ENGINEERING DESIGN SPECIFICATION

D4

SUBSURFACE DRAINAGE DESIGN

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ENGINEERING DESIGN SPECIFICATION D4
SUBSURFACE DRAINAGE DESIGN

GENERAL

D4.01 SCOPE

1. The work to be executed under this Specification consists of the design of the subsurface drainage system for the road pavement and/or subgrade.

2. This specification contains procedures for the design of subsurface drainage, including:
   (a) Subsoil and Foundation Drains
   (b) Sub-Pavement Drains
   (c) Drainage Mats, including Type A and Type B Mats.

3. Reference guidelines for the application and design of subsurface drainage include ARRB Special Reports 35 and 41, and the AUSTROADS publication – Guide to the Control of Moisture in Roads. The full titles of these guidelines are given below.

D4.02 OBJECTIVES

1. The objective in the design of the subsurface drainage system is to control moisture content fluctuations in the pavement and/or subgrade to within the limits assumed in the pavement design. ***Control Moisture Content***

D4.03 TERMINOLOGY

1. Subsoil drains are intended for the drainage of ground water or seepage from the subgrade and/or the sub-base in cuttings. ***Subsoil Drains***

2. Foundation drains are intended for the drainage of seepage, springs and wet areas within and adjacent to the foundations of the road formation. ***Foundation Drains***

3. Sub-pavement drains are intended for the drainage of the base and sub-base pavement layers in flexible pavements. They may also function to drain seepage or ground water from the subgrade. ***Sub-pavement Drains***

4. Type A drainage mats are intended to ensure continuity of a sheet flow of water under fills, to collect seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. ***Type A Drainage Mats***

5. Type B drainage mats are constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. ***Type B Drainage Mats***

D4.04 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specification

C230 – Subsurface Drainage – General

C231 – Subsoil and Foundation Drains

C232 – Pavement Drains

C233 – Drainage Mats

(b) Australian Standards

AS2439.1 – Perforated drainage pipe and associated fittings

(c) RTA Specifications

MR Form 1160 – Supply and Delivery of Seamless Tubular Filter Fabric.

3555 – Slotted Fibre Reinforced Concrete Pipe for Subsurface Drainage

MR539 – Subsurface Drainage

(d) Other

AUSTROADS – Guide to the Control of Moisture in Roads, 1983

ARRB–SR35 – Australian Road Research Board, Special Report No. 35 – Subsurface Drainage of Road Structures, Gerke R.J., 1987.

ARRB–SR41 – Australian Road Research Board, Special Report No. 41 – A structural Design Guide for Flexible Residential Street Pavements, Mulholland P.J., 1989..

SUBSOIL AND SUB-PAVEMENT DRAINS

D4.05 WARRANTS FOR USE

1. Subsoil drains are designed to drain ground water or seepage from the subgrade and/or sub-base in cuttings. ***Subsoil Drains***

2. Sub-pavement drains are designed to drain water from base and sub-base pavement layers in flexible pavements, and to drain seepage or ground water from the subgrade. ***Sub-pavement Drains***

3. Subsoil or sub-pavement drains shall be provided on both sides of the formation in the following locations, unless the geotechnical report indicates the absence of subsurface moisture at the time of investigation and the likelihood that changes in the subsurface moisture environment will not occur within the design life of the pavement and/or the pavement has been specifically designed to allow for likely variations in subgrade and pavement moisture contents:

   (a) Cut formations where the depth to finished subgrade level is equal to or greater than 400mm below the natural surface level. ***Locations***

   (b) Locations of known hillside seepage, high water table or isolated springs.

   (c) Irrigated, flood-prone or other poorly drained areas.

   (d) Highly moisture susceptible sub-grades, ie. Commonly displaying high plasticity or low soaked CBRs.

(e) Use of moisture susceptible pavement materials.

(f) Existing pavements with similar subgrade conditions displaying distress due to excess subsurface moisture.

(g) At cut to fill transitions.

