NEW SOUTH WALES

DEVELOPMENT CONSTRUCTION SPECIFICATION

C221

PIPE DRAINAGE

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
EXAMPLE 1	*Provision for acceptance of nonconformance with deduction in Payment*	*XYZ.00*	*AP*	*KP*	*2/6/97*

SPECIFICATION C221 : PIPE DRAINAGE

GENERAL

C221.01 SCOPE

1. This Specification covers the supply and installation of pipe culverts and pipe arches for stormwater drainage. ***Scope***

2. This Specification should be read in conjunction with the specification for STORMWATER DRAINAGE - GENERAL. ***Associated Specifications***

3. The work to be executed under this Specification consists of supply of pipes and pipe arches, bedding, installation and backfilling. ***Extent of Work***

4. Requirements for quality control and testing, including maximum lot sizes and minimum test frequencies, are cited in the Specification Part for Quality Requirements. ***Quality***

C221.02 REFERENCE DOCUMENTS

1. Documents referenced in this Specification are listed in full below whilst being cited in the text in the abbreviated form or code indicated. ***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 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 4680	-	Hot-dip galvanised (zinc) coatings on fabricated ferrous articles.
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 dispatch 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. Where a Contractor wishes to use drainage pipe other than the pipes described in clauses C221.04 to C221.22 inclusive, the Contractor shall submit, for agreement by the Superintendent, full details in accordance with AS/NZS 2566.1 of the characteristics of the pipe materials and embedment and design loads together with certification from the manufacturer of its suitability and quality for use in each particular application. Certification of the suitability of any pipe will address the deflection, strength, buckling and any other considerations appropriate to the particular application. Upon agreement, the Superintendent must submit an application for a variation to the development consent for approval by Council.

Buried Flexible Pipes, Submit for Approval

5. 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

6. 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

7. 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

8. Excavation and backfilling for culverts shall be undertaken in a safe manner and in accordance with all statutory requirements. ***Safety***

9. 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. Precast reinforced concrete pipes shall comply with AS 4058 and shall be of the class and size as shown on the Drawings. ***Precast 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 ***Bedding Dimensions***

pipe support types.

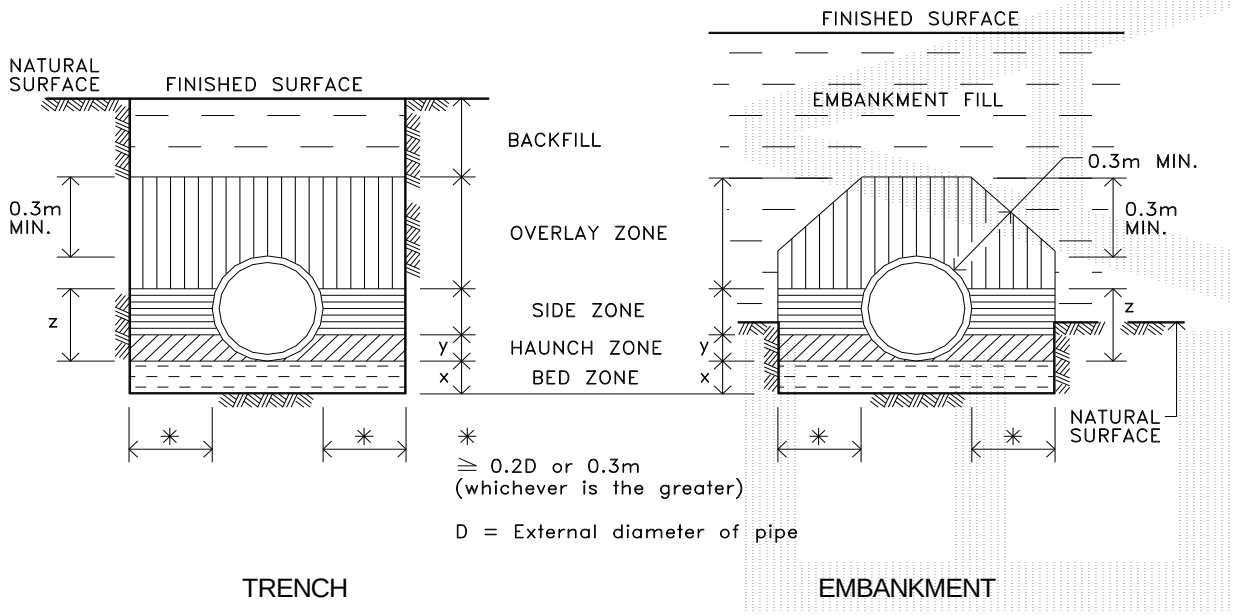

Figure C221.1 - Pipe Installation Conditions

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

D = External diameter of pipe

Table C221.1 Pipe Installation Dimensions

Material Requirements

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.

