

CITY OF DURBAN

STANDARD ENGINEERING SPECIFICATION

PART "PG"

NON-PRESSURE PIPELINES AND PRECAST

CONCRETE CULVERTS

CONTENTS OF PART PG : NON PRESSURE PIPELINES AND

PRECAST CONCRETE CULVERTS

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PART PG : NON-PRESSURE PIPELINES AND PRECAST

CONCRETE CULVERTS

PG.1 **SCOPE**

This specification covers the requirements for the supply and laying of -

- (a) foul-water gravity sewers;
- (b) stormwater sewers;
- (c) precast concrete culverts;
- (d) ducts for the protection of telephone and electricity power cables; and
- (e) sub-soil drainage.

PG.2 **INTERPRETATIONS**

PG.2.1 **Supporting Specifications**

The following standards are referred to in this specification :

S.A.B.S. 135	ISO metric black bolts, screws and nuts (hexagon and square).
S.A.B.S. 559	Vitrified clay sewer pipes and fittings.
S.A.B.S. 564	Rubber insertion sheeting.
S.A.B.S. 677	Concrete non-pressure pipes.
S.A.B.S. 791	Unplasticized polyvinyl chloride (U.P.V.C.) sewer and drain pipes and pipe fittings.
S.A.B.S. 819	Asbestos cement sewer pipes.
S.A.B.S. 921	Pitch-impregnated fibre pipes, couplings and fittings.
S.A.B.S. 974	Rubber joint rings (non-cellular) - Part I.
S.A.B.S. 986	Precast reinforced concrete culverts.
S.A.B.S. 1024	Welded steel fabric for concrete reinforcement.
S.A.B.S. 1083	Aggregates from natural sources.

All as published by general notice 463 dated 9 July 1982.

B.S. 10	Flanges and bolting for pipes, valves and fittings.
B.S. 65	Vitrified clay pipes, fittings and joints.
B.S. 2035	Cast Iron flanged pipe and flanged fittings.
B.S. 2815	Compressed asbestos fibre jointing.
ASTMC 425	Compression joints for vitrified clay Bell and Spigot pipes.

PG.2.2 **Definitions**

For the purpose of this specification the following definitions and abbreviations shall apply (in addition to those in Part "AB" : General Specification) :

- | | |
|---------------|---|
| straight pipe | - a straight pipe of uniform diameter and of standard or non-standard length. |
|---------------|---|

PG.3 **MATERIALS (CONT'D)**

PG.3.4 Pipes, Fittings and Pipe Joints (Cont'd)

PG.3.4.1 Vitrified Clay Pipes (Cont'd)

The pipes shall be supplied with 'Hep Sleeve' loose collar joints or similar approved for 150 mm diameter pipes, and with polyurethane factory applied spigot and socket joints for 225 mm and 300 mm diameter pipes. All joints shall be flexible.

The elastomeric material (polyurethane) shall comply with the requirements of A.S.T.M.C. 425 for foul-water sewer pipes. The performance of the flexible joints shall be in accordance with the requirements of B.S. 65.

PG.3.4.2 Reinforced Concrete Pipes

PG.3.4.2.1 Foul-water Sewer Pipes

Reinforced concrete pipes for foul-water sewers shall -

- (a) comply with S.A.B.S. 677 for S.I. type pipes except that the minimum cover over all the steel reinforcement shall be as follows:
 - (i) 20 mm for pipes of nominal diameter 450 mm up to and including 900 mm;
 - (ii) 25 mm for pipes of nominal diameter over 900 mm;
- (b) be manufactured by a spinning process with a spigot and socket type of joint suitable for use with a rubber ring;
- (c) be manufactured entirely from high alumina cement (H.A.C.) and shall be cured under suitable conditions for a minimum period of 2 days; and
- (d) comply with the proof load requirements for the various classes of pipe as indicated on the contract drawings and/or in the schedule of quantities.

The rubber ring joints shall comply with S.A.B.S. 974 - Part 1 and be suitable for use in sewage in a tropical climate.

PG.3.4.2.2 Stormwater Sewer Pipes

Reinforced concrete pipes for stormwater sewers shall -

- (a) comply with S.A.B.S. 677 for S.C. type pipes without lifting holes;
- (b) be manufactured with a spigot and socket type joint suitable for use with a rubber ring joint; and
- (c) comply with the proof load requirements for the various classes of pipe as indicated on the contract drawings and/or in the schedule of quantities.

The rubber ring joints shall comply with S.A.B.S. 974 - Part 1.

PG.3 **MATERIALS (CONT'D)**

PG.3.4 Pipes, Fittings and Pipe Joints (Cont'd)

PG.3.4.3 Fibre Cement Pipes and Fittings

PG.3.4.3.1 Fibre Cement Pipes and Pipe Specials

These shall comply with S.A.B.S. 819 with F.C. sleeve type couplings with rubber rings and be 4,0 m in length unless stated otherwise.

Foul-water sewer pipes up to 300 mm diameter shall have the crushing strength requirement for a class 3 pipe.

Pipes of 300 mm diameter and over, may be class B or C as indicated on the drawings and/or in the schedule of quantities.

The class of pipe to be used for stormwater drainage shall be as indicated on the contract drawings and/or in the schedule of quantities.

The pipes shall not be bitumen dipped.

All F.C. pipe specials and fittings shall have a crushing strength that is at least equal to the pipes to which they are coupled.

PG.3.4.3.2 Fibre Cement Couplings

All F.C. couplings shall be of the sleeve-type, complete with rubber rings and shall have a crushing strength not less than the pipes to which they are coupled.

PG.3.4.3.3 Rubber Rings

The rubber rings used in the couplings shall comply with the requirements of S.A.B.S. 974 : Part I and shall be suitable for use with sewage in a tropical climate.

PG.3.4.4 U.P.V.C. Pipes

These shall comply with S.A.B.S. 791, be heavy duty class, fitted with integral spigot and socket joints with rubber rings, and be supplied in 6 m lengths.

The rubber ring shall comply with S.A.B.S. 974 Part I and be suitable for use with sewage in a tropical climate.

PG.3.4.5 Cast Iron flanged Pipes and Flanged Fittings

These shall comply with B.S. 2035 for class B pipes and Class AB for fittings.