Where only one side of the formation is in cut, and the other side in fill, it may be sufficient to provide subsoil or sub-pavement drains only along the edge of the formation in cut.

4. The need for subsoil and sub-pavement drains may otherwise become apparent during the construction process, due to changes in site moisture conditions or to areas of poorer subgrade being uncovered that were not identified in the geotechnical investigation. The Design Drawings shall be suitably annotated to the potential need for subsoil or sub-pavement drains in addition to those shown on the Drawings.

During Construction

D4.06 LAYOUT, ALIGNMENT AND GRADE

1. Typical cross sections of subsoil and sub-pavement drains are shown below in Figures D4.1 and D4.2. As indicated in these figures, subsoil drain trenches are excavated to below subgrade level, while sub-pavement drains extend into or adjacent to the pavement layers to facilitate drainage of the pavement layers in addition to the subgrade.

Typical Cross Sections

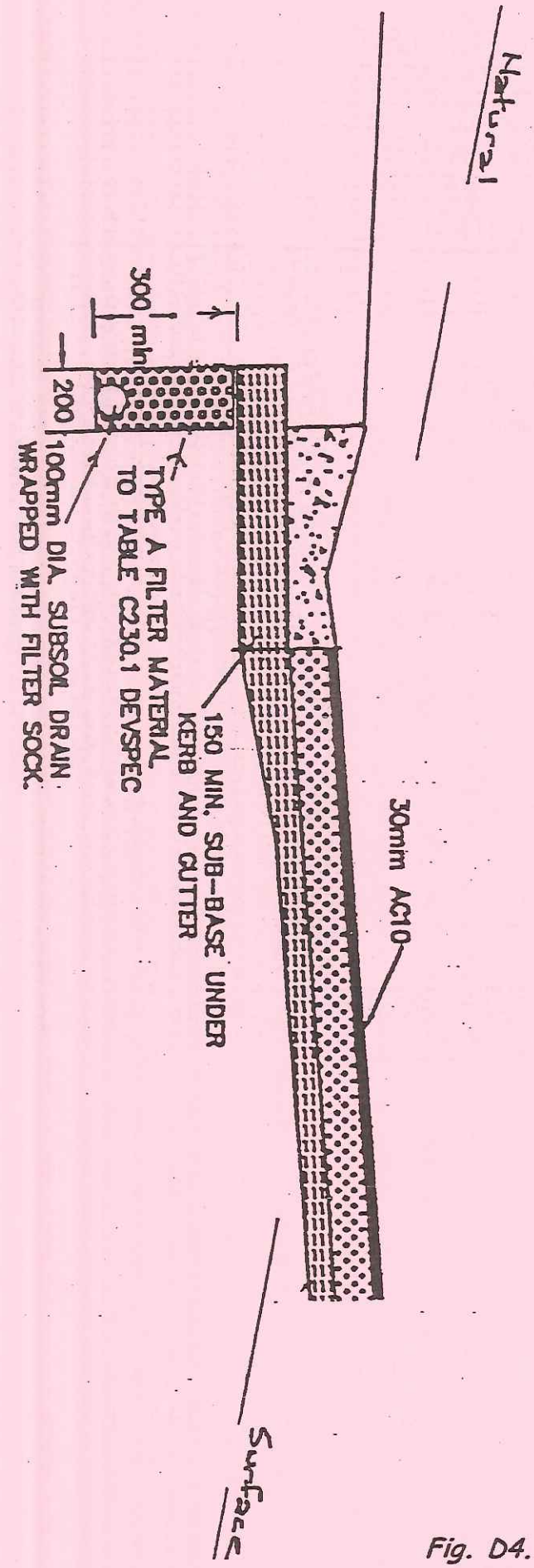
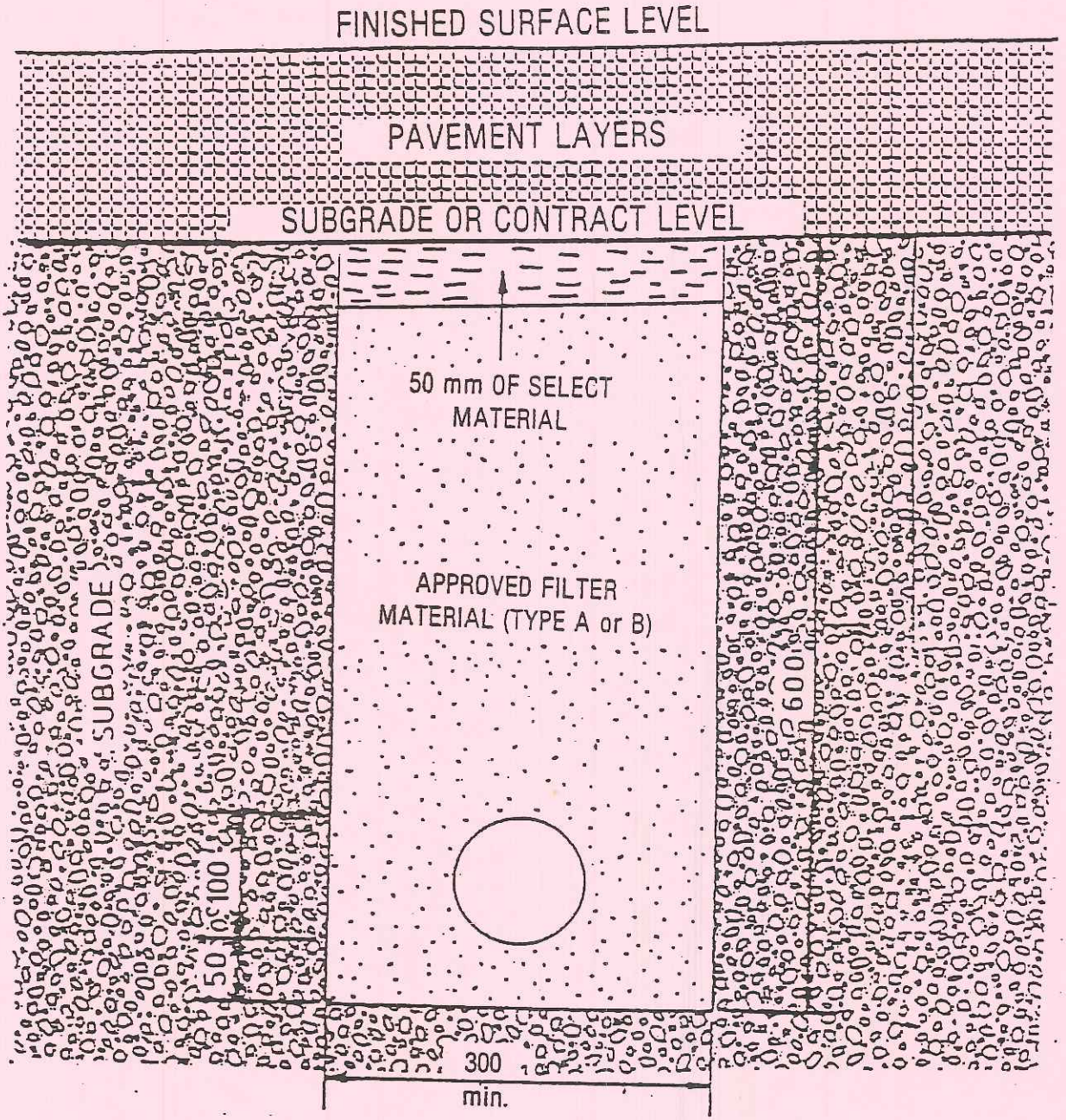


Fig. D4.1 - Typical Subsoil Drain



NOTE: ALL DIMENSIONS ARE IN MILLIMETRES.

