

DEVELOPMENT CONSTRUCTION SPECIFICATION

C221

PIPE DRAINAGE

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Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
SWR 164	A revision of Spec.C221 has been made in response to: -requests for pipe support types other than HS3 for concrete pipes, -the recently (May 1998) released revision to AS/NZS2041 for steel pipes, -the recently (Jan. 1998) released AS/NZS2566.1, Buried flexible pipelines - structural design, as it applies to UPVC pipes. This has resulted in major changes to the Spec and thus this spec has been totally revised.	<i>All</i>	<i>Revision</i>	<i>KM</i>	<i>June 1998</i>
SWR230.1	Trench widths	05	A	KM	Oct 98
SWR230.2	Change "backfill" to "select fill"	06.3	M	KM	Oct 98
SWR230.3	H3 support: Bedding compaction requirements and design checks	06.7	A	KM	Oct 98
HC221.1	Bulkheads on drainage lines > 10% grade shall be in accordance with the "drawings" (not Specification 223)	07(a).4	M	KM	18/11/98
HC221.2	Trench Stops on all lines where pipe gradient exceeds 15%.	07(a).5	A	KM	18/11/98
HC221.3	Rubber ringed joints shall be used in the road reserve, in the CBD and on all curves	07(b)(i).5	A	KM	18/11/98

HC221.4	Flush joints "where permitted"	07(b) (ii).1	M	KM	18/11/98
HC221.5	Direct side connections not permitted	07(c) (ii).1	M	KM	18/11/98
HC221.6	Embedment material under roads & kerbs	23.1	A	KM	18/11/98
HC221.7	Bedding material grading	06.3 Table 2	M	KM	18/11/98

SPECIFICATION C221 : PIPE DRAINAGE

GENERAL

C221.01 SCOPE

- | | |
|---|----------------------------------|
| <p>1. This Specification covers the supply and installation of pipe culverts and pipe arches for stormwater drainage.</p> | Scope |
| <p>2. This Specification should be read in conjunction with the specification for STORMWATER DRAINAGE - GENERAL.</p> | Associated Specifications |
| <p>3. The work to be executed under this Specification consists of supply of pipes and pipe arches, bedding, installation and backfilling.</p> | Extent of Work |
| <p>4. Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in the Specification Part for Quality Requirements.</p> | Quality |

C221.02 REFERENCE DOCUMENTS

- | | |
|---|---|
| <p>1. Documents referenced in this specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated.</p> | Documents
Standards
Test Methods |
|---|---|

(a) Council Specifications

C213	-	Earthworks
C220	-	Stormwater Drainage - General
C223	-	Drainage Structures
C230	-	Subsurface Drainage - General
C271	-	Minor Concrete Works

(b) Australian Standards

AS 1141.11	-	Particle size distribution by dry sieving.
AS 1141.51	-	Unconfined compressive strength of compacted materials.
AS 1254	-	Unplasticized PVC (UPVC) pipes and fittings for storm or surface water applications.
AS 1289.3.3.1	-	Calculation of the plasticity index of a soil.
AS 1289.5.4.1	-	Compaction control test - Dry density ratio, moisture variation and moisture ratio
AS 1289.4.3.1	-	Determination of the pH value of a soil - Electrometric method.
AS 1289.4.4.1	-	Determination of the electrical resistivity of a soil - Sands and granular materials.
AS 1289.E6.1	-	Compaction control test - Density index method for a cohesionless material.
AS 1397	-	Steel sheet and strip - Hot dipped zinc coated or aluminium/zinc coated.
AS 1646	-	Elastomeric seals for waterworks purposes.
AS 1650	-	Galvanised coatings on ferrous articles.
AS 1761	-	Helical lock-seam corrugated steel pipes.
AS 1762	-	Helical lock-seam corrugated steel pipes - Design and installation.
AS 2032	-	Code of practice for installation of UPVC pipe systems.

- AS 2041 - Buried corrugated metal structures.
- AS/NZS 2566.1 - Buried flexible pipelines, structural design
- AS 3725 - Loads on buried concrete pipes
- AS/NZS 3750.9 - Organic zinc-rich primer.
- AS/NZS 3750.15 - Inorganic zinc silicate paint.
- AS 3887 - Paints for steel structures - Coal tar epoxy.
- AS 4058 - Precast concrete pipes (pressure and non-pressure).
- AS 4139 - Fibre reinforced concrete pipes and fittings.
- AS/NZS ISO 9002 - Quality systems - Model for quality assurance in production, installation and servicing.

(c) AASHTO Standard

- M190 Bituminous coated corrugated metal culvert pipe and pipe arches.

COMMON REQUIREMENTS

C221.03 GENERAL

- 1. Pipes and/or pipe arches shall not be placed in position until the Contractor has produced documentary evidence to the Superintendent that the manufacture of the products to be used in the works has complied with the Manufacturer's Quality Plan in accordance with ISO 9002. **Compliance with Quality Plan**
- 2. Documentation shall comprise a conformance certificate to AS 4058 or AS 4139 as appropriate for each batch of pipes or pipe arches to be included in the works. Conformance certificates are to be supplied at least 24 hours in advance of despatch to site. **Certification**
- 3. Each unit shall be marked at time of manufacture with: **Marking**
 - a) Class and size.
 - b) Manufacturer's name.
 - c) Date of casting.
- 4. The Contractor shall take all necessary steps to drain the excavation to allow the foundation, the bedding and any backfilling to be compacted to the specified relative compaction. **Excavation Drainage**
- 5. Culverts shall be installed within 10mm of the grade line and within 10mm of the horizontal alignment specified on the Drawings. The Contractor shall relay any culvert which is not within these tolerances. **Tolerances**
- 6. At the discharge end of culverts terminating at pits and headwalls a 3m length of 100mm diameter subsurface drain shall be laid in the trench 100mm above the invert level of the culvert and discharging through the wall of the pit or headwall at 100mm above the invert level of the culvert or headwall. The subsurface drainage pipe shall be sealed at the upstream end and shall be enclosed in a seamless tubular filter fabric in accordance with the Specification for SUBSURFACE DRAINAGE - GENERAL. **Subsurface Drain**
- 7. Backfilling for culverts shall be undertaken in a safe manner and in accordance with all statutory requirements. **Safety**