Sieve size mm	Weight passing %	
	Bed and Haunch Zones	Side Zones
75.0	—	100
19.0	100	—
9.5	—	50 - 100
2.36	50 -100	30 - 100
0.60	20 - 90	15 - 50
0.30	10 - 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 except where explicitly approved by the Superintendent, for the first placed layer above the pipe crown in the overlay zone, in order to protect the pipe from construction damage. 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 select fill material 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 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. ***Compaction Requirements*** ***Design Check***

		Pipe Support Type						
		U	H1	H2	H3	HS1	HS2	HS3
Minimum Relative Compaction %	Bed and Haunch Zones	—	50	60	Conc-rete	50	60	70
AS1289.5.4.1 (Standard	Side Zones: Cohesionless	—	—	—	—	50	60	70
Compaction	Cohesive	—	—	—	—	85	90	95

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. Bulkheads shall be constructed in accordance with the Specification for DRAINAGE STRUCTURES on all lines where the pipe gradient exceeds 5 per cent.

Bulkheads

5. The Contractor shall present the laid and jointed pipes for inspection by the Superintendent prior to commencement of trench backfilling.

Inspection by Superintendent

(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

(ii) Flush or Butt Joints

1. Flush or butt joints shall be used only where required to extend existing culverts. If pipes with flush or butt joints are required, 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 be as detailed on the Drawings.

C221.08 BACKFILL

1. Select fill material to 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 to 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. ***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 more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction). ***Moisture Content***

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***

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***

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 organic zinc-rich 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 galvanised on both sides after fabrication in accordance with the requirements for coating thickness and mass for articles in AS/NZS 4680. ***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.

NATA Testing

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.

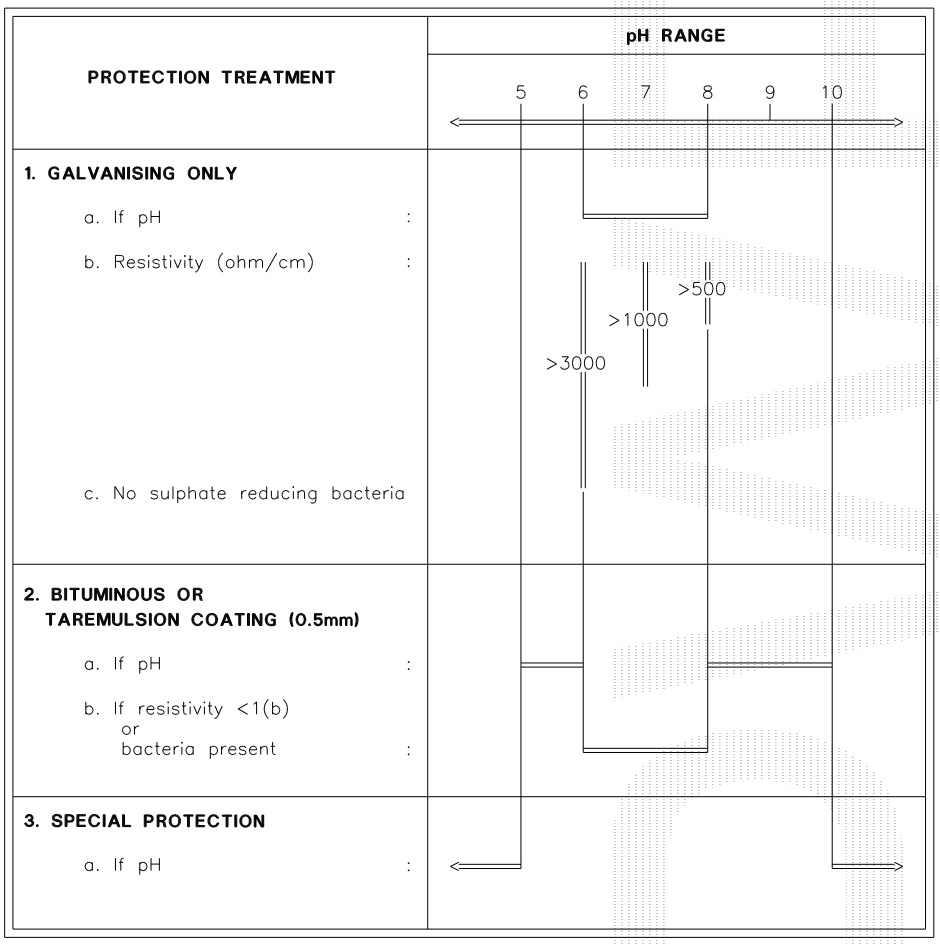

Figure C221.2 - Corrosion Protection Requirements For Steel Structures

C221.14 EXCAVATION AND FOUNDATION PREPARATION

Formation to Subgrade Level

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.

