

Roads

Master Specification

RD-DK-C1 Installation of Stormwater Drainage

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RD-DK-C1 Installation of Stormwater Drainage

1 General

- 1.1 This Part specifies the requirements for the installation of stormwater drainage infrastructure, including concrete pipes, box culverts, concrete drainage structures, subsoil drainage and miscellaneous stormwater drainage works. It also includes the installation of pipes and box culverts installed for purposes other than drainage. The works shall be carried out in accordance with the requirements specified in the Contract Documents or on the drawings.
- 1.2 "Unsuitable Material" has the meaning defined in Section 3.5 of RD-EW-C1 "Earthworks".
- 1.3 Concrete, reinforcing and formwork used in drainage works shall comply with Division ST-SC-S/C "Concrete". Drainage work under new pavement shall be completed prior to the construction of new pavement.
- 1.4 Documents referenced in this Part are listed below:
- a) AS 1289 Methods of Testing Soils for Engineering Purposes.
 - b) AS 1428.4.1 Design for access and mobility Part 4.1: Means to assist the orientation of people with vision impairment -Tactile ground surface indicators.
 - c) AS 1554.1 Welding of Steel Structures AS 1597.1 Precast reinforced concrete box culverts - Small Culverts (not exceeding 1200 mm span and 1200 mm height).
 - d) AS 1646 Rubber Joint Rings for Water Supply, Sewerage and Drainage Purposes.
 - e) AS 2758.1 Concrete Aggregates AS 3610 Formwork for Concrete.
 - f) AS 3972 Portland and blended cements.
 - g) AS 3996 Metal Access Covers, Road Grates and Frames.
 - h) AS 4058 Precast Concrete Pipes.
 - i) AS 4139 Fibre Reinforced Concrete Pipes and Fittings.
 - j) AS 4198 Precast Concrete Access Chambers for Sewerage Applications.
 - k) AS 4671 Steel Reinforcing Materials.
 - l) AS 4680 Hot-dip Galvanized (Zinc) Coatings on Fabricated Ferrous Articles.
 - m) AS 9001 Quality management systems – Requirements.
- 1.5 The work shall be undertaken in accordance with the following drawings:

Table RD-DK-C1 1-1 Drawings

Drawing		Amendment No.
Drawing No. S-4002, Headwalls:		
Sheet 17	Driveable, Type 1 RC Pipe and Box Culverts up to 600 mm high	0
Sheet 18	Driveable, Type 2 RC Pipe and Box Culverts up to 600 mm high	0
Sheet 19	for Box Culverts skew angle 0 - 20°	0
Sheet 20	for Box Culverts skew angle 21 - 45°	0
Sheet 21	for Pipe Culverts 450 - 900 mm diameter, skew angle 0 – 20°	0
Sheet 22	for Pipe Culverts 1050 - 1800 mm diameter, skew angle 0 - 20°	0
Sheet 23	for Pipe Culverts 450 - 900 mm diameter, skew angle 21 - 45°	0
Sheet 24	for Pipe Culverts 1050 - 1800 mm diameter, skew angle 21 - 45°	0
Drawing No. S-4080, Junction Boxes and Gullies:		
Sheet 1	Single Pipe Junction Boxes, Types A, B, C	5
Sheet 2	Side Entry Gullies	9

Drawing		Amendment No.
Sheet 3	Combined Junction Boxes and Side Entry Gullies	9
Sheet 6	Grated Field Pit	1
Sheet 7	Grated Inlet Pit for Concrete Side Drain	0
Sheet 13	Special Combined Junction Boxes with Side Entry Gullies or Grated Inlet.	0
Drawing No. S-4065:		
Sheet 1	Concrete Channels and Grate	6

1.6 The Department's standard drawings are available from the following web site: <https://www.dpti.sa.gov.au/standards>.