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8. Where the Contractor proposes to travel construction plant in excess of 5 tonnes gross mass over culverts, the Contractor shall design and provide adequate protective measures for the crossings and shall submit the proposals to the Superintendent for prior approval.

**Construction
Plant
Movement**

REINFORCED CONCRETE AND FIBRE REINFORCED CONCRETE PIPES

C221.04 PIPES

1. Reinforced concrete pipes shall comply with AS 4058 and shall be of the class and size as shown on the Drawings.

**Reinforced
Concrete
Pipes**

2. Fibre reinforced concrete drainage pipes shall comply with AS 4139 and shall be of the class and size as shown on the Drawings.

**Fibre
Reinforced
Pipes**

3. Unless specified otherwise, joints shall be of the flexible type and the pipes shall have special sockets incorporating rubber ring joints complying with AS 1646 and as recommended by the manufacturer.

Joints

C221.05 EXCAVATION

1. Unless otherwise indicated on the Drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

**Formation to
Subgrade
Level**

2. For normal trench conditions, the pipe shall be laid in an excavated trench with bedding as specified in Clause C221.06. The trench shall be excavated to a width 1.4 times the external diameter of the pipe, or to the external diameter of the pipe plus 300mm on each side, whichever is the greater.

**Normal Trench
Conditions**

3. Care is necessary to avoid laying pipe drainage in trenches excavated to excessive width. Pipes laid in wide trench conditions will be deemed to be in embankment conditions (positive projection). Wide trench conditions apply when, for a single pipe, the width of trench, $W \geq D + 0.6$ metre where D is the pipe diameter. For multi-cell pipes wide trench conditions apply when the width of trench, $W \geq \Sigma D + \Sigma S + 0.6$ metre where S is the square spacing between the pipelines. This definition of wide trench conditions as equivalent to embankment conditions relates to the size and geometry of the excavation utilised at construction. Pipes shown on the Drawings to require trench conditions shall not be placed under embankment conditions without a design check for compliance of the pipe strength in accordance with AS3725.

**Wide Trench
Conditions**

Design Check

C221.06 BEDDING

1. Bedding shall be in accordance with this Specification, AS3725 and AS3725 Supplement 1 for the pipe support types as shown on the Drawings. Where the pipe support type is not shown on the Drawings, the support type shall be HS3 within road reserves and H2 elsewhere.

**Pipe Support
Type**

2. Figure C221.1 and Table C221.1 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions for all AS3725 pipe support types.

