CAPRICORN MUNICIPAL DEVELOPMENT GUIDELINES

SUBSURFACE DRAINAGE DESIGN

D4

DESIGN GUIDELINE

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Keeping the Capricorn Municipal Development Guidelines up to date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using the current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.

GENERAL

D04.01. SCOPE

D04.01.01. This section sets out the Guideline for the design of the subsurface drainage system for the road pavement and/or subgrade.

D04.01.02. 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.

D04.01.03. Reference guidelines for the application and design of subsurface drainage include AUSTROADS Research Report 368, AUSTROADS - Guide to and Pavement Technology Part 2: Pavement Structural Design & AUSTROADS - Guide to the Control of Moisture in Roads. The full titles of these guidelines are given below.

D04.01.04. The following order of priority for interpretation of documents will apply: (Please note that reference to a Guideline or Standard, is reference to the latest version of the relevant document, unless specifically a version number is specifically stated)

1. CMDG D4 Subsurface Drainage Design Specification
2. AUSTROADS
3. Queensland Urban Drainage Manual (QUDM)
4. AS 2439.1 Perforated drainage pipe and associated fittings.
5. AS/NZS 1477 PVC pipes and fittings for pressure applications.

Order of Priority

D04.02. OBJECTIVES

D04.02.01. 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

D04.03. TERMINOLOGY

D04.03.01. Subsoil drains are intended for the drainage of ground water or seepage from the subgrade and/or the subbase in cuttings.

Subsoil Drains

D04.03.02. 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

D04.03.03. Sub-pavement drains are intended for the drainage of the base and subbase pavement layers in flexible pavements. They may also function to drain seepage or groundwater from the subgrade.

Sub-pavement Drains

D04.03.04. 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

D04.03.05. 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

D04.04. REFERENCE AND SOURCE DOCUMENTS

(a) CMDG Specifications

C230 - Subsurface Drainage - General
C231 - Subsoil and Foundation Drains
C232 - Pavement Drains
C233 - Drainage Mats

(b) Australian Standards

AS 2439.1(2007) - Perforated drainage pipe and associated fittings.
AS/NZS 1477(2017) - PVC pipes and fittings for pressure applications.

(c) Other

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

- Guide to and Pavement Technology Part 2: Pavement Structural Design, 2019
- Guide to Road Design, Part 5A: Drainage - Road Surface, Network, Basins and Subsurface, 2023
- Guide to Pavement Technology, Part 10: Subsurface Drainage, 2009
- The Collection and Discharge of Stormwater from the Road Infrastructure, 2006

SUBSOIL AND SUB-PAVEMENT DRAINS

D04.05. WARRANTS FOR USE

D04.05.01. The design and installation of Subsoil or Sub-pavement drains beneath/adjacent road pavement is essential where geotechnical investigations have indicated groundwater or seepage is likely to be present.

Sources of moisture

D04.05.02. Moisture can enter a road subgrade and/or pavement from:

- Seepage from groundwater
- Movement of a water table under road
- Water infiltration
- Lateral movement of moisture from the road shoulder or table drain.
- Capillary moisture from the verges
- Capillary water from a water table

D04.05.03. Vapour movements from below the road pavement

D04.05.04. 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:

Geotechnical Survey

(a) All urban and rural residential developments.

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

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

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

(e) Highly moisture susceptible subgrades, i.e. commonly displaying high plasticity or low soaked CBRs.

Locations

(f) Use of moisture susceptible pavement materials.

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

(h) At cut to fill transitions.

(i) Landscaped islands and medians.

D04.05.05. 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.