2 Materials

- 2.1 Concrete pipes, box culverts and precast drainage structures shall comply with RD-DK-S1 "Supply of Pipes and Culverts".
- 2.2 Mortar shall comprise of one part cement (complying with AS3972) and three parts sand (complying with the requirements for fine aggregate in AS 2758.1).

3 Excavation

General

- 3.1 Excavation shall comply with RD-EW-C4 "Trench Excavation and Backfill". Any clearing and grubbing in the line of the drain, including cutting back of any tree branches, shall conform to the requirements of PC-ENV2 "Environmental Protection Issues".
- 3.2 Over-excavation, taken below the levels specified, shall be filled with the specified bedding material placed in accordance with Clause 4.6 to 4.10 "Bedding" except that for large box culverts, over-excavation shall be filled with Grade 10 concrete.

Support of Utility Services in Excavations

- 3.3 Where Utility Services are encountered in an excavation, the Contractor shall comply with the requirements of PC-US1 "Utility Services", which includes liaising with the appropriate Service Authority to obtain any requirements for support of the Utility Services and comply with those requirements.

Redundant Culverts and Drainage Structures

- 3.4 Where pipe / box culverts or drainage structures become redundant, the Contractor shall ensure that the Works cannot be damaged in the future by water leaking from the redundant culverts / structure and entering the earthworks. Unless specified otherwise, the following treatments shall be applied at a minimum:
 - a) removal of any redundant culverts / structure which are encountered during excavation and backfill in accordance with RD-EW-C4 "Trench Excavation and Backfill"; or
 - b) any pipe / box culvert which is cut or broken during excavation is plugged with Grade 20 concrete to achieve a minimum penetration into the culvert of 500 mm and completely sealing the end of the culvert.
- 3.5 Where specified, the Contractor shall remove any other existing pipes, culverts and drainage structures (outside of the area of excavation) and backfill the resultant voids in accordance with Clause "Backfill and Reinstatement of Existing Pavements".

Excavated Material

- 3.6 Material excavated for drainage construction shall be treated in accordance with the requirements of RD-EW-C1 "Earthworks".

Inspection after Excavation

- 3.7 Following completion of excavation, a **Hold Point** shall apply.
- 3.8 If foundation preparation concrete is not used, the Contractor shall undertake proof rolling to verify the strength of the subgrade and identify any unsuitable material. For pipes, small box culverts and drainage structures, 2 passes of a vibrating plate compactor (Wacker Model BPU 3750 or similar) shall be used. For large box culverts, a roller with a minimum weight of 1 tonne shall be used. Where foundation preparation concrete is to be placed proof rolling will not be required.
- 3.9 The Contractor shall remove and replace any unsuitable material which has been identified.

4 Installation of Pipes and Box Culverts

Damage during Installation

- 4.1 The Contractor shall:
- verify that the load capacity of the pipes / box culverts (and associated structures) will not be exceeded during installation;
 - ensure that pipes / box culverts are not damaged during transportation, handling, placement, backfilling and subsequent construction activities; and
 - if necessary, place sufficient protective material (in accordance with the Manufacturer's Instructions and design requirements) over the pipes / box culverts to prevent damage during construction activities.
- 4.2 Any damage to reinforced concrete pipes shall be classified in accordance with AS 4058 Clause 3.4 "Workmanship and Finish" and subject to assessment in accordance with Table RD-DK-C1 4-1.

Table RD-DK-C1 4-1 Acceptability of Defects

Defect Type	Pipe Wall	Joint Surface
1	Acceptable	Not Applicable
2	Acceptable after completion of approved repair	Not Applicable
3	Reject	Not Applicable
4	Acceptable after completion of approved repair	Acceptable after completion of approved repair
5	Acceptable after completion of approved repair	Acceptable after completion of approved repair
6	Reject	Reject
7	Reject	Reject

- 4.3 Fibre reinforced pipes shall be rejected if fractures and cracks wider than 0.1 mm and deeper than 0.3 mm are present.

