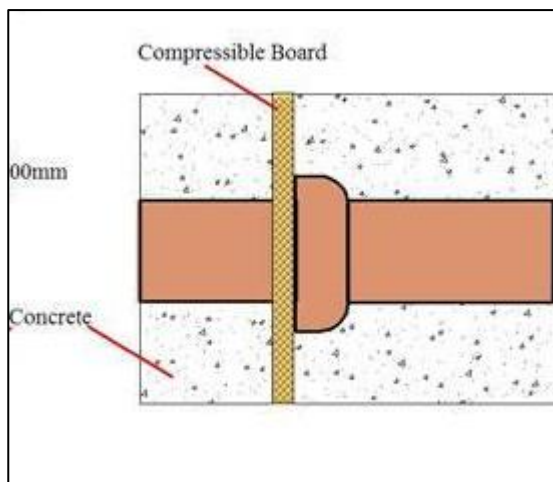
- 1 Immediately following the excavation of the trench, the pipes shall be laid and jointed on the pipe bed. Pipes shall be laid so that each one is in contact with the bed throughout the length of its barrel. The pipes shall be laid at the level and gradients shown on the drawings and schedules. The deviation in level from that specified at any point shall not exceed 20mm and in addition the algebraic difference of the deviation in level at any two points on each pipe shall not exceed 30mm. 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 50mm, or 100mm 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 that show any sign of damage shall be excluded from the works. The pipes and fittings' 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 Drainage pipe and bedding combinations shall be selected from the alternatives described in contract specific IM Appendix 5/1 or as stated in the Bills of Quantities.
- 3 Granular material shall consist of natural and/or recycled coarse aggregate complying with MSA EN 13242 and have a declaration of performance for its intended use - the declaration of performance shall demonstrate that the aggregate meets the specification.

4 Where recycled coarse aggregate is used in this Clause, it shall have been tested in accordance with Clause 710 and shall not contain more than 1% 'other' materials (Class Pipe bedding, haunching and surrounding material shall be as shown on drawings RCD 500/01 and RCD 500/03 and shall comply with the following:

- a) For pipes on beds shown on RCD Drawing 500/01 as Types A and B and RCD 500/03 as Types B, F and S the aggregate shall have:
  - i) Geometrical requirements in accordance with **Table 500 - 4** ;
  - ii) A resistance to fragmentation in Category LA<sub>50</sub> in accordance with MSA EN 13242, clause 5.2 and Table 9;
  - iii) A water-soluble sulfate content of less than 0.2% category SS0.2 in accordance with MSA EN 13242 when tested in accordance with MSA EN 1744-1, clause 10;
  - iv) All other requirements in Category NR

*For pipes on beds shown on RCD Drawing 500/03 as Types N and T the aggregate shall comply with the geometrical requirements of either **Table 500 - 4** or with*

- b) **Table 500 - 5**, and with the fragmentation, water soluble sulfate content and other requirements of (a) above;
- c) For pipes on beds shown on RCD Drawing 500/03 as Type Z concrete shall be ST2 in compliance to Clause 2602. Backfilling shall not be carried out until after the concrete has cured. The concrete bed and surround shall extend to the sides of the trench and must fill all voids. Compressible boards shall be inserted at the ring socket connections at the intervals indicated by the pipe manufacturer.



**Figure 500 - 1 Compressible Board at Pipe Joint for Type Z bed and surround**

- d) Except for filter drains and where shown in RCD 500/3 a further surround above the bed, haunch and surround described above shall be provided to a height of 300mm above the top of the pipe consisting of Class 8 lower trench fill material as described in Table 600-1 and in compliance with Series 600;
  - e) Unless otherwise described in contract specific IM 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 above and with the requirements for backfilling specified in Clause 505; and,
  - f) Pipes shown on RCD Drawing 500/03 shall be laid with slots or perforations upwards where a concrete bed is used. For other beds the slots or perforations shall be orientated as described in contract specific IM Appendix 5/1.
- 5 Materials for bedding, haunching and surrounding pipes within 500mm, or any other distance described in contract specific IM Appendix 5/1, of concrete and cement bound materials shall comply with the requirements stated in sub-Clause 601.14.
- 6 Materials for bedding, haunching and surrounding pipes placed within 500mm, or any other distance described in contract specific IM Appendix 5/1, of metallic structural elements shall comply with the requirements stated in sub-Clause 601.16.

**Table 500 - 4 EN 13242 Coarse Aggregate for Pipe Bedding, Haunching and Surround**

Category for general grading requirements	G <sub>c</sub> 80-20
Category for tolerances at mid-size sieves	G <sub>TNR</sub> (no requirements)

Category for maximum values of fines content	Natural aggregate – $f_{1.5}$	
	Manufactured aggregate, recycled aggregate – $f_4$	
Nominal pipe diameter, mm	Aggregate size, mm	
	Graded	Single
Not exceeding 140	–	4/10
Exceeding 140 but not exceeding 400	2/14 or 4/20	4/10, 6/10 or 10/20
Exceeding 400	2/14, 4/20 or 4/40	4/10, 6/14, 10/20 or 20/40

**Table 500 - 5 EN 13242 Fine and All-In Aggregate for Pipe Bedding, Haunching and Surround**

	Fine	All-in
Category for general grading requirements	Category $G_{F80}$	Category $G_{A80}$
Category for tolerances on manufacturer's declared	$GT_{FNR}$	$GT_{ANR}$
Typical grading	(no requirement)	(no requirement)
Category for maximum values of fines content	Natural aggregate – $f_3$	Natural aggregate – $f_3$
	Manufactured aggregate, recycled	Manufactured aggregate,
	aggregate – $f_{10}$	recycled aggregate – $f_{12}$

Nominal pipe diameter, mm	Aggregate size, mm	
	Fine	All-in
Not exceeding 140	0/1, 0/2, 0/4 or 0/6	0/10
Exceeding 140 but not exceeding 400		0/10 or 0/20
Exceeding 400		0/10, 0/20 or 0/40

- 7 Except where the pipeline is to be tested in compliance with Clause 509 before backfilling as specified in contract specific IM Appendix 5/1, 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 150mm 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 satisfactorily.
- 8 Duct construction shall comply with the requirements of contract specific IM 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 **Table 500 - 2** and as described in contract specific IM Appendix 5/1. Foul drains shall have watertight joints. Filter drains shall have joints complying with **Table 500 - 2**. Ducts need not have watertight joints unless otherwise described in contract specific IM Appendix 5/2.
- 3 Watertight joints shall comply with, the manufacturer's instructions and the following:
  - a) Rigid joints shall be used only where permitted in contract specific IM Appendix 5/1. Spigots and sockets of rigid joints jointed conventionally 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 50mm from the face of the socket;
  - b) Joints in PVC-U pipes shall not be made with plastic solvent;
  - c) Flexible mechanical joints may be used with surface water pipes complying with MSA EN 295;
  - d) Joints for cast iron pipes to BS 437 shall comply with MSA EN 877 and have a declared performance that meets the specification requirements; and,
  - e) Joints in thermoplastics structured wall pipe shall comply with Clause 518.
- 4 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 metres when they shall be at each pipe joint.
- 5 Joints in pipes for filter drains shall comply with **Table 500 - 2** and with the following:
  - (a) Perforated or slotted thermoplastics pipes with spigots and sockets or sleeves may be dry-jointed or jointed as described in sub-Clauses 3 and 4 of this Clause; and,
  - (b) Other perforated pipes shall be jointed as unperforated pipes of the same material.
- 6 Joints in pipes for service ducts shall comply with BS 4660, MSA EN 13598-1 and with the following:
  - (a) Pipes for ducts shall be jointed so that no silt, grit, grout or concrete surround is able to enter the duct.
  - (b) Pipes with push-fit joints shall have a register to ensure that the pipe is fully pushed into the joint.
  - (c) Joints in pipes to BS 3506 shall comply with MSA EN ISO 1452-1 to 5 as appropriate.

#### **505 Backfilling of Trenches**

- 1 Backfilling shall be undertaken immediately after the required operations preceding it have been completed.
- 2 Except where otherwise described in contract specific IM Appendix 5/1, trenches other than filter drain trenches shall be backfilled above the pipe surround material described in Clause 503, with Class 1 general fill material complying with Series 600.
- 3 Where detailed in contract specific IM Appendix 5/1 the bases of trenches formed on water

soluble soils shall be sealed with a waterproof geotextile membrane. The geotextile membrane shall be in accordance with Clause 609.

- 4 Each side of the waterproof geotextile membrane shall be protected by a layer of non-woven geotextile. The non-woven geotextile shall be in accordance with Clause 609.
  - 5 Sub-base material for the upper layer of the drain shall consist of Type 1 material to Clause 802.
  - 6 Geotextile membranes used between the upper and lower section of combined surface and sub-surface drains shall be in accordance with Clause 609.
  - 7 Use of lightweight aggregates as filter material shall be subject to the approval of the Overseeing Organisation.
  - 8 Filter drains shall be backfilled as described in contract specific IM Appendix 5/1 with Type A or Type B filter material which shall consist of natural or recycled coarse aggregate complying with MSA EN 13242 and the following:
    - (a) For Type A, grading requirements for unbound mixtures in accordance with or as shown in the Drawings.
    - (b) **Table 500 - 6** and MSA EN 13285;
    - (c) For Type B, geometrical requirements in accordance with **Table 500 - 6** or as shown in the Drawings.
    - (d) **Table 500 - 6** and MSA EN 13242;
    - (e) A resistance to fragmentation in Category LA<sub>50</sub> in accordance with MSA EN 13242, clause 5.2 and Table 9;
    - (f) A water-soluble sulfate content of less than 0.2% Category SS0.2 in accordance with MSA EN 13242 when tested in accordance with MSA EN 1744-1, clause 10;
    - (g) All other requirements in Category NR.
- a) Where recycled coarse aggregate is used in accordance with this Clause, it shall have been tested in accordance with Clause 710 and shall not contain more than 1% 'other' materials (Class X).
  - b) Filter materials shall be tested for permeability in accordance with sub-Clause 509.9 and shall comply with permeability requirements as described in contract specific IM Appendix 5/1.
  - c) Locations where Type A material is to be used shall be as specified in contract specific IM Appendix 5/1 or as shown in the Drawings.

***Table 500 - 6 Geometric Requirements for Filter Drain Material***

Standard	Type A	Type B
		MSA EN 13285
Size, mm	0/20	20/40
Grading	GE (with an additional sieve)	GC80-20
Oversize category	OC80	–
Category for tolerances at mid-size sieves	–	GTNR
Category for maximum fines	UF3 grading requirements	FNR (no requirement)
Sieve size, mm	Percentage by mass passing	
80	–	100
63	–	98 - 100
40	100	80 - 99
20	80 - 99	0 - 20
10	50 - 90	0 - 5
4	30 - 75	–
2	15 – 60	–
0.500	0 - 35	–
0.125	0 - 4	–
0.063	0 - 3	–
% in size fraction		
4/10	5 - 35	–
2/4	5 - 35	–

- d) Materials for backfilling trenches and filter drains placed within 500mm, or any other distance described in contract specific IM Appendix 5/1, of concrete or cement bound materials, shall comply with the requirements stated in sub-Clause 601.14.