PG.3.4.5.1 Flanges

The flanges shall be drilled off-centre in accordance with the following extract from the Durban Corporation Waterworks Drilling Table, which is based on the now withdrawn B.S. 10 Table "D".

PG.3 MATERIALS (CONT'D)

PG.3.4 Pipes, Fittings and Pipe Joints (Cont'd)

PG.3.4.5 Cast Iron flanged Pipes and Flanged Fittings (Cont'd)

PG.3.4.5.1 Flanges (Cont'd)

Nominal Diameter of Pipe	Diameter of Bolt Circle (± 1 mm)	Number of Bolts	Diameter of Bolts	Thickness of Flange
75	146	4	16	10
100	178	4	16	10
150	235	8	16	12
200	292	8	16	12
250	356	8	20	16
300	406	12	20	20

Any item of pipework that is found to have flanges that are incorrectly drilled shall be rejected. Reaming of bolt holes to oversize dimensions in order to make a particular piece fit shall not be permitted.

The flanges shall not be raised. Before any machined surfaces are affected by rust, they shall be coated with a mixture of white lead and tallow or other suitable protective system.

PG.3.4.5.2 Flanged Jointing Materials

Fabric reinforced rubber insertion sheeting for jointing in pipe flange joints shall comply with S.A.B.S. 564, and be of nominal thickness 3,2 mm.

Compressed asbestos fibre sheeting for jointing in flanged joints shall comply with B.S. 2815, grade B, and be of nominal thickness 3 mm.

All gaskets shall be cut circular to the outside diameter of the flange. All gaskets shall be purpose made and hand cutting and trimming of gaskets on site shall not be acceptable. Care shall be taken to ensure that all gaskets are packed properly and are not damaged by bending. For larger sizes the gaskets shall be suitably supported by wooden frames during both transit and storage.

PG.3.4.5.3 Nuts, Bolts and Washers

The pipework and fittings shall be supplied complete with all bolts, nuts and washers. The nuts and bolts shall comply with S.A.B.S. 135 and be grade 4.6 i.e. mild steel. All nuts, bolts and flat washers shall be galvanised.

PG.3. MATERIALS (CONT'D)

PG.3.4 Pipes, Fittings and Pipe Joints (Cont'd)

PG.3.4.5 Cast Iron flanged Pipes and Flanged Fittings (Cont'd)

PG.3.4.5.4 Corrosion Protection

Internal - The pipes and fittings shall be supplied unlined.

External - A coat of epoxy coal tar paint shall be applied to all cast iron pipes and fittings after installation is complete, to give a film thickness of 150 microns minimum. After testing and acceptance a further coat of epoxy coal tar paint shall be supplied to provide a total film thickness of 250 microns minimum.

PG.3.5 Pitch Impregnated Fibre Sub-Soil Pipes

These shall comply with S.A.B.S. 921 and shall be a class 2 pipe with perforated walls and tapered couplings.

PG.3.6 Ducts

These shall comply with -

- (a) S.A.B.S. 921 for pitch impregnated fibre pipes which shall be a class 2 pipe with tapered couplings used only for G.P.O. services.
- (b) S.A.B.S. 791 for U.P.V.C. pipes which shall be normal duty class with spigot and socket rubber ring joints used only for the Electricity Department cables.

PG.3.7 Portal and Rectangular Precast Concrete Culverts

PG.3.7.1 Standard Units

These shall comply with S.A.B.S. 986 for the size, type and class of culvert shown on the contract drawings or in the schedule of quantities.

In addition to the strength test requirements of S.A.B.S. 986, the culvert or culvert sections shall be capable of withstanding the appropriate proof loads given in S.A.B.S. 986 applied on any line parallel to the longitudinal axis without showing any sign of shear failure.

All broken, chipped, cracked or otherwise damaged units shall be removed from site and replaced, unless the Engineer authorizes that they may be repaired to his satisfaction.

PG.3.7.2 Special Units

These shall be capable of supporting the same loads per linear metre as the standard units.

PG.3 **MATERIALS (CONT'D)**

PG.3.7 Portal and Rectangular Precast Concrete Culverts (Cont'd)

PG.3.7.2 Special Units (Cont'd)

Special units shall be defined as those manufactured with lengths shorter than the standard or with skew ends or with purpose made openings for manholes or pipe connections greater than 400 mm diameter. No combination of any of the above specials shall be incorporated in any one unit, unless specific authority has been obtained from the Engineer.

Openings for manholes or pipe connections should preferably be positioned between standard units i.e. with half a hole per unit, and units in short lengths shall be made as closure pieces between standard units to achieve this aim.

Portals shall not be cut on site except when openings of less than 400 mm diameter have been authorised by the Engineer.

PG.3.7.3 Finishes

In addition to the standard of finish requirements of S.A.B.S. 986 the following finishes as specified in Departmental Specification Part C - Concrete, clause C.5.3 : Formed concrete surface finishes , and clause C.5.4 : Concrete upper surface finishes, shall apply :

- (a) internal surfaces of culvert except the invert - clause C.5.3 - class 3(a)
(N.B. a steel mould in good condition is acceptable for the type of finish required)
- (b) invert - clause C.5.4 - class 4
- (c) external surfaces of culvert except the deck - clause C.5.3 - class 1
- (d) deck - clause C.5.4 - class 1

A 12 mm chamfer shall be formed across each abutting end of the portal deck slab.

PG.3.7.4 Joints

Tape joints shall be a low density polyethylene coated with a polisobutylene pressure sensitive adhesive and conform to the following specification:

overall width	150 mm
overall thickness	0,3 mm
tensile strength	15 MPa (minimum)
elongation at break	300%
adhesion to steel	1,5 N/mm of width (minimum)

PG.3 MATERIALS (CONT'D)

PG.3.7 Portal and Rectangular Precast Concrete Culverts (Cont'd)

PG.3.7.4 Joints (Cont'd)

adhesion to self 1,0 N/mm of width (minimum)

temperature performance 20° to 60°C

PG.3.8 Geotextiles

The synthetic fibres of a geotextile blanket shall consist of at least 100% by mass of polypropylene, polyethylene or a polyester polymer and shall contain such additives as are necessary to render the filaments resistant to the effects of ultra-violet radiation in accordance with the following requirement :

The geotextile shall retain 80% of its specified strength after an effective exposure period of 1500 hours to direct sunlight.