DEPARTMENT OF MAIN ROADS
TYPICAL CROSS SECTION OF SUBSURFACE DRAIN

Fig. D4.2

2. In kerbed roads, the two acceptable alternative locations for the line of the trench are directly behind the kerb line. Pavement layers must extend to at least the line of the rear of the trench. ***Kerbed Roads***

3. The minimum desirable longitudinal design grade shall be 1.0–1.5%. For non corrugated pipes, an absolute minimum grade of 0.5% is acceptable. ***Grade***

4. Trench widths shall be a minimum of 300mm, with a minimum depth below finished subgrade level of 600mm in earth and 450mm in rock, and below the invert level of any service crossings. ***Trench Dimensions***

5. Outlets shall be spaced at maximum intervals of 150 metres. Where possible, subsoil and sub-pavement drainage pipes shall discharge into gully pits or other stormwater drainage structures. Where not possible, outlets shall be provided through fill batters. ***Outlets***

6. Cleanouts are to be provided at the commencement of each run of drain, and at intervals not exceeding 80 metres. Cleanouts shall generally be located directly at the rear of kerb or at the edge of shoulder, as applicable. ***Cleanouts***

FOUNDATION DRAINS

D4.07 WARRANTS FOR USE

1. Foundation drains are designed to drain excessive ground water areas within the foundation of an embankment or the base of cutting, or to intercept water from entering these areas. ***Foundation Drains***

2. The need to provide foundation drains may be apparent from the results of the geotechnical survey along the proposed road formation alignment, and in this case the location shall be shown on the plans. However, more commonly, the need to provide foundation drains is determined during construction, and hence in this situation requirements and locations cannot be ascertained at the design stage. ***Geotechnical Survey During Construction***

3. Where the road formation traverses known swampy, flood-prone, or water charged strata, the design Drawings shall be suitable annotated to the potential need for foundation drains at various locations, in addition to those shown on the Drawings.