- e) Materials for backfilling trenches and filter drains placed within 500mm, or any other distance described in contract specific IM Appendix 5/1, of metallic structural elements shall comply with the requirements stated in sub-Clause 601.16.
- f) Backfilling shall be deposited and compacted in compliance with Clause 612. Filter material for filter drains shall be deposited in layers not exceeding 225mm loose depth; each layer being compacted in compliance with Table 600-3 to 600-6 Method 3.
- g) Material shall be deposited in even layers and shall not be heaped in the trench before being spread. Spreading and compaction shall be carried out evenly without dislodging, distorting or damaging the pipe. Power rammers shall not be used within 300mm of any part of the pipe or joint.
- h) Except in carriageways, other paved areas and locations described in contract specific IM Appendix 5/1, backfill of trenches shall be brought up to ground level. Where topsoil is at the surface on the line of the trench the upper section of the backfill shall be topsoil of the thickness described in contract specific IM Appendix 6/8, or of the same thickness and quality of topsoil as the surrounding ground where no thickness is specified. 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 contract specific IM Appendix 5/1. Sheet piling and other excavation supports shall be removed as the filling proceeds unless otherwise described in contract specific IM Appendix 6/3.
- i) The position of service ducts shall be marked when the trenches are backfilled and permanent marker blocks and location posts provided as described in contract specific IM Appendix 5/2.

#### **506 Connecting to Existing Drains Chambers and Channels**

- 11 Where described in contract specific IM Appendix 5/1, existing 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 drain or other work and their positions recorded by the Contractor who shall provide to the Overseeing Organisation a copy of the record of the connections made the previous day. Where pipe connections are made to existing brick concrete or stone 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 drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe drains, special connecting pipes shall be laid and jointed as described in contract specific IM Appendix 5/1.
- j) 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 drainage system to which the

connection is to be made.

- k) Unless otherwise stated in contract specific IM Appendix 2/2, existing drains no longer required shall, as required by contract specific IM Appendix 5/1, be sealed with ST2 concrete, in compliance with Clause 2602, or removed and replaced with general fill material complying with Clause 601 and Table 600-1 and compacted in compliance with Clause 610.

## **507 Chambers**

- 1 Chambers shall include manholes, catchpits, inspection chambers, draw pits and walled soakaways. Chambers shall be of the type specified in contract specific IM Appendix 5/1 or as described in the Bills of Quantities and constructed in accordance with the following:
- a) Stormwater chambers (manholes) to drawings IM/FM 03 and IM/FM 04;
  - b) Service ducts chambers to drawings IM/FM 01 and IM/FM 02;
  - c) Water Services Corporation (WSC) drawings WS 064-120T/19 (Type A1), 065-120T/19 (Type B1), 066-120T/19 (Type C1), 067-120T/19 (Type A2), 068-120T/19 (Type B2), 069-120T/19 (Type C2), 085-120/20 (Type B4), 086-120/20 (Type C4), 087-120/20 (Type D4), 088-120/20 (Type A3 and Type A4), 089-120/20 (Type B3), 090-120/20 (Type C3), 094-120T/19 (Type D1), 095-120T/20 (Type D2), 096-120T/20, 109-120/20 (Type D3);

### **Sewage House Connection**

- d) The sewage house connection shall be as shown in the Water Services Corporation (WSC) drawing WS101-120/20;
- 2 All ST concrete referred to in this Clause shall comply with Clause 2602, unless otherwise described in contract specific IM Appendix 5/1.
- 3 Foundations to chambers shall be of 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 ST4 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 150mm of ST4 concrete may be used. Drainage shall be provided through the base of draw pits via a vertical 150 mm plastic duct 400 mm long, filled to 150mm from the top with 4/10 mm aggregate to BS EN 13242, and fitted with a 200mm recessed drain and removable circular or square grating.
- 4 Hollow concrete blockwork for chamber walls shall comply with Series 2400 and be built with mortar designation (i) in English bond or Stretcher bond. Hollow blockwork shall be

- infilled with grade C25/C30 concrete. Each infill shall be keyed-in to the next lower and upper course. All reinforcement within the concrete infill shall be as described in clause 507 and extend the full depth of the blocks coursework.
- 5 The joints of blockwork where exposed shall be finished as specified in Clause 2412 for unpointed joints. The ends of all pipes shall be neatly built into the blockwork and finished flush with mortar designation (a). Where precast concrete adjusting units are used, they shall conform to MSA EN 1917 and BS 5911-3. Benching width for chambers detailed on RCD drawing number 500/69 shall be 300mm for branch connection.
- 6 Exposed faces of hollow concrete blocks and benching in contact with discharge shall be rendered with:
- 1 2 in number coats of Class CS IV (BS EN 998-1) mortar rendering incorporating an approved primer and waterproofing additive for stormwater chambers;
  - 2 a proprietary epoxy resin coating with chemical resistance for aggressive conditions having the following characteristics:
  - 3 Compressive strength after 28 days  $\geq 75$  MPa
  - 4 Flexural strength after 28 days  $\geq 20$  MPa
  - 5 Tensile strength after 28 day  $\geq 20$  MPa
- for foul water chambers.
- 6 Preformed drawpits / chambers for traffic signal installations shall comply with the following:
- 15 be a modular twin wall stacking system of pre-formed recycled thermoplastic, with a minimum depth of 200mm, extending in increments of 150 mm and having a min 40 tonne loading when tested to MSA EN 124 D400.
  - 16 accept a minimum of 12 x 110 mm ducts, increasing by addition of optional stacking sections.
- 17 The base of the chamber shall be 150 mm Class ST2 concrete over a 150 mm compacted layer of Clause 802 Type 1 unbound mixture. Precast concrete chambers shall comply with BS 5911-3 and MSA EN 1917 and the particular requirements described in contract specific IM Appendix 5/1. Cast in situ concrete chambers shall be constructed of ST4 concrete complying with Clause 2602 and the particular requirements described in contract specific IM Appendix 5/1.
- 18 Where the depth of invert of chambers, excluding inspection chambers, exceeds 900mm below the finished surface of the carriageway or the adjacent ground, chamber steps complying with MSA EN 13101 shall be built in accordance with relevant RCD Drawings.

The steps shall have a declaration of performance for their intended use within the permanent works. Threaded components shall be galvanised in compliance with Clause 1909.

- 19 Excavation around chambers, except those described in sub-Clause 5 of this Clause, shall be backfilled with general fill material as described in Table 600-1 and compacted in compliance with Clause 612. Where mechanical compaction is impracticable, the excavation shall be backfilled with ST2 concrete. Where there are precast concrete access shafts to precast concrete chambers, the shafts shall be surrounded by a minimum thickness of 150mm of ST4 concrete, and the remaining excavation backfilled with general fill material as described in Table 600-1 compacted in compliance with Clause 612.
- 20 Chambers for foul drains shall be tested for watertightness in accordance with Clause 509.

**Chambers Covers, Gratings and Frames in Carriageways**

- 21 Chamber covers, gratings and frames in carriageways shall comply with:
- (a) MSA EN 124;
  - (b) UK DMRB CD 534
  - (c) UK DMRB CD 534 and Series IM/550 for the specific category of road (Class HD to Class IV as in the ADT MCRW, Volume 7, Charts 1 to 5).
  - (d) Any particular requirements as described in IM Appendix 5/1.
- Additionally they shall:
- (a) Have a frame and cover made of suitable material, design and construction to achieve the required in-service skid resistance potential determined by the accelerated polish test method described in BS 9124.
  - (b) Have been subjected to and passed a dynamic impact and loading test programme for resistance to movement and deformation.
  - (c) Be provided with elastomeric seals between the cover and the frame,
  - (d) Have a proven design of stress transmission reduction through the frame into the sub-structure
  - (e) Provide an enlarged surface area to spread the load onto the supporting elements through a proven load transfer system
  - (f) Ensure a silent and non-rock in operation in main roads
  - (g) The Polished Skid Resistance Value (PSRV) shall be as stated in contract specific IM Appendix 5/1 and shall be one of the following:
    - i. PSRV  $\geq$  45 for Class V to VI roads

- ii. PSRV  $\geq$  60 for Class HD to IV roads.
- 22 The Unpolished Skid Resistance Value (USRV) is not an acceptable alternative to demonstrate in-service skid resistance.
  - 23 D400 and E600 units and above shall incorporate a permanent non-rock feature by employing the triangular three-point suspension system.
  - 24 Bolts supplied for loosely coupling separate sections of covers and gratings shall be steel hexagon headed, complying with the requirements of MSA EN ISO 4016, MSA EN ISO 4018 and MSA EN ISO 4034 and be galvanized in compliance with Clause 1909. They shall not be less than size M16 complete with hexagon nut and shall be provided with means to prevent undue tightening of unit sections.
  - 25 Unless otherwise specified in contract specific IM Appendix 5/1, all covers, gratings and frames shall be supplied in a fine cast (uncoated) condition. Where a coating is specified in contract specific IM Appendix 5/1, the coating shall only be applied when the surfaces of the casting are clean, free from rust and dry.
  - 26 Not Used
  - 27 Gratings for catchpit chambers shall have a minimum waterway area as described in BS 7903.
  - 28 Two sets of lifting keys shall be delivered to the Overseeing Organisation for each type of cover supplied. At least two keyways, shall be provided in each complete cover, one in each segment for segmental covers. A recess for a prising bar shall be incorporated in manhole covers unless other means of loosening the cover from the frame are provided.
  - 29 For all pipelines the nearest joint to any chamber shall be not more than 500mm 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 500 - 7**. All ducts shall enter chambers perpendicular to the external wall, extend 10mm into the chamber, and be finished with mortar designation (i). Multiple duct entries shall be at a minimum spacing of 35mm in all directions. Where two or more ducts enter a chamber in a horizontal configuration, a precast concrete lintel shall be installed over the ducts extending to include a minimum bearing on adjacent blockwork of 100 mm on each side.

**Table 500 - 7 Length of Articulated Pipe**

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

- 30 Where the adjustment or replacement of existing frames and covers or gratings is required,

the units shall be taken up and re-fixed or removed and replaced with new units complying with sub-Clauses 12 to 19 of this Clause and Series IM/550. Particular requirements shall be as described in contract specific IM Appendix 5/1. On taking up or removal of the unit, any concrete or mortar bedding shall be broken out and the surface prepared. Where existing frames and covers or gratings are to be adjusted, the Contractor shall take up the unit and clean it, so it is free from existing mortar, any debris, rust and is dry before re-use. The adjusted or replaced units shall be laid on a mortar bed complying with sub-Clause 28 of this Clause and Series 550, clauses 556 and 557. The finished thickness of the mortar bed shall be between 10mm and 25mm. Where required in contract specific IM Appendix 5/1, covers and gratings shall be bedded using a quick setting high strength mortar with a declaration of performance for its intended use. The declaration of performance shall be provided to the Overseeing Organisation before use. Unless otherwise described in contract specific IM Appendix 5/1, adjusted or replaced frames and covers or gratings shall be set flush with the new or reinstated surface. Any additional adjustments shall be by modifying the blockwork or adjusting units in accordance with MSA EN 1917 and the works, each cover shall be lifted and the frame and seating cleaned.