**Bedding
Dimensions**

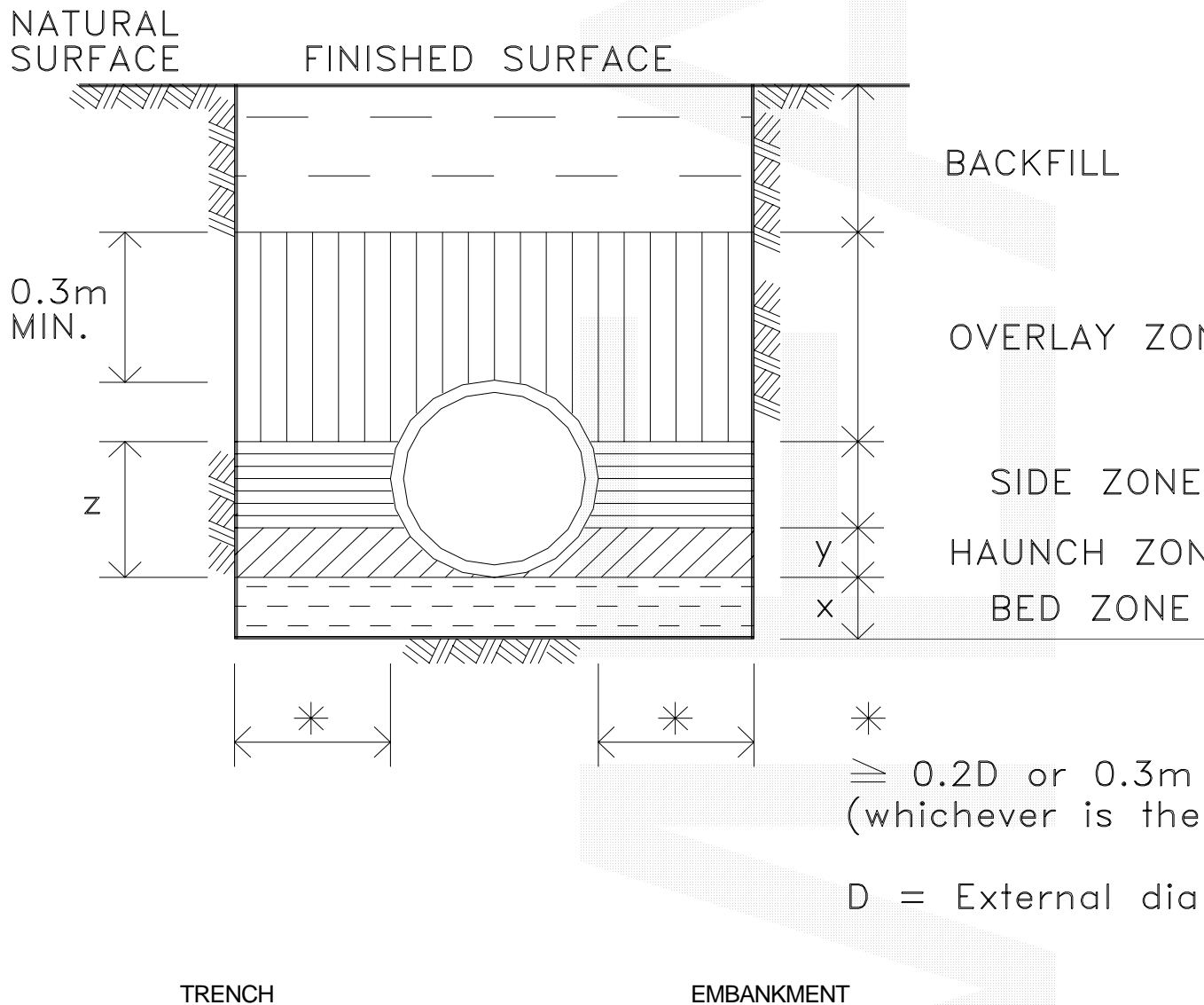


Figure C221.1 - Pipe Installation Conditions

		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Dimension (minimum)	x	75 on rock Nil on soil	100 for $D \leq 1500$ 150 for $D > 1500$		0.25 D but >100		100 for $D \leq 1500$ 150 for $D > 1500$	
	y	—	0.1D	0.3D	0.3D	0.1D	0.3D	0.3D
	z	—	—	—	—		$\geq 0.7D$	

D = External diameter of pipe

Table C221.1 Pipe Installation Dimensions

3. Bedding material for the bed and haunch zones shall consist of a granular material having a grading, determined by AS 1141.11, complying with Table C221.2, and a Plasticity Index, determined by AS 1289.3.3.1 of less than 6. Select fill material in the side zones, for pipe support type HS, shall also comply with Table C221.2, and shall have a Plasticity Index less than 12.

Material Requirements

Sieve size mm	Weight passing %	
	Bed and Haunch Zones	Side Zones
50	—	100
19.0	---	—
9.5	100	50 - 100
4.75	90 - 100	---
2.36	50 - 100	30 - 100
0.60	10 - 90	15 - 50
0.30	5 - 60	—
0.15	0 - 25	—
0.075	0 - 10	0 - 25

Table C221.2 Bedding Material Grading Limits

4. The Contractor shall advise the Superintendent of the source of bedding material.

Source

5. All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.

Layers

6. At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction).

Moisture Content

7. Compaction of backfill in the bed and haunch zones shall be to the appropriate pipe support requirements shown in Table C221.3 when tested in accordance with AS 1289.5.4.1 for standard compactive effort.. H3 Pipe Support includes concrete bedding. Concrete shall be grade N20 to AS3600. Pipe shall be suitably reinforced in accordance with AS3725 as standard elliptically reinforced pipe may not be adequate for

Compaction Requirements

H3 Pipe Support. Unless specifically selected pipes are nominated for use with H3 bedding, a design check shall be required to confirm the suitability of the proposed pipes.

Standard Compaction AS1289.5.4.1 (5.6.1)		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Density Index	Bed and Haunch Zones	—	50	60	*	50	60	70
Density Index	Side Zones: Cohesionless	—	NA	NA	NA	50	60	70
Minimum Relative %	Cohesive	—	NA	NA	NA	85	90	95

* Concrete, Grade N20 to AS 3600

Table C221.3 Bedding Material Compaction Requirements

8. The top 0.1Dmm of the bedding and haunch material directly under the pipe shall be placed and shaped accurately to house the pipe after compaction is achieved in the bedding and haunch zone external to the area of direct pipe support.

9. Where the impermeability of the natural ground and the slope of the drainage line is such that erosion of bedding material is considered by the Superintendent to be a likely problem, the Superintendent may specify cementitious stabilisation of the bedding material used in the bedding and haunch zones.

Cementitious Stabilisation

C221.07 INSTALLATION

(a) General

1. Pipes shall be laid with the socket end placed upstream. Pipes which have marks indicating the crown or invert of the pipes shall be laid strictly in accordance with the markings. Unless specified, no individual length of pipe shall be shorter than 1.2m.

Positioning of Pipes

2. In the case of pipes 1,200mm or more in diameter, laid in situations where embankments are to be more than 3m high, measured above the invert of the pipe, pipes shall be stiffened temporarily by the Contractor by interior timber struts, erected before filling is placed. Struts shall be of hardwood measuring at least 100mm by 100mm or 125mm diameter. One strut shall be placed in a vertical position at each pipe joint, thence at a spacing not greater than 1,200mm. Struts shall bear against a sill laid along the invert of the pipe and a cap bearing against the crown of the pipe. Both the sill and the cap shall be continuous throughout the length of the pipe and they shall be of sawn hardwood, of cross section not less than 100mm by 100mm. Struts shall be made to bear tightly by the use of wedges between the top of the struts and the cap. Struts, sills and caps shall be removed on completion of the embankment, unless removal is ordered earlier.

Stiffening of Culverts

Removal of Struts

3. Lifting holes in all pipes shall be sealed with plastic preformed plugs approved by the Superintendent, or a 3:1 sand:cement mortar, before the commencement of backfilling.