D04.05.06. 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

D04.06. LAYOUT, ALIGNMENT AND GRADE

D04.06.01. Typical cross sections of subsoil and sub-pavement drains are shown below in Figure D04. 06.1 - Typical Subsoil Drain and Figure D04. 06.2 - Typical Sub-pavement Drain. 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

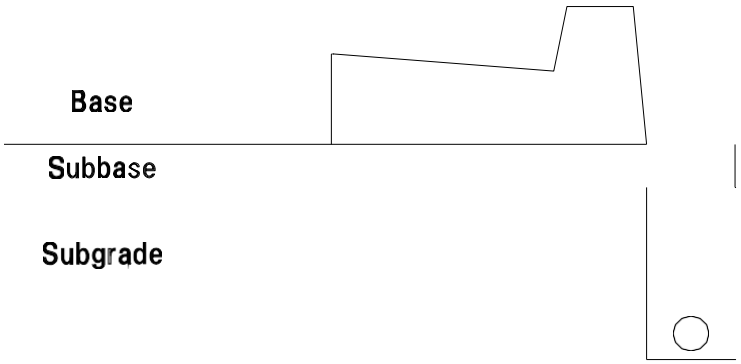

Figure D04. 06.1 - Typical Subsoil Drain

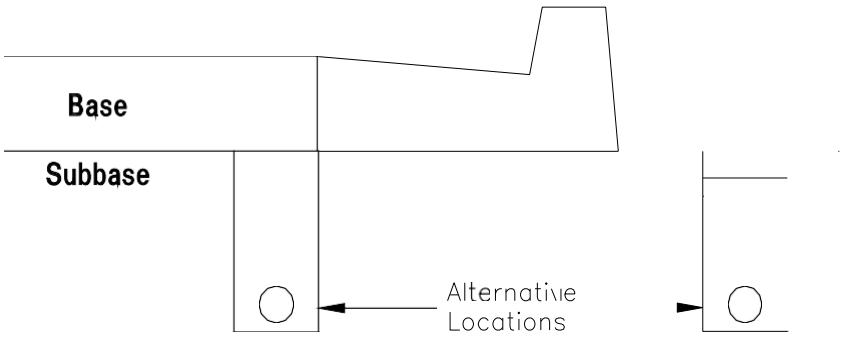

Figure D04. 06.2 - Typical Sub-pavement Drain

D04.06.02. In kerbed roads, the acceptable line of the trench is directly behind the kerb line. Pavement layers must extend to at least the line of the rear of the trench.

Kerbed Roads

D04.06.03. In un-kerbed roads, subsoil and sub-pavement drains shall be located within the shoulder, preferably at the edge of the pavement layers as shown in Figure D4.06.2 - Typical Sub-pavement Drain.

Un-kerbed Roads

D04.06.04. The minimum desirable longitudinal design grade shall be 1.0%. For non-corrugated pipes, an absolute minimum grade of 0.5% is acceptable.

Grade

D04.06.05. Trench widths shall be a minimum of 200mm (strip drain), with a minimum depth below finished subgrade level of 300mm in earth and 200mm in rock, and below the invert level of any service crossings.

Trench Dimensions

D04.06.06. 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

D04.06.07. 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

D04.07. WARRANTS FOR USE

Foundation Drains

D04.07.01. 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.

Geotechnical Survey During Construction

D04.07.02. 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.

D04.07.03. 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.

D04.08. LAYOUT, ALIGNMENT AND GRADE

Typical Cross Section

D04.08.01. Typical cross-sections of foundation drains are shown below in Figure D04. 08.1 - Foundation Drains

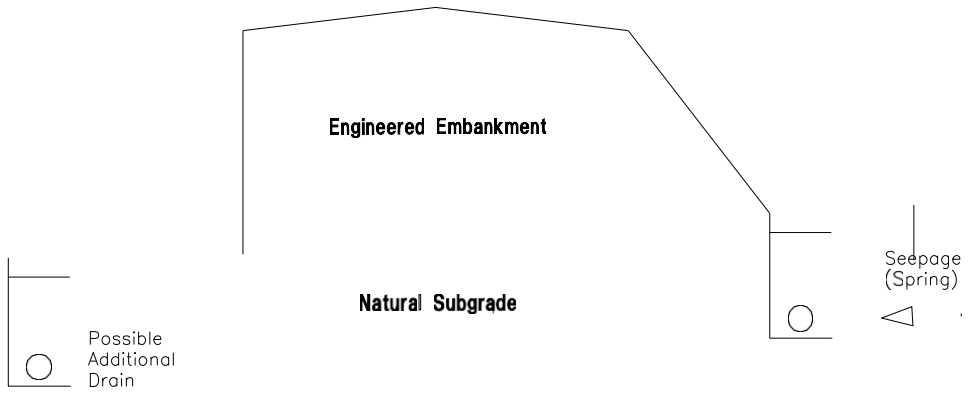

Figure D04. 08.1 - Foundation Drains

D04.08.02. The minimum design grade shall be 1.0%. For non-corrugated pipes an absolute minimum grade of 0.5% is acceptable.