Dimensions

- 4.4 The length shown on the drawings is:
- where pipes / box culverts terminate at headwalls, the length measured along the centreline of the pipes / box culverts units; and
 - at other locations, the plan length measured from centre to centre of the drainage structure (unless otherwise shown).
- 4.5 Nominal design gradients are calculated using the above lengths. Gradients are quoted in drainage schedules on the drawings are for guidance only and gradients necessary to achieve quoted invert

levels may vary from the quoted gradients, depending on the overall dimensions of drainage structures.

Bedding

- 4.6 Bedding shall be Sa-C Type C Sand, spread to a minimum compacted depth in accordance with the following:
 - a) 150 mm for pipes diameter 1500 mm or greater;
 - b) 125 mm where verification testing is to be undertaken; and
 - c) 100 mm otherwise.
- 4.7 The Contractor shall arrange for trials to be conducted to verify a method of achieving the specified compaction.
- 4.8 Prior to use of the method, a **Hold Point** shall apply.
- 4.9 For pipes, the bedding sand shall be rammed under both sides of the haunches of the pipe to a height of one third the diameter of the pipe. For large box culverts, the foundation area shall be prepared in accordance with the requirements shown on the drawings.
- 4.10 Bedding requirements for circular pipes and rectangular box culverts placed in fill are shown in Appendix 1: Culvert Installation in Fill.

Placement of Concrete Pipes

- 4.11 Concrete pipes shall be placed and jointed in accordance with the manufacturer's instructions. Pipes shall be placed with the female end upstream and with lifting holes (if any) uppermost. Lifting holes in pipes shall be filled with plugs supplied by the pipe manufacturer for that purpose.
- 4.12 Minimum spacing between pipes for multiple pipes placed in fill is shown in Figure RD-DK-C1 17-2 in Appendix 1: Culvert Installation in Fill.

Placement of Small Box Culverts

- 4.13 Small box culverts shall be placed so that the joints between base slabs are located half way between the joints on the crowns. Mortar or pipe sealant shall be used to seal the joint between the crown units and bases.
- 4.14 A bituminised tape (Densopol 60HT or equivalent) shall be used in accordance with the manufacturer's instructions to seal the joints of abutting crown units. Taping shall be done immediately prior to backfilling to minimise the risk of separation of the tape from the concrete surfaces.
- 4.15 Lifting hooks shall be cut off with a cutting disc, with both steel and concrete being ground away at least 5 mm below the surrounding concrete surface. The surface shall then be finished flush with an epoxy grout (Bauer Concast 737 S/L epoxy grout or equivalent) to give a minimum cover of 5 mm over the remnant lifting hook.
- 4.16 Minimum spacing between culverts for multiple culverts placed in fill is shown in Figure RD-DK-C1 17-1 in Appendix 1: Culvert Installation in Fill.

Placement of Large Box Culverts

- 4.17 Unless specified otherwise, crown units shall not be placed on the cast-in-place slab for a period of 48 hours after placement of the base slab concrete.
- 4.18 No superimposed loads other than the culvert crown units shall be permitted on the base slab. If the Contractor intends loading the base slab with vehicular or other traffic, full calculations demonstrating that the concrete has sufficient capacity to support such loads shall be provided to the Principal.
- 4.19 Immediately prior to positioning crown units onto the base slab, a 15 mm layer of cement mortar (1 part cement: 3 parts sand) shall be placed into the recesses in the top of the base slab onto which

- the crown units are to be placed. Excess mortar shall be removed to a minimum of 20 mm below the level of the base slab.
- 4.20 Following completion of the installation of the crown units and prior to commencement of backfilling, a stiff cement mortar (1 part cement: 3 parts sand) shall be placed into the remaining spaces of the recess as shown on the drawings.
 - 4.21 Lifting hooks shall be cut off with a cutting disc, with both steel and concrete being ground away at least 5 mm below the surrounding concrete surface. The surface shall then be finished flush with epoxy putty (Bauer Concast 737 S/L epoxy grout or approved equivalent) to give a minimum cover of 5 mm over the remnant lifting hook.
 - 4.22 Minimum spacing between culverts for multiple culverts placed in fill is shown in Figure RD-DK-C1 17-1 in Appendix 1: Culvert Installation in Fill.