Seal Lifting Holes

4. Reserved

(b) Joints in Reinforced Concrete Pipes

(i) Rubber Ringed Joints

1. Before making the joint, the spigot and socket and the rubber ring shall be clean and dry. **Clean and Dry Material**
2. The rubber ring shall be stretched on to the spigot end of the pipe, square with the axis and as near as possible to the end, care being taken that it is not twisted. The spigot end of the pipe shall then be pushed up to contact the socket of the pipe with which it is to join, and be concentric with it. The spigot end shall then be entered into the socket of the already laid pipe and forced home by means of a bar, lever and chain, or other method approved by the Superintendent. **Procedure for Rolling Rubber Rings**
3. The joint shall be tested to ensure that the rubber ring has rolled evenly into place. **Joint Test**
4. Where wedge shaped "skid" rubber rings are prescribed the Manufacturer's instructions, which include the use of lubricants, shall be followed. **"Skid" Rings**
5. Rubber ring joints shall be used on all curves, and anywhere within the road reserve or within the CBD areas. **Locations**
- (ii) Flush or Butt Joints**
1. Where Flush or butt joints are permitted, the ends of the pipes shall be butted together. **Jointing**
2. The joints shall be sealed with proprietary rubber sleeves, supplied and installed in accordance with the manufacturer's recommendations. **Sealing**
- (c) Joints in Fibre-Reinforced Cement Pipes**
- (i) New Pipes**
1. Joints shall be of a flexible type. Rubber rings shall be used to seal joints in both rebated and spigot and socket jointed pipes in the manner specified in Clause C221.07(b). Alternatively, a jointing compound comprising plasticised butyl rubber and inert fillers may be used to seal such pipes in accordance with the manufacturer's instructions. **Procedure**
- (ii) Direct Side Connections to Other Pipes**
1. Direct side connections to other pipes shall not be permitted.
- C221.08 BACKFILL**
1. Select Fill material (meeting the requirements of Table C221.2) placed in the side zones for pipe support type HS shall be compacted to the requirements shown in Table C221.3 when tested in accordance with AS 1289.5.4.1 for standard compactive effort. **Type HS Pipe Support**
2. "Ordinary fill" placed in the side zones (for all pipe support types except type HS), and overlay zones (for all pipe support types), shall consist of Selected Backfill as defined in the Specification for EARTHWORKS. It shall be placed around the pipe to the dimensions shown in Figure C221.1. **Other Pipe Support Types**
3. All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced. Testing shall be in accordance with Sub -Annexure B2./C2. **Layers**
4. At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor **Moisture Content**

more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction).

5. The remainder of the trench to the underside of the subgrade, or selected material zone as specified in the Specification for EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in the Specification for EARTHWORKS. Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in the Specification for EARTHWORKS.

Trench Backfill

6. When compacted adjacent to culverts or drainage structures, the Contractor shall adopt compaction methods which will not cause damage or misalignment to any culvert or drainage structure. Any damage caused shall be rectified, and all costs of such rectification shall be borne by the Contractor. Backfilling and compaction shall commence at the pipe or wall so as to confine remaining uncompacted material at commencement.

Precautions

Contractor's Cost

7. Material meeting the requirements of Table C221.2 Bedding and Haunch Zones or Table C221.2 Side Zones, may be used for Side zones, Overlay zones and Backfill for all pipe support conditions

STEEL PIPES AND PIPE ARCHES

C221.09 NESTABLE STEEL PIPE AND DRAINAGE UNITS

1. Nestable steel pipes and drainage units shall be supplied in accordance with AS 2041 and shall be of the class and size as shown on the Drawings.

Specification

2. The galvanised steel sheets used in manufacture shall comply with AS 1397 for steel base grade G250 and a minimum coating Class of Z600.

Galvanised Steel Sheets

3. Where specified, the pipes and drainage units shall be given a protective coating over the steel, after assembly of a coal tar epoxy paint or equivalent as approved by the Superintendent, to a thickness of 400 microns.

Protective Treatment

4. Field cut ends shall be carefully wire brushed to remove any scale followed immediately by two coats of zinc-rich organic primer complying with AS/NZS 3750.9 or two coats of inorganic zinc silicate paint complying with AS/NZS 3750.15.

Field Cuts

C221.10 HELICAL LOCK-SEAM CORRUGATED STEEL PIPE

1. Helical lock-seam corrugated steel pipe shall be supplied in accordance with AS 1761 and AS 1762 and shall be of the class and size as shown on the Drawings.

Specification

2. The galvanised steel sheet used in manufacture shall comply with AS 1397 for steel based grade G250 and a minimum coating Class of Z600.

Galvanised Steel Sheets

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3. Unless otherwise approved by the Superintendent, no part of the pipe shall incorporate steel strips which have been joined by welding. Field cut ends shall be carefully wire brushed to remove any scale followed immediately by two coats of zinc-rich organic primer complying with AS/NZS 3750.9 or two coats of inorganic zinc silicate paint complying with AS/NZS 3750.15. Pipes and coupling bands shall be given a protective hot-dip coating of bitumen on both sides to AASHTO standard M190 or equivalent as part of the process of manufacturing.

**Protective
Treatment**

C221.11 BOLTED STEEL PIPES, PIPE ARCHES AND SPECIAL SHAPES

1. Bolted steel pipes, pipe arches and special shapes shall be supplied in accordance with AS 2041 and shall be of the class and size as shown on the Drawings. The corrugated pipe or plate shall be hot-dip heavy galvanised on both sides after fabrication in accordance with AS 1650.