D4.08 LAYOUT, ALIGNMENT AND GRADE

1. Typical cross-sections of foundation drains are shown below in Figure D4.3. ***Typical Cross Section***

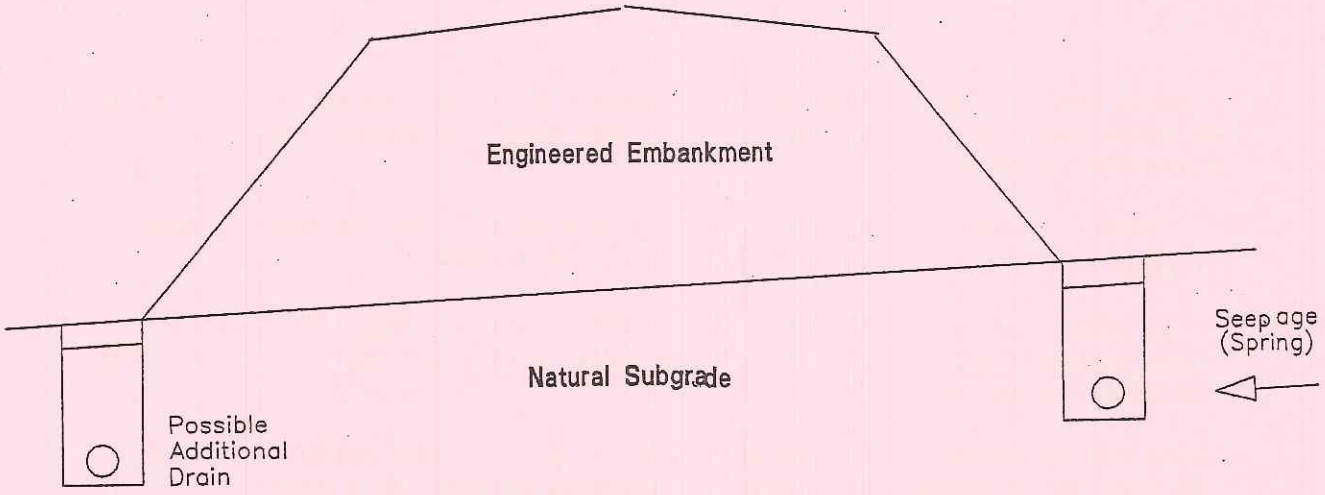


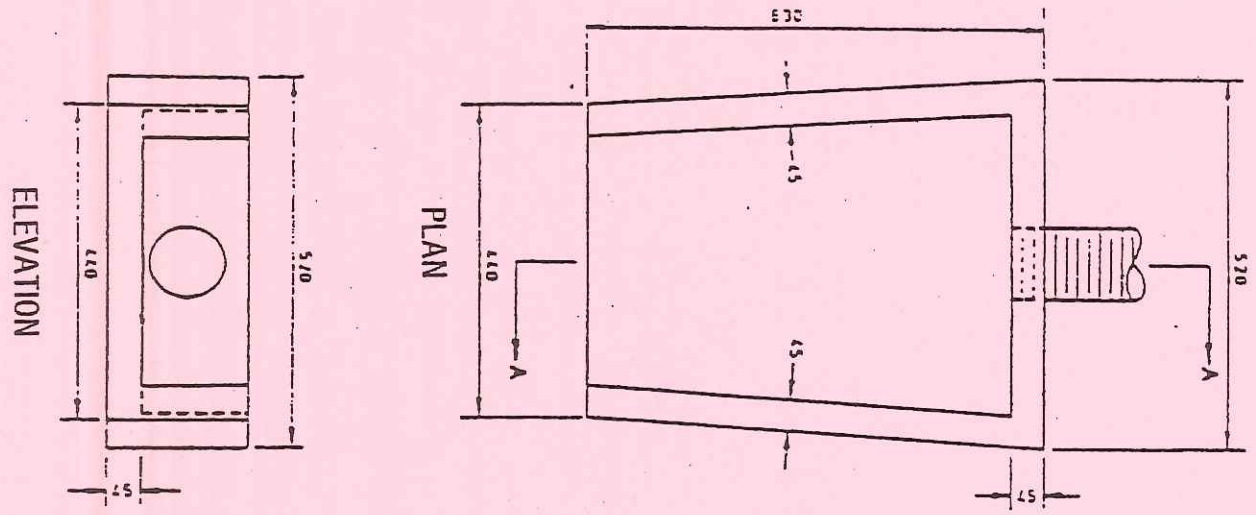
Figure D4.3 - Foundation Drains

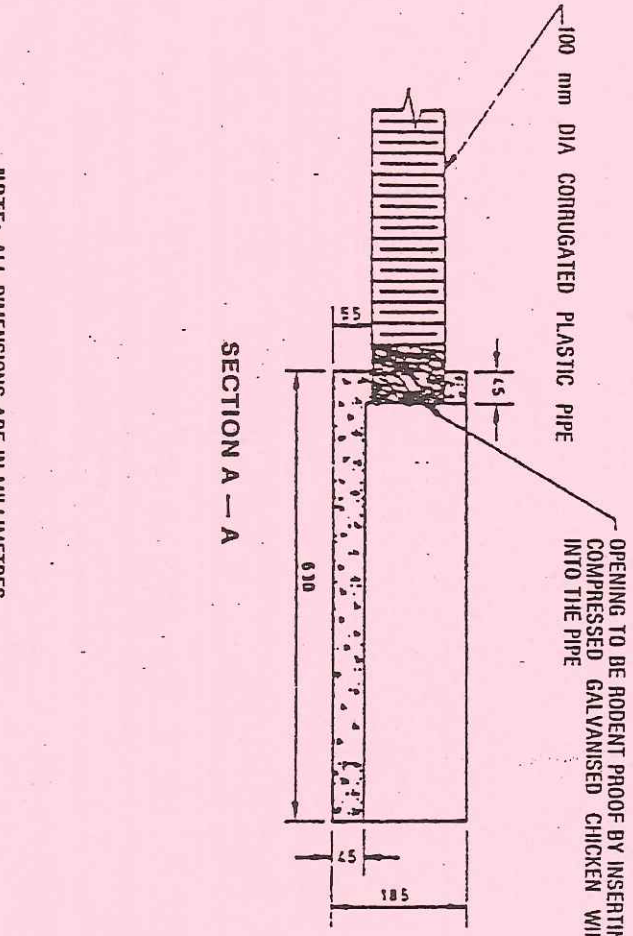
2. The minimum desirable design grade shall be 1.0–1.5%. For non corrugated pipes an absolute minimum grade of 0.5% is acceptable. ***Grade***