Junctions

- 4.23 Where a junction is shown on the drawings it shall be constructed as a bandaged joint in accordance with Clause "Extension of Existing Pipes / Box Culverts". Backfill shall not be placed against junctions until the following day.
- 4.24 The construction of the joint shall provide an unobstructed waterway of the specified dimensions in each of the Culverts after completion of the joint.

Cutting Pipes / Box Culverts

- 4.25 Cutting of pipes / box culverts to provide appropriate lengths at joints and drainage structures shall be done in such a manner that it does not affect the structural capacity of the pipes / box culverts. Reinforcement exposed during cutting of pipes / box culverts shall be painted with a thick highbuild epoxy (Megapoxy P1 or approved equivalent) applied in accordance with the manufacturer's instructions.

Extension of Existing Pipes / Box Culverts

- 4.26 Where existing pipes are to be extended, any existing headwalls or drainage structures shall be demolished and disposed of by the Contractor.
- 4.27 Cutting of existing pipes shall be carried out as specified in Clause 4.25 above. Bandaged joints shall be constructed and the joint strengthened with a concrete fillet (bandage) around the pipes forming the joint and extending at least 300 mm from the junction along the surface of each pipe. The fillet shall be a minimum of 100 mm thick and shall be reinforced with SL62 mesh to AS 4671 completely encircling both pipes forming the joint, lapped 300 mm and extending the full length of the fillet.
- 4.28 Backfill shall not be placed against fillet joints until the following day.
- 4.29 The construction of the joint shall provide an unobstructed waterway of the specified diameter in each of the pipes after completion of the joint.

5 Backfill of Trenches and Reinstatement of Existing Pavements

- 5.1 Backfill of trenches shall comply with RD-EW-C4 "Trench Excavation and Backfill". Pipes / box culverts placed in fill shall be protected from damage by construction machinery.
- 5.2 Reinstatement of any existing pavements which are to be retained shall comply with RD-PV-C6 "Reinstatement of Existing Pavements".

6 Excavation at Inlets and Outlets

- 6.1 The Contractor shall excavate as necessary to match the pipe / box culvert invert to the adjoining drainage channels or natural surface.

- 6.2 Unless shown otherwise on the drawings, the excavation shall be uniformly graded at a maximum grade of 2% or to the boundary of the road reserve, whichever extends the least. The excavation shall be the full width of the pipe / box culvert apron, with batters not steeper than 6 horizontal to 1 vertical.

7 Cast-In-Place and Precast Concrete Drainage Structures

Scope

- 7.1 If the Principal has provided a design for the drainage structures, it will be based on cast-in-place structures and the use of precast drainage structures shall be at the Contractor's risk. The information regarding location of existing culverts and services may not be sufficiently accurate for the use of precast structures. Where normal class concrete is specified on the drawings, the concrete shall comply with ST-SC-S1 "Normal Class Concrete".
- 7.2 Junction boxes shall have inspection pit covers as detailed on the drawings. Notwithstanding any note on the drawings to the contrary, junction boxes shall be provided with inspection pit covers complying with AS 3996, Class D or AS 4198, Class H as appropriate.
- 7.3 Inspection pit covers shall be installed flush with the final surface.
- 7.4 Grated junction boxes and field gullies shall include covers and frames. Grates and frames shall be fabricated to the dimensions shown on Drawing No. 4065, sheet 1. Welds shall be GP in accordance with AS 1554.1.
- 7.5 Side entry pit covers for single or multiple openings shall be minimum dimension 900 mm x 450 mm.
- 7.6 Exposed steel work other than cast iron shall be hot-dip galvanized in accordance with AS 4680.