- 31 Circular covers shall be used, and double triangular covers shall only be used when instructed by the Client and they shall meet or better the requirements for bearing pressure set above. The cover shall have a minimum opening of 600 mm and shall have a square seating.
- 32 The Contractor shall rectify any defect to carriageway covers, frames and the bedding material specified at sub clause 507.16 which materialise during the period ending five years from the date of installation.
- 33 Recessed covers may only be used in footway environment. When installed, a generous coating of petroleum jelly shall be applied between the cover and frame to prevent sand ingress and future jamming.
- 34 Where stated in contract specific IM Appendix 5/1 the sealing of a cover within the frame is required.
- 35 Access covers with a clear opening of greater than 1m shall comply with BS 9124.
- 36 Where pins or circlips are used as part of the securing device these shall be of equal cross-sectional area.
- 37 Not Used
- 38 For carriageways, chamber concrete reducer slabs with a clear span greater than that shown in the drawings shall be designed by the Contractor for the specific highway traffic loading (as described in the Eurocode) imparted by the frame and cover loading class selected from the classes in BS EN 124-1.

- 39 The bedding beneath the chamber top or gully top frame shall be free of voids.
- 40 Packing materials shall not be used in the bedding of chamber tops and gully tops.
- 41 Seatings of covers within frames shall have be manufactured as to ensure that, when trafficked, stability and quietness are achieved in accordance with MSA EN 124: 1994.
- 42 The frame bearing area shall have the following properties:
- (h) the nominal bearing pressure in relation to the test load in MSA EN 124:1994 shall be a maximum of 2.1 N/mm<sup>2</sup> for class HD - III roads and 2.5 N/mm<sup>2</sup> for class IV – VI roads;
  - (i) frames have an overall minimum bedding width of 50mm of metal and a maximum overall bedding width of 120mm of metal; and,
  - (j) for openings with corners, the external corners of the frame are solid (unless test data are provided that demonstrate the inclusion of holes does not reduce the structural integrity of the system) and may be square, curved or chamfered but at no point shall the width be less than the minimum bedding width.
- 43 The frame bearing area shall have the following properties:
- (a) frames have an overall minimum bedding width of 50mm of metal and a maximum overall bedding width of 120mm of metal; and,
- 44 The bedding flange shall have a minimum thickness of 5mm.
- 45 Where vertical frame stiffening webs/gussets are provided, they shall be located adjacent to seatings.
- 46 The tops of such triangular webs/ gussets shall be in accordance with BS 7903.
- 47 There shall be no holes within the seating areas of the bedding flanges beneath the cover seatings.
- 48 Any holes within flanges within the bedding area of the frame shall be minimal and not reduce the specified bearing area of the frame.

#### **Placing of Frames and Covers**

- 49 The frame of chamber tops and gully tops shall be placed on the bedding material so that all webs of the frame are fully supported by the frame supporting structure.
- 50 The bedding surface shall permit a bedding thickness of between 10mm and 75mm.
- 51 The webs of the frame shall not overhang the internal faces of the frame supporting structure.

- 52 Any holes within the frame shall be infilled with bedding material and the flanges of the frame enveloped by a minimum thickness of 10mm of the same material.
- 53 Exposed surfaces of the bedding material around the outside of the chamber or gully top frame shall be floated to fill any voids and remove loose fragments.
- 54 The exposed surface of the bedding material inside the chamber shall be pointed to a smooth finish.
- 55 Infill material surrounding the frame shall only be placed in contact with the frame once the bedding material has set.

#### **Placement of Frame Surround Infill Materials**

- 56 Where a self-setting infill material is used this shall be placed no higher than 40mm below the finished surface level.

#### **Securing Chamber Covers and Frames**

- 57 Chamber covers and frames shall be secured to ensure that they are not dislodged by a vehicle.

#### **Reinstatement Works - Frame Supporting Structure**

- 58 Where rebuilding involves more than one course of blockwork or precast concrete cover frame seating ring, an adjusting course shall be used to meet the specified finished surface level.
- 59 Frame supporting structure reconstruction shall be hollow blockwork in compliance with Clause 2400 (without holes or frogs) or adjusting units in accordance with MSA EN 1917 and BS 5911-3, bedded on mortar that achieves a compressive strength exceeding 20N/mm<sup>2</sup> Class Md in accordance with MSA EN 998 and Clause 2404 before loading.

#### **Re-bedding**

- 60 The re-bedding of chamber and gully frames and covers shall be in accordance with Series 550.
- 61 Mixing and placing of proprietary bedding materials for blockwork courses shall be in accordance with the manufacturer's instructions.
- 62 Site made mortar shall be in accordance with Clause 2404.
- 63 Bedding layers greater than 50mm thick shall be placed in two stages.
- 64 The first layer of the mortar shall be no thicker than 40mm.



### **Reinstatement of Surrounding Flexible Carriageway**

- 65 The reinstatement of the surround surfacing shall be in accordance with Series 550.
- 66 There shall be no contact between any compaction device and the frame or cover to avoid damaging the frame, cover or the bedding layer.

### **Reinstatement of Surrounding Flexible Carriageway**

- 67 Surface boxes shall comply with BS 5834 Parts 1 to 4 (excluding those parts that are relevant to gas distribution).

## **508 Gullies and Pipe Junctions**

- 1 Gullies shall be trapped, untrapped or sumpless as described in contract specific IM Appendix 5/1 and be in accordance with RCD Drawing Numbers 500/14, 500/15 and 500/69. All ST concrete referred to in this Clause shall comply with Clause 2602 unless otherwise described in contract specific IM Appendix 5/1 "chute gullies shall not be used unless instructed by the overseeing authority".
- 2 Gullies shall be constructed so that no part of the spout or trap has a cross-sectional area less than 2/3 that of the outlet. The depth of water seal in trapped gullies shall be not less than 50mm.
- 3 Precast concrete gullies and cover slabs shall comply with BS 5911-6. In situ concrete gullies shall be as described in contract specific IM Appendix 5/1 and constructed of ST4 concrete of 150mm minimum thickness, using permanent or removable shuttering.
- 4 When constructing an in situ sumpless gully, the pot shall not distort under pressure.
- 5 Where in situ concrete gullies are formed with permanent shuttering, such shuttering shall have current product acceptance scheme certification in accordance with sub-Clauses 104.25 and 104.26.
- 6 Gully gratings, kerb type gully covers and frames shall comply with MSA EN 124: 1994 and the following and shall be of the classes and sizes described in contract specific IM Appendix 5/1.
- 7 The upper surface of gully gratings shall be flat except where otherwise described in contract specific IM Appendix 5/1. Slots in gratings or between gratings and frames shall not be orientated parallel to the direction of traffic except where the slots are less than 150mm long or less than 20mm wide. Minimum waterway areas shall be as specified in contract specific IM Appendix 5/1. Unless otherwise specified in contract specific IM Appendix 5/1, all gratings and frames shall be supplied in a fine cast (uncoated) condition. Where a coating is specified in contract specific IM Appendix 5/1, the coating shall only be

- applied when the surfaces of the casting are clean, free from rust and dry. Frames shall be bedded on mortar complying with sub-Clause 507.22. Blockwork shall comply with sub-Clause 507.4.
- 8 Backfilling to precast gullies shall be carried out up to sub-formation level with general fill material Class 1, as described in Table 600-1 compacted in compliance with Clause 612. Where mechanical compaction is impracticable, the backfilling shall be in ST2 concrete. The remainder of the backfilling shall be in appropriate capping and road pavement materials except that where mechanical compaction of capping or unbound mixture for subbase is impracticable ST2 concrete shall be used.
- 9 Gully connection pipes shall be either flexible or rigid not exceeding 0.7m in length with flexible joints for a distance of 2m from the gully and shall be in accordance with Clause 507 when entering chambers. Junction pipes shall be manufactured of the same type and class of material as the remainder of the pipes in the run.
- 10 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. Saddles may be used to form junctions only where permitted in contract specific IM Appendix 5/1. No internal projections greater than 5mm will be permitted. Saddles for plastics pipes shall be installed in accordance with the manufacturer's recommendations. Saddles and pipes shall be surrounded with ST2 concrete.
- 11 Where the adjustment or replacement of existing frames and gratings is required, the units shall be taken up and re-fixed or removed and replaced with new units as described in Series 550. On taking up or removal of the unit, any concrete or mortar bedding shall be broken out and the surface prepared. Where existing frames and covers or gratings are to be adjusted, the Contractor shall take up the unit and clean it, so it is free from existing mortar, any debris, rust and is dry before re-use. The adjusted or replaced units shall be laid at a level, unless otherwise described in contract specific IM Appendix 5/1, 6 mm below the adjoining road surface on a mortar bed complying with sub-Clause 507. The finished thickness of the mortar bed shall be between 10 mm and 25 mm. Where required in contract specific IM Appendix 5/1, covers and gratings shall be bedded using a quick setting high strength mortar which shall have a declaration of performance for its intended use, the declaration of performance shall be provided to the Overseeing Organisation before use. Any additional adjustment shall be made by modifying the blockwork in compliance with sub-Clause 507.3 or by using a frame of suitable depth. On completion of the works, each grating shall be lifted and the frame and seating cleaned.

### **Performance Guarantee**

- 12 The Contractor shall guarantee the works (frame, cover, bedding, infill, surfacing from defects and settlement) for a period of 5 years.

### **509 Testing and Cleaning**

- 1 Drains required in contract specific IM Appendix 5/1 to have watertight joints shall be tested as described in contract specific IM Appendix 1/5 in sections, e.g. 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, as part of the rectification work, a water test as described in sub-Clause 3 of this Clause may be carried out as an alternative compliance test. Before testing, the ends of the pipeline to be tested, including those of short branches, shall be plugged and sealed.
- 2 For the pipeline air test, air shall be pumped in by suitable means until a stable pressure of 100mm head of water is indicated in a U-tube connected to the system. The air pressure shall not fall to less than 75mm 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 50mm head of water and the permissible loss shall then be no more than 13mm 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 1.2m above the crown of the pipe at the high end and not more than 6m above the pipe at the low end. Steeply graded pipelines shall be tested in sections so that the above maximum is not exceeded. The test shall commence not less than 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 1.2m 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 350mm diameter, excluding service ducts shall be checked by drawing through each completed length of pipe a spherical mandrel of a diameter 10% less than the nominal bore of the pipes being tested.
- 5 During the progress of the works all existing chambers, gullies and rodding eyes shall be kept clean and free from obstruction. On completion of the whole of the works, all chambers, gullies and drains including verge/ surface water drains and filter drains but excluding all fin and narrow filter drains shall be flushed from end to end with water and left free from obstructions and silt. Catchpit chambers shall be left clean and free from silt.
- 6 Unless otherwise required in contract specific IM Appendix 90/1 all carrier, foul and filter drains but excluding all fin and narrow filter drains shall be surveyed by Closed Circuit

- Television (CCTV) in accordance with the relevant requirements of the UK DMRB CS 551 – Drainage Surveys.
- 7 The pipes and filter material of filter drains shall at all times be left clean and free from silt and obstruction.
  - 8 Where described in contract specific IM Appendix 1/5, samples of one or more partly watertight joints for pipelines up to and including 900mm 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.
  - 9 Permeability tests shall be as described in contract specific IM Appendix 5/1.
  - 10 Service ducts shall be checked by drawing a wooden mandrel, as shown on RCD Drawing Number 500/51, through as the ducts are laid. Where a set has to be given to the line of ducts the wooden mandrel shall be replaced by an iron mandrel 250mm 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 contract specific IM Appendix 5/3.
- 2 Surface water channels shall comply with Clause 1103.
- 3 Drainage channel blocks shall comply with Clause 1101. Pre-cast concrete channel blocks shall comply with MSA EN 1340. The declaration of performance shall be submitted to the Overseeing Organisation and it shall demonstrate that the channel blocks meet the specification.