3. Foundation drains shall be a minimum trench width of 300mm, with a variable trench depth to suit the application and ground conditions on site. ***Trench Dimensions***

4. Outlets shall be spaced at maximum intervals of 150 metres and shown in Figure D4.4. ***Outlets***

5. Where practicable, cleanouts are to be provided at the commencement of each run of foundation drain and at intervals not exceeding 80 metres. Where not practicable to provide intermediate cleanouts, outlets shall be spaced at maximum intervals of 100 metres as shown in Figure D4.5. ***Cleanouts***

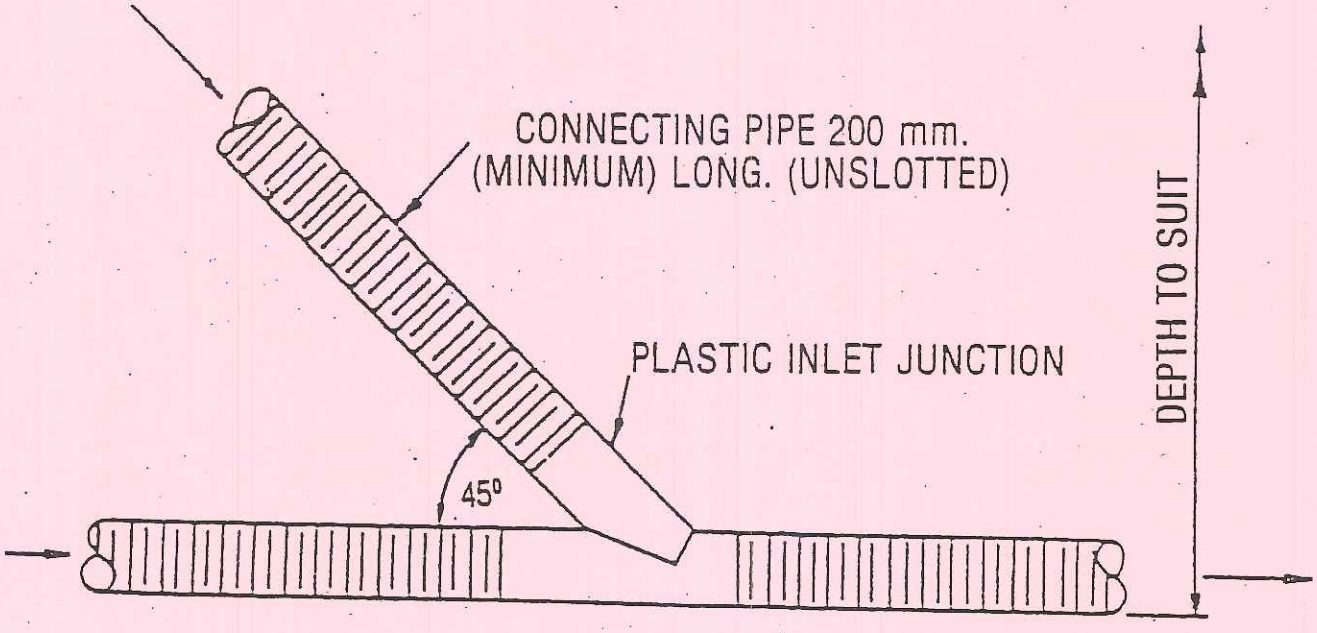




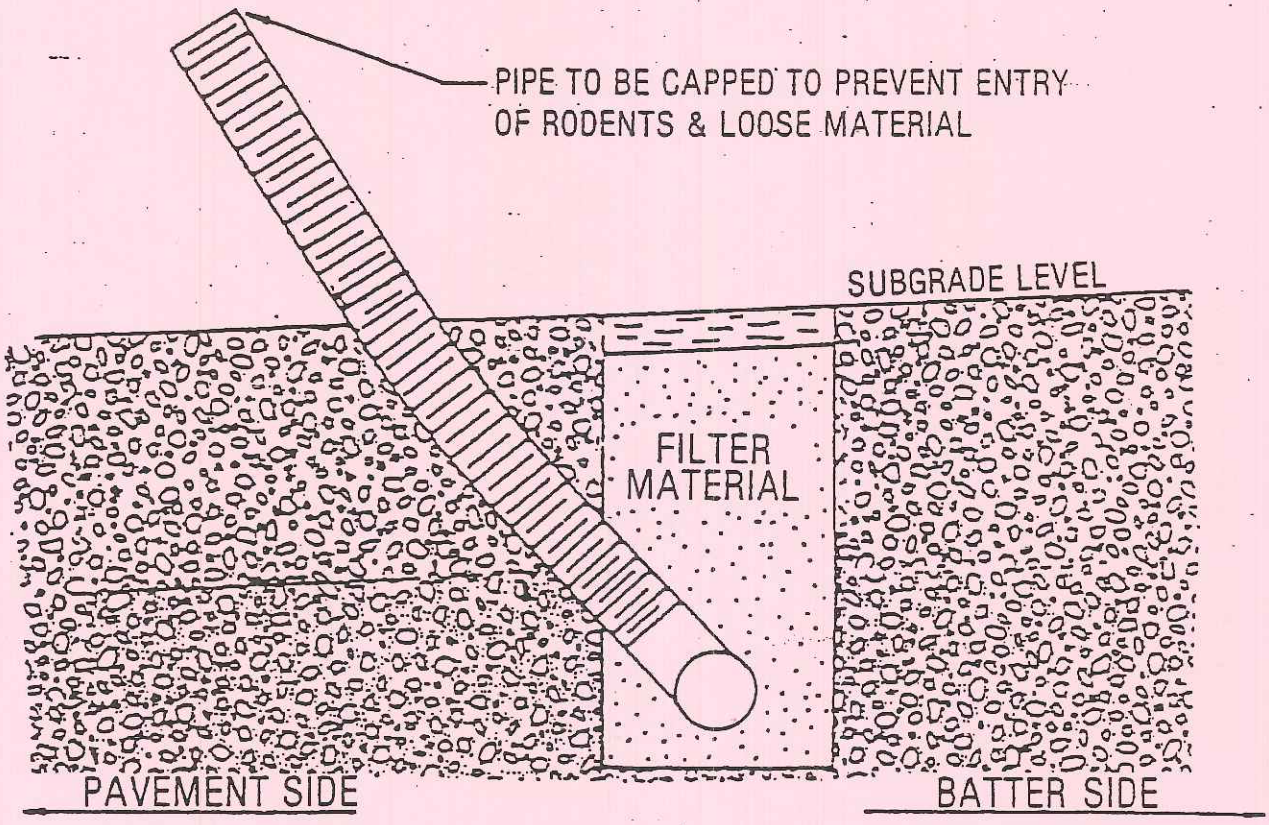
NOTE: ALL DIMENSIONS ARE IN MILLIMETRES
ALL CONCRETE 15 MPa AS SPECIFIED IN SECTION D OF SPECIFICATION.