Specification

2. Also, after assembly, all bolted steel pipes, pipe arches and special shapes shall be given a protective coating on the outside of the steel plate, of a coal tar epoxy paint complying with AS 3887 or equivalent paint approved by the Superintendent. Invert plates shall be coated on the outside before they are placed on the pipe bed. The plate surface shall be cleaned and degreased with a cleaning solution recommended by the protective coating manufacturer. The protective coating shall be applied to give a uniform minimum dry thickness of 400 microns. Any coating damaged shall be recoated by first cleaning any grease, mud or other foreign matter from the affected area. The area shall then be recoated so that the minimum dry thickness of the coating is 400 microns.

**Protective
Treatment**

C221.12 MATERIALS AND SURFACE TREATMENT OF STEEL PIPES AND PIPE ARCHES

1. All steel pipes and pipe arches will require an Engineer's certification that the pipe materials and surface treatments are adequate to provide for installation and in-service loading as well as corrosion protection for a satisfactory design life of 100 years unless indicated otherwise on the Drawings. Such certification shall address the chemistry of the soil, groundwater, stream and backfill material as specified in Clause C221.13.

**Engineer's
Certification**

C221.13 MATERIAL AGAINST STEEL STRUCTURES

1. The severity of corrosive attack on steel structures will depend on the pH value and electrical resistivity of the soil surrounding the structure and the pH value of the water in the stream.

2. Besides meeting the normal requirements of the bedding, selected backfill materials and the materials used for embankment construction above the steel structures and within a horizontal distance from the structure equal to the height of the filling over the structure, the pH and resistivity limits as shown in Figure C221.2 will determine the level of corrosion protection required.

3. Notwithstanding the height of fill, embankment material within 6m of the structure shall conform to these requirements.

4. The pH and electrical resistivity of the material shall be determined in accordance with AS 1289.4.3.1 and AS 1289.4.4.1.

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5. The Contractor shall nominate the sources of the various materials and submit documentary evidence from a NATA registered laboratory that the representative samples conform to the requirements of this clause and the protective treatment provided. The samples shall be pretreated if necessary so as to represent the condition and grading when compacted and in service.

NATA Testing

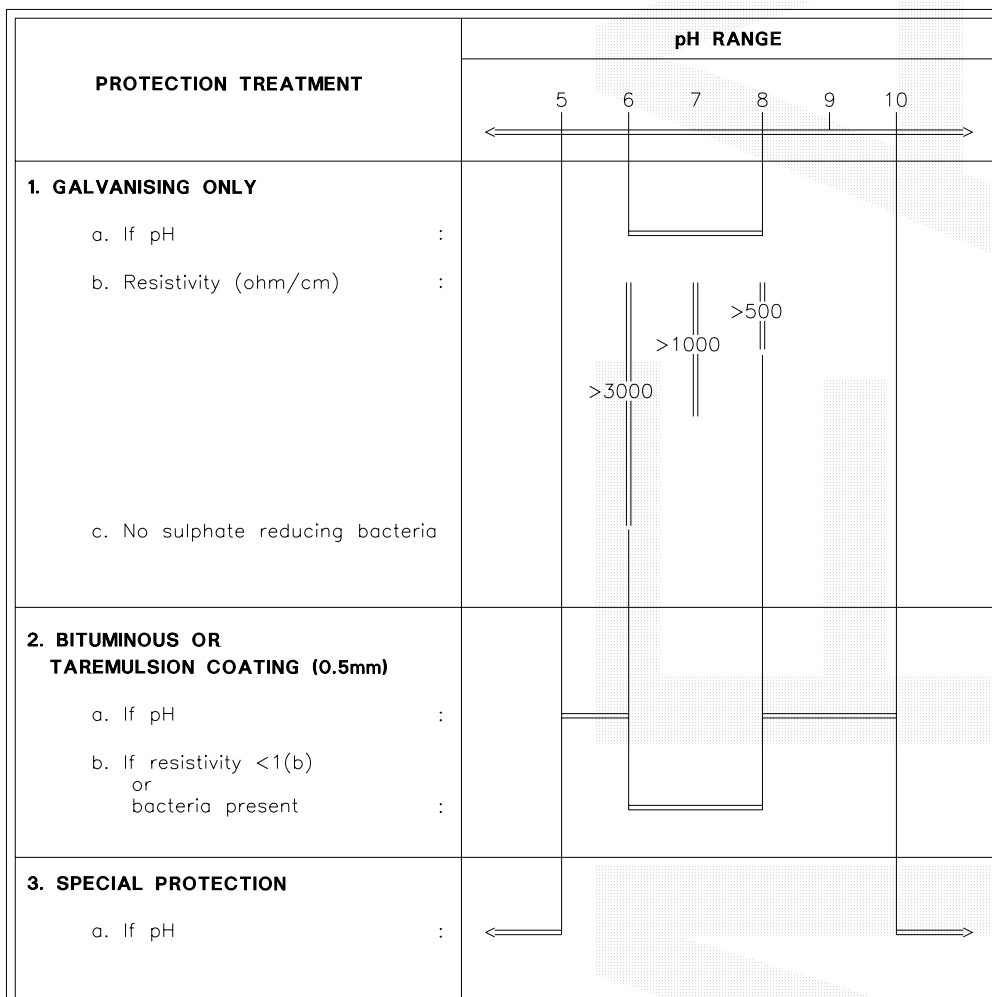


Figure C221.2 - Corrosion Protection Requirements For Steel Structures

C221.14 EXCAVATION AND FOUNDATION PREPARATION

1. Unless otherwise indicated on the Drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.

Formation to Subgrade Level

2. The trench shall be excavated to a level 75mm below the design invert and for a minimum width of 600mm on each side of the structure.