The grade of geotextile shall conform to Table 1 of SABS 0221-1988.

SABS 0221-1988

TABLE 1 - GRADES OF GEOTEXTILES

1	2	3	4	5	6	7	8	9	10	11
Property	Grades									
	1	2	3	4	5	6	7	8	9	10
Thickness, mm	Minimum value									
	as specified by manufacturer									
Mass per unit area, g/m ²	100	100	140	140	200	200	240	240	300	300
Penetration load, kN	1,0	1,0	1,5	1,5	2,5	2,5	3,0	3,0	4,0	5,0
Tensile strength, kN/m	6	6	10	10	13	13	18	18	25	30
Permeability, 1/s.m ²										
High flow	200	-	170	-	130	-	80	-	40	-
Low flow	-	25	-	20	-	15	-	10	-	5

All tests shall be carried out in accordance with the code of practice for the testing of geotextiles SABS 0221-1988.

The Engineer's approval of the make and grade of the geotextiles shall be obtained by the Contractor before any geofabric is ordered or used on the works.

PG.3.9 Anchor Blocks

All concrete for anchor blocks as detailed on the relevant contract drawings shall comply with the requirements for grade 15/26 concrete contained in Departmental Specification : Part "C" : Concrete.

PG.3 **MATERIALS (CONT'D)**

PG.3.10 Stone for Sub-Soil Drains

The aggregate used for the sub-soil drain shall consist of 19 mm coarse aggregate conforming to Table 7 of S.A.B.S. 1083.

PG.3.11 Sand Backfill for Sub-Soil Drains

Sand for sub-soil drain backfill shall consist of sands conforming to Table 1 of S.A.B.S. 1083.

PG.4 **PLANT**

PG.4.1 Handling and Rigging

The plant and rigging equipment used for the handling and placing of pipes, fittings and culvert units shall be such that no pipe, fitting or culvert unit shall be over stressed or damaged during any operation covered by the specification.

The pipes, fittings and culvert units shall not be dropped, bumped or subjected to shock or rough handling and any item damaged during transit or handling shall be rejected by the Engineer.

Care shall be taken to make sure that no damage is caused to plastic pipes by sharp objects. The use of bare cables, chains, hooks or narrow skids shall not be permitted and the Contractor shall supply canvas sleeves, padded skids and ramps of a sufficient width to prevent damage to the pipes and fittings. The dragging or skidding of pipes and fittings in contact with the ground shall not be permitted.

PG.4.2 Setting Out

PG.4.2.1 Pipelines

The apparatus used for line, level and positional control shall be accurate, sturdy and in good operational condition. The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment of the pipeline.

PG.4.2.2 Portal and Rectangular Precast Concrete Culverts

A laser shall be used for the final positioning of the culvert units with the laser beam being positioned centrally and immediately below the soffit of the roof slab.

PG.4.3 Testing

The Contractor shall provide all pumps, gauges, calibrated storage tank, tools, plugs, bracing and fittings necessary for the tests required in terms of clause PG.7.

PG.4 **PLANT (CONT'D)**

PG.4.4 Special Machines and Equipment

Any special machines and equipment recommended by the pipe manufacturers for the installation of their pipes shall be used and the Engineer shall have the right to require the Contractor to use only such equipment.

In particular the following tools shall be used :

- (a) torque wrenches set to the correct torque for the tightening of all bolted connections;
- (b) when pipes are cut to non-standard lengths, the ends shall only be reduced to size by means of a field turning machine.

PG.5 **CONSTRUCTION**

PG.5.1 General

PG.5.1.1 Earthworks

Earthworks for both foul-water and stormwater sewers shall comply with Departmental Specification : Part "DB" : Earthworks for Pipe Trenches. Earthworks for precast concrete culverts shall comply with Departmental Specification : Part "DD" : Earthworks for Structures.

PG.5.1.2 Bedding

The provision of the bedding material together with the operation of its placing and compaction for the various classes of bedding are specified in Part "DB" : Earthworks for Pipe Trenches. As bedding is an integral part of pipelaying, Part "DB" must be read in conjunction with this specification.

PG.5.1.3 Stacking of Pipes and Specials

All pipes and specials shall be segregated according to diameters and classes.

Pipes shall be stored on level ground that is free from stones and sharp objects, and shall be so stacked that the load on each pipe is uniform throughout its length. Socketed pipes shall be so stacked that the sockets are at different ends in each alternate layer and protrude from the stack.

The height of any stack shall not exceed 1 m. All pipes manufactured from plastic materials shall be stored under shade.

All couplings shall be stored lying flat, and rubber rings shall be stored in a cool, dark place, away from grease and oil.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.1 General (Cont'd)

PG.5.1.4 Inspection at the Laying Site

All pipes, specials, valves and fittings shall be carefully examined by the Contractor for internal and external damage at the following stages:

- (a) on arrival at the laying site;
- (b) prior to laying;
- (c) after laying;
- (d) prior to backfilling; and
- (e) during backfilling.

All damage or defects of any kind shall be repaired by the Contractor to the satisfaction of the Engineer immediately after detection at any of the above inspections. Where, in the opinion of the Engineer, satisfactory repairs are not practicable, the damaged materials shall be replaced by the Contractor at his own cost.

PG.5.1.5 Laying General

All pipelaying and jointing shall be undertaken by experienced pipelayers who shall, when requested, produce proof of their capabilities to the satisfaction of the Engineer.

The various types of pipes and culverts shall be handled and laid in accordance with the manufacturer's instructions. The Contractor shall provide the latest copy of the instructions and shall ensure that all pipe layers have a good working knowledge of the required procedures. Notwithstanding anything contained in the instructions the Engineer's interpretation shall be final.

Pipes and culverts shall be lowered gently and carefully into the trench without jarring or bumping by crane, derrick, or other approved lifting tackle and care shall be taken not to damage the items. The hand installation of pipes shall only be permitted when using U.P.V.C. or A.C. pipes up to a nominal diameter of 150 mm unless authorised by the Engineer.