#### **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 contract specific IM 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 shall be adequately sealed with 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.

- 3 The Contractor shall notify the Overseeing Organisation 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 contract specific IM 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 A filter material or as otherwise described in contract specific IM Appendix 5/1.

#### **512 Backfilling to Pipe Bays and Verges on Bridges**

- 1 Unless otherwise described in contract specific IM Appendix 5/1, filling to pipe bays and verges on bridges shall be well graded granular material not exceeding 20mm size containing not more than 3% of material passing the 0.063mm sieve and with a uniformity coefficient of more than 5. It shall be laid and compacted in compliance with sub-Clauses 505.14 and 15. The material shall meet the sulfate requirement.

#### **513 Permeable Backing to Earth Retaining Structures**

- 1 Unless otherwise described in contract specific IM Appendix 5/1, permeable backing shall consist of one of the following materials:
  - a) A minimum thickness of 300mm of granular material complying with the requirements of Clause 505 for Type A material and, in addition, satisfying the following criteria:

Piping ratio, defined as

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

Permeability ratio, defined as

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

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.

- 2 Porous no-fines concrete cast in situ 225mm thick complying with the requirements of Clause 2603.

- 3 Precast hollow concrete blocks complying with the MSA EN 771-3 laid in stretcher bond with dry joints in 225mm thick walling with holes vertical. The blocks shall have a declaration of performance for their intended use which shall demonstrate that the blocks meet the specification.

## **514 Fin Drains**

### **General**

- 1 Fin drains shall comply with this Clause and the special requirements described in contract specific IM Appendix 5/4. The term fin drain shall mean a planar geo-composite structure designed to perform the same function as a narrow filter drain.
- 1 Where fin drains are designed for lateral entry of water from one side only the requirements for flow rates in sub-Clauses 4 and 5 of this Clause shall apply to the face or plane designed to admit or transmit water.
- 2 The materials of which the drain is made shall be treated 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 highway construction materials. After exposure to ultraviolet light the Overseeing Organisation may require evidence that the materials still comply with the requirements of this Clause. The drain shall be protected from damage and ultraviolet light and be labelled to identify the grade and manufacturer or supplier. Where necessary, the side intended for entry of water and the direction of in-plane flow shall be identified.

### **Geotextile**

- 3 The geotextile shall:
  - a) conform to MSA EN 13252 and the details stated in contract specific IM Appendix 5/4, it shall have a declaration of performance for its intended use, the declaration of performance shall demonstrate that the geotextile meets the specification and shall be submitted to the Overseeing Organisation prior to the commencement of fin drain work;
  - b) in both machine and cross-machine directions, sustain a tensile load of not less than 5.0kN/m at break and have a minimum failure strain of 10% when determined in accordance with MSA EN ISO 10319;
  - c) have a minimum static puncture resistance of 1200N when determined in accordance with MSA EN ISO 12236;
  - d) have a mean hole diameter < 40mm when tested to MSA EN ISO 13433;

- e) have a size distribution of pore openings such that the apparent opening size O90 when determined in accordance with MSA EN ISO 12956 is as stated in contract specific IM Appendix 5/4; and, have water permeability characteristics as stated in contract specific IM Appendix 5/4.

**Composite Drain**

4 Where a composite drain is installed in an existing drain the following steps shall be undertaken:

- i) removal of approximately 400mm depth of media from the drain;
- ii) positioning of a non-woven geotextile over the exposed media;
- iii) placement and compaction of sub-soil in compliance with Class 4 material (see Table 600-1) to form a V-channel profile;
- iv) placement of 35mm to 50mm of topsoil.

The maximum depth from the top of the topsoil to the channel invert shall be 200mm.

To ensure the grass roots get air as well as water after compaction, the subsoil shall be non-cohesive and have a permeability in excess of 10-4m/s.

5 The composite drain shall:

- a) have a flow rate through each face of the drain of more than 75% of the value specified in sub-Clause 4(e) of this Clause on the side or sides where inflow occurs. This value may be found by either:
  - a) direct measurement of the composite drain using a modified version of BS 6906: Part 3; or,
  - b) calculation based on the flow rate obtained by the standard test in BS 6906: Part 3 and the percentage contact area of the drainage core obtained from sub-Clause 12 of this Clause or other appropriate method;
- b) have values of long term in-plane flow rates as stated in contract specific IM Appendix 5/4 when determined in accordance with sub-Clauses 13 and 14 of this Clause. The values of hydraulic gradient and minimum applied stresses shall be as given in **Table 500 - 8**.

**Table 500 - 8 Applied Stresses (kN/m<sup>2</sup>) and Hydraulic Gradient**

Drain Type	5	6	7	10
<b>Sub-Clause 15:</b>				
Normal Stress	50	50	50	100

Shear Stress	10	10	10	10
<b>Sub-Clause 16:</b>				
Normal Stress	100	100	100	100
<b>Sub-Clause 16:</b>				
Hydraulic	0.1	1.0	1.0	0.1
Gradient	1.0			1.0

### Joins

- 6 Fin drains shall be capable of being jointed longitudinally or laterally into pipe systems or chambers for inflow and outflow purposes and be self-jointing either directly or through purpose made attachment pieces for forming continuous drain lengths. All such joints shall be formed so as to prevent the ingress of soil particles or other extraneous material into the drain.

Fin drain joints transverse to the direction of flow shall have values of in-plane flow rates not less than that required by sub-Clause 5 of this Clause.

Fin drain joints parallel to the direction of flow and any exposed edges shall be protected from the ingress of soil by a geotextile wrapping with a minimum overlap of 150mm.

### Pipes

- 7 For drain Type 6 pipes shall be perforated or porous and comply with sub-Clause 501.3.
- For drain Type 7 pipes shall be unperforated thermoplastics pipe complying with Clause 518 slotted longitudinally along the top surface and stress relief treated (if required) in accordance with the system manufacturer's specification.
- 8 Pipe joints shall comply with the requirements of the relevant British Standard for the pipe used or Clause 518.

### Backfill and Surround Material

- 9 Pipe surround material for drain Types 6 and 7 shall comply with Clause 503 or Type A or C material complying with Clause 505.
- Where fin drains are installed in a trench backfill material shall be the original as-dug material from the trench unless otherwise specified in contract specific IM Appendix 5/4.



### **Dimensions**

- 10 The pipe diameter shall be as stated in contract specific IM Appendix 5/4. The drain slope angle ( $x$ ) shall be not greater than 15% from the vertical unless otherwise stated in contract specific IM Appendix 5/4.

### **Installation and Handling**

- 11 Where fin drains are assembled on site the assembly area shall be clean and dry and free of wind-borne pollutants. Any material which becomes contaminated must be replaced. No geotextile or core material shall be exposed to daylight (or any source of ultraviolet radiation) for a period exceeding a cumulative total of 50 hours. Any geotextile or core material 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 that the materials of the drain still comply with the requirements of this Clause.

Where fin drains are laid in trench, the trench bottom shall be free of irregularities and to the required levels given in contract specific IM Appendix 5/4. Rock and other hard protuberances shall be removed and any excess cut in the trench bottom filled and compacted back to the required grade with suitable excavated or imported material.

The drain shall be laid with the appropriate face against the side of the trench adjacent to the carriageway and in the appropriate direction. This side of the trench shall have walls sufficiently clean to enable the fin drain to come into close contact with the wall when the trench is backfilled and compacted. Compaction shall be in accordance with Clause 612. Fin drains installed as part of the works shall be protected from surface water, contamination, and accidental damage during construction.

The fin drain, pipe surround and backfill shall be installed so as to cause no damage to the fin drain. Where any damage does occur, the damaged materials shall be replaced by new material.

After the installation of the fin drain has been completed a marker tape shall be laid approximately 75mm above the fin drain. The tapes shall be green self-coloured PVC or polythene plastic not less than 0.1mm thick and 150mm wide.

### **Identification**

- 12 The Contractor shall obtain and make available the following information for each separate consignment of fin drain delivered to site:
- a) geotextile declaration of performance;
  - b) core name, grade/number and mass per unit area;
  - c) names and addresses of system producer core and pipe manufacturers;

- d) manufacturing characteristics and constituents of core. This shall include composition and type of constituent filaments, threads, fibres, films, tapes and other components;
- e) consignment number and delivery date; and,
- f) a copy of the site delivery note.

#### **Test Method for the Percentage Contact Area of Drainage Core**

13 The test determines the area of one face of a drainage core which will be in contact with a geotextile filter as a percentage.

- a) The apparatus required is as follows:
  - i. loading device able to apply a compressive load of at least 2kN and having a flat steel base;
  - ii. flat steel loading plate 200mm x 200mm;
  - iii. printers ink and roller (or pad);
  - iv. sheet of thin compressible rubber; and,
  - v. planimeter.
- b) The test procedure shall be as follows. Cut three representative test specimens 200mm x 200mm ( $\pm 2$ mm). Apply ink to one 200mm x 200mm face of a specimen and cover with a sheet of plain paper and a thin compressible rubber sheet. Place the prepared specimen into the loading device and gradually apply the load of 2kN and maintain for 5 minutes. Release the load and remove the specimen and separate it from the paper. Using the planimeter find the total area of the paper which has received an imprint. Repeat for all specimens;
- c) The percentage contact area =
$$\frac{\text{total area of imprint}}{\text{area of test specimen}} \times 100$$
- d) The report shall include:
  - i. a reference to this method;
  - ii. sample identification details;
  - iii. individual and mean percentage contact areas; and,
  - iv. details of any deviation from the specified test procedure.
- e) Alternative methods of determining the percentage contact area may be employed with the prior approval of the Overseeing Organisation.

### **Test Method for Determining the Thickness of Fin Drains Under Specified Normal and Shear Stresses**

14 The test determines the thickness of the fin drain under sustained normal and shear stresses. A long-term thickness (at 100,000 hours) is calculated by extrapolation and a short term equivalent normal load which produces the long-term thickness is determined.