Trench Width Select Fill

3. Where unsuitable material, as determined by the Superintendent, is encountered at the foundation level, it shall be removed to a depth approved by the Superintendent. The additional excavation shall be backfilled with material complying with, and compacted to, the requirements for HS3 pipe support as specified in Clause C221.06.

Unsuitable Material

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4. Where rock is encountered at the foundation level, the foundation shall be excavated for an additional depth of 250mm, or 0.25 times the structure width, whichever is the lesser and for a width equal to the width of the structure. The additional excavation shall be backfilled with material complying with, and compacted to, the requirements for HS3 pipe support as specified in Clause C221.06.

**Rock
Foundation**

C221.15 BEDDING

1. Bedding shall meet the requirements of Clause C221.06. The thickness of uncompacted bedding material between the foundation and the outer surface of corrugation shall not be less than 75mm. The uniform blanket of loose material which provides the minimum 75mm thick bedding, shall be placed on the shaped, compacted selected material foundation to allow the corrugations of the structure invert to bed in and become filled with the material.

Depth

C221.16 INSTALLATION

(a) General

1. The assembly of all corrugated steel pipes and pipe arches as well as helical lock-seam corrugated steel pipes shall be carried out in accordance with the manufacturer's recommendations. These recommendations shall be submitted to the Superintendent before assembly or laying of the culverts is commenced.

**Manufacturer's
Recommendations**

2. If deemed necessary after consultation with the manufacturer, temporary bracing of corrugated steel pipes or pipe arches shall be carried out in accordance with the manufacturer's recommendations.

**Temporary
Bracing**

(b) Joints

1. Corrugated steel pipes or pipe arches shall be joined in accordance with the manufacturer's recommendations and AS 2041.

Method

2. Where helical-lock seam corrugated steel pipes are to be joined, both ends of the join shall be rerolled with four annular corrugations of pitch 68mm. Coupling of the rerolled ends shall be made in accordance with AS 1761 by using semi-corrugated bands. Rubber ring joint seals shall be used in conjunction with the coupling bands except where specifically indicated otherwise in the Drawings.

**Ends to be
Rerolled**

3. All joints or lap joints in pipes or pipe arches (excluding rubber ring joint coupling bands) shall be covered with strips of geotextile material approved by the Superintendent to prevent loss of sand backfill or bedding into the pipe.

**Geotextile
Cover Material**

C221.17 BACKFILL

1. Compaction of the material in the side support and overlay zones shall comply with the requirements of clause C221.06 except that the required relative compaction in the side support and overlay zones shall be 95 per cent (or Density Index 70%) (AS 1289.5.4.1 standard compaction). Backfill shall be placed around the steel pipe or structure, to a minimum dimension equal to the pipe width, on both sides.

**Selected
Material**

2. All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.

Layers



- | | |
|---|---|
| <p>3. At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction).</p> | <p>Moisture Content</p> |
| <p>4. The remainder of the trench to the underside of the subgrade, or selected material zone as specified in the Specification for EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in the Specification for EARTHWORKS. Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in the Specification for EARTHWORKS.</p> | <p>Trench Backfill</p> |
| <p>5. The Contractor shall check the shape of the culvert during backfilling to ensure that on completion of backfilling, the vertical and horizontal centreline dimensions of the pipe or structure shall not vary from the manufacturer's specified dimensions by more than plus or minus 2 per cent for pipes and pipe arches.</p> | <p>Distortion of Structure Shape</p> |

C221.18 INVERT PROTECTION OF CORRUGATED STEEL PIPES AND PIPE ARCHES

- | | |
|--|--|
| <p>1. Where shown on the Drawings, the invert of corrugated steel pipes and pipe arches shall be protected using sprayed concrete.</p> | <p>Sprayed Concrete</p> |
| <p>2. The sprayed concrete shall be placed to a thickness of not less than 100mm over the crest of the corrugations and to a width such that the bottom third of the pipe circumference is covered symmetrically about the invert of the pipe.</p> | <p>Depth and Width</p> |
| <p>3. All foreign material shall be removed from the surface to be protected. Where corrosion has occurred all loose scale shall be removed.</p> | <p>Scale Removal</p> |
| <p>4. The production, application and curing of sprayed concrete shall be in accordance with the Specification for MINOR CONCRETE WORKS.</p> | <p>Associated Specification</p> |
| <p>5. The sprayed concrete shall be reinforced with a fabric of hard drawn steel wire 4mm diameter with 200mm square mesh. The fabric shall be securely supported at a central location within the sprayed concrete by non-metallic supports.</p> | <p>Sprayed Concrete Reinforcement</p> |
| <p>6. Laps in fabric shall be 300mm and a cover of 50mm of sprayed concrete shall be provided to the fabric at all edges.</p> | <p>Laps in Fabric</p> |
| <p>7. Immediately after placement of the sprayed concrete, all free water shall be removed and the surface coated with cement slurry.</p> | <p>Cement Slurry Application</p> |
| <p>8. No water shall be allowed to flow over the surface of the sprayed concrete for twenty-four hours after the placement of sprayed concrete.</p> | <p>Water Flow</p> |

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UPVC PIPES

C221.19 CULVERT MATERIALS

1. Unplasticised PVC (UPVC) Pipes and Fittings shall be manufactured in accordance with AS 1254 and shall be of the type and size as shown on the Drawings.
2. Embedment material in the bedding, side support and overlay zones shall be in accordance with the material specified as bed and haunch zone material in Clause C221.06.
3. Trench backfill material shall satisfy the requirements for embankment material as defined in the Specification for EARTHWORKS.