Trench Width Select Fill

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.

Unsuitable

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.

Material

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 Recommen-dations

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 re-rolled 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 non-woven geotextile material, of minimum 250mm width and of minimum mass 270 grams per square metre in accordance with the requirements for geotextile in the Specification for SUBSURFACE DRAINAGE – GENERAL, 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 (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

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***

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. ***Distortion of Structure Shape***

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

1. Where shown on the Drawings, the invert of corrugated steel pipes and pipe arches shall be protected using sprayed concrete. ***Sprayed Concrete***

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. ***Depth and Width***

3. All foreign material shall be removed from the surface to be protected. Where corrosion has occurred all loose scale shall be removed. ***Scale Removal***

4. The production, application and curing of sprayed concrete shall be in accordance with the Specification for MINOR CONCRETE WORKS. ***Associated Specification***

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. ***Sprayed Concrete Reinforcement***

6. Laps in fabric shall be 300mm and a cover of 50mm of sprayed concrete shall be provided to the fabric at all edges. ***Laps in Fabric***

7. Immediately after placement of the sprayed concrete, all free water shall be removed and the surface coated with cement slurry. ***Cement Slurry Application***

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. ***Water Flow***

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. ***Specification***

2. Embedment material in the bedding, side support and overlay zones shall be in accordance with 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.

C221.20 EXCAVATION AND BEDDING

Formation to Subgrade Level

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.

Bedding Dimensions

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.

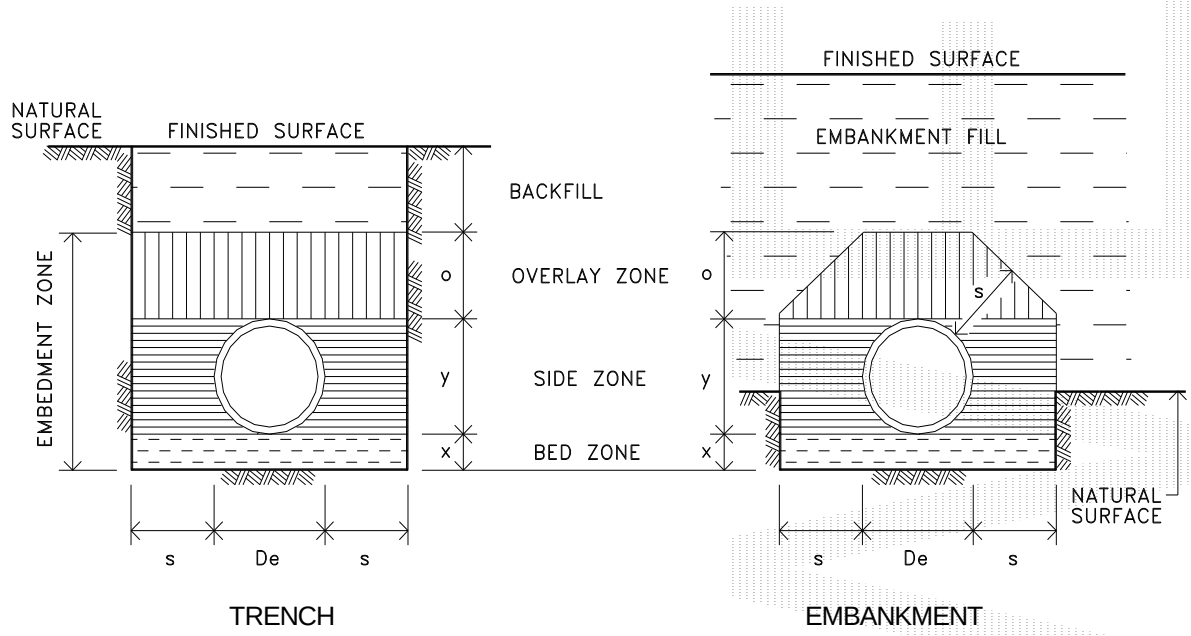

Figure C221.3 - Pipe Installation Conditions

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 the required relative compaction in the bedding zone shall be 95 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 required relative compaction in the side support and overlay zones shall be 95 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 RESERVED

C221.24 RESERVED

C221.25 RESERVED

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**	≥95%	C221.20
7.	**Backfill - UPVC Pipes**		
	(a) Side and Overlay Zone Compaction	≥95%	C221.21

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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