- a) The apparatus required is as follows:
  - a) a suitable compression testing machine, which shall have a vertical travel at least the nominal thickness of the specimen. It shall be capable of sustaining the necessary loads to within
  - b) 1% accuracy for the duration of the test;
  - c) the compression testing apparatus, which shall include a fixed base plate and parallel moveable top plate with flat steel surface with sufficient friction to permit the development of the required shear forces;
  - d) a means of measuring the mean thickness of the specimen to an accuracy of 0.01mm.
  - e) As an alternative to (i) and (ii), an appropriate inclined plane and kentledge system may be employed to produce the normal and shear loads.
- b) The test procedure shall be as follows:
  - i) Cut six representative specimens of minimum size 100mm x 100mm symmetrically about the core design. Three specimens shall be tested in accordance with (v) below and three in accordance with (vi) below;
  - ii) The test specimen shall be placed symmetrically on the base plate and covered by the top plate. The means of measuring thickness shall be attached and the initial thickness measured;
  - iii) Apply the load smoothly and as quickly as possible to the top plate. The full load (normal and shear) shall be applied in less than 20 seconds and sustained for at least 1000 hours. The applied stresses shall be those given in **Error! Reference source not found.** At least four measurements of thickness shall be made during each unit of logarithmic time after the first minute. Determine the long term thickness of the specimen as the thickness of the specimen at 1000 hours reduced by  $2T$  where  $T$  is the difference in thicknesses of the specimen thickness recorded at 100 hours and 1000 hours. Repeat the test on the two other specimens. The test specimens shall be maintained at a constant temperature of  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$  throughout the test period.
  - iv) Apply increasing increments of normal load to the specimen. Determine the short term equivalent load which shall be the load which when applied for a period of  $20 \pm 5$  minutes produces a specimen thickness equal (within an

accuracy of  $\pm 0.05\text{mm}$ ) to the long term thickness of the specimen obtained at (v) above. Repeat the test on the other two specimens.

- c) The report shall include:
- i) a reference to this method;
  - ii) sample identification details;
  - iii) the initial thickness of the sample;
  - iv) the applied load;
  - v) the thickness of each sample at 100 and 1000 hours and the mean of the three results;
  - vi) a plot of percentage reduction in thickness against logarithmic time;
  - vii) the mean long-term thickness;
  - viii) the mean short term equivalent load; and,
  - ix) any deviations from the specified test procedure.

### **Determining In-plane Flow Under Compressive Loading**

- 15 In-plane flow shall be determined in accordance with BS 6906: Part 7 except that the following conditions shall apply:
- i) the applied normal stress shall be the greater of the value given in **Error! Reference source not found.** (for sub-Clause 15) or the mean short term equivalent stress as determined in sub-Clause 15 (b) (iv) of this Clause;
  - ii) the sample shall be tested such that the measured flow (or flows) is in the same direction as the principal flow (or flows) when the fin drain is in service;
  - iii) the foam rubber option of the test procedure shall be used (details of the foam rubber to be used may be obtained from the Overseeing Organisation); and,
  - iv) the hydraulic transmissivity shall be reported for each of the hydraulic gradients employed.

### **Test Methods**

- 16 Notwithstanding the requirements of sub-Clauses 13, 14 and 15 of this Clause, variations in the test methods specified therein shall be made where deemed necessary by the British Board of Agreement (or equivalent) following consultation with the manufacturer. All such variations shall be recorded in the report.

### **Certification**

- 17 Fin drains and constituent materials, other than the geotextile and aggregates, shall have current product acceptance scheme certification in accordance with sub-Clauses 104.25 and 104.26 certifying the appropriate physical properties when tested in accordance with

this Clause.

### 515 Narrow Filter Drains

#### General

- 1 Narrow filter drains shall comply with this Clause and the special requirements described in contract specific IM Appendix 5/4.
- 2 They consist of a porous or perforated pipe laid in a narrow trench surrounded by granular material where the granular material and/or the pipe is enclosed by a layer of geotextile filter. Narrow filter drains and fin drains perform the same function.

#### Materials

- 3 The materials used in the drain 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 highway construction materials. After exposure to ultraviolet light the Overseeing Organisation 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.
- 4 The geotextile used in narrow filter drains shall comply with all requirements of sub-Clause 514.4 for geotextiles used in fin drains.
- 5 Filter drains shall be type A, B, C or D as shown in RCD 500/01.
- 6 Pipes and fittings shall comply with sub-Clause 514.8. Where coilable pipes are used they shall be capable of being straightened so as to lie flat without restraint in the trench bottom before backfilling.
- 7 The granular material used for trench infill shall comply with the requirements for non-plasticity, LA category and sulfate content of sub-Clause 505.8 and have a grading within the limits of **Table 500 - 9**. The material shall meet the permeability requirements described in contract specific IM Appendix 5/4.

**Table 500 - 9 Narrow Filter Drain – Trench Infill Grading Requirements**

	Type 8	Type 9
Standard	MSA EN 13242	MSA EN 13242

<b>Size, mm</b>	1/20	10/40
<b>Grading</b>	G <sub>c</sub> 80-20	G <sub>c</sub> 85-15
<b>Aggregate</b>	Coarse	Coarse
<b>Category for tolerances at mid-size sieves</b>	as stated in contract specific IM Appendix 5/4	as stated in contract specific IM Appendix 5/4
<b>Category for maximum fines</b>	f <sub>2</sub>	f <sub>2</sub>
<b>Additional requirements</b>	d/8 0-3% passing by mass	d/80 0-3% passing by mass

### Dimensions

- 8 The pipe diameter shall be as stated in contract specific IM Appendix 5/4. The drain slope angle (x) shall be not greater than 15% from the vertical unless otherwise stated in contract specific IM Appendix 5/4.

### Installation and Handling

- 9 Before, during and after installation the geotextile shall be protected from contamination, damage and exposure to ultraviolet radiation in accordance with sub-Clause 514.12.
- 10 The excavated trench bottom shall be free of irregularities and to the required levels given in contract specific IM Appendix 5/4. Rock and other hard protuberances shall be removed and any excess cut in the trench bottom filled and compacted back to the required grade with suitable excavated or imported material. Drain Type 9 shall have trench walls 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.
- 11 Narrow filter drains installed as part of the works shall not be used for the disposal of surface water run-off during construction. Narrow filter drains exposed to surface water ingress shall be temporarily protected.
- 12 Marker tapes shall conform and be installed in accordance with sub-Clause 514.11.
- 13 The Contractor shall obtain and make available the information required in sub-Clause 514.12 in respect of the geotextile and pipe.

## 516 Combined Drainage and Kerb Systems

### **General**

- 14 Combined drainage and kerb systems listed in contract specific IM Appendix 1/10 shall be treated as features to be designed by the Contractor. Combined drainage and kerb systems shall conform to MSA EN 1433 and to the special requirements in contract specific IM Appendix 5/5.
- 15 Combined drainage and kerb systems shall be suitable for their intended use and place of installation in the works and as stated in contract specific IM Appendix 5/1. The Contractor shall provide a declaration of performance for each type of combined drainage and kerb system proposed to the Overseeing Organisation prior to the commencement of drainage works. The declaration(s) of performance shall demonstrate that the system(s) meet the requirements of the specification.
- 16 Design flows given in contract specific IM Appendix 5/5 shall be accommodated without surcharge within the main combined drainage and kerb section and beneath the underside of any inlet slot sections.
- 17 Where applicable, the width and depth of combined drainage and kerb system units shall not exceed the dimensions given in contract specific IM Appendix 5/5.
- 18 When used adjacent to pervious surfacing materials, units shall incorporate side entry inlets to permit drainage of water held within the pervious surfacing. Inlets shall comply with the requirements of contract specific IM Appendix 5/5 and shall have the capacity to drain pervious surfacing.

### **Classification**

- 19 Combined drainage and kerb systems, excluding in situ system, shall be classified as follows according to their intended use and shall be as stated in contract specific IM Appendix 5/5:
- i) C 250;
  - ii) D 400; and
  - iii) where, exceptionally, combined kerb and drainage units have to be located in areas subjected to large numbers of high-speed heavy goods vehicles, Class E600 combined kerb and drainage units shall be considered.

### **Water Tightness**

- 20 Joints between units comprising the system 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.

### **Installation and Handling**

- 21 Combined drainage and kerb systems shall be laid and jointed in accordance with the manufacturer's instructions.
- 22 Adjacent carriageway, footway, verge or central reserve to bedding, backing, surrounding or jointing of combined drainage and kerb units shall be in accordance with the manufacturer's instructions.
- 23 Junctions, connecting pipes and other fittings comprising the combined drainage and kerb system shall comply with sub-Clause 501.3 and shall be as described in contract specific IM Appendix 5/5. The combined drainage and kerb system shall incorporate measures to enable rodding of the outfall pipework and adequate access for jetting by water jetting equipment into the system.

### **Cleaning**

- 24 Combined drainage and kerb systems shall be cleaned out by appropriate means and shall be left clean and free from all obstruction. The completed combined drainage and kerb systems shall be surveyed in accordance with the relevant requirements in contract specific IM Appendix 5/5.

## **517 Linear Drainage Channel Systems**

### **General**

- 1 The linear drainage channel systems listed in contract specific IM Appendix 1/10 shall be treated as features to be designed by the Contractor and shall conform with requirements stated in contract specific IM Appendix 1/10 and IM Appendix 5/6. In situ linear drainage channel systems shall conform, where applicable, to sub-Clauses 517.2 to 517.17. Prefabricated, or manufactured, linear drainage channel systems shall conform to MSA EN 1433.
- 2 Linear drainage channel systems shall be suitable for their intended use and place of installation in the works. The Contractor shall provide evidence of such suitability for the purpose to the Overseeing Organisation. For prefabricated or manufactured linear drainage systems this shall be the declaration of performance. The declaration of performance shall demonstrate that the linear drainage system meets the requirements of the specification.
- 3 Design flows given in contract specific IM Appendix 5/6 or as directed by the Overseeing Organisation shall be accommodated without surcharge within the main channel section and beneath the underside of any inlet slot sections.



- 4 Where applicable, the width and depth of linear drainage channel system units shall not exceed the dimensions given in contract specific IM Appendix 5/6.
- 5 Dimensions of inlet slots shall comply with the following criteria:
  - a) for prefabricated linear drainage channel systems they shall conform to MSA EN 1433; and,
  - b) for in situ linear drainage channel systems they shall conform to MSA EN 1433.
- 6 When used adjacent to porous asphalt surfacing materials, units shall also incorporate side entry inlets to permit drainage of water held within the porous asphalt. Inlets shall comply with the requirements of contract specific IM Appendix 5/6 and shall have the capacity to drain porous asphalt.

### **Weathering Resistance**

- 7 Marking relating to the grade of weathering resistance for drainage channels made of concrete shall be as stated in contract specific IM Appendix 5/6.