Specification

C221.20 EXCAVATION AND BEDDING

1. Unless otherwise indicated on the Drawings or approved by the Superintendent, the formation shall be completed to subgrade level and the pipes then installed in the normal trench condition.
2. Figure C221.3 and Table C221.4 indicate the dimensions of bedding and backfilling for pipes laid in trench conditions and embankment conditions, unless otherwise indicated on the Drawings.

Formation to Subgrade Level

Bedding Dimensions

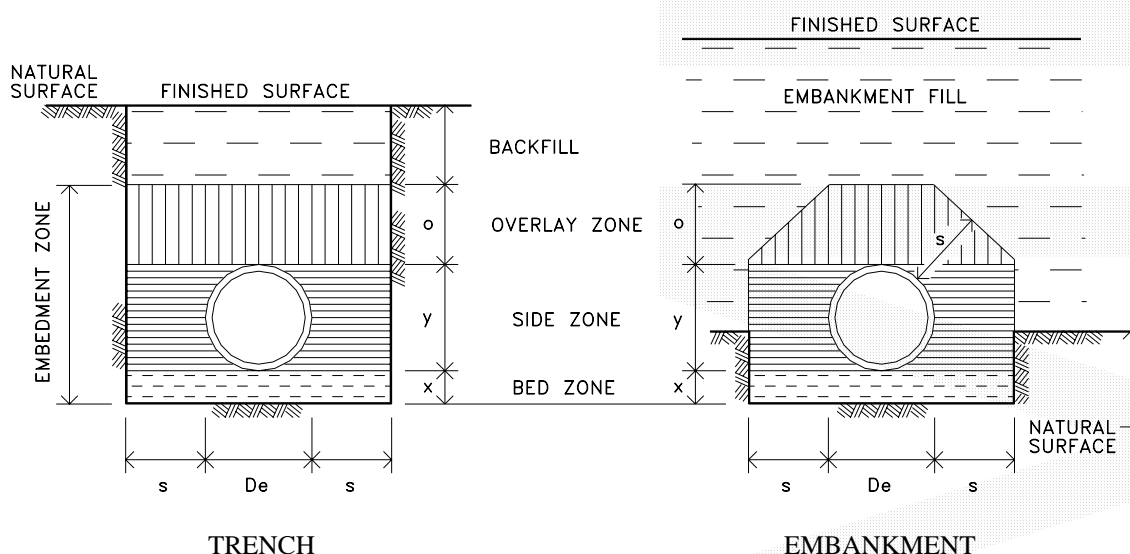


Figure C221.3 - Pipe Installation Conditions

Extreme External Dia (De)mm	Minimum Dimensions (mm)			
	x	s	o	y
≥75 ≤150	75	100	100	Pipe dia.
>150 ≤300	100	150	150	Pipe dia.
>300 ≤450	100	200	150	Pipe dia.

NOTE: Where multiple pipes are laid side by side, the minimum distance between the pipes shall be dimension “s” for the larger of adjacent pipes.

Table C221.4 - Trench and Embedment Dimensions

3. Bedding zone material shall be placed and compacted in accordance with the requirements in Clause C221.06 except that it shall be compacted to a Density Index of 70 per cent (AS 1289.5.4.1 Standard compaction).

C221.21 INSTALLATION

1. Embedment of the UPVC pipe shall be in accordance with the requirements of AS/NZS 2566.1 and to the dimensions shown in Figure C221.3.

2. Pipe laying shall be in accordance with Part 7 of AS 2032 and solvent-cement pipe jointing shall be in accordance with Part 3 of AS 2032. Jointing may be performed with the pipes either in the trench or at ground level. All pipes, or jointed pipelines, shall be lowered into the trench without being dropped. Pipelines shall be placed so that joints are not strained.

Laying and Jointing

C221.22 BACKFILL

1. Compaction of the material in the side support and overlay zones shall comply with the requirements of clause C221.06 except that the side support and overlay zones shall be compacted to a Density Index of 70 per cent (AS 1289.5.4.1 standard compaction).

Embedment Compaction

2. All material shall be compacted in layers not exceeding 150mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.

Layers

3. At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content, which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction).

Moisture Content

4. The remainder of the trench to the underside of the subgrade, or selected material zone as specified in the Specification for EARTHWORKS, shall be backfilled with material satisfying the requirements for embankment material as defined in the Specification for EARTHWORKS. Where excavation is approved through the selected material zone, the section of trench within the select material zone shall be backfilled with selected material as defined in the Specification for EARTHWORKS.

Trench Backfill



SPECIAL REQUIREMENTS

C221.23 EMBEDMENT MATERIAL UNDER ROADS AND KERBS

Backfill under roads

1. For all pipe drainage located under roadways or kerbs, material in the bedding, haunch, side support, overlay zones and backfill shall be in accordance with the material specified as bed and haunch zone material in Clause C221.06.

Material

2. Compaction of the material in the bedding, haunch, side support, overlay zones and backfill shall comply with the requirements of clause C221.06 except that the required compaction of all material shall be of Density Index 70 (AS 1289.5.4.1 standard compaction).

Compaction

3. The final 200mm (minimum) of fill below the underside of Subbase shall be backfilled with material satisfying the requirements of Subbase material as per Specification C242 - Flexible Pavements, and shall have a minimum relative compaction of 98 per cent (AS 1289.5.4.1 standard compaction).