Control of the level and line of the pipeline, to ensure correct placing to designed line and level, shall be by side and top lines or other acceptable means approved by the Engineer. If the former method is used the Contractor shall provide sight rails in accordance with the requirements for the control of the dimensions for the trench excavation as specified in Part "DB" : Earthworks for Pipe Trenches clause DB.5.3.2.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.1 General (Cont'd)

PG.5.1.5 Laying General (Cont'd)

Control of the level and line of the culvert shall be by laser. All internal surfaces of pipes and fittings shall be kept clean and free of foreign matter both during and after laying. The surfaces of all joints shall be thoroughly cleaned before the pipe or special is placed in its final position. No water shall be allowed to come in contact with or run through any pipe before the joint has been completed and at no time shall muddy, clayey or dirty water be allowed to enter the pipe. Exposed ends of pipe and fittings in the trench shall be sealed by suitable end caps at all times when pipelaying is not actually in progress.

Laying shall commence at the lower end of the trench and proceed upgrade. Pipes and fittings must be laid with their spigots or male end pointing in the direction of the flow.

All pipes and culverts shall be laid in a straight line, both in the horizontal and vertical plane, between adjacent manholes or catchpits except where shown on the contract drawings or directed by the Engineer.

Each pipe, fitting or culvert unit shall mate uniformly with the next to preserve an invert free from steps.

Except with the prior consent of the Engineer, the laying of pipes and the bedding cradle, if specified, between any two consecutive manholes shall be checked by the Engineer's representative for line and level before the selected fill blanket is placed.

Where pipes are required to be cut on site, only manufacturer's recommended special machines shall be used and the resultant pipe end must be clean and uniform.

No pipes shall be left overnight or during rainy weather without sufficient backfilling between pipe couplings to prevent flotation.

Where pipes are indicated on the contract drawings to be laid to a horizontally curved alignment the pipes must be fully jointed in a straight line and subsequently deflected with the previously laid pipe suitably anchored to prevent movement. Care must be taken to ensure the pipes are laid in a smooth curve with equal deflections at each joint.

PG.5.2 Laying of Specific Types of Pipes, Culverts and Sub-Soil Drains

PG.5.2.1 Pipes

The method of laying and bedding shall be such that the pipes are laid with their barrels bearing on the completed bedding cradle for their full length with joint holes formed in the bedding to ensure that the pipes are not supported on their collars.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.2 Laying of Specific Types of Pipes, Culverts and Sub-Soil Drains (Cont'd)

PG.5.2.1 Pipes (Cont'd)

Temporary supports of differing materials to that of the bedding cradle shall not be used.

Special precautions shall be observed when U.P.V.C. pipes have been specified. For pipes that have bowed, the laying technique will have to be modified such that the finished pipeline conforms to the line and level tolerances specified. The bedding cradle and selected fill blanket will be required to be constructed immediately after pipelaying to provide support and protection to the U.P.V.C. pipe.

PG.5.2.2 Precast Concrete Culvert Units

PG.5.2.2.1 General

Precast units shall be lifted and handled only by means of lifting devices approved by the manufacturer. After the units have been installed the lifting eyes shall be caulked with 1:3 cement/sand mortar placed in mounds on the deck slab, each mound being 150 mm diameter by 50 mm high.

The Contractor shall exercise due care not to damage, overstress, or displace any culverts by the imposition of any loads such as may be caused by the movement of his own vehicles or compaction equipment. Where superimposed moving loads in excess of those prescribed in the applicable road traffic ordinance are likely to pass over completed culverts during the construction of the works, the Contractor shall provide sufficient additional cover over the culverts to ensure that the design stresses on the culverts are not exceeded.

PG.5.2.2.2 Cast In Situ Invert Slabs

Cast in situ invert slabs shall be constructed in accordance with Departmental Specification Part "C" : Concrete and in the locations shown on the drawings or as directed. They shall be reinforced as detailed on the drawings.

PG.5.2.2.3 Precast Invert Slabs

Unless a bedding cradle or stone mat is indicated on the drawings a layer of selected granular material of thickness at least 100 mm in soil or 200 mm in rock shall be placed on the bottom of the excavation, levelled, compacted to at least 93% Mod. A.A.S.H.T.O. density and trimmed to grade and line to form a bed to receive the precast invert slabs. The slabs shall be carefully placed on the prepared bed to line and grade and so bedded that they are uniformly supported over their whole area on the bedding material.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.2 Laying of Specific Types of Pipes, Culverts and Sub-Soil Drains (Cont'd)

PG.5.2.2 Precast Concrete Culvert Units (Cont'd)

PG.5.2.2.4 Placing of Upper Portion

The units of the upper portion of precast portal and rectangular culverts shall be placed accurately on the invert slabs with a thin layer of 1:3 cement/sand mortar between the horizontal contact surfaces to ensure a firm and uniform support.

The legs of the portals shall be fixed in position as detailed on the drawing.

The units of the upper portion shall be butt-jointed end to end. Joint openings greater than 8 mm shall be filled with an approved epoxy/sand mortar.

Where two or more culverts are placed side by side to form a multi-barrel culvert, the space between the culverts shall be filled with 1:3 cement/sand mortar up to the level of the top of the culvert.

PG.5.2.2.5 Backfilling of Units

The backfilling around and above the culvert units shall comply with the requirements of Part "DD" : Earthworks for Structures, clause DD.5.6 : Backfill around Structures.

PG.5.2.3 Ducts

Ducts shall be laid and jointed true to line and shall be evenly supported for their full length on the bedding which shall be evenly and thoroughly compacted.

Cable ducts under roadways shall be encased with a minimum of 75 mm of grade 10/26 concrete and extend to a minimum of 675 mm behind the kerb line. Both ends of the cable duct are to be sealed with a 50 mm plug of cement mortar.

The Contractor is responsible for recording accurately the position and extent of the cable ducts. This information must be given to the Engineer's representative in writing who will verify the positions before backfilling of the trench.

At both ends of the duct the Contractor will be required to lay concrete cable duct markers which will be supplied to the Contractor on site free of charge and he will be responsible for their storage.