DEPARTMENT OF MAIN ROADS
DETAIL OF OUTLET STRUCTURES

Figure D4.4 - Outlets



ELEVATION



SECTION

DEPARTMENT OF MAIN ROADS

Figure D4.5

DRAINAGE MATS (BLANKETS)

D4.09 WARRANTS FOR USE

1. Type A drainage mats are designed where there is a need to ensure continuity of a sheet flow of water under fills, to collect surface seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. Type A drainage mats are constructed after the site has been cleared and grubbed and before commencement of embankment construction. *Type A Mats*

2. Type B drainage mats are designed where there is a need to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. Type B drainage mats shall be constructed after completion of the subgrade construction and before construction of the pavement. *Type B Mats*

3. The need to design for the provision of drainage mats should be apparent from the result of the geotechnical survey along the proposed road formation alignment. *Geotechnical Survey*

MATERIALS

D4.10 SUBSOIL AND SUB-PAVEMENT DRAIN PIPE

1. Pipes designated for subsoil, foundation and sub-pavement drains shall be 100mm dia. Slotted pipe.

2. Corrugated plastic pipe shall be Class 1000 conforming with the requirements of AS2439.1. Joints, couplings, elbows, tees and caps shall also comply with AS2439.1.

3. Slotted fibre reinforced cement pipe shall be designated type "100 DMR" meeting the requirements of RTA Specification No. 3555..

4. Slotted rigid UPVC pipe shall be of a type and class approved by Council.

5. All pipe shall be slotted, and fitted with seamless tubular filter fabric complying with MR Form 1160, except for cleanouts and outlets through fill batters which shall be unslotted pipe.

D4.11 INTRA PAVEMENT DRAIN PIPE

1. Pipes for use in Type B Drainage Mats shall be designated 100mm diameter slotted fibre reinforced cement pipe, designated type 100 DMR pipe, meeting the requirements of RTA Specification 3555, shall be designated for intra pavement drains where crushed rock sub-base layer thicknesses are greater than 200mm, for edge drains where any part of the shoulder consists of material other than concrete, and for use in Type B Drainage Mats.

D4.12 FILTER MATERIAL

1. The types of filter material covered by this Specification shall include:

(a) Type A filter material for use in subsoil, foundation, and sub-pavement (trench) drains and for Type B drainage mats.

(b) Type B filter material for use in subsoil, foundation and sub-pavement (trench) drains.

(c) Type C filter material comprising crushed rock for use in Type A drainage mats.

(d) Type D filter material comprising uncrushed river gravel for use in Type A drainage mats.

2. Material requirements and gradings for each type of filter material are included in the Construction Specification, SUBSURFACE DRAINAGE GENERAL.

3. The type of filter material specified to backfill the sub-surface drainage trenches (subsoil, foundation and sub-pavement drains) shall depend on the permeability of the pavement layers and/or subgrade and the expected flow rate. Generally, Type A filter material is used for the drainage of highly permeable subgrade or pavement layers such as crushed rock or coarse sands, while Type B filter material is used for the drainage of subgrade and pavement layers of lower permeability such as clays, silts or dense graded gravels. Further guidance to the selection of appropriate filter material is contained in ARRB Special Report 35.

D4.13 GEOTEXTILE

1. Where necessary to provide separation (ie. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material, geotextile shall be designated to encapsulate the filter material. The geotextile shall comply with the requirements included in the Construction Specification, SUBSRUFACE DRAINAGE GENERAL.

2. Geotextile shall also be designated for both Type A and Type B Drainage Mats.

DOCUMENTATION

D4.14 DESIGN DRAWINGS AND CALCULATIONS

1. The proposed location of all subsurface drains shall be clearly indicated on the Design Drawings, including the nominal depth and width of the trench, and the location with respect to the line of the kerb/gutter or edge of pavement. Where practicable, the location of outlets and cleanouts shall also be indicated on the Drawings.

2. Assumptions and/or calculations made in the determination of the need or otherwise for subsurface drainage in special circumstances or as a variation to the requirements of this specification shall be submitted to Council for approval with the Design Drawings.

SPECIAL REQUIREMENTS

D4.15 RESERVED

D4.16 RESERVED

D4.17 RESERVED

D4.18 RESERVED