Foundation Preparation for Drainage Structures

- 7.7 Where detailed on the drawings, foundation preparation concrete shall be placed below cast-in-place structures.
- 7.8 Bedding shall be in accordance with section "Bedding".
- 7.9 Excavation below the specified levels shall be filled with either Sa-C Type C Sand and compacted to the same standard as the bedding or with Grade 10 concrete where foundation preparation concrete is to be placed under the structure.

Formwork

- 7.10 Both internal and external surfaces of walls shall be formed. If the Contractor can demonstrate that the ground is stable and will stand vertically without any distress or contamination of the concrete, the concrete may be cast against the ground, provided that:
- the wall thickness is increased by at least 50 mm over that detailed; and
 - the cover to reinforcement adjacent to the ground is increased by at least 50 mm.
- 7.11 External formwork shall be used for the top portion of junction boxes and gullies contained within the road pavement in all cases. Formwork shall be used for all exposed faces of headwalls and drainage structures.

Precast Drainage Structures

- 7.12 Where a precast drainage structure is used, the external joint with the pipes / box culverts shall be strengthened with a concrete fillet encircling the culvert at the joint. The fillet shall be a minimum of 100 mm thick 10 MPa concrete (or rapid mix equivalent). The inside joint shall be rendered flush with the inside wall of the structure with mortar (1 part cement and 3 parts sand) or equivalent.

8 Minor Accesses and Junctions

- 8.1 Pipes / box culverts used under any minor accesses and junctions for side drains shall be placed in the centre of the side drain with the same grade as the side drain. The pipes / box culverts shall allow unimpeded flow of water in the side drain.

9 Subsoil Drainage

- 9.1 This Clause only applies where the construction of subsoil drainage is specified on the drawings or in the Contract Documents.
- 9.2 Subsoil drainage shall be installed and the trench backfilled in accordance with the manufacturer's instructions. Following placement of the subsoil drain and prior to backfilling, a **Hold Point** shall apply.
- 9.3 Flushout points shall be provided where shown on the drawings. Flushout points shall consist of 100 mm diameter UPVC pipe connected to the subsoil drain and rising vertically to approximately 100 mm below the finished surface level and fitted with a threaded cap. A removable concrete cover (Ri Industries Flanged I.O cover and frame Type 1 – ϕ 150 mm or equivalent) shall be provided.

10 Existing Drainage Connections

- 10.1 Existing stormwater connections from private properties and Council stormwater systems shall be maintained at all times.
- 10.2 Any works involving modification or connection to existing private, Council or Drainage Authority stormwater infrastructure must be undertaken in consultation with the relevant owner of the stormwater infrastructure.

11 Sedimentation

- 11.1 Soil and any other material entering the pipes / box culverts or drainage structures shall be removed so that the pipe / box culvert provides an unobstructed waterway of the specified dimensions at all times up to the completion of all of the work on the Site.
- 11.2 Any sedimentation prevention measures (such as sediment traps, silt fences and straw bales) shall be fully functional at the completion of all of the work on the Site.

12 Treatment of Redundant Stormwater Infrastructure

- 12.1 Where pipe / box culverts or drainage structures become redundant, the Contractor shall ensure that the Works cannot be damaged in the future by water leaking from the redundant culverts / structure and entering the earthworks. Unless specified otherwise, the following treatments shall be applied at a minimum:
- removal of the redundant culverts / structure and backfill in accordance with RD-EW-C4 "Trench Excavation and Backfill"; or
 - a pipe / box culvert is plugged with Grade 20 concrete to achieve a minimum penetration into the culvert of 500 mm and completely sealing the end of the culvert.