On all surfaced roads the markers shall be set to the correct level in the road channel. Where there is no surfacing or channel the marker shall be set in 75 mm thick grade 10/19 concrete as directed by the Engineer.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.2 Laying of Specific Types of Pipes, Culverts and Sub-Soil Drains (Cont'd)

PG.5.2.4 Sub-Soil Drains

The size and detail of the drain shall be as shown on the contract drawings or as specified in Part "AA" Project Specification. The trench excavation and backfilling with sand together with the trench bottom preparation shall be in accordance with Part "DB" : Earthworks for Pipe Trenches. It should be noted that if a sub-soil pipe is being laid as part of the sub-soil drain the perforations are to be positioned at the invert of the pipe.

PG.5.3 Jointing

PG.5.3.1 General

All pipe joints and the operation of jointing shall be carried out strictly in accordance with the pipe suppliers instructions. In particular -

- (a) all rubber rings and seals shall be carefully inspected after being placed in position and before the joint is closed to ensure that they have not suffered any cuts, tears or other damage and are not in any other way defective;
- (b) care shall be taken to ensure that -
 - (i) all jointing surfaces are cleaned immediately prior to jointing;
 - (ii) the joint gaps in the bedding remain clear and the alignment of the pipe remains true;
 - (iii) the full weight of the pipe does not rest on the rubber ring during jointing;
 - (iv) pipes with damaged jointing surfaces are not used in the pipe run between manholes but are set aside for building into manhole walls etc.;
- (c) pipes and fittings of different materials shall be jointed only with special adaptors recommended by the pipe manufacturer; and
- (d) where a pipeline passes through a rigid structure and to prevent possible shear failure of the pipe, two flexible joints shall be positioned on each side of the structure. These shall be positioned 0,3 m and 0,8 m respectively from the nearside faces of the structures.

PG.5.3.2 Special Jointing Applications

PG.5.3.2.1 Fibre Cement Pipes

Fibre cement pipes shall be jointed with asbestos cement collars and rubber sealing rings. The collars shall have an internal rubber spacer ring to ensure the flexibility of the joint. The spacer ring in collars for gravity sewers shall be such as to provide a continuous invert through the joint.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.3 Jointing (Cont'd)

PG.5.3.2 Special Jointing Applications (Cont'd)

PG.5.3.2.2 Precast Concrete Culvert Units

Roof

The recess formed by the 12 mm chamfer in all transverse joints between portals shall first be sealed with a 1:3 cement/sand mortar and allowed to dry. Surplus mortar shall be removed and a single layer of tape shall be applied to all external roof joints with a further 150 mm overlap down the walls.

The tape shall be applied to a clean concrete surface, which shall be dry and free from grease, oil or other contaminants and which has been primed with a suitable approved primer evenly applied to the manufacturer's recommended specification. When the primer is dry, but tacky, the tape shall be applied to give a wrinkle free wrapped joint.

Walls

A 300 mm width of structural grade filter fabric shall be glued to the walls with bituseal or other approved adhesive.

PG.5.4 Pipes and Culverts on Steep Grades

PG.5.4.1 Pipes

Where shown on the drawings or detailed in Part "AA" : Project Specification, anchor blocks complying with clause PG.5.4.3 and extending a minimum of 150 mm into both the trench sides and bottom shall be constructed. Where heavy duty U.P.V.C. pipes are used on steep grades no anchor blocks are required.

PG.5.4.2 Culverts

Where culverts are constructed on gradients steeper than 1:5 particular care shall be taken to protect the excavations from stormwater damage. After the trenches have been excavated and the trench bottom prepared successive units starting from the lower end shall be placed firmly against each other to prevent subsequent movement.

PG.5.4.3 Anchor Blocks

Anchor blocks shall be constructed to the dimensions directed by the Engineer or as shown on the contract drawings using concrete grade 15/26.

The concrete shall be well compacted round the pipe and against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces shall not be permitted. Excess excavation shall be replaced with grade 15/26 concrete at the Contractor's expense. Care shall be taken to leave the pipe joints accessible.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.4 Pipes and Culverts on Steep Grades (Cont'd)

PG.5.4.3 Anchor Blocks (Cont'd)

No anchor blocks shall be concreted until the approval of the Engineer has been obtained.

PG.5.5 Building Pipes into Manholes

For foul-water sewers the length of all pipes built into a manhole shall not exceed 1,0 m. Furthermore, the first and last lengths of rigid foul-water sewer pipes laid in any trench and connecting to such built-in pipes shall not exceed 2,0 m in length.

For stormwater pipes, the length of pipe built into a manhole or catchpit shall not exceed 2,5 m.

Where pipes are built into manhole walls, the concrete or brickwork shall be trimmed neatly over the pipe. Except where specifically detailed on the drawings exposed ends of pipes in manholes are to be set flush with the face of the manhole. Closure pieces are to be carefully cut by experienced pipelayers, and no full collars will be allowed on the inside face of the manholes. Particular care must be taken when building pipes into manholes to ensure that the gap between the pipe and the manhole wall is fully caulked from both sides of the wall and rendered completely watertight.

Every U.P.V.C. pipe built into a manhole shall have clean dry sand complying with S.A.B.S. 1083 glued to its outside as recommended by the pipe manufacturer using special P.V.C. cement (Heinkel S.A. (Pty) Limited, tangit or equal approved) to ensure good adhesion to the base concrete.

PG.5.6 Future Foul-water Sewer Connections and Extensions

Where indicated on the drawings or ordered by the Engineer, the Contractor shall build into manholes a length of pipe to provide for future extensions or connections. The length of such pipe shall be no longer than is necessary to establish the socket or end cap wholly clear of the manhole wall and/or base slab so as to permit the making of the future joint. All such built-in pipes shall be set to the line, level and grade of the future connection.

Foul-water sewer pipes built in to manhole walls for future extensions or connection shall not be longer than 1,0 m and shall be fitted with standard end caps or stoppers, and shall be completely watertight.

Concrete pipes built into manholes for future extensions or connections shall be sealed with brickwork and mortar sufficient to prevent the ingress of water.

PG.5 **CONSTRUCTION (CONT'D)**

PG.5.7 Concrete Encasement of Pipes

In addition to the requirements of Part "DB" : Earthworks for Pipe Trenches, clause DB.5.5.6 Concrete encasement, the lower part of the encasement shall be constructed as for a class A bedding. Once the sewer has been tested and approved, the encasement of the pipes shall be completed, care being taken to ensure that the expansion joints in the upper part of the encasement coincide with that in the lower part.