### **Classification**

- 8 Linear drainage channel systems shall be classified as follows according to their intended use and shall be as stated in contract specific IM Appendix 5/6:
  - a) D 400 on Class 4 to 7 roads;  
and
  - b) E 600 on Class 1 – 3 Roads
  - c) where, exceptionally, linear drainage channel systems have to be located in areas subjected to large numbers of heavy goods vehicles, Class E600 combined kerb and drainage units shall be used.

### **Linear Drainage Channels Placed Outside the Carriageway Edgelines**

- d) The bolt attachment of the cast iron grating to the channel shall be with declared by the producer as compatible for heavy duty traffic areas with high axial forces (braking, steering);
- e) The channels shall have galvanised steel profile reinforcement of the grating to channel contact area.
- f) The inbuilt slope shall be either continuous or cascaded as directed by the Overseeing Organisation.
- g) The installation of the channels shall be strictly in accordance with the manufacturer's drawings. This shall include:

- i. Vertical and horizontal joints;
- ii. Vertical expansion joints;
- iii. Sealing of joints;
- iv. Concrete bedding haunching, surround and nosing - Minimum C32/40 compressive strength.
- v. Bituminous joint and mastic infill (where required)

**Transverse Linear Drainage Channels (Monolithic)**

- h) When installed transversely to the flow of traffic linear drainage channels shall be of the monolithic, one-piece type with integral grating and channel manufactured from polymer concrete.
- i) IMPORTANT – The nosing (approach and departure nosing) shall be of elastomeric concrete approved by the Overseeing Organisation.
- j) The installation of the channels shall be strictly in accordance with the manufacturer's drawings. This shall include:
  - i. Vertical and horizontal joints;
  - ii. Vertical expansion joints;
  - iii. Sealing of joints;
- a) Concrete bedding haunching and surround up to the nosing - Minimum C32/40 compressive strength.
- b) Epoxy mortar (where required by the manufacturer).
- c) Bituminous joint and mastic infill (where required)

**Water Tightness**

- 9 Joints between units comprising the system and between adjacent construction and the system shall be designed to avoid leakage of surface water. Where applicable, joints between bridge deck waterproofing and component parts passing through the waterproofing shall be watertight. Sealants shall also be compatible with the waterproofing system.
- 10 Junctions, connecting pipes and other fittings comprising the linear drainage channel system shall comply with sub-Clause 501.3 and shall be as described in contract specific IM Appendix 5/6. The linear drainage channel system shall incorporate measures to enable rodding of the outfall pipework and adequate access for jetting by water jetting equipment into the system.

### **Cleaning**

- 11 The linear drainage channel systems shall be cleaned out by appropriate means and shall be left clean and free from all obstruction on completion of the works. The completed linear drainage channel systems shall be surveyed in accordance with requirements stated in contract specific IM Appendix 5/6.

### **In Situ Systems**

- 12 In situ systems shall comply with the requirements of sub-Clauses 1103.1, 1103.3 and 1103.4. They shall also comply with the requirements of sub-Clause 1103.2 except that the concrete shall be considered as plain concrete within the terms of this sub-Clause, irrespective of the inclusion of reinforcement.
- 13 In situ systems shall be slip formed except for sections at gullies which shall be hand formed. Full depth joints shall be constructed at the interface at each side of gullies with a 25mm thick filler board complying with Clause 1015 and sealed in accordance with Clauses 1016 and 1017.
- 14 The central void may be formed by an inflated tube which is then removed, or by an in situ suitable pipe or similar former fit for the purpose. At gully positions the inner former shall be pre-sleeved with a suitable pipe or similar former fit for the purpose which shall be of sufficient length to overlap the two joints on either side of the gully.
- 15 The central void shall be checked in accordance with sub-Clause 509.4. Verification of slot widths shall be determined by suitable templates.
- 16 Reinforcement shall comply with Series 1700. Cover to reinforcement shall be not less than 75mm.
- 17 Trial lengths and testing of in situ channels shall be undertaken in accordance with contract specific IM Appendix 100-5 and clauses 6 and 8.6 of BS 5931 and the relevant paragraphs of clause 9 of MSA EN 1433 respectively.

## **518 Thermoplastics Structured Wall Pipes and Fittings**

### **General**

- 1 Thermoplastics structured wall pipe shall comply with this Clause and the special requirements described in contract specific IM Appendix 5/1. The term structured wall pipe shall mean all types of smooth bore pipe except solid wall homogeneous pipe. Typical forms of construction classified as structured wall pipes include: single wall externally structured smooth bore, twin wall, foamed core and spirally wound.

- 2 The term fitting shall mean a product used in conjunction with the pipe to form the system but excluding gullies manhole chambers, inspection chambers and access chambers.

### **Materials**

- 3 The materials from which the pipe and fittings are made, shall be treated 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 soil, highway construction materials and highway drainage systems. In addition, the materials from which the pipe and fittings are made, shall not incorporate any additives in quantities sufficient to cause microbiological degradation or to impair the conformity to the chemical, physical and mechanical properties or impact resistance requirements given in sub-Clause 5 of this Clause. The specification of the raw material shall be agreed between the certification body, as defined in sub-Clause 15 of this Clause, and the manufacturer and may incorporate re-processable and/or recyclable material. The agreed specification shall incorporate tolerances for each of the relevant characteristics defined in the appropriate clause of MSA EN 13476. The Contractor shall submit to the Overseeing Organisation, prior to commencement of the works, completed information sheets in accordance with contract specific IM Appendix 5/7.

### **Dimensions**

- 4 Systems for carrier drainage shall be between 150mm and 900mm nominal internal diameter. Pipes for narrow filter drains shall be 110mm or 150mm nominal internal diameter. Pipes for service ducts shall have nominal internal diameters of between 50mm and 150mm. Pipes for sub-soil drainage shall incorporate slots or holes with a minimum cross sectional area of 1000mm<sup>2</sup> per metre run of pipe.
- 5 The bore of the pipe and fittings shall be in accordance with the standard tolerances for nominal bores given in MSA EN 476.

### **Appearance**

- 6 The system shall have a smooth bore and be free from any burs, flash or other inconsistencies that could have a detrimental effect on the performance of the system. Pipes and fittings for drainage shall be externally coloured either terracotta or black. The colour of ducting pipes shall be in accordance with National Joint Utilities Group publication "Guidelines on the Positioning and Colour Coding of Utilities' Apparatus". Any variation in the colour shall be described in contract specific IM Appendix 5/2.

### **Structured Wall Pipe**

- 7 The structured wall pipe shall have the properties defined in **Table 500 - 10**.

**Table 500 - 10 Requirements for Structured Wall Pipes**

Property	Relevant Standard	Requirement
General	MSA EN ISO 2897-1,  MSA EN ISO 2897-2 and BS ISO 11922-1	Dimensions to be specified
Ring stiffness	MSA EN ISO 9969	6 kN/m <sup>2</sup> minimum. Lower stiffness values are permitted if design calculations to MSA EN 1295-1 based on site specific installation conditions, indicate satisfactory performance.)
Creep Ratio	MSA EN ISO 9967	PVC-U – maximum 2.5  PP and PE – maximum 4.0
High-volume low-pressure jetting	WRc Jetting Test Method	Minimum acceptable failure pressure 137 bar.
Longitudinal bending	sub-Clause 518.13	Pipes with nominal diameters ≤ 350 mm to have a difference in dimensions when measured in the vertical axis of less than 5% of the pipe length and no local permanent deformation occurs during the test.
Impact resistance at 0°C	MSA EN 1411 with d25 striker of 1 kg	Preliminary test – test 10 pieces as described in MSA EN 1411, dropping the striker from a height of 1m. If any test pieces fail, subject the pipe to the full test given in clause 7.3 of MSA EN 1411 starting the striker from a drop height of 400 mm. The mean minus 1.64 times the standard deviation must exceed 1m.
Impact resistance at 23°C	MSA EN 1411 with striker as above	Value to be derived from the same batch of pipe as used in the impact resistance test at 0°C. The H50 (mean) value - 10% to be used as the minimum value for quality control testing. Alternatively the 0°C test can be used as a QC test if the manufacturer chooses.
Rodding resistance	sub-Clause 518.14	Pipes with nominal diameters ≤ 350 mm to have an average failure energy >3 joules
Static friction coefficient  (ducts)	TS 12-24	Pass
Creep at elevated temperature(ducts)	MSA EN ISO 9967	Test to be carried out at 45°C, creep ratio to be less than 2 times the values to MSA EN ISO 9967.

Resistance to point loads (ducts)	sub-Clause 518.15	No perforation at 10% rod travel
Tensile strength of a seam	MSA EN 1979	MSA EN 13476

### Fittings

- 8 The fittings for use with structured wall pipe shall have the properties defined in **Table 500 - 11**.

**Table 500 - 11 Requirements for Fittings**

Property	Relevant Standard	Requirement
General	MSA EN ISO 2897-1, MSA EN ISO 2897-2 and MSA EN ISO 11922-1	Dimensions to be specified
Ring stiffness (excluding couplers)	ISO 13967	6kN/m <sup>2</sup> minimum
Rodding resistance	sub-Clause 518.14	Fittings with nominal diameters ≤ 350 mm to have an average failure energy >3 joules
Strength and flexibility of fabricated fittings	MSA EN 12256	MSA EN 12256
Impact resistance (drop test)	Drop Test to MSA EN 12061: 1999	Fall height 1000mm at a temperature of 0°C. Product less than ND 300 shall show 'no damage'. Others may fail but must be identified as 'handle with care'
Watertightness of fabricated fittings	MSA EN 1053	0.5 bar for 1 minute

### Pipe and Fittings

- 9 The pipe and fittings shall have the properties defined in **Table 500 - 12**.

**Table 500 - 12 Requirements of the Systems**

Property	Relevant Standard	Requirement
Leaktightness of joints – diameter distortion (watertight joints)	MSA EN 1277 Method 4 Condition B Temperature (23 ± 2)°C	Use default values from MSA EN 1277

Leaktightness of joints – angular deflection (watertight joints)	MSA EN 1277 Method 4 Condition C Temperature (23 ± 2)°C	Use default values from MSA EN 1277
Leakage rate from partially-watertight joints	sub-Clause 509.9	Less than 20 times the square of the ID of the pipe in metres shall flow through the joint in litres per minute
Resistance to wheel loads	MSA EN 1437 adapted to suit HA loading conditions	Less than 5% deformation when loaded to 100 kN (for unequal branches only)

### **Bedding, Backfill and Surround Material**

- 10 All systems shall be installed in accordance with the pipe and bedding combinations given in CD 533 (UK Design Manual for Roads and Bridges 4.2.5). Other combinations shall be supported by calculations in accordance with MSA EN 1295-1 UK National Annex. Bedding, backfill and surround materials are classified in Clause 503 and Clause 505.

### **Installation and Handling**

- 11 The bedding, surround and backfill shall be installed so as to cause no damage to the pipes and fittings. Installation of the pipe and fittings, particularly, procedures for preparation and execution of jointing operations, shall be in accordance with the manufacturer’s instructions.