13 Test Procedures

- 13.1 The Contractor shall use the following test procedures (refer https://www.dpti.sa.gov.au/contractor_documents) to verify conformance with the Specification:

Table RD-DK-C1 13-1 Test Procedures

Test		Procedure Number
Sampling of Soil, Aggregates and Rocks		DIT Technical Procedure TP 226
Preparation of Samples		AS 1289.1
Site Selection by Stratified Random Technique		AS 1289.1.4.2
Field Density:	Nuclear Method	AS 1289.5.8.1
Moisture Content:	Oven Drying Method	AS 1289.2.1.1
	Microwave Method	AS 1289.2.1.4
Maximum Dry Density:	Modified Compaction Rapid Method	AS 1289.5.2.1 & DIT Technical Procedure TP 165*
Dry Density Ratio		DIT Technical Procedure TP 320

*This test may only be used for control testing, not for verification testing.

14 Hold Points

14.1 The following is a summary of Hold Points referenced in this Part:

Document Ref.	Hold Point	Response Time
3.7	Inspection after excavation	1 working day
4.8	Prior to use of compaction method for bedding	1 working day
9.2	After placing subsoil drain and prior o backfilling	1 working day

15 Measurement

15.1 If measurement is required for the purpose of payment, the measurement of pipes / box culverts shall be based on the length of installed Culvert and the measurement of kerb and gutter shall include the gutter across the openings of gullies (which may include deflector vanes).

16 Verification Requirements and Records

16.1 The Contractor shall supply written verification that the following requirements have been complied with and supply the verification with the lot package.

Table RD-DK-C1 16-1 Verification Requirements and Records

Section Ref.	Subject	Property	Test Procedure	Test Frequency	Acceptance Limits
4.17 – 4.22	Placement of Large Culverts: dimensions, level and position	Placement tolerances	As specified in Part ST-SC-S3	As specified in Part ST-SC-S3	Within ± 20 mm of specified horizontal position and within ± 10 mm of specified vertical position, with the proviso that, notwithstanding tolerances, the invert of the structure shall not impede the gravity flow of water into or from the structure
4.6 – 4.10	Culvert Bedding	Compaction	DIT Technical Procedure TP 320	The Contractor shall develop a method specification in accordance with Clause 4.7	Not less than 90%
5.1 – 5.2	Backfill	Compaction	DIT Technical Procedure TP 320	Refer Part RD-EW-C5	Refer Part RD-EW-C5
7	Drainage Structures: Concrete Requirements	Concrete Requirements, vide Division 3 "Concrete"	As specified in Division ST-SC-S/C "Concrete"	As specified in Division ST-SC-S/C "Concrete"	As specified in Division ST-SC-S/C "Concrete"
7.1 – 7.12	Placement of Drainage Structures: dimensions, level and position	Variation in cross-sectional dimensions:	As specified in Part ST-SC-S3	As specified in Part RD-EW-C1	Within ± 6 mm of specified dimension
		Misplacement from specified position:	As specified in Part ST-SC-S3	As specified in Part ST-SC-S3	Within ± 20 mm of specified position
		Permissible surface irregularities:	As specified in Part ST-SC-S3	As specified in Part ST-SC-S3	Less than 10 mm
		Variation of reduced levels of invert from specified level:	As specified in Part ST-SC-S3	As specified in Part ST-SC-S3	Within ± 10 mm of specified position, with the proviso that, notwithstanding tolerances, the invert of the structure shall not impede the gravity flow of water into or from the structure.
9.1 – 9.3	Subsoil Drainage: level and position	Misplacement from horizontal position	Tape Measure	Every 10 m	Within ± 100 mm of specified position
		Variation from specified level	Surveyors Level	Every 10 m	Within ± 30 mm of specified level; with the proviso that, notwithstanding tolerances, gravity flow of water to the drainage outlet shall be provided