No backfilling over the concrete shall be commenced until the concrete has achieved a compressive strength of 15 MPa.

PG.5.8 Concrete Protection to Shallow Pipes

Where detailed on the contract drawings, the Contractor shall provide a reinforced concrete slab protection to the pipe.

The bedding to the pipes shall be undertaken in accordance with the requirements of Departmental Specification Part "DB" - clause DB.5.5 Bedding except that the minimum cover of the selected fill blanket may be reduced from the 300 mm specified to a minimum of 100 mm depending upon the depth of cover to the pipe. Following the compaction of the fill blanket the Contractor shall supply and lay a 100 mm thick reinforced concrete slab on top of the fill blanket. The slab shall be grade 20/26 concrete reinforced with welded fabric reinforcement ref. 245 to S.A.B.S. 1024. Construction joints shall be provided at spacings not exceeding 2,0 m along the length of the slab. No backfill material shall be placed until the concrete has achieved a compressive strength of 15 MPa.

PG.6 **TOLERANCES**

PG.6.1 General

Tolerances will be determined on the basis of permissible deviations from a designated location, alignment, grade and level and will apply both during laying and to the backfilled pipe or culvert.

Measurements shall be taken to the -

- (a) invert of the pipe or culvert whenever possible for level control;
- (b) crown with due allowances being made for the actual pipe dimension should the invert be inaccessible for measurements; and
- (c) top centre of the pipe or culvert for alignment control.

Subject to the permitted manufacturing tolerances, pipes and culverts shall be laid to the design line and level without steps or lips at the joints between successive pipes or culvert units or other irregularities in the bore of the completed pipeline.

There shall be no back falls in the completed pipeline or culvert.

PG.6 **TOLERANCES (CONT'D)**

PG.6.2 Overall Centre Line Control and Manhole Locations

The permissible deviation of the location in plan of the centre line of the pipeline from the designated location shall not exceed 100 mm. This location will be treated as the control location for the purpose of locating intersections whether for manholes or catchpits. Such manholes or catchpits shall be constructed at the meeting points of intersecting pipelines subject to only such deviation as can be tolerated by the junction channels or specials.

PG.6.3 Manhole and Stormwater Invert Levels

The maximum permissible deviation from the designated invert level at each manhole or stormwater inlet shall be 10 mm. However this permissible deviation shall be reduced to a value such that the gradient of the pipeline between any two successive manholes does not vary by more than 10% from the design gradient.

PG.6.4 Alignment and Grade for Pipes Laid in a Straight Line between Control Points

PG.6.4.1 Foul-water Sewers

- (a) The alignment of the pipe and its invert level shall at no place between control points at successive manholes or catchpits deviate from a straight line between the said control points by more than the tolerance 't'.

The formula for calculating 't' shall be -

$$t = 5 + \frac{L^{\frac{1}{2}} D^{\frac{1}{2}} S^{\frac{1}{2}}}{30}$$

where t = tolerance in millimetres;

L = length in millimetres of the straight line;

D = nominal internal diameter of the pipe in millimetres; and

S = grade of the pipeline (e.g. where grade is 1:40; S = 0,025)

- (b) The level of any joint shall not exceed the above tolerance 't' when measured from the straight line joining the preceding and succeeding joints.

PG.6.4.2 Stormwater Sewers

The alignment of the pipe and its invert level shall not deviate from a straight line between control points at successive manholes or inlets by more than 10 mm when measured over any 6 m length. All such deviations shall be gradual and shall not be successively reversed.

PG.6 **TOLERANCES (CONT'D)**

PG.6.4 Alignment and Grade for Pipes Laid in a Straight Line between Control Points (Cont'd)

PG.6.4.3 Ducts

Except where a change of direction or other alignment is shown on the drawings or ordered, the deviation from a straight line joining the ends of any straight section of ducting shall not exceed 35 mm at any point along a duct when measured over any 6 m length. All such deviations shall be gradual and shall not be successively reversed.

PG.6.5 Precast Concrete Culvert Units

The maximum permissible deviations are as follows :

- | | | |
|-----|--|-----------------------|
| (a) | departure from established alignment | 25 mm |
| (b) | departure from invert level | 10 mm |
| (c) | variation from specified internal width at invert | 10 mm |
| (d) | variation from plumb of external face of side wall | 3 mm per metre height |

PG.6.6 Pipes Laid with a Horizontal Curved Alignment

Where pipes are indicated on the contract drawings to be laid to a horizontally curved alignment, the following permissible deviations to the alignment shall apply:

- (a) the maximum angular deflection per length of pipe shall not exceed that specified by the pipe manufacturer to provide a watertight joint;
- (b) subject to (a) the permissible deviation to the designed curved horizontal alignment measured at the pipe joints shall not exceed the following:
 - foul-water sewers - 15 mm
 - stormwater sewers - 30 mm;
- (c) the permissible deviations to the invert level of the pipes shall comply with those pertaining to pipes laid in a straight line between control points.

PG.7 **TESTING**

PG.7.1 General

The Contractor shall provide all labour and apparatus including expansible plugs, stoppers, pumps, pressure gauges, manometers, mirrors, lights etc., that may be required for carrying out the tests.

PG.7 TESTING (CONT'D)

PG.7.1 General (Cont'd)

All acceptance tests shall be carried out in the presence of the Engineer and at such times and in such manner as the Engineer may direct.

All test results shall be recorded in the manner directed, whether or not the pipeline passed the test. No backfilling shall be undertaken until the Engineer has given his written acknowledgement that the pipeline has passed the requisite tests.

Notwithstanding any acknowledgement by the Engineer in terms of the above, after backfilling and compaction have been completed, the Engineer may order that the pipeline be retested to check that it has not been disturbed or damaged during backfilling. If any defects are found in a pipeline they shall either be made good or the pipeline relaid as directed by the Engineer, all work being at the Contractor's expense.

Upon completion of each length of pipeline between adjacent manholes or such other shorter lengths as agreed by the Engineer, the Contractor shall give the requisite 8 normal working hours period of notice to the Engineer to enable him to check the pipeline for alignment, grade, appearance etc. Upon the Engineer's approval, the Contractor may then complete the bedding leaving the joints exposed if a water test of the pipeline is specified.