### **Identification**

- 12 The Contractor shall maintain records with the following information for each separate consignment of structured wall pipe or fittings delivered to Site:
- a) system name, ring stiffness grade/number and size;
  - b) name and address of the system manufacturer;
  - c) consignment number and delivery date; and,
  - d) a copy of the site delivery note.

### **Test Method for Longitudinal Bending**

- 13 The test specimen shall be a six-metre length of pipe or the maximum length available from the manufacturer (if less than six metres);
- a) The apparatus shall include:
    - a) 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; and,

- b) a means of measuring the vertical distance between the pipe at the centre of the span and a fixed point of reference to an accuracy of  $\pm 0.5\text{mm}$ .
- b) The test procedure shall be as follows:
  - a) condition the specimen for at least 1 hour at  $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ;
  - b) set the supports at a distance apart equal to the length of pipe minus 500mm;
  - c) place the pipe symmetrically on the supports;
  - d) measure the distance between the top of the supports and the fixed point of reference, in the vertical axis through the centre line of the pipe;
  - e) after a period of two minutes measure the distance between the underside of the pipe at mid span and the fixed point of reference; and,
  - f) record the difference in readings as a percentage of pipe length.

#### **Test Method for Rodding Resistance (Internal Puncture)**

14 The test specimens shall be twenty specimens cut from the structured wall pipe where each specimen shall be 242mm to 246mm in length and a quarter section of the circumference or twenty specimens cut from a number of identical fittings.

- i) The apparatus shall include:
  - i) a standard drop weight pipe testing apparatus capable of dropping a tup from a height of 1m;
  - ii) a 300g tup which can be varied in 30g multiples with a striker consisting a steel rod 18mm in diameter with a 9mm hemispherical end; and,
  - iii) a 250mm x 250mm box containing dry Leighton Buzzard sand (Garside quarry) such that there is at least 100mm of sand beneath the test specimen when bedded down.
- ii) The procedure shall be as follows:
  - a) mark the intended point on the inside of the pipe on the intersection of the centre lines. With profiled pipes the point of impact shall be at the point nearest the intersection that mid-way between the ribs or in the middle of a hollow corrugation;
  - b) alternatively mark the intended point of impact on the section of fitting;
  - c) condition the test specimens in air at a temperature of  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for a period of at least one hour before the test;
  - d) locate the box under the drop tube of the impact apparatus;
  - e) embed the specimen into the sand using a vibrator with the inner surface exposed and facing upwards;
  - f) locate the specimen such that the marked point of impact is under the centre line of the tup;



- g) drop the tup from a height of 1m on to the inner surface of the specimen within 10 seconds of removing the specimen from the conditioning environment;
  - h) examine the specimen for damage. Damage is defined as a puncture or crack of the inner layer. Ductile bending or “whitening” is not considered to be damage;
  - i) if the specimen exhibits no damage the next test shall be conducted with a tup of 30g greater mass. If the specimen does exhibit damage the next test shall be conducted using a tup of 30g smaller mass; and,
  - j) after having completed the 20 strikes calculate the average of the energies where a pass (no damage) was recorded and the average of the energies where a failure (damage) was recorded, then calculate the average of the two averages.
- iii) The test report shall include:
- i) identification of the samples;
  - ii) the overall average; and,
  - iii) whether or not the specimens were damaged.

#### **Test Method for Resistance to Sharp Objects**

15 Test specimens shall be three samples of duct each 300mm long.

- i) The apparatus shall include:
  - i) a compression testing machine;
  - ii) a 4.7mm diameter steel rod with an hemispherical end;
  - iii) and a 120° steel vee block at least 300mm long.
- ii) The test method shall be as follows:
  - i) condition the test specimens for at least 1 hour at  $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ;
  - ii) insert the steel rod in the jaws of the moveable platen of the compression testing machine so that the hemispherical end protrudes at least 15% of the nominal pipe diameter;
  - iii) position the specimen in the vee block and place directly below the steel rod, for twin-walled pipe the specimen shall be positioned firstly so that the rod strikes on the corrugation or rib, and secondly in the valley (where possible);
  - iv) set the machine to lower at a rate of 5mm/min; and allow the rod to travel into the pipe a distance equal to 10% of the nominal internal diameter of the pipe (T10 mm) or until the pipe wall is perforated. When the outer skin of a twin wall pipe is perforated before 10% is attained, the rod travel up to the point of failure shall be recorded (Tf mm) and the rod allowed to travel to the inner wall. The rod travel shall be continued to a total of 10% (ie T10 - Tf) or until complete penetration occurs.

- v) For each test specimen: pipe size, reference, maximum load and rod travel shall be recorded.

16 Notwithstanding the requirements of sub-Clauses 11, 12 and 13 of this Clause, variations in the test methods specified therein shall be made where deemed necessary by the British Board of Agrément (or equivalent) following consultation with the manufacturer and in agreement with the Overseeing Organisation. All such variations shall be recorded in the report.

### **Certification**

17 Pipes and fittings shall have current product acceptance scheme certification in accordance with sub-Clauses 104.25 and 104.26 certifying the appropriate physical properties when tested in accordance with this Clause.

### **519 Concrete Bagwork**

1 ST4 concrete in compliance with Clause 2602 shall be used throughout. The concrete filling to the bags shall have a low workability with a slump of 25mm.

2 The bags shall be hessian sandbags complying with BS 1214. The size of the bags shall be such that when filled, the dimensions shall be 450mm x 300mm x 150mm. The bags shall be placed in position and shaped to the profile shown on the drawings by striking with a flat timber board until all faces are flat and all edges square.

3 The finished exposed faces of the bagwork shall not be punctured or torn and no tucked ends shall be visible.

4 Each concrete bag is to be spiked to the one below and the bottom row spiked to the foundation with 10mm x 200mm mild steel dowel bars. Where the concrete bags have a concrete backing, alternate rows of bags shall be spiked to the backing concrete with 10mm x 200mm mild steel dowel bars at 45 degrees to the horizontal with one dowel per bag in the row.

5 Where bagwork forms a headwall, headwall foundations are to be cast against the excavated face and any overdig filled with ST4 concrete.

6 Formed concrete surfaces shall be to Class F1 finish and unformed surfaces to Class U1 finish in accordance with Clause 1708.

7 Where bagwork is provided to protect watercourses, before placing the bags, the banks shall be cut into horizontal steps to provide a suitable foundation and shall be covered in geotextile to the requirements of Clause.

8 The bottom course of bags shall be at least 450mm below the stream bed and all

succeeding courses shall be horizontal and all vertical joints shall be staggered in alternate courses. Headers shall be placed at every third bag in alternate courses.

- 9 The bagwork shall be thoroughly soaked with water upon completion of the construction to saturate the hessian bags.

## **520 The Cleaning of Existing Drainage Systems**

- 1 Where stated in contract specific IM Appendix 5/1, the Contractor shall clean existing drainage systems in accordance with this Clause.
- 2 The Contractor shall take measures when clearing blocked drains to ensure that adjacent water courses or groundwater via soakaways, will not be contaminated. Contamination includes mud or soil being washed or flushed into streams as well as other more obvious contaminants including diesel fuel, oil and chemicals.
- 3 Initial attempts to clear blocked drains prior to jetting, shall be undertaken by hand rodding and any debris and silt removed by the operation shall be removed off site. The Contractor shall report any localised blockages that cannot be cleared by rodding to the Overseeing Organisation.
- 4 Where jetting is required in contract specific IM Appendix 5/1 the procedures stated in Clause 521 shall be followed.

### **Cleaning of Gullies, Catchpits, Soakaways and Oil Separators**

- 5 At each chamber all mud and vegetation in the vicinity of the chamber likely to impede the flow of water shall be removed. After lifting the cover or grating the chamber shall be cleansed of all water, detritus, debris and silt, refilled with clean water to the outlet level, and all covers and gratings replaced and evenly bedded.
- 6 Cleaning of chambers shall be by mechanical means. The vehicle used to clean existing chambers shall be equipped with a 125mm diameter gulley arm with boom jets, an exhauster with a minimum output of 5.95cum/min and minimum 5455 litres capacity. Sediment, detritus and liquor from the chamber shall not be permitted to discharge into the outlet. This may be achieved either by plugging the outlet during cleaning, or by simultaneous jetting and abstraction of liquor from the chamber using a tanker fitted with low-pressure high-volume water jets around the boom.
- 7 Gullies and chambers not cleaned for whatever reason, blocked connections and broken or cracked covers, gratings or frames shall be marked to aid subsequent identification.
- 8 Oil separators shall be refilled with uncontaminated water following the cleaning operation.
- 9 The Contractor shall dispose of all surplus water, debris and arisings from the works off site at a licensed tip.

### **Cleaning or Testing of Piped Drainage Systems and Subway Drainage Channels**

- 10 Routine cleaning or testing of piped drainage systems and subway drainage channels shall be carried out by rodding or low-pressure high-volume jetting in accordance with Clause 521.
- 11 The location of any obstruction that cannot be removed by flushing shall be marked on the ground using a wooden peg or other semi-permanent means and reported to the Overseeing Organisation.
- 12 All covers which have been removed for cleaning operations shall be replaced and evenly bedded.
- 13 The Contractor shall report any damage and defects to the drainage system or components to the Overseeing Organisation each day, or immediately if considered a safety hazard.

### **Cleaning Kerb or Channel Offlet Pipes**

- 14 Where necessary all vegetation and debris shall be removed from around metal kerb weirs and the cover lifted for cleaning.
- 15 Offlets shall be cleaned such that all silt and loose obstructions are removed from the pipe. This shall be achieved by rodding or by using lorry-mounted drain clearance equipment comprising combination pressure jetting with high air flow suction equipment. The vehicle shall also be equipped with a hydraulically powered grid lifter.
- 16 The Contractor shall ensure that each end of the offlet is free from vegetation or other obstructions including any material expelled from the pipe. Where the invert of the outlet is below the invert of the ditch, the bottom of the ditch shall be excavated until the invert of the pipe is exposed and the ditch invert regraded to facilitate flow from the outlet.
- 17 The location of any obstruction that cannot be removed shall be marked on the ground using a wooden peg or other semi-permanent means and reported to the Overseeing Organisation.
- 18 All covers lifted for cleaning operations shall be replaced and evenly bedded.

### **Cleaning of Bridge Drainage Systems**

- 19 Cleaning of bridge bearing shelves, subway sumps, grit chambers and other bridge drainage systems shall be carried out by one of the following methods:
  - a) vacuum/air suction having the ability to remove materials from depths of up to 9.0m with a suction facility capable of displacing 55m<sup>3</sup>/min of air at 95% vacuum;

- b) low-pressure high-volume jetting in accordance with Clause 521; and,
  - c) sweeping.
- 20 All adjacent surfaces of the structure shall be protected to prevent staining by arisings from the cleaning operation. All arisings shall be taken off site.
- 21 The Contractor shall report to the Overseeing Organisation any damage or defects to the bridge drainage system.