17 Appendix 1: Culvert Installation in Fill

Figure RD-DK-C1 17-1 Single and Multiple Box Culverts

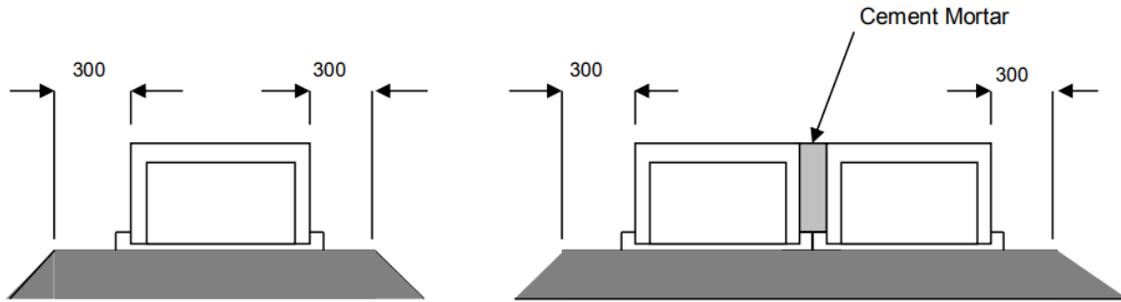


Figure RD-DK-C1 17-2 Multiple Pipes

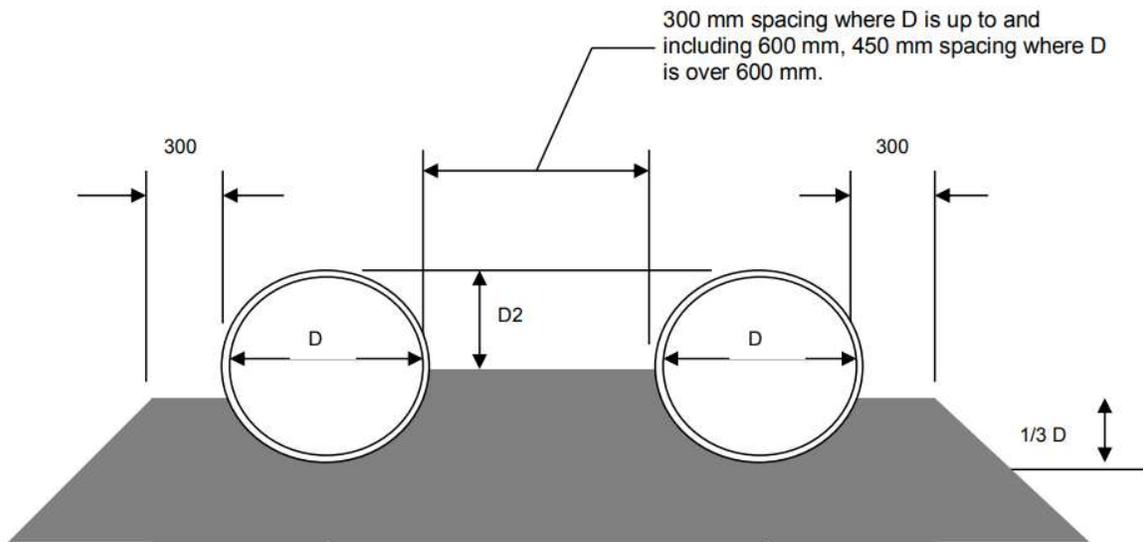
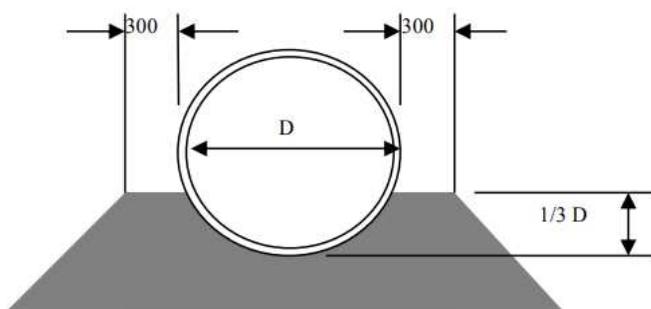


Figure RD-DK-C1 17-3 Single Pipes



NOTE:

1. Not to scale.
2. All dimensions in millimetres.
3. D = Internal pipe diameter.
4. Refer to specification for bedding and backfill requirements