PG.7.2 Testing of Foul-water Sewers

PG.7.2.1 General

The Engineer shall require one of the following to be carried out on a foul-water sewer or any section of it:

- (a) an air test on pipes (other than concrete pipes) of diameter up to 750 mm;
- (b) a water test in the case of concrete pipes of diameter up to 750 mm;
- (c) a visual internal inspection in the case of pipes of diameter greater than 750 mm.

The foul-water sewer shall only be tested in sections between manholes, the section under test being isolated from other sections by means of suitable plugs or stoppers that have been braced adequately.

PG.7.2.2 Tests and Acceptance/Rejection Criteria

PG.7.2.2.1 Air Test

Pipelines above the water table : An approved air testing machine shall be used to raise the gauge pressure in the section of the pipeline under test to 3,75 kPa. After a 2 min stabilization period the pressure shall be reduced to 2,5 kPa. The machine shall then be switched off and the time taken for the pressure to drop from 2,5 to 1,25 kPa shall be determined. The time taken shall be greater than the applicable of the following values:

PG.7 TESTING (CONT'D)

PG.7.2 Testing of Foul-water Sewers (Cont'd)

PG.7.2.2 Tests and Acceptance/Rejection Criteria (Cont'd)

PG.7.2.2.1 Air Test (Cont'd)

<u>Nominal diameter of pipe, mm</u>	<u>Minimum time (in minutes) taken for pressure to drop from 2,5 kPa to 1,25 kPa.</u>
150	3
200	4
225	4,2
250	4,5
300	6
375	7,5
450	9
600	12
750	15

Pipelines below the water table: An approved air testing machine shall be used to raise the gauge pressure in the section of the pipeline under test 2,5 kPa above the static water pressure. After this pressure has been attained and the machine stopped, any change in pressure shall be noted. There shall be no discernible loss for a period of at least 5 minutes.

PG.7.2.2.2 Water Test

The section of the pipeline under test and the manhole chamber at the upper end of the said section shall be filled with water to such depth that every portion of the pipeline is subjected to a pressure of not less than 12 kPa and not more than 60 kPa. During the test, nowhere shall there be any discernible leakage of water. An appropriate period, which shall be not less than 10 minutes, shall be allowed for initial absorption and the loss of water over the next 30 minutes shall be noted. The amount lost shall be less than the applicable of the following rates per 100 m of pipeline per hour:

<u>Nominal diameter of pipe, mm</u>	<u>Maximum loss rate, litres per 100 m per h.</u>
150	9,0
200	12,0
225	13,5
250	15,0
300	18,0
375	22,5
450	27,0
600	36,0
750	45,0

Should any section of the pipeline fail to pass the water test, a re-test will be permitted and, in such case, acceptance or rejection of the section shall be determined on the result of the re-test.

PG.7 **TESTING (CONT'D)**

PG.7.2 Testing of Foul-water Sewers (Cont'd)

PG.7.2.2 Tests and Acceptance/Rejection Criteria (Cont'd)

PG.7.2.2.3 Rejection

In the case of F.C., V.C., and U.P.V.C. pipes, failure under the air test will be deemed to be cause for rejection. After such rejection the Contractor may apply a water test to locate the source of failure, rectify the pipeline, and re-apply the air test. In the case of reinforced concrete pipes, failure under the water test will be deemed to be cause for rejection.

PG.7.3 Testing of Stormwater Sewers and Culverts

Stormwater sewers will not normally be pressure tested but will be inspected visually by the Engineer to ensure that they have been laid in accordance with the specification and only if there is any doubt will the Engineer order a water test.

PG.7.4 Testing of Cable Ducts

After the requirements of clause PG.7.1 have been approved by the Engineer the Contractor can complete the bedding and backfilling.

After the laying of ducts and the backfilling have been completed, the interior of the ducts shall be thoroughly cleaned by twice drawing a cylindrical cleaning brush through each duct, once in each direction. The ducts shall then be proved by drawing through them a polished hardwood mandrel having spherical ends and of length 300 mm. The diameter of the mandrel shall be 3 mm less than the internal diameter of the duct.

PG.8 **MEASUREMENT AND PAYMENT**

PG.8.1 General

Earthworks for both foul-water and stormwater sewers shall be measured in accordance with Departmental Specification : Part "DB" : Earthworks for Pipe Trenches.

Earthworks for precast concrete culverts shall be measured in accordance with Departmental Specification : Part "DD" : Earthworks for Structures.

The operation of placing and compacting bedding materials including concrete and concrete encasement of pipelines is specified and measured separately in clause 8 of Departmental Specification : Part "DB" : Earthworks for Pipe Trenches.

All cast in-situ concrete work required in conjunction with the construction of the precast concrete culvert shall be scheduled and measured in accordance with the requirements of clause 8 of Departmental Specification : Part "C" : Concrete.

PG.8 MEASUREMENT AND PAYMENT (CONT'D)

PG.8.1 General (Cont'd)

The pipeline, culverts and ducts will be measured linearly on slopes as laid.

No deductions will be made from the measured length for pipe specials but deductions will be made for the internal length of manholes.

The G.P.O. will supply to site for use by the Contractor all pitch fibre ducts and couplings required for cable ducts. The Contractor will be responsible for supplying all the scheduled U.P.V.C. cable ducts required for the Electricity Department cables. Concrete cable duct markers will be supplied to site free of charge to the Contractor.

Generally the construction of a sub-soil drain shall consist of stone, wrapped in a geofabric blanket and with a sub-soil pipe if required. The size and detail of the sub-soil drain will be detailed in the contract drawings, in Part "AA" : Project Specification or in the schedule of quantities.

The measurement of any additional excavation to accommodate the sub-soil drain, the disposal of surplus material, the importation and placing of the stone portion of the drain has been included in Part "DB" : Earthworks for Pipe Trenches.

Only the provision and laying of the geofabric blanket and the sub-soil pipe portion of the sub-soil drain will be measured in this specification under clause PG.8.11.

PG.8.2 Pipelaying

The unit of measurement shall be linear metres (m).

Separate items will be scheduled for pipes of different materials, diameters and classes.