**521 Low-Pressure High-Volume Jetting of Drainage Systems**

- 1 Where stated in contract specific IM Appendix 5/1, the Contractor shall clean existing drainage systems in accordance with this Clause.
- 2 The drainage systems to be cleaned shall be as detailed in the contract specific IM Appendix 5/1.
- 3 The pipe material of the drainage systems to be cleaned shall be identified in contract specific IM Appendix 5/1. Where the material is unknown and cannot be verified by either visual inspection, without recourse to man-entry, or from drainage records, or damage to the pipeline is the suspected cause of a blockage, cleaning shall proceed on the basis of use of the lowest pump pressure stated in **Table 500 - 13**.
- 4 Where the cleaning forms part of the pre-cleansing works for the CCTV survey of drainage systems, the works shall be detailed in contract specific IM Appendix 90/1.

**Jetting of Piped Drainage Systems**

- 5 Cleaning shall take place from downstream of the blockage in an upstream direction. The pipe shall be plugged below the jetting point to prevent contaminants flowing to the watercourse. The cleaning shall take place from a chamber, although it may be necessary to make a temporary excavation into the pipeline in some circumstances.
- 6 Should the Contractor find that it is not possible to jet in an upstream direction, then the pipe shall be plugged below the blockage and the jetter then used to “back jet” to a suction hose.

**Table 500 - 13 Maximum Pump Pressures (Recommended)**

Material	Maximum pump pressure (bar/psi)
Unknown/structurally damaged	80/1200
Brick/Block/Masonry	100/1500
Plastics – Structural Wall	127/1900

Plastics – Solid Wall	127/1900
Concrete	340/5000
Clay	340/5000

- 7 The Contractor shall select a jethead that is appropriate for delivering the maximum jetting pressure for the pipe material and also the minimum volume of water for the appropriate pipe diameter stated in **Table 500 - 14**.
- 8 The jet head shall be of a configuration such that the number and direction of jets are adequate to be directed to the sides and soffit of the pipeline to prevent debris passing over the top of the jetting head.

**Table 500 - 14 Jetting Flow Rates (Minimum)**

Pipe Diameter	Minimum jetting flows
<230 mm	156 l/m
450 mm	270 l/m
900 mm	300 l/m
1600 mm	342 l/m

- 9 The Contractor shall provide suitable jetting equipment that shall include the provision of the following:
- i) operation at a maximum rate of 850 l/min at 150 bar/2250 psi;
  - ii) liquid ring vacuum pump operating with air flows of 4000m<sup>3</sup> per hour, with a working vacuum of not less than 90%;
  - iii) a minimum of 20m of 100mm diameter suction hose for cleaning pipes up to 300mm diameter and
  - iv) 150mm diameter suction hose for cleaning pipes of diameter greater than 300mm;
  - v) minimum of 150m of 25mm or 38mm diameter jetting hose and a capability of jetting up to 200m;
  - vi) automatic and continuous water recycling; and,
  - vii) silt, sand and rubble to be de-watered prior to discharge at licensed tip.
- 10 The Contractor shall ensure that no damage occurs to the manhole chamber or pipeline during insertion of the jetting equipment.
- 11 The jetting head shall be propelled through or over the blockage and then the hose pulled backwards enabling the force of the jet to break up the blockage material. The minimum

force necessary to penetrate the blockage shall be used but the pump pressures should not exceed those stated in **Table 500 - 13**.

- 12 The hose shall be rewound at a rate of between 100mm and 200mm per second.
- 13 There is a possibility that damage may occur to certain pipe materials should the jetting head remain stationary thus the Contractor must ensure that the jetting head never remains stationary for more than 60 seconds.
- 14 Where the presence of perforated pipes and porous concrete pipes in piped highway drainage systems is discovered during the course of the works, the Overseeing Organisation shall be notified immediately and the cleaning operation suspended for that section of the works.

### **Cleaning of Linear Drainage Systems**

- 15 Where possible the Contractor shall clear blockages in linear drainage channels and combined kerb drainage units by rodding.
- 16 Where silt removal is necessitated, the use of pressure jetting will result in the loss of pressure through the grating, slot or drainage holes together with the escape of silt and debris, unless the apertures can be temporarily covered. The application of pressure shall be regulated such that there is only sufficient to drive the jetting head across the silt to access remote from the point of entry.
- 17 If necessary, the jetting head shall be changed for one that can deliver the highest volume of water at low pressure. The water pressure shall be sufficient to agitate the silt.
- 18 The nozzle shall be drawn back to the point of entry at a rate of between 100mm and 200mm per second.

### **Silt Removal**

- 19 Suitable measures such as stoppers shall be positioned downstream of the drainage system to be cleaned to minimise the risk of sediment causing contamination of watercourses or soakaways.
- 20 Wherever practical the Contractor shall use equipment to carry debris over a greater depth than one atmosphere and with a capability to suck liquid.
- 21 All arisings from the cleaning process shall be disposed of in an environmentally sensitive manner in accordance with current legislation.

### **Health and Safety**

- 22 The use of high-pressure water can result in serious internal injuries that may not be

apparent at the skin surface.

- 23 The Contractor shall ensure that all hoses are free from damage and that the equipment is in full working order.
- 24 Where overhead electric cables are present, there is a potential danger from accidental strike by a jet of water.

### **522 Hydrodynamic (Vortex) Separators**

- 1 Vortex separators shall be installed in accordance with the manufacturer's requirements and requirements stated in contract specific IM Appendix 100-10.
- 2 The formation level of the vortex separator shall be blinded with ST1 concrete in accordance with Series 2600.
- 3 The thickness of the concrete blinding shall be in accordance with the manufacturer's requirements and requirements stated in contract specific IM Appendix 100-10.
- 4 Vortex separators shall have no moving parts.
- 5 Internal components of the vortex separator shall be constructed from stainless steel and/or polyethylene.

### **523 Grassed Surface Water Channels**

- 1 For grassed surface water drainage channels a Type 5 or 6 fin drain in accordance with Clause 514 incorporating a double cusped central impermeable core shall be installed at the edge of the pavement construction and in accordance with contract specific IM Appendix 5/3.
- 2 The double cusped central core shall be made from polyethylene or polypropylene and in accordance with Clause 514.
- 3 The grassed surface water channel construction shall comprise of graded subsoil, a layer of topsoil and sub-surface drainage.
- 4 Prior to placing subsoil, the formation shall be ripped to a depth exceeding 150mm to provide a key between the existing ground and subsoil layer.
- 5 The subsoil shall be non-cohesive.
- 6 The subsoil shall be free from stones larger than 50mm.
- 7 Where an impermeable membrane is required, the subsoil shall be free from flints.
- 8 Subsoil shall be placed in layers, not exceeding 100mm thick and compacted in



- accordance with Table 600-4 to 600-34 using a vibrating plate compactor Ref No. 4 Method 1 or Ref No. 2 Method 3.
- 9 The subsoil shall be shaped to the required channel cross sectional and longitudinal profiles stated in the contract specific IM Appendix 5/3.
- 10 Where stated in the contract specific IM Appendix 5/3, biodegradable geosynthetic reinforcement shall be placed between the subsoil and topsoil layers to provide support until the grass becomes established.
- 11 Fixings used to hold a geosynthetic in place shall not pierce the impermeable liner.
- 12 The surface material shall be topsoil class 5B in accordance with BS 3882 in contract specific IM Appendix 600-8 and the following:
- i) the topsoil texture shall be a sandy loam or loamy sand;
  - ii) the topsoil shall have a pH greater than 5.5;
  - iii) the topsoil depth shall be between 35mm and 50mm once compacted.
- 13 Topsoil shall be compacted in accordance with Table 600-3 to 600-6 using a vibrating plate compactor Ref No. 4, Method 1 or Ref No. 2 Method 3 but the number of passes shall be reduced to two.
- 14 A grassed surface water channel shall be seeded or lined with turf in accordance with this Clause.
- 15 The steps for seedbed or turf bed preparation shall be:
- a) application of seedbed fertiliser at a ratio of 10:15:10 for N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O at 30 g/m<sup>2</sup>; and,
  - b) final raking or harrowing before seeding, hydroseeding or turfing in accordance with contract specific IM Appendix 5/3.
- 16 Where turf is used, it shall be placed immediately after compaction of the topsoil to minimise the risk of soil fines being washed away by surface runoff.
- 17 Where turf is used, an allowance shall be made for its thickness when defining the finished level of the topsoil.

## 524 Chambers Performance Indicators

- 1 The performance indicators listed in **Table 500 - 15** shall be complied with for the duration indicated and in fulfilment of the requirements in the Special Conditions of Contract, clause 58.
- 2 The performance indicators (Chambers) for completed works as described in **Table 500 - 15** shall apply as follows:
  - i) Start of service: Target Value
  - ii) After five (5) years of service: Limit Value

**Table 500 - 15 Performance Indicators: Target Values**

Ref	Indicator	Target value	Limit value
<b>1</b>	<b>Manhole Wall (or Render)</b>		
A	Cracking	None	None
B	Spalling	None	None
C	Chemical aggression deterioration	None	None
D	Pitting	None	None
E	Delamination	None	None
<b>2</b>	<b>Manhole Base Benching (or Render)</b>		
A	Cracking	None	None
B	Spalling	None	None
C	Chemical aggression deterioration	None	None
D	Pitting	None	None
E	Delamination	None	None
<b>3</b>	<b>Manhole Reducer Slab</b>		
A	Cracking	None	None
B	Subsidence	None	None
C	Rocking	None	None
D	Dislevelling	None	None
<b>4</b>	<b>Manhole Ductile Frame and Cover</b>		
A	Broken parts	None	None
B	Settlement	None	None
C	Warping	None	None
D	Distortion	None	None
E	Subsidence	None	None
F	Cracking	None	None
G	Deformation	None	None
H	Detached parts (Eg. hinge)	None	None
I	Missing parts	None	None
J	Loss of tight fit (frame / cover)	None	None
K	Dislevelling	None	None
L	Sheared grille	None	None
M	Polishing (Skid resistance loss)	None	None
<b>5</b>	<b>Manhole Rebate</b>		
A	Cracking	None	None
B	Pitting	None	None

<b>Ref</b>	<b>Indicator</b>	<b>Target value</b>	<b>Limit value</b>
<i>C</i>	Spalling	None	None
<i>D</i>	Ravelling	None	None
<b>6</b>	<b>Manhole Surround Surface</b>		
<i>A</i>	Subsidence	None	None
<i>B</i>	Microcracking	None	None
<i>C</i>	Cracking	None	None
<i>D</i>	Fretting	None	None
<i>E</i>	Dislevelling	None	None
<i>F</i>	Settlement	None	None
<i>G</i>	Deformations,	None	None
<i>H</i>	Corrugations	None	None
<i>I</i>	Shoving	None	None
<i>J</i>	Fatting	None	None
<i>K</i>	Pitting	None	None
<i>L</i>	Scuffing	None	None
<b>6</b>	<b>Joints</b>		
<i>A</i>	Delamination	None	None
<i>B</i>	Cracking	None	None
<i>C</i>	Open	None	None
<i>D</i>	Tearing	None	None
<i>E</i>	Fatting	None	None