Grade

D04.08.03. Foundation drains shall be a minimum trench width of 200mm (strip drain), with a variable trench depth to suit the application and ground conditions on site.

Trench Dimensions

D04.08.04. Outlets shall be spaced at maximum intervals of 150 metres.

Outlets

D04.08.05. 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.

Cleanouts

DRAINAGE MATS (BLANKETS)

D04.09. WARRANTS FOR USE

D04.09.01. 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

D04.09.02. Drainage Mats (Blankets) are used where a pavement is to be placed within or below the natural groundwater level and it is necessary to lower the water table.

D04.09.03. Type A drainage mats are constructed after the site has been cleared and grubbed and before commencement of embankment construction. The minimum thickness of compacted filter material shall be 300mm plus an allowance for the expected consolidation or 500mm if the amount of consolidation of embankment foundation is not known.

Type A Mats

D04.09.04. Type B drainage mats shall be constructed after completion of the subgrade construction and before construction of the pavement.

Type B Mats

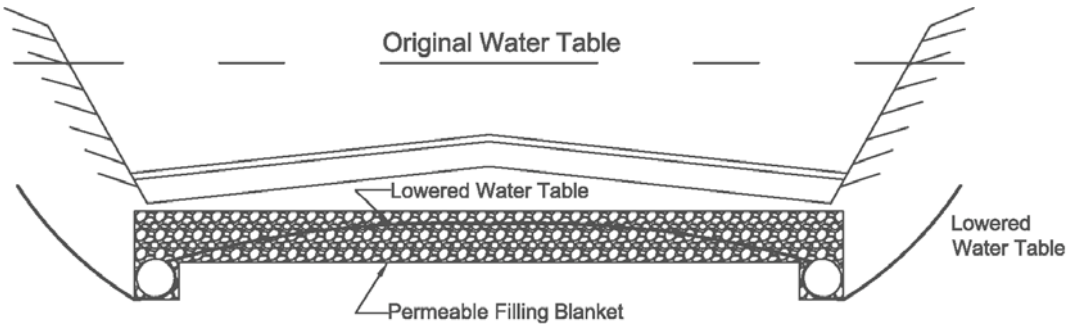

Figure D04.09.1 - Horizontal Filter blanket
(Source: ARRB SR 35, 1987)

MATERIALS

D04.10. SUBSOIL AND SUB-PAVEMENT DRAINPIPE

D04.10.01. Pipes designated for subsoil, foundation and sub-pavement drains shall be strip drains.

D04.11. FILTER MATERIAL

D04.11.01. 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.

D04.11.02. Material requirements and grading for each type of filter material are included in the Construction Specifications, SUBSURFACE DRAINAGE GENERAL C230 and SUBSOIL AND FOUNDATION DRAINS C231.

D04.11.03. 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 AUSTROADS: The Collection and Discharge of Stormwater from the Road Infrastructure.

D04.12. GEOTEXTILE

D04.12.01. Where necessary to provide separation (i.e., 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 Specifications, SUBSURFACE DRAINAGE GENERAL C230 and SUBSOIL AND FOUNDATION DRAINS C231.

D04.12.02. Geotextile shall also be designated for both Type A and Type B Drainage Mats.

DOCUMENTATION

D04.13. DESIGN DRAWINGS AND CALCULATIONS

D04.13.01. The proposed location of all subsurface drains shall be clearly indicated on the Design Drawings, including the nominal depth and width of the trench, location with respect to the line of the kerb/gutter or edge of pavement and the location of outlets and cleanouts.

D04.13.02. Design procedure of subsurface pavement drains shall be in accordance with AUSTROADS Guide to Pavement Technology, Part 10: Subsurface Drainage.