Capping

C221.24 BULKHEADS

1. Where a pipeline is installed at a grade of fifteen (15) percent or steeper, concrete bulkheads of Grade 20 concrete complying with the Specification for MINOR CONCRETE WORKS, 150mm minimum thickness shall be constructed as follows:

- (a) Where concrete bedding or encasement to pipe is required, the 150mm thick bulkhead shall be cast integral with the concrete bedding or encasement across the width of trench and shall be keyed into both sidewalls a minimum of 150mm in other than rock and 75mm in rock. The bulkhead shall extend to 150mm below finished surface level or to other such lower level as directed by the Superintendent.
- (b) Where other bedding, or no bedding, is applicable, the bulkhead shall also be keyed into the bottom of the trench 150mm in other than rock and 75mm in rock for the full width of trench.
- (c) A 75mm nominal diameter drain hole shall be provided in the concrete bulkhead immediately above the top of the encasement bedding or foundation and crushed rock or gravel shall be placed in and at the upstream end of the drain hole to act as a filter. The gravel shall be 10 to 20mm in size within 150mm in all directions upstream and above the invert of the drainhole beyond which another 150mm thick surround of gravel 2 to 10mm in size shall be placed.

2. The distance between trench stops shall be determined by the following formula:

$$D = \frac{100}{G}, \text{ whereby}$$

D = Distance between stops in m,
G = Grade of pipe expressed in percentum.

C221.25 TRENCH STOPS

1. Where a pipeline is laid on bedding at a grade of ten (10) percent or steeper, trench stops consisting of polyethylene bags of minimum thickness 0.25mm filled with clay or other approved material and sealed in an approved manner, shall be constructed

as follows:

- (a) At the socket side of the joint nearest to the position of a stop required in accordance with the formula hereinafter, a recess 100mm deep to suit the width of bag shall be excavated into the bottom of the trench across its full width and into both sidewalls to a level halfway up the diameter of the pipe.
- (b) The polyethylene bags shall be placed around the pipe, to a level halfway up the diameter of the pipe, so as to give close contact with the pipe and to fill the entire space between the excavated recess and the pipe. Bags shall not be placed onto sand bedding.

2. The distance between trench stops shall be determined by the following formula:

$$D = \frac{100}{G}, \text{ whereby}$$

D = Distance between stops in m,
 G= Grade of pipe expressed in percentum.

C221.26 Reserved

C221.27 Reserved

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LIMITS AND TOLERANCES

C221.26 SUMMARY OF LIMITS AND TOLERANCES

1. The limits and tolerances for materials and product performance related to the various clauses in this Specification are summarised in Table C221.5 below.

Item	Activity	Limits/Tolerances	Spec Clause
1.	Culvert Position		
	(a) Grade Line	± 10mm	C221.03
	(b) Horizontal Alignment	± 10mm	C221.03
2.	Bedding		
	(a) Bed and Haunch Zone Compaction	Table C221.3	C221.06
3.	Backfill - Concrete Pipes		
	(a) Side and Overlay Zone Compaction	Table C221.3	C221.08
4.	Backfill - Steel Pipes		
	(a) Side and Overlay Zone Compaction	Table C221.3, HS3	C221.17
	(b) Pipe/Structure		
	(i) Horizontal and Vertical Variation	< 2% of specified dimensions	C221.17
5.	Sprayed Concrete		
	(a) Over crest of corrugations over bottom third of pipe circumference	> 100mm	C221.18
6.	Bedding Zone Compaction UPVC	≥95%	C221.20
7.	Backfill - UPVC Pipes		
	(a) Side and Overlay Zone Compaction	≥95%	C221.21
8.	Under Roads and Kerbs		
	Bedding Zone and Backfill	≥95%	C223.2
	Capping (Subbase material)	≥95%	C223.3

Table C221.5 - Summary of Limits and Tolerances

MEASUREMENT AND PAYMENT

C221.27 PAY ITEMS

1. Payment shall be made for all the activities associated with completing the work detailed in this Specification on a Schedule of Rates basis in accordance with Pay Item C221(a).
2. A lump sum price for this item shall not be accepted.
3. If any item for which a quantity of work is listed in the Schedule of Rates has not been priced by the Contractor, it shall be understood that due allowance has been made in the prices of other items for the cost of the activity which has not been priced.
4. Subsoil drains at pits and headwalls are measured and paid in accordance with this Specification and not in the Specification for SUBSURFACE DRAINAGE - GENERAL.
5. Selected material around pipes, trench backfill in embankment material to the underside of the selected material zone and selected material backfill within the selected material zone where approved, is measured and paid in accordance with this Specification and not in the Specification for EARTHWORKS.
6. Sprayed concrete invert protection is measured and paid in accordance with this Specification and not in the Specification for MINOR CONCRETE WORKS.
7. Miscellaneous minor concrete work not included in the pay items in this specification shall be in accordance with pay items described in the Specification for MINOR CONCRETE WORKS.
8. Bulkheads are measured and paid in accordance with the Specification for DRAINAGE STRUCTURES.

Pay Item C221(a) PIPE CULVERTS

1. The unit of measurement shall be the linear metre measured along the centreline of each particular type, class and size of stormwater drainage pipe culvert and shall be the plan length between centres of gully pits or faces of headwalls.
2. The schedule rate shall include:
 - Supply
 - Survey and setting out
 - Bedding
 - Jointing (including connections)
 - Subsoil drains at pits and headwalls
 - Temporary bracing and strutting
 - Bituminous painting
 - Sprayed concrete lining and other protective measures
 - Selected material backfilling
 - Embankment material trench backfilling

SPECIFICATION C221 - PIPE CULVERTS

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