The unit rate for pipelaying shall include for -

- (a) the supply of all pipes complete with couplings and jointing materials, their inspection, transport and handling;
- (b) the laying, including curved alignment where specified, jointing, building pipes into manholes, catchpits and through rigid structures, all cutting and wastage of materials; and
- (c) testing and cleaning of pipelines. A separate item will be provided for water testing of stormwater lines if required.

PG.8.3 Pipe Specials and Fittings

The unit of measurement shall be Number (No.) and shall be measured as an Extra Over item PG.8.2 Pipelaying. Separate items will be scheduled for each type and size of pipe special and fitting.

PG.8 MEASUREMENT AND PAYMENT (CONT'D)

PG.8.3 Pipe Specials and Fittings (Cont'd)

The unit rate for pipe specials and fittings shall include for -

- (a) the supply of all pipe specials complete with couplings and jointing materials, their inspection, transport and handling;
- (b) the setting and jointing of the pipe specials; and
- (c) testing and cleaning.

PG.8.4 Future Connections

The unit of measurement shall be Number (No.).

Separate items will be scheduled for each type and diameter of pipe built into a manhole or inlet to provide for a future connection.

The unit rate for future connections shall include for -

- (a) the supply of all pipes, collars, end caps or materials for sealing the pipes as specified, their inspection, transport and handling; and
- (b) the laying, building into the manhole or inlet, sealing the end, testing, cleaning and all cutting and wastage of materials to comply with the 1,0 m length restrictions as specified.

PG.8.5 Anchor Blocks

Where a number of anchor blocks are of the same size, and are fully detailed on the contract drawings they will be scheduled by type and the unit of measurement shall be Number (No.).

Where anchor blocks vary in size the unit of measurement will be cubic metre (m³) the unit rate for anchor blocks shall include for -

- (a) additional restricted excavation, filling of over-break with concrete and disposal of material; and
- (b) supply of all labour, transport and materials to construct complete the anchor block.

PG.8.6 Connections to Existing Foul-water or Stormwater Sewers

The unit of measurement shall be Sum.

Details of such items together with a summary of activities that the rate is to cover will be stated in Part "AA" : Project Specification or in the schedule of quantities.

PG.8 **MEASUREMENT AND PAYMENT (CONT'D)**

PG.8.7 **Standard Precast Concrete Portal and Rectangular Culverts**

The unit of measurement shall be linear metre (m) with the length measured along the soffit of the culvert.

Separate items will be scheduled for the different sizes, lengths of unit, classes and types of culverts and in the case of portal culverts either with or without precast concrete invert slabs.

The unit rate for precast concrete portal and rectangular culverts shall include for -

- (a) the supplying complete of the precast concrete units, testing, loading, transport and off loading; and
- (b) installation, laying including grouting with 1:3 cement/sand mortar or epoxy mortar into the invert slabs as detailed on the contract drawings, sealing of joints greater than 8 mm with epoxy mortar and sealing of lifting holes.

PG.8.8 **Special Precast Concrete Portal and Rectangular Culvert End Units**

The unit of measurement shall be Number (No.) measured as an Extra Over to item PG.8.7.

The unit rate shall include for the additional cost of manufacture, laying, and jointing special culverts.

PG.8.9 **Cast In-Situ Concrete Invert Slabs**

The relevant items specified in clause 8, Part C : Concrete, will be scheduled for all cast in-situ concrete work.

PG.8.10 **Precast Concrete Portal and Rectangular Culverts : Roof and Wall Joints**

Separate items will be scheduled for both roof and wall joints. The unit of measurement shall be Number (No.).

The unit rate shall include for -

- (a) the supplying complete of all jointing materials; and
- (b) preparation, including filling of chamfer with mortar and application of jointing materials as specified.

PG.8.11 **Ducts**

PG.8.11.1 **Pipe Ducts**

The unit of measurement for ducts shall be linear metre (m).

Separate items will be scheduled for pipe ducts of different materials and diameters, whether for the G.P.O. or Electricity Departments and for concrete encasement under carriageways.

PG.8 MEASUREMENT AND PAYMENT (CONT'D)

PG.8.11 Ducts (Cont'd)

PG.8.11.1 Pipe Ducts (Cont'd)

The unit rate for ducts shall include for -

(a) G.P.O. Cable Ducts

- (i) the storage of the ducts on site, inspection, transport and handling on site; and
- (ii) laying, jointing, cutting, wastage, building into draw pits, cleaning, testing, laying draw wire, sealing ends and the additional difficulty of laying in multi-pipe banks.

(b) Electricity Cable Ducts

- (i) the supply of all pipe ducts; and
- (ii) laying, jointing, cutting, wastage, cleaning, testing, sealing ends and the additional difficulty of laying in multi-pipe banks.

PG.8.11.2 Concrete Encasement of Ducts under Carriageways

The unit of measurement shall be the cubic metre (m³) and the volume of the concrete shall be computed from the rectangle formed allowing for 75 mm of concrete between each pipe minus the volume occupied by the pipes.

The unit rate for concrete encasement of ducts under carriageways shall include for -

- (a) provision of concrete and formwork; and
- (b) placing and compaction of concrete and testing.

PG.8.11.3 Cable Duct Markers

The unit of measurement shall be Number (No.)

The unit rate for cable duct markers shall include for storage on site of the cable duct markers supplied by the Department, excavation and laying including concrete bedding if required.

PG.8.12 Sub-Soil Drains

Refer to clause PG.8.1.

PG.8.12.1 Geofabric Blanket

The unit of measurement shall be square metres (m²).

The unit rate for geofabric blanket shall include for its supply, laying, joining, cutting and waste.

PG.8 **MEASUREMENT AND PAYMENT (CONT'D)**

PG.8.12 Sub-Soil Drains (Cont'd)

PG.8.12.2 Sub-Soil Pipes

The unit of measurement shall be linear metres (m).

The unit rate for sub-soil pipes shall include for the supply of all pipes, laying, and jointing.

PG.8.13 Concrete Protection to Shallow Pipes

The unit of measurement shall be square metres (m²) which will be computed from the pay trench width and the length of protection required.

The unit rate for concrete protection for shallow pipes shall include for the supply, placing and compaction of all materials including the welded steel fabric reinforcement.